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Costela-Lăcrimioara Șerban
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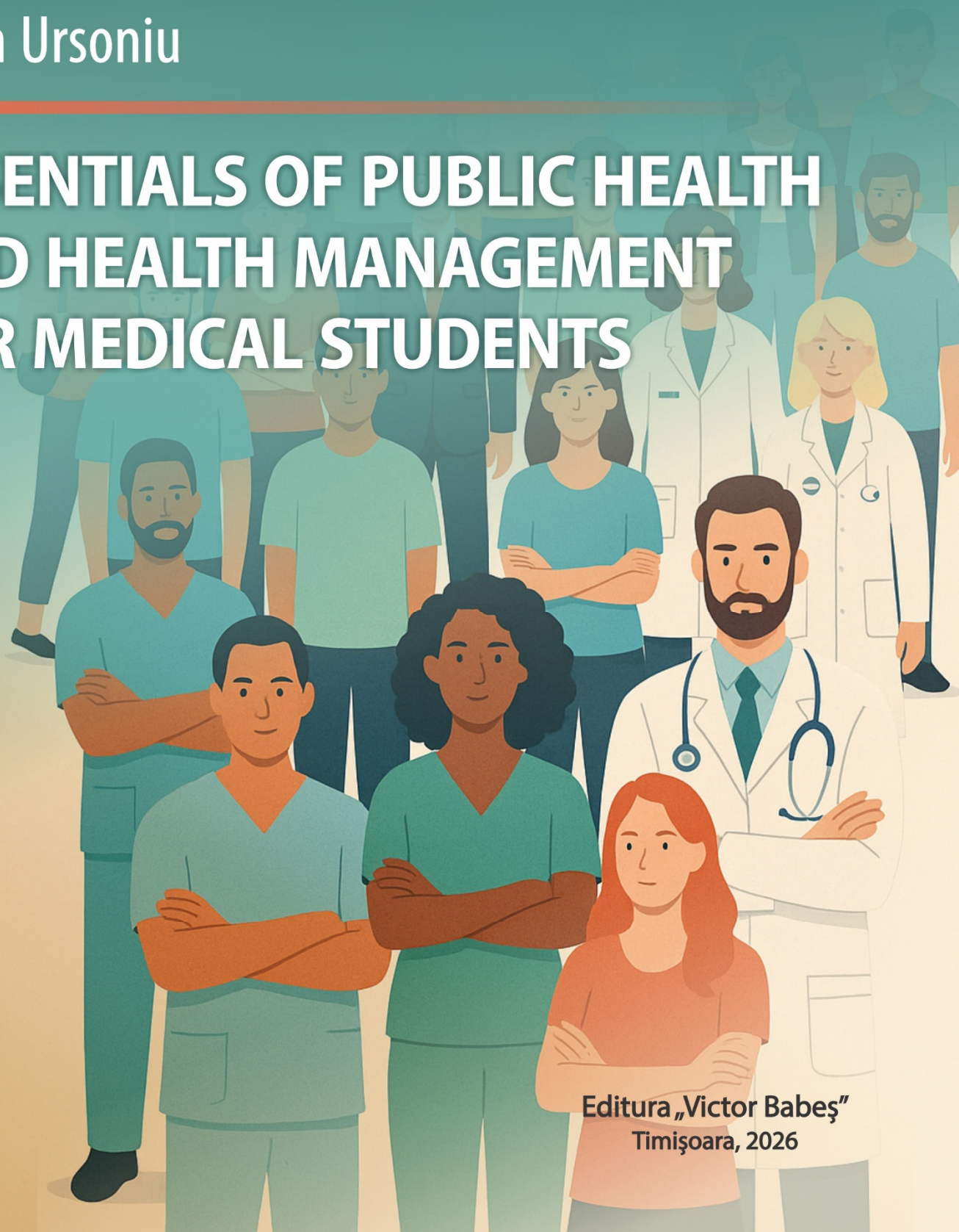
ESSENTIALS OF PUBLIC HEALTH AND HEALTH MANAGEMENT FOR MEDICAL STUDENTS



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Contents

1. Public Health: Foundations and Core Concepts

Learning Objectives

At the end of this chapter, students should be able to:

- **Define public health** and explain its scope and purpose within modern healthcare systems;
- **Distinguish public health from clinical medicine**, emphasising the population-based and preventive approach;
- **Describe key historical milestones** in the development of public health;
- **Explain the core functions of public health** and the essential public health services;
- **Apply a basic public health problem-solving framework** to population health issues;
- **Recognise the role of equity, prevention, and intersectoral collaboration** in improving population health.

1.1. Definition, Scope, and Purpose of Public Health

Public health is defined as *'the science and art of preventing disease, prolonging life, and promoting health through organised efforts of society."* This definition emphasises that health protection is not solely the responsibility of individuals or healthcare professionals, but a collective societal endeavour grounded in scientific evidence.

Unlike clinical medicine, which focusses primarily on diagnosing and treating disease in individual patients, public health operates at the **population level** and places a strong emphasis on prevention. Its central aim is to create conditions that reduce health risks and support health before disease occurs.

Public health therefore acts *upstream*, addressing the social, economic, environmental, and behavioural determinants of health. Through policies and interventions that improve living and working conditions, reduce harmful exposures, and promote equitable access to resources, public health seeks to maximise health outcomes at the population level. In modern healthcare systems, public health integrates epidemiology, policy development, and collective action to protect and improve health on a large scale.

1.2. What Distinguishes Public Health from Clinical Medicine

The fundamental distinction between public health and clinical disciplines lies in the **unit of concern**. While clinical medicine focusses on the individual patient, public health addresses whole communities and populations.

At its core, the ethical principle of **social justice**, which asserts that every individual has the right to achieve optimal health. From this perspective, health is understood not as a privilege, but as a fundamental human right supported by societal structures.

This ethical framework has direct practical implications. Public health systematically identifies and addresses **health inequalities**—avoidable and unjust differences in health outcomes between population groups. As a result, public health interventions often prioritise vulnerable and disadvantaged populations, with the aim of reducing disparities while improving general population health.

Public health is therefore both a **scientific discipline** and a **social commitment**, combining measurable health outcomes with equity as a guiding value.

1.3. Historical Evolution of Public Health

Public health has evolved in response to changing social conditions, scientific discoveries, and population needs. Its history reflects society's growing understanding of the relationship between health, environment, and social organisation.

1.3.1. Early Public Health Practices

Since antiquity, societies have recognised the link between environmental conditions and health. Ancient civilisations such as Egyptians, Greeks and Romans implemented early public health measures, including organised water supply systems, waste disposal infrastructure, and isolation of individuals during epidemics. Although empirical in nature, these practices demonstrate early population-based health thinking.

1.3.2. Public Health in the Middle Ages

The Middle Ages were marked by devastating epidemics, particularly the bubonic plague. These events led to the introduction of quarantine measures and early sanitary controls. However, public health actions remained largely reactive, focussing on crisis response rather than systematic prevention.

1.3.3. The Industrial Revolution and Modern Public Health

The Industrial Revolution brought rapid urbanisation, overcrowding, and poor working conditions, creating favourable conditions for communicable diseases such as tuberculosis and cholera. This period marked the emergence of public health as a distinct field.

Edwin Chadwick's 1842 report demonstrated the strong link between environmental conditions and population health and advocated for sanitation, clean water, and urban reform, fundamental elements of modern public health.

1.3.4. Scientific Foundations

Advances in microbiology, particularly the work of Louis Pasteur and Robert Koch, established the microbial causes of infectious diseases and laid the groundwork for vaccination and systematic disease control.

In parallel, Johann Peter Frank highlighted the social determinants of health, arguing for state responsibility in health regulation and integrated social interventions.

1.3.5. Public Health in the Twentieth Century

The twentieth century saw the global institutionalisation of public health, exemplified by the establishment of the World Health Organisation in 1948. Public health expanded beyond disease control to include health promotion, education, and social development.

In Romania, Iacob Felix contributed significantly to the development of social hygiene, highlighting the relationship between health, education, and economic conditions. After 1990, public health evolved into an independent academic and professional discipline that encompassed public health and health management.

1.4. The Core Functions of Public Health

Public health fulfils its mission through three interrelated core functions: **assessment, policy development, and assurance (Figure 1)**. Together, these functions provide a structured framework for understanding how public health systems identify health problems, design responses, and ensure effective implementation at the population level.

These functions are operationalised through the **Ten Essential Public Health Services**, which guide professional competencies and public health practice:

1. Monitoring population health;
2. Diagnosing and investigating health problems;
3. Informing, educating, and empowering the population;
4. Mobilising community partnerships;
5. Developing health-promoting policies;
6. Enforcing public health laws and regulations;
7. Ensuring access to essential health services;
8. Maintaining a competent public health workforce;
9. Evaluating health programmes and interventions;
10. Supporting research and innovation in public health.

Figure 1. Public health functions and services

1.4.1. Assessment

Assessment involves the **systematic collection, analysis, and interpretation of data** on the health status of populations. Its purpose is to identify health problems, detect trends, and recognise groups at increased risk.

Examples of assessment activities include:

- Monitoring the incidence and prevalence of diseases such as diabetes, cardiovascular disease, or infectious outbreaks;
- Analysing mortality rates and life expectancy across regions or socio-economic groups;
- Conducting health surveys to evaluate behaviours such as smoking, alcohol consumption, or physical activity.

Through assessment, public health professionals can identify priority health issues and provide an evidence base for decision-making. Without reliable data, effective public health action is not possible.

1.4.2. Policy Development

Policy development involves using scientific evidence to design strategies, programmes, and policies that address identified health problems and promote population health.

This function includes:

- Developing national or local health strategies, such as obesity prevention plans or vaccination programmes;
- Establishing regulations that protect health, for example, restrictions on smoking in public spaces or measures to reduce air pollution;
- Prioritising interventions based on cost-effectiveness and population impact.

Example: When assessment data reveal an increase in childhood obesity, policy development can involve introducing school-based nutrition programmes, the regulation of food marketing to children and promoting physical activity through urban planning.

Policy development transforms data into **coordinated action**, ensuring that public health responses are systematic rather than fragmented.

1.4.3. Assurance

Assurance ensures that **public health policies and services are effectively implemented**, accessible, and of adequate quality. It focusses on translating plans into real benefits for the population.

Key assurance activities include:

- Ensuring access to essential preventive and healthcare services, such as immunisation, screening programmes, and maternal care;
- Monitoring the quality and effectiveness of public health interventions;
- Maintaining a competent public health workforce through training and continuous professional development.

Example: A national vaccination policy fulfils its purpose only if vaccines are available, healthcare workers are trained, and coverage rates are monitored to ensure population protection.

Assurance closes the public health cycle by making sure that policies lead to tangible improvements in population health.

Integration of the Core Functions

In practice, the three core functions are **continuous and interconnected**. Assessment identifies problems, policy development proposes solutions, and assurance ensures implementation and evaluation. Together, they form the operational backbone of public health systems.

1.5. Main Areas of Public Health Activity

Public health action is commonly structured around three main areas: **health promotion, health protection, and health services**. Together, these areas address health determinants, prevent disease, and ensure access to essential care at the population level (Figure 2).

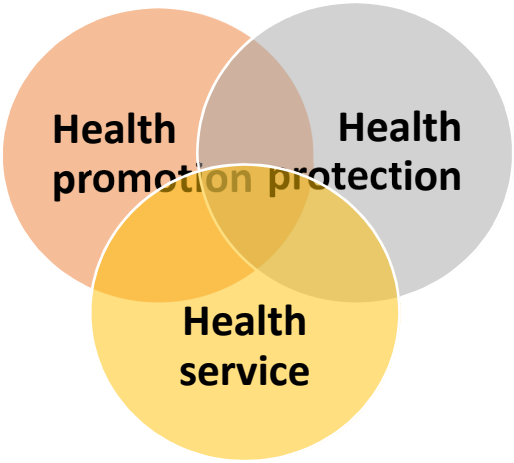

Figure 2. Public Health Activities

1.5.1. Health Promotion

Health promotion focusses on **enabling individuals and communities to increase control over their health** by addressing behavioural, social, and environmental determinants of health.

Key characteristics:

- Emphasis on education, empowerment, and supportive environments;
- Focus on long-term prevention rather than short-term treatment;
- Active participation of individuals and communities.

Examples of health promotion activities include:

- Anti-smoking and alcohol reduction campaigns;
- Promotion of physical activity and healthy nutrition;
- Sexual and reproductive health education programmes.

Health promotion aims not only to inform, but also to create conditions that make healthier choices easier and more accessible.

1.5.2. Health Protection

Health protection involves **preventing disease and injury by reducing exposure to health risks** through regulatory, environmental, and technological measures.

This area focusses on collective interventions that protect the entire population, including vulnerable groups.

Examples of health protection activities include the following:

- Vaccination programmes against infectious diseases;
- Control of food safety and water quality;
- Environmental health measures, such as air pollution monitoring;
- Prevention and control of epidemics.

Health protection functions as a 'shield' at the population level, reducing health threats before they result in illness.

1.5.3. Health Services

The health services component of public health ensures **equitable access to essential preventive and curative services**, particularly for populations at risk.

Public health-related services include:

- Maternal and child health services;
- Screening and early detection programmes (e.g., cancer screening);
- Community-based preventive care.

This area emphasises organisation, accessibility, quality, and continuity of care, ensuring that health systems respond effectively to population needs.

Integration of the Main Areas

In practice, these three areas are **complementary and interdependent**. For example, reducing cardiovascular disease requires health promotion (change in lifestyle), health protection (regulation of tobacco and food content), and accessible health services (screening and treatment).

Together, they form a comprehensive framework to improve population health and reduce health inequalities.

1.6. Partners in Public Health and Health in All Policies (HiAP) Approach

Effective public health action depends on **intersectoral collaboration**, as many of the most important determinants of health are outside the healthcare system. The **Health in All Policies (HiAP)** approach recognises that policies in non-health sectors—such as education, transport, housing, labour, and the environment—have a significant impact on population health and health equity. HiAP promotes systematic consideration of health implications in all public policies.

1.6.1. Government

The government plays a central role in HiAP by ensuring that **health considerations are integrated across all sectors of public policy**. This includes:

- Developing intersectoral strategies that incorporate health objectives beyond the health ministry;
- Assessing the health impact of policies in areas such as urban planning, transport, and employment;
- Creating legislative and regulatory frameworks that support population health and reduce inequalities.

Under HiAP, the government acts not only as a provider of health services, but also as a coordinator of policies that shape the social and environmental conditions for health.

1.6.2. Communities

Communities are essential partners in the HiAP framework because **policies are most effective when they reflect local realities and population needs**. Community participation contributes to:

- Identifying health priorities and vulnerable groups;
- Ensuring that interventions are culturally acceptable and equitable;
- Supporting policy implementation through civic engagement and shared responsibility.

HiAP emphasises the empowerment of the community as a mechanism for achieving sustainable and equitable health outcomes.

1.6.3. Employers and the Economic Sector

Employers influence health through **work conditions, income security, and workplace policies**. Within HiAP, the economic sector is encouraged to:

- Promote safe and healthy work environments;
- Implement workplace health promotion programmes;
- Support work–life balance policies that contribute to physical and mental well-being.

Economic policies that prioritise decent work and employee health directly contribute to improved population health.

1.6.4. Mass Media and Communication Actors

The mass media plays a critical role in HiAP by **shaping public discourse and influencing health-related behaviours**. Their responsibilities include:

- Disseminating accurate, evidence-based health information;
- Supporting public health campaigns across sectors;
- Reducing the spread of misinformation that undermines public trust;
- Effective communication is essential to translate policy into informed public action.

Intersectoral Responsibility for Health

The HiAP approach highlights that **health is a shared responsibility across all sectors of society**. By fostering collaboration between government, communities, employers, the media, and other stakeholders, public health policies can achieve greater coherence, reduce health inequalities, and produce lasting improvements in population health.

2. Health Status and the Determinants of Health

Learning Objectives

By the end of this chapter, students should be able to:

- **Define health status** using internationally accepted frameworks (WHO) and explain its multidimensional nature;
- **Describe the main categories of health determinants**, including biological, behavioral, social, economic, environmental, and commercial determinants;
- **Explain the life-course approach to health**, highlighting how early-life, adult, and ageing-related exposures influence health outcomes;
- **Analyze health inequalities and disparities**, with reference to social gradients, vulnerable populations, and intergenerational effects;
- **Discuss the role of environmental and urban determinants**, including housing, transport, pollution, and the built environment, in shaping population health;
- **Identify the influence of commercial actors on health**, including the food, tobacco, alcohol, pharmaceutical, and digital industries;
- **Apply conceptual models of health determinants** (e.g. Dahlgren–Whitehead model) to real-world public health problems;
- **Recognize the implications of health determinants for public health policy and prevention strategies**, including Health in All Policies (HiAP).

2.1. Health Status at Population Level

An essential premise of public health is that **health cannot be understood solely at the individual level**. Although clinical medicine focusses primarily on the diagnosis and treatment of disease in individual patients, public health is concerned with the **health status of populations**, seeking to understand patterns, distributions, and determinants of health outcomes within and between groups.

The health status at the population level reflects the **aggregate result of biological characteristics, living conditions, behaviours, social structures, and environmental exposures**, rather than isolated medical events. For this reason, public health adopts a broader analytical framework, integrating medical knowledge with epidemiology, sociology, economics, and environmental sciences.

2.1.1. Definition of Health Beyond the Absence of Disease

The World Health Organisation (WHO) defines health as *"a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."* Although this definition has been widely adopted, it is important to interpret it **critically and pragmatically** within public health practice.

Rather than describing an ideal or absolute state, modern public health uses this definition to emphasise the following:

- health is **multidimensional**;
- health is influenced by **contextual and social factors**;
- improving health requires more than medical care alone.

At the population level, health is therefore understood as a **dynamic condition**, shaped by social organisation and public policies, and measurable through indicators such as life expectancy, morbidity, disability, and self-perceived health.

2.1.2. Dimensions of Health

Health status encompasses several interrelated dimensions, each contributing to overall well-being.

- **Physical health.** Refers to the proper functioning of physiological systems and the absence or control of disease. At the population level, physical health is reflected in indicators such as the prevalence of chronic diseases, mortality rates, and physical functioning.
- **Mental health.** Encompasses emotional well-being, cognitive functioning, and the ability to cope with stress and daily demands. Mental health disorders represent a growing public health challenge, contributing significantly to disability and a reduced quality of life.
- **Social health.** Refers to the capacity to form and maintain meaningful social relationships and to participate in community life. Social cohesion, social support, and inclusion are strong predictors of population health outcomes.
- **Emotional health.** Relates to emotional regulation, resilience, and interpersonal competence. Emotional health influences coping strategies, adherence to medical recommendations, and health-related behaviours.
- **Spiritual health.** Involves meaning, purpose, and personal values. Although culturally variable, spiritual health can influence health behaviours, stress management, and overall well-being, particularly in contexts of chronic disease and end-of-life.

In public health, these dimensions are not considered separately, but as **interconnected components** that collectively shape health outcomes.

2.1.3. Health Status versus Healthcare

A critical distinction in public health is the difference between **health status** and **healthcare services**. Although access to medical care is important, it explains only a limited proportion of health outcomes in the population.

Research consistently shows that:

- improvements in medical care account for a relatively small share of gains in life expectancy;
- social, economic, behavioural, and environmental factors exert a much greater influence on health status.

For example, two populations with similar healthcare systems can show markedly different health outcomes due to differences in income distribution, education levels, housing conditions, or environmental exposures.

This distinction has major implications for public health policy, emphasising the need to act **upstream**, before disease develops, rather than focussing exclusively on treatment.

2.1.4. Measuring Health Status in Populations (for details see Chapter 5)

Population health status is assessed using a combination of quantitative and qualitative indicators, including:

- mortality and life expectancy;
- disease prevalence and incidence;
- disability-adjusted life years (DALYs);
- self-rated measures of health and quality of life.

These indicators allow public health professionals to:

- identify priority health problems;
- monitor trends over time;
- compare health outcomes across population groups;
- assess the impact of policies and interventions.

Therefore, understanding health status is the **starting point** for identifying determinants of health and designing effective public health strategies.

2.2. Conceptual Models of the Determinants of Health

Understanding why populations are healthy or unhealthy requires more than listing risk factors. Public health therefore relies on **conceptual models of health determinants**, which organise the complex interactions between biological, behavioural, social, economic and environmental influences on health. These models provide a structured framework for analysis, policy development, and intervention design.

Rather than attributing disease to individual choices alone, determinant models emphasise that **health outcomes are socially produced**, shaped by conditions in which people are born, grow, live, work, and age.

2.2.1. The Socio-ecological Perspective

At the core of public health thinking lies the **socio-ecological model**, which conceptualises health as the result of interactions between individuals and multiple layers of influence.

This perspective highlights that:

- individual behaviour is shaped by social and environmental contexts;
- interventions targeting only individuals are often insufficient;
- sustainable health improvements require action at multiple levels.

The socio-ecological model typically includes the following levels:

- individual (biological characteristics, knowledge, attitudes);
- interpersonal (family, peers, social support);
- community (schools, workplaces, neighbourhoods);
- societal and policy level (laws, economic systems, cultural norms).

From a public health perspective, this model reinforces the principle that **health is a shared societal responsibility**, not only an individual one.

2.2.2. The Dahlgren–Whitehead "Rainbow" Model

One of the most influential frameworks in public health is the **Dahlgren–Whitehead model**, often referred to as the "rainbow model" of health determinants (Figure 3).

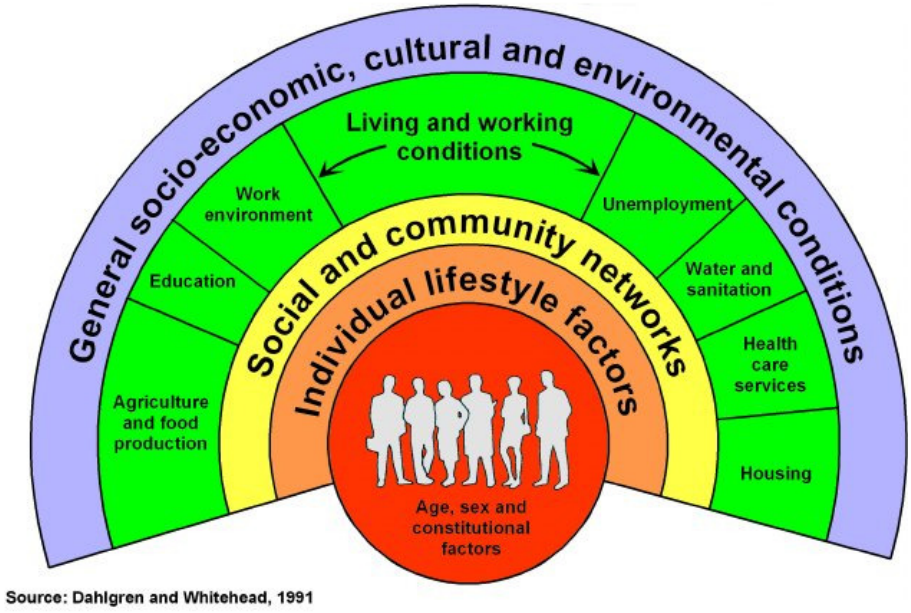

Figure 3. The Dahlgren–Whitehead "Rainbow" Model

This model organises the determinants into concentric layers:

Individual characteristics: age, gender, and genetic factors, which are largely non-modifiable;

Individual lifestyle factors: behaviours such as diet, physical activity, smoking, alcohol consumption, and sleep;

Social and community networks: family support, social cohesion, community participation, and social capital;

Living and working conditions: employment, education, housing, access to healthcare, working environment, and food availability;

General socioeconomic, cultural, and environmental conditions: economic policies, income distribution, education systems, environmental protection, and cultural norms.

A key strength of this model is its **visual clarity** and emphasis on **upstream determinants**. It clearly illustrates that individual behaviours are embedded within broader social and economic structures.

2.2.3. From Risk Factors to Determinants

Traditional biomedical approaches focus primarily on **risk factors**, such as hypertension, hypercholesterolemia, or smoking. Although these are important, public health extends the analysis asking **why these risk factors are distributed unevenly between populations**.

For example:

- smoking rates are higher in socioeconomically disadvantaged groups;
- obesity prevalence varies by education and income level;
- occupational exposures differ by sector of employment.

Determinant models shift attention from individual blame to **structural causes**, including education, income inequality, and access to healthy environments.

This change is essential to address **health inequalities** and design interventions that are effective and equitable.

2.2.4. Life-course Approach to Health Determinants

Public health increasingly adopts a **life-course perspective**, which recognises that health outcomes are shaped by exposures and experiences accumulated over time.

The key principles of this approach include:

- early life conditions have long-term health effects;
- disadvantages tend to accumulate over the lifespan;
- there are critical periods during which exposures have particularly strong impacts.

For example:

- poor maternal nutrition may increase the risk of chronic disease in adulthood;
- childhood adversity is associated with higher rates of mental health disorders and cardiovascular disease later in life;
- educational attainment influences employment opportunities, income, and health behaviours throughout life.

The life-course approach strengthens the rationale for early interventions and preventive policies.

2.2.5. Health in All Policies (HiAP)

An increasingly important framework in public health is **Health in All Policies (HiAP)**. This approach recognises that health outcomes are influenced by policies developed **outside the health sector**, including transport, education, housing, agriculture, and environmental protection.

HiAP promotes:

- systematic consideration of health impacts in all public policies;
- intersectoral collaboration between governmental and nongovernmental actors;
- prevention of unintended negative health consequences of non-health policies.

Examples include:

- urban planning that promotes walkability and reduces air pollution;
- education policies that reduce school dropout rates and improve long-term health outcomes;
- labour policies that improve working conditions and occupational safety.

HiAP aligns strongly with modern public health governance and accreditation standards that emphasise systems thinking and population-based prevention.

2.2.6. Why Conceptual Models Matter in Practice

Conceptual models of health determinants are not purely theoretical. They are essential tools for:

- identifying priority areas for intervention;
- designing multi-sector public health policies;
- reducing health inequities;
- evaluating the impact of public policies on health outcomes.

For medical professionals, understanding these models enhances the ability to:

- interpret population health data;
- communicate effectively with policymakers and communities;
- integrate clinical practice with public health principles.

Health determinants operate at multiple, interconnected levels. Conceptual models such as the socio-ecological framework, the Dahlgren–Whitehead model, the life-course approach, and Health in All Policies provide essential tools for understanding, preventing, and reducing population health problems and inequalities.

2.3. Categories of Health Determinants

Health status is shaped by a complex interaction of multiple categories of determinants. For analytical and practical purposes, these determinants are commonly grouped into **biological, behavioural, social, economic, environmental, and health system determinants**. Although presented separately, they interact continuously and should be understood as part of an integrated system that influences population health.

2.3.1. Biological Determinants

Biological determinants refer to **inherent individual characteristics** that influence susceptibility to disease and response to environmental exposures.

These include:

- age;
- gender;
- genetic and epigenetic factors;
- physiological characteristics.

Key aspects:

- Age is a strong predictor of disease risk, with different patterns of morbidity and mortality throughout life;
- Sex-related biological differences influence the prevalence, clinical presentation, and outcomes of the disease;
- Genetic predisposition contributes to the risk of many diseases, including cancer, cardiovascular disease, and inherited disorders.

Public health relevance

Although biological determinants are largely non-modifiable, they:

- interact with behavioural and environmental exposures;
- guide risk stratification and targeted prevention;
- Inform early detection strategies.

Modern public health increasingly recognises the role of **epigenetics**, demonstrating how social and environmental factors can influence gene expression across generations.

2.3.2. Behavioural Determinants

Behavioural determinants include **individual actions and lifestyle patterns** that directly influence health outcomes. Although often framed as personal choices, these behaviours are strongly shaped by social, economic, and environmental contexts.

Key behavioural determinants include the following:

- dietary habits;
- physical activity;
- tobacco use;
- alcohol and substance use;
- sleep patterns;
- stress management and coping strategies.

Examples:

- Unhealthy diets and physical inactivity contribute to obesity, cardiovascular disease, diabetes, and certain cancers;
- Tobacco use remains one of the leading preventable causes of morbidity and mortality worldwide;
- Chronic stress and sleep deprivation are associated with mental health disorders, metabolic dysregulation, and cardiovascular disease.

Public health perspective

Effective public health action goes beyond individual counselling and includes:

- health promotion campaigns;
- regulatory policies (e.g., tobacco taxation, food labelling);
- creation of supportive environments that enable healthy choices.

This reinforces the principle that **behavioural change is most sustainable when supported by structural interventions**.

2.3.3. Social Determinants of Health

Social determinants refer to the **conditions under which people are born, grow, live, work, and age**, and are among the strongest predictors of health outcomes at the population level.

Core social determinants include the following:

- education;
- employment and working conditions;
- income and social protection;
- social inclusion and exclusion;
- family and community support.

Evidence and Impact

- Higher educational attainment is consistently associated with better health outcomes and a longer life expectancy.
- Unemployment and job insecurity are associated with poorer mental and physical health.
- Social isolation increases the risk of morbidity and premature mortality.

Health inequalities

Social determinants explain much of the observed **health gradient**, where health improves with each step up the socioeconomic ladder. These inequalities are the following:

- systematic;
- avoidable;
- socially produced.

Addressing social determinants is, therefore, central to reducing health inequities and improving population health.

2.3.4. Economic Determinants

Economic determinants influence health directly and indirectly through material conditions and access to resources.

Key economic determinants include the following:

- income level and income distribution;
- poverty and material deprivation;
- economic stability and employment opportunities.

Examples:

- Low income limits access to nutritious food, safe housing, and healthcare;
- Income inequality within societies is associated with worse health outcomes, even in high-income countries;
- Economic crises are often followed by increases in mental health disorders and reduced access to care.

Public health implications

Economic policies such as minimum wage laws, social protection programmes, and taxation systems have measurable effects on population health, underscoring the importance of **intersectoral policy action**.

2.3.5. Environmental Determinants

Environmental determinants encompass **physical, chemical and built environments** that affect health.

These include the following:

- air and water quality;
- housing conditions;
- occupational exposures;
- climate change;
- urban design and transportation systems.

Examples:

- Air pollution contributes to respiratory and cardiovascular diseases;
- Inappropriate housing increases the risk of infectious diseases and mental health problems;
- Climate change affects health through heatwaves, extreme weather events, food insecurity, and vector-borne diseases.

Public health perspective

Environmental determinants highlight the need for:

- preventive regulation;
- environmental protection policies;
- sustainable development strategies.

They also illustrate the close relationship between **public health and planetary health**.

2.3.6. Health System Determinants

Health systems themselves are critical determinants of population health.

Key elements include:

- accessibility of healthcare services;
- quality and safety of care;
- affordability and financial protection;
- availability of preventive services.

Examples:

- Universal access to primary care is associated with better population health outcomes;
- Inequitable access to healthcare reinforces existing social inequalities;
- Strong preventive services reduce the burden of avoidable diseases.

Public health role

Public health professionals contribute to:

- health system planning and evaluation;
- monitoring equity in access to care;
- strengthening preventive and community-based services.

2.3.7. Interaction between Determinants

A defining feature of modern public health is the recognition that **health determinants do not act in isolation**.

For example:

- low income can limit access to healthy food and safe environments for physical activity;
- occupational conditions influence stress levels and health behaviours;
- environmental exposures disproportionately affect socially disadvantaged groups.

Understanding these interactions is essential to design effective and equitable interventions.

Health outcomes are shaped by multiple, interacting categories of determinants. Although biological factors influence susceptibility, determinants of the social, economic, behavioural, environmental, and health system play a dominant role in shaping population and health inequalities. Addressing these determinants requires comprehensive multi-sector public health action.

2.4. Health Inequalities and Equity

Health outcomes are not randomly distributed within populations. There are systematic differences in health status, life expectancy, and disease burden between social groups. These differences are known as **health inequalities** and represent a central concern of modern public health.

Understanding health inequalities is essential for medical professionals, as they reflect **avoidable and unjust differences** that arise from the unequal distribution of health determinants.

2.4.1. Defining Health Inequalities

Health inequalities refer to **measurable differences in health status or in the distribution of health resources between population groups**, defined by characteristics such as:

- socioeconomic status;
- education level;
- occupation;
- gender;
- ethnicity;
- geographic location.

Not all health differences are inequalities. Public health distinguishes between:

- **health differences** (eg, age-related disease patterns), which may be unavoidable;
- **health inequalities**, which are systematic, socially produced, and potentially preventable.

2.4.2. The Social Gradient in Health

A fundamental concept in public health is the **social gradient in health**.

Rather than affecting only the most disadvantaged groups, health outcomes improve **at each step up the socioeconomic ladder**. This gradient is observed in:

- morbidity and mortality;
- life expectancy;
- prevalence of chronic diseases;
- self-rated health.

Key Implication

Health inequalities are not limited to extreme poverty. They reflect **structural conditions** that affect the entire population, which makes population-wide strategies essential.

2.4.3. Equity versus Equality in Health

A crucial distinction in public health is between **equality** and **equity**. **Equality** refers to providing the same resources or services to everyone. **Equity** involves allocating resources according to need, with the aim of achieving comparable health outcomes.

For example:

- equal access to healthcare does not guarantee equitable outcomes if social barriers prevent certain groups from benefiting equally;
- equitable interventions may require targeted support for vulnerable populations.

Equity-orientated public health strategies recognise that different populations require **different levels and types of support** to achieve similar health outcomes.

2.4.4. Vulnerable and Marginalised Populations

Certain population groups experience a disproportionate burden of ill health due to cumulative disadvantage.

These groups may include the following:

- people with low socioeconomic status;
- unemployed or precariously employed populations;
- migrants and ethnic minorities;
- people with disabilities;
- rural or underserved communities.

Vulnerability arises not from individual characteristics alone, but from **structural and contextual factors** such as discrimination, limited access to services, and social exclusion.

2.4.5. Pathways Linking Determinants to Health Inequalities

Health inequalities emerge through multiple interacting pathways:

- **material pathways**, involving living and working conditions;
- **psychosocial pathways**, including chronic stress and lack of control;
- **behavioural pathways**, shaped by constrained choices rather than individual preference;
- **healthcare access pathways**, which affect prevention, diagnosis, and treatment.

These pathways operate cumulatively throughout the life course, reinforcing the disadvantage over time.

2.4.6. Measuring Health Inequalities

Public health relies on population-level data to identify and monitor health inequalities.

Common indicators include:

- life expectancy and healthy life expectancy;
- infant and maternal mortality rates;
- prevalence of chronic diseases;
- access to preventive and curative services.

Stratifying health data by socioeconomic variables allows public health professionals to move beyond averages and identify **hidden disparities**.

2.4.7. Reducing Health Inequalities Public Health Strategies

Effective strategies to reduce health inequalities operate at multiple levels and include the following:

- improving early childhood development and education;
- reducing poverty and income inequality;
- creating healthy working and living environments;
- ensuring equitable access to high-quality healthcare;
- implementing Health in All Policies (HiAP).

Importantly, interventions that focus solely on individual behaviour are insufficient and can even **widen inequalities** if they disproportionately benefit more advantaged groups.

2.4.8. Implications for Medical Practice

For future physicians, addressing health inequalities involves the following:

- recognising social determinants in clinical encounters;
- adapting communication and care to patients' social contexts;
- advocating for vulnerable populations;
- collaborating with public health and community services.

This perspective aligns clinical medicine with population health goals and strengthens the physician's role as caregiver and advocate.

Health inequalities are systematic, avoidable, and unjust differences in health outcomes driven by the unequal distribution of health determinants. Promoting health equity requires coordinated action across sectors, informed by robust data and grounded in social justice principles.

2.5. A Life-Course Approach to Health

The **lifecourse approach** emphasises that health is shaped by exposures and experiences throughout an individual's life, from preconception to old age. It recognises that early life events can have lasting effects on later health outcomes, while interventions at any stage can influence the health trajectory.

2.5.1. Early Life Determinants

Prenatal and perinatal factors: maternal nutrition, exposure to toxins, infections during pregnancy.

Childhood experiences: breastfeeding, vaccination, early education, and nurturing environments.

Example: Children who experience malnutrition or recurrent infections are at increased risk of chronic diseases such as obesity, diabetes, and cardiovascular disease in adulthood.

2.5.2. Adulthood Determinants

Behavioural factors: diet, physical activity, smoking, alcohol consumption.

Social factors: occupation, income, stress, and social support networks.

Environmental factors: housing quality, urban pollution, access to healthcare.

Example: Adults who maintain regular physical activity, balanced diets, and avoid smoking show a reduced incidence of type 2 diabetes and cardiovascular disease.

2.5.3. Ageing and Older Adults

Vulnerability increases due to cumulative exposure to risk factors, chronic diseases, and frailty.

Preventive measures such as vaccination, screening, and social participation improve quality of life.

Example: Regular balance exercises reduce risk in older adults, while social programmes reduce isolation and improve mental health.

2.5.4. Intergenerational Effects

Health is influenced not only by individual life experiences, but also by those of previous generations. Factors such as parental education, socioeconomic status, and environmental exposures can affect children's health and perpetuate health inequalities between generations.

Beyond social transmission, growing evidence from epigenetic research suggests that biological mechanisms may partially mediate these intergenerational effects. Epigenetics refers to heritable changes in gene expression that occur without alterations in the DNA sequence itself. Mechanisms such as DNA methylation, histone modification, and non-coding RNA regulation can influence the activation or silencing of genes in response to environmental conditions.

Adverse exposures experienced by parents, particularly during sensitive periods, such as preconception, pregnancy, and early development, can induce epigenetic modifications that shape the physiology of their offspring. For example, maternal malnutrition or obesity during pregnancy has been associated with epigenetic alterations in genes involved in metabolic regulation, which could increase the child's risk of obesity and type 2 diabetes. In addition, chronic psychosocial stress can influence the epigenetic regulation of stress response pathways (e.g., glucocorticoid receptor signaling), affecting emotional regulation and vulnerability to mental health disorders.

Some studies suggest that certain epigenetic marks may persist into subsequent generations, although the extent and stability of true transgenerational epigenetic inheritance in humans remain under investigation. However, even intergenerational effects limited to pregnancy-mediated biological programming have profound public health implications.

Example: Children from low-income families may have limited access to healthy food and healthcare, increasing the risk of obesity or asthma. These social disadvantages can interact with biological embedding mechanisms, including epigenetic modifications, increasing the risk of obesity, asthma, cardiovascular disease, and mental health disorders. Without structural interventions, these risks can persist into the next generation.

Key Insight: The life-course perspective integrates social determinants of health with biological embedding processes. It supports preventive public health strategies that target critical windows: preconception, pregnancy, early childhood, and adolescence to interrupt cycles of disadvantage and promote long-term population health equity.

2.6. Commercial Determinants of Health

Health outcomes are not only shaped by biology, behaviour, and social factors, but also by **commercial interests**. Industries often influence health directly or indirectly through marketing, lobbying, and product design.

2.6.1. Key Industries

- **Food and beverage industry**: Production and marketing of ultra-processed foods high in sugar, salt, and unhealthy fats contribute to obesity, diabetes, and cardiovascular disease.
- **Tobacco industry**: Aggressive marketing and lobbying hinder tobacco control policies; smoking remains one of the leading preventable causes of death worldwide.
- **Alcohol industry**: Promotes consumption through advertising and sponsorship; excessive alcohol use is linked to liver disease, accidents, and mental health disorders.
- **Pharmaceutical industry**: Influences prescribing practices and policy, sometimes prioritising profit over public health.
- **Digital and technology sectors**: Social media and online platforms affect health behaviours, including physical inactivity, dietary choices, and mental health.

2.6.2. Mechanisms of Influence

- **Marketing**: Direct advertising, sponsorships, product placement.
- **Lobbying and political influence**: Delaying or weakening public health regulations.
- **Conflict of interest**: Funding research or policy initiatives that favour commercial goals over health.

2.6.3. Examples of Public Health Responses:

- Sugar taxes and regulation of advertising unhealthy foods to children;
- Smoke-free public spaces, plain packaging, and tobacco taxation;
- Restrictions on alcohol sales and promotion;
- Policies that promote transparency and regulation in pharmaceutical marketing.

Key Insight: Commercial determinants demonstrate that health is shaped by structural and policy environments, not just individual choice. Public health strategies must address these influences to reduce preventable diseases.

2.7. Implications for Public Health Policy and Medical Education

Understanding health status and its determinants has profound implications for both **public health policy** and **medical education**. Because health is shaped largely outside the healthcare system, effective improvement of population health requires coordinated action across sectors and informed medical professionals capable of operating within complex health systems.

2.7.1. Implications for Public Health Policy

Public health policy must address the **root causes of ill health**, not only its clinical manifestations. This requires shifting the focus from downstream interventions (treatment) to **upstream strategies** that influence social, economic, and environmental determinants.

Key policy implications include the following:

- prioritising prevention over cure;
- investing in early life interventions with long-term health benefits;

- reducing the social and economic inequalities that drive health disparities;
- integrating health considerations into non-health sectors such as education, transport, housing, and urban planning.

This approach is formalised in the **Health in All Policies (HiAP)** framework, which recognises that decisions taken outside the health sector often have greater health impacts than healthcare itself.

Health in All Policies (HiAP)

HiAP promotes:

- intersectoral collaboration;
- shared accountability for health outcomes;
- systematic assessment of the health impacts of public policies.

For example, transport policies influence physical activity and air pollution, while education policies affect health literacy and lifelong opportunities.

2.7.2. From Population Data to Policy Action

Health indicators and inequality measurements are not merely descriptive tools. They serve to:

- identify priority health problems;
- guide resource allocation;
- evaluate the effectiveness of interventions;
- ensure accountability and transparency in decision-making.

Evidence-based public health policy is based on the **translation of epidemiological data into actionable strategies**, balancing scientific evidence with ethical considerations and feasibility.

2.7.3. The Physician's Role in Addressing Determinants of Health

Although physicians cannot directly modify all determinants of health, they play a critical role in:

- identifying vulnerable patients and populations;
- mitigating the health effects of social disadvantage;
- advocating for equitable policies and services;
- supporting preventive strategies at the individual and community levels.

This perspective reinforces the idea that **clinical excellence and public health responsibility are not opposing goals, but complementary ones**.

Improving population health requires policies that address social determinants and reduce health inequalities, supported by a medical workforce trained to think beyond individual disease. Integrating public health principles into medical education is essential to achieve sustainable and equitable health outcomes.

3. Prevention

Learning Objectives

By the end of this chapter, students should be able to:

- **Define prevention**
- **Describe the levels of prevention** (primordial, primary, secondary, tertiary) and their role in public health;
- **Provide examples of preventive interventions** at individual and population level;
- **Understand prevention as a continuum** across the life course and healthcare system;
- **Recognize the role of prevention in reducing disease burden and health inequalities.**

Prevention is a cornerstone of public health and is integral to health promotion. Its central goal is to reduce the incidence, prevalence, and burden of the disease by intervening at various stages of the disease continuum. Prevention operates at multiple levels, addressing both individual and population health determinants, including biological, behavioural, social, and environmental factors.

Although prevention and health promotion overlap conceptually, prevention focusses on concrete interventions to reduce risk and disease progression, while health promotion is broader, encompassing the enhancement of overall well-being, empowerment, and health literacy.

3.1. Levels of Prevention

3.1.1. Primordial Prevention

Primordial prevention targets the upstream determinants of health, in order to prevent the development of risk factors themselves. Unlike primary prevention, which addresses established risk factors, primordial prevention addresses the social, environmental, and policy contexts that generate these risk factors (Figure 4).

Key Domains:

- **Policy interventions:** Examples include the taxation of tobacco and sugary beverages, urban planning policies that promote physical activity, and legislation on occupational safety;
- **Socioeconomic factors:** Improving education, housing, and social equity reduces exposure to health risks associated with low socioeconomic status;
- **Environmental interventions:** Reducing pollution, ensuring access to clean water and sanitation, and promoting safe urban infrastructure to prevent injury and the risk of chronic disease.

Primordial prevention is aligned with the framework of “social determinants of health” and the socio-ecological model, emphasising that health outcomes are strongly influenced by factors

outside individual control. Evidence shows that interventions targeting social determinants (for example, community-based health promotion, policy-level interventions) can reduce disease incidence and improve population health equity.

Example in practice: Countries that implement comprehensive anti-smoking policies (e.g., high taxation, advertising restrictions, public smoking bans) have demonstrated reductions in smoking prevalence and associated chronic diseases over decades.

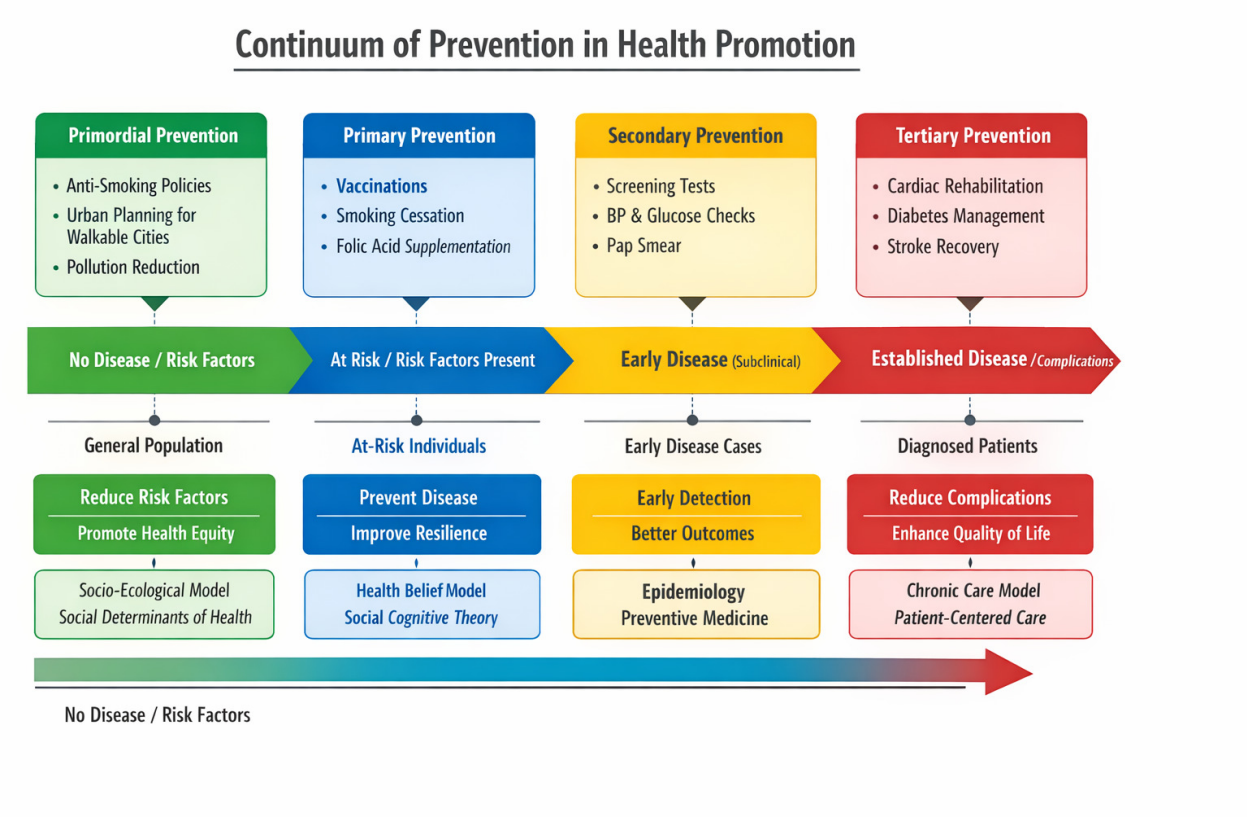

Figure 4. Continuum of prevention

3.1.2. Primary Prevention

Primary prevention focusses on healthy people at risk of developing disease. Interventions aim to reduce exposure to known risk factors and improve protective factors (Figure 4).

Key Interventions:

- **Vaccination programmes:** Vaccines against HPV, influenza, hepatitis B, and measles provide direct protection and benefits to herd immunity;
- **Behavioural interventions:** Smoking cessation programmes, physical activity, and nutritional education reduce modifiable risk factors;
- **Prophylactic pharmacological measures:** For example, statins for people at high risk of cardiovascular disease or folic acid supplementation in pregnancy to prevent neural tube defects.

Evidence: Studies show that primary prevention significantly reduces the incidence of cardiovascular disease, cancer, and infectious diseases. For example, HPV vaccination programmes have led to a measurable decrease in cervical precancerous lesions in countries with high coverage rates.

Theoretical basis: Primary prevention reflects the biomedical model integrated with health behaviour theories, such as the Health Belief Model and Social Cognitive Theory, which explain how knowledge, attitudes, and social influences shape preventive behaviours.

3.1.3. Secondary Prevention

Secondary prevention focusses on early detection and intervention to stop progression and reduce complications. Screening and early diagnostic tests are the primary strategies (Figure 4).

Key Approaches:

- **Screening programmes:** Mammography, colonoscopy, Pap smears, blood pressure monitoring, and diabetes screening;
- **Risk stratification:** Identifying high-risk individuals for targeted preventive measures;
- **Early treatment:** Initiating therapy at the first signs of the disease to prevent severe outcomes.

Evidence: Early detection of hypertension or type 2 diabetes through regular screening can significantly reduce the incidence of myocardial infarctions, strokes, and renal failure. Similarly, colorectal cancer screening reduces both incidence and mortality.

Theoretical integration: Secondary prevention combines the principles of epidemiology, biostatistics, and clinical medicine principles. It also involves a cost-effectiveness analysis to ensure that screening programmes provide the greatest health benefits relative to expenditure.

3.1.4. Tertiary Prevention

Tertiary prevention is targeted at people with established disease to reduce morbidity, mortality, and disability. It includes rehabilitation, chronic disease management, and palliative care (Figure 4).

Key Components:

- **Medical management:** Optimal pharmacotherapy, surgical interventions, and chronic disease care plans;
- **Rehabilitation:** Physical, occupational, and speech therapy for patients with stroke or injury;
- **Lifestyle modification support:** Exercise programmes, nutritional counselling, and mental health interventions to enhance functional recovery.

Evidence: Cardiac rehabilitation after myocardial infarction reduces recurrent cardiovascular events by up to 25%, and structured diabetes management programmes prevent complications such as neuropathy and retinopathy.

Academic perspective: Tertiary prevention reflects the chronic care model, focussing on patient-centred care, multidisciplinary teamwork, and continuity of care. It intersects with health systems research, focussing on optimising resource allocation for improved patient outcomes.

3.2. Integrative Perspective: The Continuum of Prevention

Prevention is most effective when implemented as a continuum, integrating primordial, primary, secondary, and tertiary strategies. For example, prevention of cardiovascular disease involves:

- **Primordial strategy:** Policy-driven reduction in sodium intake in processed foods;
- **Primary strategy:** Promotion of exercise and diet modification in healthy individuals;
- **Secondary strategy:** Early detection of hypertension and hyperlipidaemia by screening;
- **Tertiary strategy:** Cardiac rehabilitation and disease management for patients after myocardial infarction.

This integrative approach ensures that health interventions are comprehensive, cost-effective and equity-focused, addressing both individual and population health needs.

3.2.1. Evidence-Based Considerations and Policy Implications

Cost-effectiveness: Preventive interventions, especially at the primordial and primary levels, are highly cost-effective. For example, vaccination programmes and tobacco taxation generate high returns on investment by reducing future healthcare costs.

Health equity: Prevention strategies must consider social determinants of health to reduce disparities. Populations with lower socioeconomic status often face barriers to accessing preventive services, which require tailored interventions.

Impact at the population level: Large-scale preventive programmes, such as mandatory folic acid fortification or national immunisation campaigns, have shown measurable improvements in population health outcomes.

Behavioural and environmental synergy: Combining individual behavioural interventions with structural and environmental changes maximises the effectiveness of prevention.

Prevention is a multilayered, evidence-based approach essential for health promotion. By addressing risks at different stages—from societal determinants to individual disease management—it reduces disease incidence, morbidity, and mortality, while improving quality of life. Academic frameworks such as the socio-ecological model, the chronic care model, and health behaviour theories provide the conceptual foundation for designing, implementing, and evaluating preventive strategies.

The effective integration of prevention throughout life, healthcare settings, and communities is a central strategy to achieve sustainable health improvements, reduce healthcare costs, and promote health equity.

4. Screening: Concept, Types, and Evaluation of Tests

Learning Objectives

By the end of this section, students should be able to:

- **Define screening** and distinguish it from diagnostic testing.
- **Identify the main types of screening** used in public health practice.
- **Explain the epidemiological principles** underlying screening, including sensitivity, specificity, predictive values, and disease prevalence.
- **Explain the principles of effective screening**, including the Wilson and Jungner criteria.
- **Describe the benefits and harms of screening**, including over-diagnosis and screening-related biases.
- **Apply ethical principles** and shared decision-making in screening contexts.
- **Understand screening from a population health perspective**, including equity and health system implications.
- **Respect informed consent and the right not to participate** in screening programs.
- **Critically appraise screening recommendations** and avoid non-evidence-based or low-value screening.

4.1. Concepts

4.1.1. Definition of Screening

Screening is a public health strategy that involves the **systematic application of tests or examinations to asymptomatic individuals** to identify those who are at sufficient risk of a specific disease to benefit from further diagnostic evaluation or early intervention.

Unlike clinical diagnosis, which is initiated by symptoms or patient complaints, screening is **proactive and population-oriented**. It targets people who perceive themselves as healthy, with the aim of detecting disease in its **preclinical or early stage**, when treatment is more effective and results are improved.

From a public health perspective, screening is not merely a clinical act, but a **structured population-based intervention**, implemented according to predefined protocols, eligibility criteria, quality standards, and evaluation mechanisms.

4.1.2. Purpose of Screening Programmes

The overarching purpose of screening programmes is to **reduce the burden of disease at the population level**, measured through reductions in the following:

- Disease-specific mortality;
- Disease-related morbidity;
- Complications and disability;
- Healthcare costs associated with advanced disease.

These goals are not achieved by identifying all cases but by **shifting the distribution of disease severity** toward earlier, more treatable stages.

4.1.3. Key Objectives of Screening

Screening programmes serve several interrelated objectives:

a) Early Detection

Screening aims to identify the disease **before clinical symptoms appear**, during a latent or asymptomatic phase. Early detection allows timely intervention, often resulting in:

- Less invasive treatment;
- Better prognosis;
- Improved quality of life.

Example: Detection of cervical dysplasia by Pap smear screening prevents progression to invasive cervical cancer.

b) Reduction of Mortality

Well-designed screening programmes have the potential to **reduce cause-specific mortality**, particularly for diseases with a long preclinical phase and effective treatment options.

Example: Mammography screening has been shown to reduce breast cancer mortality in specific age groups when implemented appropriately.

c) Reduction of Morbidity and Complications

Even when the reduction in mortality is modest, screening can significantly reduce disease-related complications by allowing earlier disease control.

Example: Early detection of diabetes reduces the risk of microvascular and macrovascular complications.

d) Improvement of Health System Efficiency

By preventing late-stage disease, screening contributes to:

- Reduced hospitalisations;
- Lower costs for complex treatments;
- Better allocation of healthcare resources.

From a systems perspective, screening represents a **preventive investment** rather than a curative expense.

4.1.4. Screening as a Population Health Intervention

It is essential to emphasise that screening is:

- **Population-based**, not opportunistic;
- **Evidence-driven**, supported by epidemiological data;
- **Integrated in health systems**, not isolated clinical actions.

A screening programme is justified only when it demonstrates a **favourable balance between benefits and harms**, including false positives, over diagnosis, psychological impact, and resource use.

Thus, screening reflects the intersection of:

- Epidemiology (prevalence of disease and natural history);
- Clinical medicine (diagnostic accuracy and effectiveness of treatment);
- Ethics (informed consent, equity, non-maleficence);
- Health policy (cost-effectiveness and impact on the population).

4.1.5. Conceptual Positioning within Prevention

Screening occupies a **central role in secondary prevention**, acting as a bridge between:

- Primary prevention (risk reduction);
- Clinical care (diagnosis and treatment).

However, modern public health increasingly frames screening within an **equity-based approach**, ensuring that access, participation, and outcomes are not determined by socioeconomic status, gender, or geographic location.

4.2. Types of Screening

There are several types of screening programmes, differentiated according to the characteristics of the target population, the level of risk, and the specific public health objectives.

4.2.1. Mass Screening (Population-Based)

Population-based screening refers to the **systematic invitation of all individuals within a defined population group** (usually defined by age and sex) to undergo a screening test, regardless of individual risk factors.

Key Characteristics:

- Centrally organised and publicly coordinated;
- Clearly defined eligibility criteria;
- Standardised screening intervals and protocols;
- Continuous quality assurance and evaluation;
- Active call–recall systems.

Public Health Rationale This model aims to achieve **high coverage and equity**, ensuring that access to early detection does not depend on socioeconomic status, health literacy, or healthcare-seeking behaviour.

Examples:

- Cervical cancer screening programmes (Pap smear / HPV test);
- Breast cancer screening using mammography;
- Colorectal cancer screening (FOBT, FIT, colonoscopy).

Strengths:

- Reduces health inequalities;
- Enables monitoring of population-level outcomes;
- Strong evidence base when properly implemented.

Limitations:

- High organisational and financial demands;
- Risk of overdiagnosis if eligibility criteria are not evidence-based;
- Requires robust health system infrastructure.

Population-based screening is considered the **gold standard** in public health and is strongly emphasised in international accreditation frameworks.

4.2.2. Opportunistic Screening (Case-Finding)

Opportunistic screening occurs when screening is offered **during a healthcare encounter initiated for another reason**, rather than through a systematic population invitation.

Key Characteristics:

- Individual-level initiative (clinician- or patient-driven);
- No centralised registry or recall system;
- Highly dependent on healthcare access and use patterns.

Examples:

- Blood pressure measurement during routine visits;
- Random glucose testing in primary care;
- Assessment of smoking status during consultations.

Strengths:

- Low organisational cost;
- Flexible and easy to implement;
- Useful in resource-limited settings.

Limitations:

- Inconsistent coverage;
- Higher risk of inequity;
- Limited population-level impact.

Clinical perspective: Opportunistic screening plays a complementary role, but **cannot substitute** organised population screening programmes.

4.2.3. Targeted (High-Risk) Screening

Targeted screening focusses on individuals or subgroups identified as having a **higher than average risk** of developing a specific disease.

Risk Stratification Criteria:

- Family history;
- Genetic predisposition;
- Occupational exposure;
- Behavioural risk factors;
- Previous medical conditions.

Examples:

- Pathogenic variant carriers of BRCA undergoing intensified breast cancer surveillance;
- Lung cancer screening with low-dose CT in heavy smokers;
- Hepatitis screening in high-risk populations.

Strengths:

- Higher yield per screened individual;
- Improved cost-effectiveness;
- Reduced risk of over diagnosis compared to population-wide screening.

Limitations:

- Requires accurate risk identification;
- Risk of stigmatisation;
- May miss cases outside predefined risk groups.

Modern relevance: Targeted screening reflects the shift toward **precision public health**.

4.3. Validity Indicators for Screening Tests

For a screening programme to be effective, the tests used must be valid and reliable, which means that they must accurately distinguish between people who truly have the disease and those who do not. The main indicators of test validity are sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). These parameters are fundamental to epidemiological evaluation and programme design.

Table 1. Classification of Cases Based on the Results of a Screening Test and the Diagnostic Gold Standard

Test Result	**Diagnostic Positive**	**Diagnostic Negative**	**Total**
Test Positive	True Positives (test positive, diagnosis positive)	False Positives (test positive, diagnosis negative)	Total Test Positive
Test Negative	False Negatives (test negative, diagnosis positive)	True Negatives (test negative, diagnosis negative)	Total Test Negative
Total	Total Diagnostic Positive	Total Diagnostic Negative	

This table, commonly known as a **2×2 contingency table** or **diagnostic classification matrix**, is the foundational framework used in epidemiology and clinical research to evaluate the performance of screening and diagnostic tests. It compares the result of the **screening test** with the **reference (gold standard),** which is assumed to identify the true status of the disease.

The four principal outcome categories are as follows:

- **True positives (TP):** Individuals who truly have the disease and are correctly identified as positive by the screening test. These cases represent the primary intended benefit of screening, as they allow for early detection and timely intervention.
- **False Positives (FP):** Individuals who do not have the disease but receive a positive screening result. These results can lead to anxiety, unnecessary confirmation tests, increased healthcare costs, and potential overtreatment.
- **False Negatives (FN):** Individuals who have the disease but are incorrectly classified as negative by the screening test. This category is clinically significant, as it can delay diagnosis and treatment, increase the risk of complications, and reduce therapeutic effectiveness.
- **True Negatives (TN):** Individuals who do not have the disease and are correctly classified as negative. These cases reflect the appropriate reassurance and avoidance of unnecessary interventions.

4.3.1. Sensitivity (Se) and Specificity (Sp)

- **Sensitivity** represents the proportion of people who truly have the disease and are correctly identified by the test as positive (true positives). High sensitivity minimises false-negative results and is particularly important in conditions where missing a case would have serious health consequences (Table 1).

$$\text{Se} = \frac{True\ positive\ \ (TP)}{All\ with\ positive\ diagnosis\ (TP+FN)}$$

Example: if a cervical cancer screening test has a sensitivity of 95%, it correctly detects 95% of women who actually have pre-cancerous or cancerous lesions.

- **Specificity** represents the proportion of healthy individuals that are correctly identified by the test as negative (true negatives). High specificity minimises false-positive results and reduces unnecessary follow-up investigations and patient anxiety (Table 1).

$$\text{Sp} = \frac{True\ negative\ \ (TN)}{All\ with\ negative\ diagnosis\ (AN+FP)}$$

Example: a test with 90% specificity correctly classifies 90% of healthy individuals as disease-free, while 10% may receive a false-positive result.

4.3.2. Positive Predictive Value (PPV) and Negative Predictive Value (NPV)

- **PPV (Positive Predictive Value)** represents the probability that an individual truly has the disease if the test result is positive. PPV depends on the prevalence of the disease in the respective population (Table 1).

$$\text{PPV} = \frac{True\ positive\ \ (TP)}{All\ with\ positive\ test\ (TP+FP)}$$

Example: If we test a population in which 1% of people have a disease, the PPV will be low because many of those with a positive test result will, in fact, be healthy.

- **NPV (Negative Predictive Value)** represents the probability that an individual is healthy if the test result is negative. NPV also depends on the prevalence of the disease (Table 1).

$$\text{NPV} = \frac{True\ negative\ \ (TN)}{All\ with\ negative\ test\ (TP\ +FN)}$$

Example: in a population where the prevalence of a disease is low, the NPV will be high, meaning that negative test results are generally reliable.

4.3.3. Relationship between Prevalence, PPV, and NPV

The prevalence of a disease directly influences the PPV and NPV, which, in turn, affects the accuracy of the screening tests in different populations. In populations with low disease prevalence, even a test with high sensitivity and specificity will have a low PPV, resulting in a relatively large number of false-positive results. In such settings, many individuals may receive an incorrect positive result, which can lead to unnecessary anxiety and additional costly investigations.

Example of PPV and NPV calculation

Consider a test with **90% sensitivity** and **95% specificity** applied in a population of **1,000 individuals**, where the prevalence of the disease is **1%**.

Diseased individuals: Among the 10 people with the disease (1% of 1,000), the test correctly identifies 9 (90% sensitivity), while 1 person receives a false-negative result.

Healthy individuals: Among the remaining 990 healthy people, the test correctly classifies 941 as healthy (95% specificity), but produces 49 false positives.

Therefore, among the 58 individuals with a positive test result (9 true positives and 49 false positives), only 9 are truly diseased, leading to a **low PPV** despite good intrinsic test performance.

4.3.4. Accuracy

The accuracy of a screening test reflects its overall ability to produce correct results and is determined by both sensitivity and specificity. Global accuracy is defined as the proportion of all correct results (true positives and true negatives) out of the total number of tests performed. However, accuracy alone is not always a reliable indicator of test performance, particularly in populations where the prevalence of disease is low (see Table 1).

Accuracy = $\frac{TP+TN}{Total\ investigated\ patients}$

4.3.5. Likelihood Ratios (LR)

The **Likelihood Ratio (LR)** combines sensitivity and specificity to indicate how strongly a test result changes the probability that an individual has a disease. There are two main types: the **positive likelihood ratio (LR^+)** and the **negative likelihood ratio (LR^-)**.

4.5.5.1. Positive Likelihood Ratio (LR^+)

LR^+ represents the ratio between:

- the probability of obtaining a positive result in a person with the disease, and
- the probability of obtaining a positive result in a healthy person.

In other words, LR^+ indicates how much a positive test result increases the probability of the disease.

Formula:

$$\mathbf{LR^+ = \frac{Se}{1-Sp}}$$

Interpretation:

- **LR^+ > 10:** strong evidence supporting the presence of disease
- **LR^+ = 5–10:** moderate diagnostic value
- **LR^+ < 2:** limited value to confirm the disease

Example: For a test with 90% sensitivity and 95% specificity:

$LR^+ = 0.90 / (1 - 0.95) = 0.90 / 0.05 =$ **18**

This means that a positive result greatly increases the probability of disease.

4.5.5.2. Negative Likelihood Ratio (LR^-)

LR^- indicates how much a negative test result reduces the probability of disease. It compares:

- the probability that a diseased person receives a negative result, with
- the probability that a healthy person receives a negative result.

Formula:

$$\mathbf{LR^- = \frac{1-Se}{Sp}}$$

Interpretation:

- **LR^- < 0.1:** excellent for ruling out disease
- **LR^- = 0.1–0.5:** moderate ability to exclude the disease
- **LR^- > 1:** poor value to rule out disease

Example: With 90% sensitivity and 95% specificity:

$LR^- = (1 - 0.90) / 0.95 = 0.10 / 0.95 \approx$ **0.105**

Therefore, a negative result significantly reduces the probability of disease.

4.3.6. The Importance of Balancing Validity Indicators

An ideal screening test would have both very high sensitivity and specificity, producing reliable PPV and NPV regardless of the prevalence of the disease. However, in practice, there is always a trade-off between these measures. For serious or life-threatening diseases, higher sensitivity is usually prioritised to minimise false negatives. In contrast, for less critical conditions, higher specificity may be preferred to reduce the number of false positives.

Validity indicators, sensitivity, specificity, PPV, and NPV, are essential to evaluate the performance of the screening test. The relationship between PPV/NPV and prevalence highlights the importance of selecting an appropriate target population: higher prevalence of the disease improves the predictive value and reduces the likelihood of misleading results. Although accuracy remains a useful measure, it does not always provide a complete picture; balancing all indicators is crucial to ensure effective and beneficial screening.

4.3.7. What If a Screening Test Is Based on a Range of Values?

When a test measures a continuous variable (e.g., blood glucose for diabetes or PSA levels for prostate cancer), establishing a **decision threshold (cut-off value)** is essential. The chosen cut-off determines whether a result is classified as positive or negative, and therefore influences both sensitivity and specificity. Adjusting the cut-off inevitably involves a trade-off between these measures.

The Receiver Operating Characteristic (ROC) curves are used to evaluate the performance of the diagnostic test and visually illustrate the trade-off between sensitivity and specificity at different cut-off points (Figure 5).

The ROC curve is constructed by plotting the following:

- **Sensitivity (true-positive rate)** on the vertical axis, and
- **False-positive rate (1 – specificity)** on the horizontal axis.

Each point on the curve corresponds to a specific threshold:

- A **lower cut-off** increases the sensitivity, but decreases the specificity (more false positives).
- A **higher cut-off** increases specificity but reduces sensitivity (more false negatives).

Key interpretation principles:

The closer the ROC curve lies to the **upper-left corner**, the better the test performance.

The **Area Under the Curve (AUC)** reflects the overall test accuracy:

- **AUC > 0.9:** excellent test
- **0.7 < AUC ≤ 0.9:** good to moderate performance
- **0.5 < AUC ≤ 0.7:** poor diagnostic performance

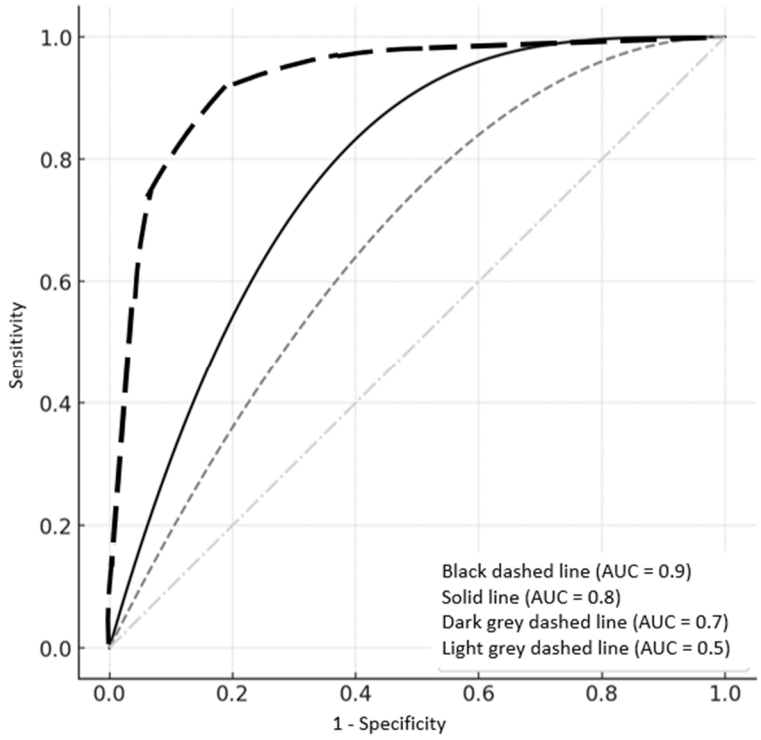

Figure 5. ROC curves corresponding to classification models with varying performance levels.

The **Area Under the Curve (AUC)** reflects the discriminatory ability of a model: higher AUC values indicate superior diagnostic performance and a greater capacity to distinguish correctly between diseased and non-diseased individuals.

The **Youden Index** is a metric derived from sensitivity and specificity that supports the identification of the **optimal decision threshold** on the ROC curve. This represents the cut-off value that simultaneously maximises both sensitivity and specificity, thus achieving the most balanced and efficient test performance in clinical or screening contexts.

• Youden Index formula:

Youden Index = Sensitivity + Specificity − 1

• Role in threshold selection:

For each potential cut-off value, the Youden Index is calculated, and the threshold associated with the **highest index value** is selected. This value represents the point that best separates diseased from healthy individuals and maximises the overall effectiveness of the test.

• Example:

For a test with 90% sensitivity and 95% specificity, the Youden Index is: Youden Index = 0.90 + 0.95 − 1 = **0.85**

Using the ROC Curve (Figure 5) together with the Youden Index

The typical process for selecting an optimal cut-off using both tools involves the following steps:

- **Construct the ROC curve:** Sensitivity and specificity are calculated for a range of cut-off values, and these pairs are plotted to form the ROC curve.
- **Compute the Youden Index for each cut-off:** The index is applied to every point on the ROC curve, generating a numerical value for each threshold.
- **Identify the cut-off point that maximises the Youden Index:** The optimal threshold is the one with the **highest index value**, corresponding to the point on the ROC curve closest to the upper-left corner (high sensitivity and high specificity).
- **Adjust decisions based on clinical context:** Depending on the severity of the disease and the screening objectives, the threshold may be shifted:
    - toward **higher sensitivity** (lower cut-off) when missing cases would have serious consequences, or
    - toward **higher specificity** (higher cut-off) when avoiding false positives is clinically or economically important.

Examples and Applications of ROC Analysis:

- ***Screening for high-mortality diseases:*** In conditions such as lung cancer, a lower cut-off point may be preferred to maximise sensitivity, accepting more false positives to minimise missed cases.
- ***Screening for rare diseases:*** For low-prevalence conditions, such as rare genetic disorders, a higher cut-off point may be selected to limit false positives and avoid unnecessary diagnostic procedures, even at the cost of somewhat lower sensitivity.

Advantages and Limitations of the ROC Curve:

- **Advantages:** The ROC curve provides a clear visual assessment of the ability of a test to discriminate between disease and non-disease in all possible cut-off values. It supports the evidence-based selection of a decision threshold and facilitates the comparison between competing diagnostic tests or models.
- **Limitations:** Although ROC analysis incorporates sensitivity and specificity, it does **not account for disease prevalence** and therefore does not directly reflect **Positive Predictive Value (PPV)** or **Negative Predictive Value (NPV)**, which are essential for real-world clinical decision making. Furthermore, the AUC may underestimate the relevance of a test in scenarios where **high sensitivity is clinically prioritised**, even at the expense of lower specificity.

ROC curves and the Youden Index are complementary tools that play a central role in the interpretation and optimisation of diagnostic and screening tests. The ROC curve offers a comprehensive visual representation of test performance across thresholds, while the Youden Index identifies the cut-off that provides the most balanced trade-off between sensitivity and specificity. Together, they support rigorous and context-sensitive clinical decision-making.

4.4. Screening Strategies: Sequential and Simultaneous Testing

4.4.1. Sequential Testing

Sequential testing involves administering an initial screening test, followed by a second test that is applied only to individuals with a positive first result. This strategy generally **increases specificity** by reducing the number of false positives, although it may do so at the expense of **lower sensitivity**, since some true cases may be missed after the first testing stage. Sequential approaches are particularly useful when confirmatory tests are more accurate, costlier, or more invasive, and therefore should be reserved for a smaller subset of individuals.

• **Example:** Hypertension screening may begin with an initial blood pressure measurement, followed by ambulatory or repeated blood pressure monitoring over time to confirm the diagnosis and reduce the likelihood of misclassification due to transient elevations.

4.4.2. Simultaneous (Parallel) Testing

Simultaneous testing, or parallel testing, consists of performing **two or more tests at the same time** to maximise disease detection. This strategy typically **increases sensitivity** and reduces the probability of missing true cases; however, it also tends to **increase the number of false positives**, which can result in additional follow-up procedures and a higher use of resources. Parallel testing is often applied in settings where early detection is critical or where the consequence of a missed case would be severe.

• **Example:** The concurrent use of serological and imaging tests to detect an infectious or systemic disease can improve the likelihood of identifying affected individuals at an earlier stage, particularly when no single test is sufficiently accurate on its own.

Screening represents a cornerstone of public health practice, contributing to disease prevention and improved quality of life at both the individual and population levels. The effectiveness of a screening programme depends on selecting an appropriate target population, using tests with appropriate sensitivity and specificity, and carefully considering ethical, economic, and organisational implications. A solid understanding of these concepts is essential to responsibly implement screening and ensure that its benefits to patients and communities outweigh potential harms.

4.5. Screening Programmes

4.5.1. Key Stages in the Implementation of a Screening Programme:

- **Initial assessment and characterisation of the target population.** Before implementation, it is essential to analyse the prevalence and risk distribution of the disease between age groups, sexes, and relevant risk factors to allocate resources efficiently and ensure that the screening is directed toward the populations most likely to benefit.
- **Pilot testing of the programme.** Before national or large-scale deployment, pilot studies on a smaller population sample can be used to assess feasibility, participation and

acceptability, operational logistics, costs, and preliminary health outcomes. These pilots provide evidence to refine protocols and improving programme design.

- **Ongoing evaluation and programme improvement.** Continuous monitoring is required to assess long-term effectiveness, including participation and coverage rates, stage of diagnosis, survival and health outcomes, cost-effectiveness, and broader system-level impact. Iterative evaluation supports adaptation over time and helps to ensure that the screening remains clinically justified, equitable, and sustainable.

4.5.2. The Wilson–Jungner Criteria for Screening Programmes

In 1968, Wilson and Jungner published the landmark WHO report *Principles and Practice of Screening for Disease*, which established a set of criteria to guide decisions about whether a screening programme should be implemented. Although formulated more than five decades ago, these principles **remain the foundation of modern screening policy**, with adaptations reflecting advances in medicine, ethics, and health systems.

Screening is **not inherently beneficial**; it is justified only when specific conditions are met to ensure that benefits outweigh harms at the population level.

The Classic Wilson and Jungner Criteria

1. **Condition should be a major health problem**

The disease should represent a **significant burden** in terms of morbidity, mortality, disability, or societal impact.

Examples:

- Cervical, breast, and colorectal cancers;
- Cardiovascular disease risk factors (e.g., hypertension).

This criterion ensures that screening resources are directed toward conditions with a significant public health impact.

2. **There should be accepted treatment for patients with recognised disease**

Screening is justified only if **early detection leads to better outcomes** than treatment initiated after clinical presentation.

Screening without effective treatment is ethically unacceptable.

Example:

Screening for hypertension is justified because early treatment reduces the risk of stroke and myocardial infarction.

3. **Facilities for diagnosis and treatment should be available**

The health system must be able to do:

- Confirmatory diagnosis;
- Timely treatment;
- Follow-up and long-term care.

A screening programme is ineffective if positive cases cannot access appropriate care.

4. There should be a recognisable latent or early symptomatic stage

The disease must have a **detectable preclinical phase** during which the intervention alters its natural history.

Examples:

- Cervical intraepithelial neoplasia;
- Asymptomatic hypertension.

Diseases with sudden onset and no latent phase are generally **not suitable** for screening.

5. There should be a suitable screening test

The test should be as follows:

- Valid (sensitive and specific);
- Safe;
- Acceptable to the population;
- Simple and affordable.

High sensitivity reduces false negatives; adequate specificity limits false positives and unnecessary interventions.

6. The test should be acceptable to the population

Participation is critical for the impact on the population.

Factors influencing acceptability:

- Invasiveness;
- Cultural beliefs;
- Convenience;
- Perceived benefits and risks.

Low acceptability undermines effectiveness, even if the test is technically excellent.

7. The natural history of the condition should be adequately understood

Understanding disease progression allows identification of:

- The optimal timing for screening;
- The stage in which the intervention is most effective;
- This criterion protects against **overdiagnosis** and overtreatment.

8. There should be an agreed policy on whom to treat as patients

Clear protocols must define the following:

- What constitutes a positive screen?
- Diagnostic thresholds;
- Treatment pathways.

This ensures consistency, transparency, and equity.

9. The cost of case-finding should be economically balanced

Screening costs must be justified in relation to:

- Healthcare budgets;
- Competing health priorities;
- Long-term savings from disease prevention;
- Cost-effectiveness analysis is now central to screening decisions.

10. Case-finding should be a continuous process, not a "once and for all" project

Screening must be:

- Ongoing;
- Periodically evaluated;
- Adapted on the basis of new evidence.

This criterion highlights screening as a **system-level intervention**, not a single test.

4.5.3. Benefits and Harms of Screening

Screening programmes aim to detect disease in its preclinical phase, when intervention can improve outcomes. However, screening also carries **potential harms**, and a balanced understanding is essential for evidence-based medical practice.

Benefits of Screening

- **Reduction in disease-specific mortality**

The primary benefit of screening is the **reduction of mortality** through early diagnosis and timely treatment.

Examples:

  - Cervical cancer screening reduces mortality by detecting precancerous lesions;
  - Screening for colorectal cancer reduces both incidence and mortality.

Importantly, screening primarily affects **disease-specific mortality**, not always overall mortality.

- **Reduction of disease-related morbidity**
  - Early detection often allows for:
    - Less aggressive treatment;
    - Fewer complications;
    - Improved functional outcomes.

Example:
Early detection of diabetes prevents microvascular and macrovascular complications.

- **Population-level health gains**

When coverage is high, screening contributes to:

  - Improved population health indicators;
  - Reduced burden on healthcare systems;
  - More efficient allocation of resources.

Harms and Limitations of Screening

- **False-positive results**

False positives may lead to:

  - Anxiety and psychological distress;
  - Unnecessary diagnostic procedures;
  - Increase in healthcare costs;
  - High false-positive rates undermine public trust in screening programmes.

- **False-negative results**

False negatives may:

  - Provide false reassurance;
  - Delay in diagnosis and treatment;
  - Reduce future healthcare-seeking behaviour.

- **Over-diagnosis**

Overdiagnosis refers to the detection of a disease that **would never have caused symptoms or harm** during the lifetime of a person.

Key concern: Overdiagnosis leads to overtreatment, exposing individuals to harm without benefit.

Common examples: Certain prostate and thyroid cancers.

- **Lead-time and length-time bias**

Lead-time bias: Earlier detection falsely appears to increase survival time without changing the time of death.

Length-time bias: Screening preferentially detects slower-growing, less aggressive disease.

These biases can distort the perceived effectiveness of screening programmes.

- **Ethical and social harms:**
  - Medicalisation of healthy individuals;
  - Increased inequities if access is unequal;
  - Opportunity costs (resources diverted from higher impact interventions).

4.5.4. Ethical and Legal Aspects of Screening

Screening raises specific ethical challenges because it involves **apparently healthy individuals**.

- **Informed consent**

Participants must receive:

  - Clear information on benefits and risks;
  - Explanation of possible outcomes;
  - Opportunity to decline participation.

Informed consent is a core ethical requirement, even in population-based programmes.

- **Autonomy and the "right not to know"**

Individuals have the right to:

  - Refuse screening;
  - Decline in the receipt of certain results.

This is particularly relevant in genetic and prenatal screening.

- **Beneficence and non-maleficence**

The screening must demonstrate that:

  - Expected benefits outweigh harms;
  - Preventable suffering exceeds screening-related risks.

Justice and Equity

Ethical screening programmes should:

  - Reduce health inequalities;
  - Ensure equal access and follow-up;
  - Avoid discrimination or stigmatisation.

Failure to reach vulnerable populations may **worsen existing disparities**.

Legal responsibilities

Health authorities must ensure:

  - Quality assurance;
  - Data protection and confidentiality;
  - Accountability for programme outcomes.

4.5.5. Population vs. Individual Perspective in Screening

One of the key tensions in screening lies between **population health benefits** and **individual-level risks**.

Population Perspective

From a public health standpoint:

- Small individual benefits may translate into large population gains;
- Screening decisions are guided by epidemiology and cost-effectiveness;
- Policies aim to maximise the overall health impact.

Individual Perspective

For the individual:

- The probability of direct benefit may be low;
- The experience of harm (false positive, anxiety) is immediate and personal;
- Personal values and risk tolerance vary;
- Role of the Physician.

Physicians act as **mediators** between population policy and individual care. Their responsibilities include:

- Explaining screening in understandable terms;
- Supporting shared decision-making;
- Avoiding unnecessary or non-evidence-based screening.

4.5.6. The Role of Advanced Technologies in Screening

Recent technological advances in early disease detection have the potential to substantially improve the effectiveness and precision of screening programmes.

Biomarker-based screening tests. The use of molecular and biochemical biomarkers for the detection of cancer and other chronic diseases offers a more precise and often less invasive alternative compared to traditional screening methods.

Genetic screening. Genetic testing allows to identify individuals with an inherited predisposition to certain diseases, enabling targeted prevention and early intervention. However, this approach also raises important ethical considerations, including issues related to autonomy, confidentiality, and the psychological impact of genetic risk disclosure.

Artificial Intelligence (AI) in data interpretation. AI-driven tools can improve diagnostic accuracy by supporting automated interpretation of medical images (such as mammography, CT, or retinal scans) and by reducing the frequency of false-positive and false-negative results. Furthermore, AI can optimise clinical workflows and support population-level risk stratification.

4.5.7. Screening Models in High-Income versus Low- and Middle-Income Countries

Organisation and implementation of screening programmes vary significantly between high-income countries and low- and middle-income countries (LMIC), largely due to differences in resources, infrastructure, and health system capacity as follows:

Resources and infrastructure. High-income countries generally benefit from well-developed healthcare infrastructure, trained personnel, and access to advanced technology, which facilitates large-scale population-based screening programmes. In contrast, LMICs often face resource constraints, requiring the adaptation of screening models, prioritisation of high-risk groups, and integration of screening activities into existing primary care services.

Financing models and accessibility. In many high-income countries, screening programmes are publicly funded and universally accessible, making them part of national preventive health strategies. By comparison, screening initiatives in LMICs are frequently supported by international partners or non-governmental organisations and may be limited to specific regions, communities, or high-risk populations, depending on available financial and logistical resources.

5. Demography

Learning objectives

By the end of this chapter, students should be able to:

- Explain why demographic analysis is fundamental to public health planning and policy;
- Describe core demographic indicators, including population size, age and sex structure, and population density;
- Interpret population pyramids and assess their implications for health service needs;
- Analyze demographic dynamics, including fertility, mortality, and migration, and their impact on population health;
- Understand the concept and public health relevance of the elderly dependency ratio;
- Describe the stages of the demographic and epidemiologic transition and their implications for disease patterns;
- Explain the significance of life expectancy as a summary indicator of population health;
- Interpret cause-specific and preventable mortality patterns across populations;
- Assess the role of behavioral, environmental, and healthcare-related factors in shaping mortality patterns;
- Apply mortality indicators to inform prevention strategies and health system priorities;
- Explain the concept and public health relevance of age- and sex-standardized mortality rates;
- Analyze trends in major causes of death in relation to epidemiologic transition;
- Differentiate between life expectancy, healthy life expectancy (HALE), and years of potential life lost (YPLL), quality adjusted life years (QALY);
- Define avoidable mortality and distinguish between preventable and treatable causes of death;
- Assess the public health implications of migration at national and global levels.

Demography is a fundamental discipline for the planning and evaluation of public health systems. Analysis of populations allows us to identify major trends such as population ageing, migration, and epidemiological transitions. Demography examines populations from three primary perspectives: their size, structure, and dynamics. This means that demographers study how many people there are, how they are distributed by age, sex, education, marital status, and other characteristics, and how these attributes change over time.

5.1. Why Is Demography Critical to Public Health?

Health risk assessment. Different age and gender groups are exposed to different health risks. For example, children are more vulnerable to infectious diseases, while older adults are more prone to chronic diseases. Understanding population structure therefore helps to identify public health priorities.

Resource planning. Health systems must be prepared to meet the demand of the population. Knowledge of demographic trends supports projections on the future need for hospitals, clinics, healthcare workers, and long-term care services.

Control and monitoring of diseases. Demographic data contribute to forecasting disease spread and monitoring pandemics. For example, migration rates can influence the speed with which infectious diseases spread across regions or countries.

5.1.1. Core Demographic Factors

Total population. This is the fundamental unit of demographic analysis and serves as the basis for calculating other indicators, such as birth and mortality rates.

Population density. Represents the number of people per unit of area. Density has implications for infrastructure needs and epidemiological risk (for example, infectious diseases spread more rapidly in highly populated urban areas).

Population structure. The distribution of the population by age and sex influences healthcare needs, such as maternal and child health services or geriatric care.

5.2. Static Demographic Indicators and Their Impact on Public Health

Static demography refers to the study of a population at a given time point. It uses indicators such as population size, density, and age-sex structure to understand the distribution and needs of populations.

5.2.1. Population Size

Population size is a basic indicator that shapes the planning of health resources. In countries with large and predominantly young populations (for example, India), health policies are often oriented toward combating infectious diseases and improving maternal and child healthcare. On the contrary, countries with ageing populations (such as Japan) need more developed services for the management and long-term care of chronic diseases.

5.2.2. Age and Gender Structure

Age structure

Young population (0–14 years). This group requires significant investment in child and adolescent health. Conditions such as malnutrition and infectious diseases are more common in this category.

Working-age population (15 to 64 years). This group is economically productive and supports both young and older populations. Access to reproductive health services and prevention of chronic diseases are particularly important.

Older population (65+ years). This category requires geriatric care, chronic disease management, and palliative services. Countries with a high proportion of older adults must adapt their health and social care infrastructure to the ageing of the population.

Gender structure

The gender structure reflects the proportion of men and women in the total population and is shaped by biological, social, and economic factors. Although males are slightly more numerous at birth, this ratio changes throughout life course due to gender-specific mortality differences.

Global demographic analyses show that, despite a higher proportion of men in countries such as India and China, most regions of the world have more women than men, particularly in older age groups, due to longer life expectancy.

Across the life course:

- Childhood and adolescence**.** Boys have slightly lower survival rates than girls and are more prone to accidents and illness.
- Adulthood (15 to 64 years). Male mortality is higher due to occupational hazards, risk-taking behaviours, traffic injuries, and the increased incidence of certain chronic diseases, which gradually shifts the ratio in favour of women beginning in mid-adulthood.
- Older age (65+ years). Women represent a significantly larger share of the elderly population, reflecting a higher life expectancy and accumulated mortality differentials throughout life.

Policy implications

Changes in the gender ratio have direct implications for health and social policy. Populations with a high proportion of young men may require investments in injury prevention and behavioural health, while predominantly female elderly populations require expanded geriatric and long-term care services. Understanding gender-age structure is therefore essential for aligning health and social care systems with real population needs.

5.2.3. Population Density

Population density affects both access to healthcare and the risk of transmission of infectious diseases. Highly dense urban areas are more susceptible to outbreaks (for example, COVID-19) due to increased social contact, while sparsely populated rural areas may face barriers to essential health services due to limited infrastructure and service availability.

5.3. Elderly Dependency Ratio

The **Elderly Dependency Rate (EDR)** is a demographic indicator that measures the proportion of older people, usually 65 years and older, who are considered outside the labour force, relative to the economically active population aged 15 to 64 years. This indicator is used to assess the economic and social pressure placed on the working-age population to support ageing populations.

Formula:

$$\text{EDR} = \frac{\text{Population 65+years}}{\text{Population 15–64 years old}} \times 100$$

A higher EDR indicates a greater demand for pension systems, healthcare services, and long-term care, as well as increased fiscal pressure on the working-age population.

Practical example: Let us assume that in a country there are 10 million people aged 65 and over and 40 million between the ages of 15 and 64. The calculation of the elderly dependency ratio will be as follows:

Elderly Dependency Ratio = 10,000,000 / 40,000,000 × 100 = 25%

This means that there are 25 elderly people per 100 people in the working-age population.

5.3.1. The Importance of the Elderly Dependency Ratio

5.3.1.1. Impact on the Economy and the Labour Force

The elderly dependency ratio reflects the economic pressure exerted by older people on the working-age population. A high ratio indicates that a relatively small number of working individuals must support a large number of elderly persons, which may lead to several economic and social challenges:

Pressure on the pension and social welfare systems. A high elderly dependency ratio places enormous pressure on pension funds and other social programmes that provide financial support to older adults. As the number of retirees increases relative to the working population, the long-term sustainability of these systems becomes increasingly difficult to maintain.

Reduction in available workforce. As the population ages and the number of elderly people increases, the proportion of people able to work decreases. This can lead to labour shortages in certain sectors and negatively affect productivity and economic growth.

Higher health care expenditures. Older adults require more long-term health resources and medical care. A high elderly dependency ratio implies an increase in the demand for health and care services, leading to higher public spending in this sector.

5.3.1.2. Social and Demographic Implications

Population ageing. The elderly dependency ratio is an indicator of population ageing, a global phenomenon in both developed and developing countries. As fertility rates decrease and life expectancy increases, the proportion of elderly people in relation to the working population tends to increase, creating a demographic imbalance.

Intergenerational balance. A high elderly dependency ratio may affect the balance between generations. Younger people, who must support a growing number of elderly individuals, face an increasing economic burden. This can generate social tensions and lead to changes in social and fiscal policies.

Youth emigration. In many countries with high ageing rates, young people migrate in search of better economic opportunities, which can further worsen the elderly dependency ratio. This may result in a rapid decline in the working-age population and an increased burden on those who remain.

5.3.1.3. Use in Public and Health Policy

The elderly dependency ratio is an important indicator for governments and policy makers when designing strategies to address population ageing. The key areas in which this indicator is applied include the following:

Planning pension and social security systems. Governments use this indicator to anticipate future funding needs for pension systems. If the elderly dependency ratio increases, adjustments to retirement age, pension contributions, or alternative support programmes for older adults may become necessary.

Policies to improve the health of the elderly. As populations age, health systems must adapt to growing needs, including care for chronic diseases and conditions associated with ageing, such as dementia or arthritis. The dependency indicator helps in planning these resources.

Promoting active inclusion. Another important strategy is to keep older people in the workforce for a longer period, either through incentives to work at older ages, retraining programmes, or more flexible working conditions. This can reduce pressure on younger generations.

5.3.2. Global Trends in the Elderly Dependency Ratio

In many countries, the elderly dependency ratio is increasing, reflecting global population ageing associated with demographic transition:

Developed countries. West European countries, Japan, and the United States have high elderly dependency ratios due to declining fertility and increasing life expectancy. Japan, for example, has one of the highest elderly dependency ratios in the world, with a large elderly population and a shrinking workforce.

Developing countries. In many countries in Africa, Asia, and Latin America, elderly dependency ratios are currently lower due to younger population structures. However, as the demographic transition progresses, these regions are also expected to experience rapid increases in elderly dependency in the coming decades.

Policy examples. Countries such as Germany and Sweden have implemented active policies to address this challenge, including encouraging employment beyond retirement age and supporting home care for elderly people. On the contrary, countries lacking strong ageing management strategies may face significant economic pressures.

5.4. Dynamic Demography: Births, Deaths, and Migration

Dynamic demography analyses changes in the population over time. These changes are influenced by three main phenomena: births, deaths, and migration.

5.4.1. Natality

Natality refers to the number of live births per 1,000 inhabitants in a given period.

$$\textbf{Birth rate} = \frac{live\ births}{total\ population} \text{ x } 1000$$

Practical example:

If in a population of 100,000 people, 1,500 children are born in one year, the birth rate is:

Birth rate = (1,500 / 100,000) × 1,000 = 15 live births per 1,000 people

Birth rates are influenced by socio-economic, cultural, political, and biological factors.

a) Demographic factors:

– gender distribution;
– age structure of the population, especially of women;
– marriage and divorce patterns.

b) Medical-biological factors:
– primary and secondary female infertility;
– male infertility;
– genital pathology;
– sexual hygiene.

c) Social factors:

– prolonged education;
– level of female participation in socio-economic activities;
– social class affiliation and mobility.

d) Population migration

e) Legislative factors:
– labour and family codes;
– child allowance systems;
– maternal and child protection programmes;
– family-planning policies, including abortion legislation.

f) Subjective factors (family-planning):
– attitudes toward the desired number of children;
– subjective motivations underlying demographic behaviour;
– contraceptive methods and means.

g) Local traditional factors:
– historical development of the area;
– cultural level;
– local customs;
– religion.

5.4.2. Fertility

Fertility expresses the biological capacity of women to give birth. The **total fertility rate** represents the average number of children a woman will have in her lifetime.

$$\textbf{Fertility rate} = \frac{number\ of\ live\ births}{number\ of\ women\ aged\ 15-49} \text{ x } 1000$$

Reproductive capacity can be better assessed by calculating the average number of live births per woman aged 15 to 49 years, known as the **gross fertility rate**.

Generally, a gross fertility value greater than 2.1 is considered sufficient to ensure population replacement.

Since only female newborns represent real reproductive units, an accurate assessment of reproductive capacity must consider only female live births. In this case, we refer to **gross reproduction** (the average number of female live births per woman aged 15 to 49 years).

In Europe, fertility rates are generally low, with many countries below the 2.1 children per woman threshold required to maintain a stable population.

Fertility periods in Romania

1948–1955: average gross fertility rate of 3.23 children per woman

1956–1966: period of availability of abortions, during which gross fertility dropped from 2.9 to 1.9 children per woman

1967–1989: "pro-natalist period," with gross fertility between 3.7 children per woman (1967) and 2.2 (1989)

After 1990: sharp decline in gross fertility, from 1.8 children per woman (1990) to 1.7 (2022)

Romania ranks among the highest in the European Union in terms of teenage motherhood. Almost half (45%) of mothers under 15 years of age in EU member states are from Romania. The country records **34 live births per 1,000 adolescent girls**. In Europe, only two countries show slightly higher values: Bulgaria and Georgia, with **36.8 and 38.3 live births**, respectively. Practically, **one in ten newborns has an adolescent mother**.

5.4.3. General Mortality

General mortality is a key indicator of population health. It reflects the number of deaths occurring in a population over a given period and is usually expressed per 1,000 inhabitants. This indicator helps public health professionals assess the burden of diseases, living conditions, access to health services, and the impact of social and environmental determinants of health.

Crude Mortality Rate (CMR):

$$\text{Crude Mortality Rate} = \frac{\text{Number of deaths in a year}}{\text{Mid-year total population}} \text{ x } 1000$$

Practical Example: If a population of 200,000 people records 2,000 deaths in one year:

Crude Mortality Rate=2000/ 200000 × 1000=10 deaths per 1,000 population

Key considerations in interpreting mortality:

The crude mortality rate does **not control for age structure**, which may lead to misleading comparisons between populations with different demographic profiles.

Populations with a high proportion of older adults may show higher mortality rates even when overall health services are high-quality.

To enable meaningful comparisons between countries or over time, **age-specific mortality rates** and **age-standardised mortality rates (ASMR)** are often calculated.

Public health relevance:

General mortality trends inform policy planning, resource allocation, and priority setting in national health systems.

Increases in mortality can signal emerging epidemics, worsening socioeconomic conditions, or deficiencies in healthcare delivery.

5.4.4. Infant Mortality

Infant mortality refers to the number of deaths among children **under one year of age**, expressed per 1,000 live births in a given year. It is considered one of the most sensitive and comprehensive indicators of population health, as it reflects maternal health, quality of perinatal and neonatal care, nutrition, living conditions, and access to health services.

Infant Mortality Rate (IMR):

$$\text{Infant Mortality Rate} = \frac{\text{Deaths of children} < 1 \text{ year}}{\text{Number of live births}} \text{ x1000}$$

Practical Example: If 10,000 children are born in one year and 100 die before reaching one year of age:

IMR=100 / 10000 × 1000 = 10 deaths per 1,000 live births

Components of Infant Mortality

Infant mortality is subdivided into specific periods that allow for a more precise identification of causes and risk factors.

Neonatal Mortality (0–27 days):

$$\text{Neonatal Mortality Rate} = \frac{\text{Deaths } 0-27 \text{ days}}{\text{Number of live births}} \text{ x1000}$$

Strongly associated with **perinatal care**, maternal health, prematurity, low birth weight, birth trauma, and congenital anomalies.

Early Neonatal Mortality (0–6 days):

$$\text{Early Neonatal Mortality Rate} = \frac{\text{Deaths } 0-6 \text{ days}}{\text{Number of live births}} \text{ x1000}$$

Typically associated with obstetric complications, intrapartum care, respiratory distress, and severe congenital anomalies.

Late Neonatal Mortality (7–27 days):

$$\text{Late Neonatal Mortality Rate} = \frac{\text{Deaths } 7-27 \text{ days}}{\text{Number of live births}} \text{ x1000}$$

More frequently associated with infections, complications of prematurity, and inadequate neonatal follow-up.

Post-neonatal Mortality (28–364 days):

$$\text{Post-neonatal Mortality Rate} = \frac{\text{Deaths } 28-364 \text{ days}}{\text{Number of live births}} \text{ x}1000$$

Often associated with **nutritional problems, respiratory infections, accidents, environmental hazards, or social deprivation**.

Leading Causes of Infant Mortality (Typical Patterns in Many Countries):

- Conditions that originate in the perinatal period (prematurity, birth asphyxia, low birth weight);
- Congenital malformations and chromosomal anomalies;
- Respiratory and infectious diseases;
- Sudden Infant Death Syndrome (SIDS) in some settings;
- Socioeconomic and environmental risk factors.

Public Health Importance of Infant Mortality

Serves as a **key performance indicator** for maternal and child health programmes.

High IMR is often correlated with:

- limited access to prenatal and neonatal care;
- inadequate vaccination coverage;
- malnutrition;
- unsafe housing and sanitation conditions.

Used to evaluate policies such as:

- maternal nutrition and antenatal care;
- skilled birth attendance;
- neonatal intensive care services;
- promotion of breastfeeding;
- immunisation and child survival programmes.

Monitoring trends over time supports strengthening the **health system and equity assessments** between regions and socioeconomic groups.

5.4.5. Maternal Mortality

Maternal mortality represents the number of deaths among women due to complications that occur during pregnancy, childbirth, or postpartum period (typically up to 42 days after delivery), expressed per 100,000 live births.

$$\textbf{Maternal Mortality Ratio (MMR)} = \frac{\textbf{Number of maternal deaths}}{\textbf{Number of live births}} \text{ x}100{,}000$$

Practical example: If, in a given year, a country records 5 maternal deaths among 20,000 live births, then:

MMR = (5 / 20,000) × 100,000 = 25 maternal deaths per 100,000 live births

Public health importance:

Maternal mortality reflects both access to and quality of medical care during pregnancy and childbirth. High rates can indicate limited access to antenatal services or skilled birth attendants.

The leading causes of maternal mortality include postpartum bleeding, infections, eclampsia, and complications from unsafe abortions.

Reducing maternal mortality is a key global health priority and a central goal within the Sustainable Development Goals (SDGs) of the United Nations.

5.4.6. Age-Specific Mortality

Age-specific mortality measures the death rate within defined age groups. It is essential to understand how mortality risk varies across the course of life and to identify vulnerable population segments.

$$\textbf{Age-Specific Mortality Rate} = \frac{\textbf{Number of deaths in an age group}}{\textbf{Population in the same age group}} \times 1000$$

Practical example: If a population includes 50,000 people aged 65–75 years and 500 deaths occur within this group in one year, then:

Age-Specific Mortality Rate = (500 / 50,000) × 1,000 = 10 deaths per 1,000 people aged 65–75 years

Public health importance:

Mortality among children and adolescents can signal gaps in the prevention and management of infectious diseases or injuries.

Mortality among adults and older people is more often associated with chronic diseases (eg, cancer, cardiovascular disease). Understanding these patterns supports the design of prevention and palliative care programmes.

This indicator is crucial for identifying high-risk life stages, such as the neonatal period or advanced age.

5.4.7. Gender-Specific Mortality

Gender-specific mortality measures differences in mortality rates between men and women. This indicator highlights inequalities related to biological factors, health behaviours, and access to healthcare services.

$$\textbf{Gender-Specific Mortality Rate} = \frac{\text{Number of deaths in one gender}}{\textbf{Population of the same gender}} \text{ x}1000$$

Practical example: If, in a population of 100,000 men, there are 1,200 deaths recorded in one year, then:

Male Gender-Specific Mortality Rate = (1,200 / 100,000) × 1,000 = 12 deaths per 1,000 men

Public health importance:

Men generally exhibit higher mortality rates than women in most age groups, partly due to lifestyle-related risk factors (eg, alcohol use, smoking, accidents).

Differences in mortality between sexes may reflect not only biological variation, but also unequal access to healthcare or culturally influenced health seeking behaviour.

These data inform the development of sex-specific public health interventions (e.g., cardiovascular disease prevention programmes for men, reproductive health programmes for women).

5.5. Population Pyramid

A population pyramid is a graphical representation that illustrates the distribution of a population by age group and sex. It provides an intuitive visual profile of a population's demographic history, current structure, and potential future trends.

Population pyramids are typically structured with:

- **Age groups** arranged on the vertical axis (often in 5-year cohorts), and
- **Population counts or percentages** for males (usually displayed on the left) and females (on the right).

Interpretative examples:

- A **broad-based triangular pyramid** indicates a *young population* characterised by high fertility and, frequently, higher mortality in younger age groups.
- A **narrow base combined with a wider apex** reflects an *ageing population*, associated with low fertility, increased life expectancy, and a higher proportion of elderly individuals.

Comparative patterns by development level:

- In **high-income countries**, population pyramids tend to be more rectangular, reflecting sustained low fertility, delayed childbearing, and high survival into older ages.
- In **low and middle-income countries**, pyramids generally remain wide at the base, indicating high fertility, younger age structures, and often higher infant and child mortality.

Public health relevance:

- Population pyramids support planning for **healthcare services, workforce needs, pension systems, and social protection**.
- They enable the identification of **demographic pressure points**, such as youth bulges, population ageing, or shrinking working-age cohorts.
- They are essential tools in **epidemiological forecasting** and resource allocation in health programmes.

5.6. Natural Increase (Natural Population Change)

The natural increase represents the difference between the number of live births and the number of deaths in a given population over a specified period, excluding the effects of migration. It reflects whether a population is growing naturally or declining.

Formula:

$$\text{Natural Increase Rate} = \frac{\text{Live Births} - \text{Deaths}}{\text{Mid-Year Population}} \times 1000$$

A **positive value** indicates natural growth population.

A **negative value** indicates natural population decline.

Example: In a population of 10,000 inhabitants, if 200 live births and 150 deaths are recorded in one year, then:

Natural Increase Rate = $(200-150) / 10{,}000 \times 1000 = 5$ per 1,000 population

This represents a **natural increase**, which means that the population grew independently of the migration flows.

Public health importance:

Resource planning. The natural increase informs projections of future demand for healthcare, education, housing, and social infrastructure.

Assessment of demographic transition. Populations with high fertility and positive natural increase are typically in earlier stages of demographic transition, whereas persistent natural decline is characteristic of late-transition or post-transition societies, often accompanied by accelerated population ageing.

Labour force implications. Population growth can sustain a younger and potentially more productive workforce, while population decline may result in labour shortages and increased pressure on the pension and health systems.

5.7. Demographic and Epidemiologic Transition

5.7.1. Demographic Transition

The demographic transition describes the change from a regime of high birth-and-death rates to one characterised by low fertility and low mortality. It typically unfolds across four conceptual stages:

- **Pre-transition:** High fertility and high mortality; minimal population growth.
- **Early transition:** Mortality begins to decline due to improvements in hygiene, nutrition, and medical care; population growth accelerates.
- **Late transition:** Fertility declines, population growth slows, and the structure of the age begins to shift.
- **Post-transition:** Persistently low fertility and mortality; population stabilises or declines, with increasing population ageing.

This transition reflects broader **socioeconomic development, urbanisation, education expansion, female labour force, and health system improvements**.

5.7.2. Epidemiologic Transition

The epidemiologic transition accompanies the demographic transition and refers to shifts in the predominant burden of disease over time.

Populations evolve from:

- A mortality profile dominated by **infectious diseases, maternal and child health conditions, and malnutrition**, to
- One dominated by **non-communicable diseases (NCDs)** such as cardiovascular diseases, cancers, diabetes, and chronic respiratory disorders.

5.7.2.1. Contextual patterns

In many **low-income settings**, infectious diseases and undernutrition remain prevalent alongside a growing burden of NCDs, a phenomenon known as the **double burden of disease**.

In **post-transition societies**, healthcare systems increasingly focus on chronic disease management, long-term care, and prevention of lifestyle-associated risk factors (e.g., obesity, hypertension, tobacco and alcohol use).

5.7.2.2. Implications for health systems and policy

During **Stages 1 to 2,** resources are prioritised for maternal and child health, infectious disease control, vaccination, sanitation, and nutrition programmes.

During **stages 3 to 4**, investments shift to **elderly care, prevention and management, rehabilitation, and palliative services**, along with promotion of healthy ageing and reduction of risk factors.

5.7.2.3. Extended Theoretical and Applied Perspectives

The concept of **epidemiologic transition** describes the long-term change in the predominant causes of morbidity, disability, and mortality within a population, as societies evolve socially, economically, and demographically. Traditionally, this transition reflects a progression from a health profile dominated by **infectious diseases, maternal and child mortality, and nutritional deficiencies**, to a profile characterised primarily by **chronic, degenerative, and lifestyle-related conditions**. Contemporary research, however, demonstrates that this process is neither uniform nor linear and that multiple transitional patterns may coexist within and across populations.

- **Non-linear and Incomplete Transitions**

In many low- and middle-income countries, the epidemiologic transition does not unfold clearly in a sequential manner. Instead, there is often a **partial or overlapping transition** in which infectious and parasitic diseases remain significant contributors to mortality and morbidity, while, simultaneously, the incidence and prevalence of **non-communicable diseases (NCDs)** such as cardiovascular disease, diabetes, cancer, and chronic respiratory disease rise sharply.

This co-existence produces a **"double burden of disease"**, and in some contexts a **"triple burden"** when injuries and violence are also the major contributors. For health system planning, this implies the need for **parallel investment in both communicable-disease control and chronic-disease prevention and management**, rather than a simple reallocation of resources from one domain to the other.

- **Transition in Behavioural and Environmental Risk Factors**

The epidemiologic transition is closely interlinked with a **transition in risk exposure**. Structural social changes, such as urbanisation, economic development, changes in the workforce, and globalisation, modify the lifestyle and environmental determinants of health. Key trends include:

  - reduced physical activity and sedentary living patterns;
  - increased consumption of ultra-processed and energy-dense foods;
  - a higher prevalence of tobacco and alcohol use;
  - occupational exposures and environmental pollution.

As a result, the burden of disease becomes increasingly shaped by **modifiable behavioural and social determinants**, underscoring the strategic importance of **population-level prevention policies**, fiscal regulation, health promotion, and environmental interventions rather than exclusively clinical approaches.

- **Within-Country Inequalities and Heterogeneous Transitions**

The dynamics are not homogeneous across all groups within a country. Significant **socio-economic, geographic, and cultural gradients** persist. Rural and socioeconomically disadvantaged populations can continue to be disproportionately affected by **infectious diseases, undernutrition, and preventable maternal and child deaths**, while urban, higher-income, and more educated populations exhibit a disease profile dominated by **NCDs and longevity-associated conditions**.

This stratification produces **unequal health outcomes** and calls for **targeted, equity-oriented public health strategies**, tailored to the specific epidemiologic and social characteristics of subpopulations.

- **Globalisation, Mobility, and Emerging Health Threats**

The modern epidemiologic transition is shaped by **global interconnectivity**. International travel, trade flows, migration, environmental change, and urban crowding facilitate:

  - the **re-emergence** of previously controlled diseases (e.g., tuberculosis with multidrug resistance);
  - the **emergence of novel pathogens** and zoonotic spill overs;
  - faster geographical spread of epidemics and pandemics.

These dynamics illustrate that epidemiologic transition is no longer limited within national borders; it is a **transboundary and dynamic phenomenon that requires** global surveillance systems, cross-sectoral coordination, and resilient public health infrastructures.

- **Population Ageing, Multimorbidity, and Care Complexity**

As life expectancy increases, the epidemiologic transition leads not only to a higher prevalence of chronic disease, but also to:

  - **multimorbidity** (the coexistence of multiple chronic conditions);
  - increasing demand for **long-term care**, rehabilitation, and geriatric services;
  - higher health system **costs and care** coordination needs.

Therefore, health systems must shift from episodic, acute-care models to **integrated patient-centred chronic-care frameworks**, emphasising continuity of care, multidisciplinary management, and integration of social care.

- **Toward a "Fourth Transition": Technology, Environment, and Mental Health**

Recent literature proposes the emergence of a **new transitional phase**, characterised by:

  - increasing prevalence of **mental-health disorders and psychosocial stressors**;
  - behavioural addictions and exposures to the digital environment;
  - climate-related health risks (heat stress, vector-borne diseases, displacement);
  - complex interactions between technology, the environment, and human biology.

This perspective broadens the classical framework, recognising that contemporary health challenges extend beyond the infectious–non-communicable dichotomy and are deeply embedded in **societal, ecological, and technological contexts**.

The epidemiologic transition is a **context-dependent process** that reshapes the structure of the disease, the distribution of risk factors, and the organisation of health systems. Understanding its dynamics is fundamental for designing **evidence-based public health policies**, ensuring equitable access to care, and anticipating future health needs in ageing and socioeconomically diverse populations.

5.8. Cause-Specific Mortality

Cause-specific mortality measures the death rate attributable to a particular cause (for example, cancer, road traffic injuries, or cardiovascular disease), expressed in relation to the total population.

Cause-Specific Mortality Rate Formula

$$\text{Cause-specific Mortality Rate} = \frac{\text{Number of deaths from a specific cause}}{\text{Total population}} \times 1000$$

Practical example: If, in a population of 1,000,000 people, 5,000 individuals die from cancer in a given year, the cancer-specific mortality rate is:

5000 / 1 000 000 × 1000 = 5 deaths per 1,000 population

Public-health relevance:

Cause-specific mortality allows health authorities to identify the diseases and external causes that contribute the most to premature death and prioritise targeted prevention and control policies.

In high-income countries, non-communicable diseases (NCDs)—particularly cardiovascular diseases and cancers—are the leading causes of mortality. Effective prevention programmes, screening, early detection, and evidence-based treatment strategies are essential to reduce these deaths.

In many low- and middle-income countries, infectious diseases such as malaria, tuberculosis, and HIV/AIDS still account for a substantial share of mortality, requiring disease-specific public health programs and internationally supported interventions.

5.9. Avoidable Mortality (Preventable and Treatable)

Avoidable mortality refers to deaths that could be avoided through effective public-health interventions *or* by timely access to appropriate healthcare services. In other words, it reflects both the ability of society to prevent disease *before it occurs* and the ability of the health system to manage disease *once it has developed*. Consequently, avoidable mortality is a key indicator of population health and the performance of the health system.

5.9.1. Components of Avoidable Mortality

Avoidable mortality is commonly divided into two interrelated components: **preventable mortality** and **treatable (amenable) mortality**.

Preventable Mortality

Preventable mortality includes deaths that can be avoided mainly through **public health actions and prevention policies**, acting upstream of the onset of the disease. Specifically, these deaths are influenced by population-level interventions that target behavioural, environmental, and social risk factors.

For example, deaths from smoking-related lung cancer, alcohol-related diseases, road traffic injuries, and vaccine-preventable infections can be reduced through tobacco control, alcohol regulation, injury prevention strategies, vaccination programmes, and health promotion campaigns. Therefore, preventable mortality reflects primarily the effectiveness of **health promotion and disease prevention strategies**.

Treatable Mortality (Amenable)

On the contrary, treatable mortality refers to deaths that could be avoided through **early diagnosis, timely access to care, and effective medical treatment**. These deaths occur after the onset of the disease and are closely related to the functioning of healthcare services.

Typical examples include ischemic heart disease, stroke, pneumonia, and colorectal cancer, conditions for which survival is largely dependent on early detection, appropriate treatment, and continuity of care. Therefore, treatable mortality reflects the **quality, accessibility, and responsiveness of the healthcare system**.

5.9.2. Interaction between Prevention and Care

Importantly, preventable and treatable mortality are not mutually exclusive. Instead, they are complementary. For example, lung cancer mortality can be reduced *both* through prevention measures (such as taxation, advertising restrictions, and smoking cessation programmes) *and* through early detection and timely treatment. This highlights the need for integrated public health and healthcare approaches.

5.9.3. Avoidable Mortality in Romania

Within the European Union, Romania has the **highest rate of treatable mortality**, indicating significant challenges in access to timely and effective healthcare. At the same time, Romania also ranks among the countries with the **highest preventable mortality**, suggesting an insufficient impact of prevention policies and public health programmes.

Taken together, these patterns point to systemic gaps in prevention, early detection, and chronic disease management, particularly for cardiovascular diseases, respiratory infections, and selected cancers.

Public Health Relevance

From a public health perspective, avoidable mortality serves as a **key performance indicator** for health systems. It helps identify priority areas for intervention and supports evidence-based policy decisions. Additionally, reducing avoidable mortality requires coordinated action at multiple levels, including health promotion, primary care, specialised medical services, and intersectoral public policies.

5.10. Age- and Demographically-Adjusted Mortality Rates

An **adjusted mortality rate** is a mortality rate that has been statistically standardised to account for differences in demographic structure—most commonly age and gender—between two or more populations. Adjustment is necessary because demographic composition strongly influences crude mortality rates; without adjustment, comparisons between populations may be misleading.

Why is an adjustment necessary?

Adjusted mortality is used to eliminate the confounding effect of demographic differences so that mortality levels can be compared **fairly and accurately** between populations or over time.

Example: When comparing a younger population with an older one, the older population will naturally exhibit a higher crude mortality rate, simply because mortality increases with age. Without age standardisation, one might incorrectly conclude that the older population is less healthy, whereas the difference may be due primarily to demographic structure rather than to true differences in disease risk or health system performance.

Age-adjusted mortality rates are therefore essential for:

- evaluating trends over time in the same population;
- comparing health outcomes between countries or regions;
- monitoring inequality-related mortality differences;
- informing policy decisions and resource planning.

5.10.1. Types of Adjusted (Standardised) Mortality

Adjusted or standardised mortality rates are used to remove the influence of differences in the age structure of populations when comparing mortality between regions, populations, or time periods. Two principal approaches are used: **direct standardisation** and **indirect standardisation**. Each method has specific advantages depending on the availability and quality of mortality and population data.

5.10.1.1. Direct Age Standardisation of Mortality

Direct standardisation involves applying **age-specific mortality rates** from the study population to a **standard reference population** with a predefined age distribution. This method is appropriate when detailed and reliable age-specific mortality data are available.

Steps in direct standardisation

- **Divide the population into age groups** (e.g., 0–4, 5–14, 15–64, 65+ years).
- **Calculate age-specific mortality rates** for each age group in each study population.
- **Apply the age-specific rates to the standard population** to obtain the number of expected deaths in each age group.
- **Sum the expected deaths** in all age groups and divide by the total standard population to obtain the **age-adjusted mortality rate**.

Practical example – direct adjustment. Two cities (A and B) differ in their age structure. Although City A shows a higher crude mortality rate, it also has a much larger proportion of older adults. By standardising mortality against a reference population, we can determine whether the observed difference reflects population ageing or true health disparities (Table 2).

Table 2. Example of direct age standardisation of mortality

Age group	Standard population	Mortality rate City A	Expected deaths A	Mortality rate City B	Expected deaths B
0–4	5,000	0.002	10	0.001	5
5–14	8,000	0.001	8	0.002	16
15–64	30,000	0.005	150	0.003	90
65+	7,000	0.040	280	0.030	210
Total	**50,000**		**448**		**321**

After adjustment, City B shows a **lower standardised mortality rate** than City A, indicating that the excess mortality in City A cannot be explained solely by its older population structure.

Strengths of direct adjustment: preferred for cross-country comparisons, time-trend analyses, and reporting at national or sub-national level when age-specific rates are reliable.

5.10.1.2. Indirect Age Standardisation of Mortality

Indirect standardisation is used when **age-specific mortality rates in the study population are unavailable, unstable, or based on small numbers**. Instead, **standard age-specific mortality rates** from a reference population are applied to the age structure of the study population to estimate the **expected number of deaths**.

The comparison between **observed** and **expected** deaths is expressed using the **Standardised Mortality Ratio (SMR).**

Steps in indirect standardisation

- **Obtain standard age-specific mortality rates** from a well-defined reference population (e.g., national or regional rates).
- **Apply these rates to the study population** to calculate the **expected number of deaths** in each age group.
- **Compare observed vs. expected deaths** by calculating the **SMR**:

SMR= Observed deaths / Expected deaths

Interpretation

- **SMR = 1.0** → mortality equal to the expected level
- **SMR > 1.0** → excess mortality compared to the reference population
- **SMR < 1.0** → lower-than-expected mortality

Practical example – indirect adjustment In a factory with 1,000 employees, the standard mortality rate for the relevant age structure is **5 deaths per 1,000** individuals, so **5 deaths are expected**. If **10 deaths are observed**, the SMR is:

SMR=10 / 5=2.0

An SMR of **2.0** indicates that mortality in this worker population is **twice the expected level**, which warrants investigation of occupational and environmental risk.

Strengths of indirect adjustment: appropriate for small populations, occupational cohorts, rare diseases, or incomplete mortality records.

5.10.2. Importance for Public-Health of Adjusted Mortality

Age-adjusted mortality is essential for **valid comparisons** of population health and evidence-based decision-making in public health and health policy.

5.10.2.1. Comparison of Mortality between Populations

Across countries or regions. Populations differ in age composition; standardised mortality removes this distortion and enables a meaningful comparison between high-income and low- or middle-income settings.

Between cities or administrative areas. Cities with older populations show higher crude mortality by default; adjusted mortality reveals **true health performance differences** rather than demographic artefacts.

5.10.2.2. Evaluation of Public-Health Interventions

Evaluation of the effectiveness of the programme. Standardisation allows an unbiased evaluation of vaccination programmes, screening initiatives, tobacco-control policies, and chronic disease management programmes.

Monitoring secular trends. Adjusted mortality supports long-term surveillance by distinguishing mortality changes due to **population ageing** from those attributable to **clinical or public health interventions**.

5.10.2.3. Identification of Health Inequalities

Revealing vulnerable or disadvantaged groups. Age- and sex-adjusted mortality can uncover inequalities masked by crude rates, highlighting disparities by socioeconomic status, ethnicity, occupation, or geography.

Informing policy and resource allocation. Standardised mortality indicators guide strategic investment in prevention, service delivery, and risk-reduction policies in high-burden groups.

5.11. Determinants Influencing Mortality Trends

5.11.1. Demographic Change

Ageing of the population. As life expectancy increases and fertility declines, many societies undergo demographic ageing. Older populations experience higher mortality from chronic and degenerative diseases, particularly cardiovascular disease, cancer, and neurodegenerative disorders, while infant and maternal mortality declines. Ageing changes the overall mortality profile to non-communicable causes and increases the demand for long-term care, rehabilitation, and palliative services.

Age structure effects. Populations with a younger demographic profile typically exhibit lower crude mortality rates, since younger age groups are less vulnerable to natural causes of death. However, such populations can show relatively higher mortality from injuries, violence, and infectious diseases.

5.11.2. Medical Progress and Access to Health Care

Advances in medical technology and clinical care. Modern diagnostics, pharmacological therapies, minimally invasive surgery, and intensive care have substantially reduced mortality from many acute and infectious conditions (e.g., tuberculosis, HIV/AIDS, pneumonia). Expanded immunisation, antibiotics, improved perinatal and neonatal care, and cancer therapies have contributed to marked increases in survival between age groups.

Equitable access to health services. Countries and regions with broad and affordable access to high-quality health services tend to report lower mortality. On the contrary, financial barriers, geographic isolation, workforce shortages, and cultural barriers contribute to excess mortality, particularly for preventable and treatable conditions. The resilience of the health system, continuity of care, and primary care coverage are critical modifying factors.

5.11.3. Socio-economic Determinants

Education. Higher educational attainment is associated with greater health literacy, healthier behaviours, and increased use of preventive services. Populations with low education levels experience higher mortality due to delayed care-seeking, sustained exposure to risk factors, and reduced capacity to navigate health systems.

Poverty and social inequality. Poverty is strongly correlated with elevated mortality risks. Low-income groups are more likely to experience inadequate housing, food insecurity, occupational hazards, environmental exposure, and limited access to care. Social stratification amplifies health inequities, disproportionately affecting marginalised groups such as ethnic minorities, migrants, and individuals in rural or deprived urban areas.

5.11.4. Individual Behaviours and Lifestyle Factors

Health-risk behaviours. Tobacco use, harmful alcohol consumption, unhealthy diet and physical inactivity are the main contributors to mortality from non-communicable diseases, including ischemic heart disease, stroke, type 2 diabetes, and several cancers.

Protective lifestyle factors. Regular physical activity, balanced nutrition, weight control, and avoidance of high-risk behaviours are associated with lower mortality, particularly among adults and older people. Population-level interventions (taxation, labelling, urban design, and behavioural programmes) are essential complements to individual risk reduction.

5.11.5. Environmental Determinants

Environmental pollution. Air, water, and soil pollution increase the risk of respiratory and cardiovascular disease, malignancies, and adverse pregnancy outcomes. Urban centres with sustained high levels of pollution typically report higher cause-specific mortality from these conditions.

Climate change and extreme events. Heatwaves, cold spells, floods, and wildfires increase short-term mortality, particularly among the elderly and people with chronic disease. Climate change also alters the geographic distribution of vector-borne and zoonotic infections (e.g., malaria, dengue, West Nile virus), influencing mortality patterns over time.

5.11.6. Epidemics and Pandemics

Infectious-disease outbreaks. Epidemics such as HIV/AIDS, influenza, COVID-19, and emerging pathogens can produce sharp, short-term increases in mortality and sustained indirect effects due to health system disruption, delayed care, and excess deaths from non-infectious conditions. The impact varies by age, comorbidity profile, and capacity of the health system.

5.12. Trends in the Main Causes of Mortality

In recent decades, mortality patterns have evolved substantially in line with the **epidemiologic transition, a** shift from infectious, nutritional, and maternal causes of death to chronic, degenerative, and external causes as dominant contributors.

5.12.1. The Epidemiologic Transition

Pre-transition phase. Historically, mortality profiles were dominated by infectious diseases (e.g., cholera, tuberculosis, malaria), maternal complications, and high infant mortality, driven by poor sanitation, overcrowding, limited medical care, and widespread poverty.

Post-transition phase. In most high-income countries and an increasing number of middle-income settings, **non-communicable diseases (NCDs)**—including cardiovascular disease, diabetes, and cancer, along with external causes (injuries, suicides) now account for the majority of deaths. The transition is uneven between and within countries, producing 'double-burden' contexts in which infectious and chronic diseases coexist.

5.12.2. Non-Communicable Diseases (NCDs)

Cardiovascular diseases. The leading global cause of death, driven by hypertension, hyperlipidemia, obesity, smoking, and metabolic risk. Mortality arises primarily from ischemic heart disease and stroke, with strong behavioural and socio-environmental determinants.

Cancer. Cancer incidence and mortality have increased in ageing populations. Lung, colorectal, and breast cancers are the major contributors to cancer-related mortality. Key risk factors include tobacco use, unhealthy diet, obesity, occupational and environmental exposures, and delayed diagnosis.

Diabetes mellitus. Mortality from diabetes has increased markedly, mainly due to obesity, sedentary lifestyles, and ageing of the population. Diabetes substantially increases the risk of cardiovascular disease, renal failure, infections, and premature mortality.

Additional contextual note: In many countries, multimorbidity and clustering of risk factors amplify mortality, underscoring the need for integrated models of prevention and chronic care.

5.12.3. Infectious Diseases

Although their relative contribution to global mortality has declined, infectious diseases remain highly consequential in many low- and middle-income countries.

HIV/AIDS. A major cause of mortality in parts of Sub-Saharan Africa, despite advances in antiretroviral therapy and prevention.

Tuberculosis. Global mortality has declined, but TB persists in regions with high HIV coinfection, drug resistance, and fragile health systems.

Malaria. Predominantly affects children in Sub-Saharan Africa and tropical regions. Large-scale prevention and treatment programmes have reduced mortality, although progress remains fragile and climate sensitive.

5.12.4. External Causes (Injuries, Suicide, Homicide)

Unintentional injuries. Road traffic accidents are one of the leading causes of premature mortality, especially when road infrastructure, enforcement, and safety legislation are inadequate. Young adults are disproportionately affected.

Suicide. Suicide is one of the leading causes of death in many countries, particularly among adolescents and adults of working age. Stigma, mental health service gaps, substance use, and socio-economic stressors contribute significantly.

5.13. Case-Fatality – Proportional Mortality

Case-fatality is an epidemiological indicator that measures the proportion of individuals who die from a specific disease or condition relative to the total number of individuals affected by that disease. In other words, the case-fatality rate reflects the severity of a disease, as it expresses the probability of death among persons diagnosed with the condition.

Formula

Case-Fatality Rate (CFR) = (Number of deaths due to the disease ÷ Number of diagnosed cases) × 100

Example If 100 individuals are diagnosed with severe influenza in a hospital and 5 of them die, the case-fatality rate is:

CFR = (5 ÷ 100) × 100 = 5%

This indicates that 5% of the patients diagnosed with severe influenza died from the disease.

Public Health Relevance

Evaluation of the severity of the disease. The case-fatality rate is essential to assess the clinical severity and lethality of a disease and it supports decision-making on the level of intervention required to prevent deaths.

Monitoring during epidemics. During epidemics, CFR is a key indicator used to assess the gravity of the outbreak and to guide resource allocation. For example, during the COVID-19 pandemic, CFR estimates were closely monitored to better understand the mortality risk associated with infection.

5.14. Life Expectancy at Birth

Life expectancy at birth represents the average number of years that a newborn is expected to live, assuming that age-specific mortality rates observed at birth remain constant throughout the individual's lifetime. It is one of the most widely used indicators for assessing the general health status of a population.

Life expectancy is derived from life tables that incorporate the probability of death at each age.

Life Expectancy at Birth = Σ (Age-specific survival probabilities across all age groups)

Practical example In a country where life expectancy at birth is 75 years, a newborn is expected, on average, to live 75 years, assuming current mortality patterns remain unchanged. In countries with highly developed health systems and good access to quality care, life expectancy can exceed 80 years, whereas in settings with limited access to healthcare and higher mortality, life expectancy can drop to 60 years or less.

5.14.1. Importance for Public Health of Life Expectancy at Birth

5.14.1.1. Indicator of Overall Population Health

Life expectancy is a key summary measure of population health. Higher life expectancy reflects favourable conditions such as access to healthcare, adequate nutrition, sanitation, and advantageous socioeconomic environments. It also signals the success of public health interventions, including vaccination, infectious disease control, and chronic disease management.

5.14.1.2. Assessment of Health System Performance

Countries with a higher life expectancy typically benefit from more effective health systems, improved access to medical services, and better management of major risk factors (e.g., cardiovascular disease, cancer, diabetes).

5.14.1.3. Regional Differences and Social Inequalities

Life expectancy varies markedly between geographic regions and socioeconomic groups. For example, countries in Sub-Saharan Africa - where access to healthcare is limited and the burden of infectious diseases such as HIV/AIDS and malaria is high - tend to have substantially lower life expectancy than high-income countries. Within countries, disparities in income and access to health services also contribute to significant differences in life expectancy between social groups.

5.15. Healthy Life Expectancy (HALE)

Healthy Life Expectancy (HALE) measures the average number of years an individual can expect to live in good health, that is, free from severe disability or chronic disease that significantly affects quality of life. Unlike total life expectancy, which accounts for all years lived, HALE emphasises quality by quantifying the duration of life lived in a healthy state.

HALE is calculated using life tables in conjunction with data on the prevalence of diseases and disabilities between age groups. Total life expectancy is adjusted to account for the years lived with disability or chronic illness.

HALE = Total Life Expectancy − Years Lived with Disability

Practical Example

If life expectancy at birth in a country is 80 years, but individuals are expected to live, on average, 10 years with disability or health conditions that reduce quality of life, then:

HALE = 80 − 10 = 70 healthy years of life

This indicates that on average, individuals can expect to live 70 years in good health and 10 years with health limitations or disability.

5.15.1. Public Health Relevance of HALE

5.15.1.1. Assessing Population Health Beyond Longevity

High life expectancy does not automatically imply good quality of life. A population may live longer, but many of those years with severe disability or chronic disease. HALE helps

policymakers identify true health needs and prioritise interventions aimed at improving functional health, not just survival.

5.15.1.2. Health System Planning

HALE provides critical information for the planning of the health system. Populations with a long life expectancy, but low HALE require greater investment in chronic disease prevention, rehabilitation, and disability management.

5.15.1.3. Indicator of Public Health Intervention Success

An increase in HALE signifies not only longer survival, but also prolonged maintenance of health. Preventive programmes that address chronic diseases such as hypertension or diabetes—can extend the number of years of good health.

5.15.1.4. Differences between Countries and Socioeconomic Groups

As with life expectancy, HALE varies between nations and socioeconomic contexts. Populations in countries with well-resourced health systems tend to experience healthier life years than those in resource-limited settings, making HALE a valuable indicator to assess health inequalities.

5.15.2. Differences between Life Expectancy and Healthy Life Expectancy

Although both indicators are essential for understanding population health, they represent distinct concepts:

Life expectancy at birth measures only the duration of life, regardless of its quality. An individual may live to 85 years, but spend the last 15 years with severe chronic disease or disability.

Healthy Life Expectancy (HALE) accounts for quality by excluding years lived with significant disability or illness, providing a more realistic measure of population health and well-being.

Examples

• In a country with a life expectancy of 80 years and a HALE of 65 years, the average person is expected to live 15 years with health conditions that significantly impair quality of life.
• In another country with the same life expectancy (80 years) but a HALE of 75 years, the population enjoys substantially more years of good health.

5.16. Years of Potential Life Lost (YPLL)

Years of Potential Life Lost (YPLL) quantifies the number of years of life lost due to premature death, relative to a predetermined reference age (often the national life expectancy). YPLL focusses specifically on premature mortality and measures the social impact of deaths occurring earlier than expected.

Average YPLL = Σ (Target Age − Age at Death)/population who died before the target age

Target age: The reference or standard age (for example, 75 years).

Age at death: The age at which the individual dies.

Practical Example If the target life expectancy is 75 years and a man dies at age 50, premature death contributes:

YPLL = 75 − 50 = 25 years lost

For multiple premature deaths in the same population:

• A death at age 30 → YPLL = 75 − 30 = 45 years

• A death at age 60 → YPLL = 75 − 60 = 15 years

Total YPLL = 25 + 45 + 15 = 85 years lost

Average YPLL = 85 ÷ 3 = 28.3 years lost

Interpretation

Higher YPLL values indicate a substantial burden of premature mortality, especially when deaths occur among children, adolescents, and young adults.

Public Health Applications

• YPLL supports the establishment of priorities in health policy by highlighting conditions that disproportionately affect younger populations (eg, traffic injuries, suicide, early-onset chronic diseases).

• It is particularly useful for assessing the impact of diseases and injuries that result in premature death, such as certain cancers and early-age cardiovascular mortality.

5.17. Migration

Migration is a fundamental process within dynamic demography, which examines changes in populations over time. In addition to births and deaths, migration represents a key determinant that shapes the structure and dynamics of populations. Unlike fertility and mortality, which are natural demographic processes, migration involves the voluntary or forced movement of individuals between two locations, either within the borders of a country (internal migration) or across national borders (international migration).

Migration affects the size, composition, and geographic distribution of populations and is influenced by a wide range of economic, social, political, and environmental factors.

5.17.1. Types of Migration

5.17.1.1. Internal Migration

Internal migration refers to the movement of individuals within the borders of a country, typically between rural and urban areas or between different regions of the same country. It has a direct impact on the distribution of the population and regional economic development.

Urbanisation. This is one of the most significant demographic phenomena associated with internal migration. The migration from rural to urban is driven by the search for employment opportunities, access to education, health services, and other essential amenities.

Rural-to-rural migration. Movements between rural communities can be shaped by access to agricultural land, water resources, and regional economic opportunities.

5.17.1.2. International Migration

International migration involves the movement of individuals from one country to another and can occur for economic, political, conflict-related, or environmental reasons.

Economic migration. Individuals migrate to improve their economic conditions, seeking better employment, higher incomes, and improved living standards. This form of migration is particularly common in low- and middle-income countries, where populations relocate to more developed nations in search of economic opportunity.

Refugees and forced migration. Migration driven by conflict, persecution, political instability, or natural disasters constitutes forced migration. Refugees and asylum seekers relocate primarily for safety, and such movements can significantly alter the demographic structure of receiving countries and regions.

5.17.1.3. Temporary and Permanent Migration

Temporary migration refers to movement for a limited period, such as seasonal workers or short-term economic migrants who eventually return to their country of origin. This type of migration often contributes to financial inflows through remittances.

Permanent migration involves long-term relocation to a new country or region. Permanent migrants can influence long-term demographic change in receiving countries by contributing new skills and cultural diversity.

5.17.2. Determinants of Migration

Migration is shaped by *push factors* and *pull factors* that explain why individuals leave one place and choose to settle in another.

5.17.2.1. Push Factors

These are conditions that prompt individuals to leave their place of origin:

- **Poverty and unemployment:** lack of economic opportunity and poor living conditions.
- **Conflict and violence:** wars, ethnic conflicts, political or religious persecution, and political instability.
- **Natural disasters:** earthquakes, floods, droughts, and climate-related disruptions that lead to short- or long-term displacement.

5.17.2.2. Pull Factors

These refer to characteristics of the receiving country or region that attract migrants:

- **Economic opportunities:** well-paid jobs, economic growth, and access to resources.
- **Access to education and health care:** well-developed social systems that offer better life prospects.
- **Political stability and security:** environments that ensure the safety and protection of civil and political rights.

5.17.3. The Demographic Impact of Migration

Migration produces significant demographic effects in both origin and destination countries.

5.17.3.1. Changes in Age and Sex Structure

- **Countries of origin.** Migrants are often young adults, particularly men. Therefore, outmigration can contribute to population ageing and labour-force depletion, while also generating gender imbalances in some regions.
- **Destination countries.** The reception of young migrants can mitigate population ageing and support the sustainability of the workforce. Migration may also reshape the ethnic and cultural composition.

5.17.3.2. Economic Impact

- **Remittances.** The financial transfers support economic development in the origin countries, improving access to education and health services for the left-behind households.
- **Labour markets.** Migration not only fills workforce gaps in destination countries, but can also generate economic and social tensions when competition arises with local workers.

5.17.3.3. Cultural and Social Change

Cultural diversity. Immigration improves sociocultural diversity and introduces new perspectives and innovations, although inadequate integration can cause social tension.

Brain drain. Origin countries, particularly developing countries, may experience significant losses of skilled labour when qualified professionals emigrate, potentially constraining economic and social development.

5.17.4. Public Health Implications of Migration

Migration has important implications for public health in both the origin and destination contexts.

5.17.4.1. Access to Health Services

International migrants may face barriers to accessing health systems due to legal status, language differences, and cultural barriers. Ensuring equitable access is essential to prevent adverse population-level outcomes.

Internal migrants, especially rural to urban populations, may encounter congestion and service shortages within urban health systems.

5.17.4.2. Transmission of Infectious Diseases

International migration can facilitate the spread of infectious diseases, particularly when migrants originate from regions with high disease burdens (e.g., tuberculosis, HIV/AIDS, hepatitis). This places additional pressure on health systems and requires stronger epidemiological surveillance and prevention programmes.

5.17.4.3. Mental Health and Migration

Migrants, especially those displaced by force, can be exposed to psychological trauma, stress, and depression that arise from displacement, social isolation, and integration challenges. Migrant mental health, therefore represents a critical dimension of public health that requires adequate support and counselling services.

6. Morbidity: A Key Indicator in Public Health

Learning Objectives
By the end of this chapter, students should be able to:

- **Define and apply core measures of morbidity**, including incidence and prevalence, in both clinical and population health contexts;
- **Differentiate between incidence and prevalence** and explain their relationship to disease duration, case fatality, and recovery;
- **Interpret morbidity indicators critically**, recognizing how demographic, social, and health system factors influence their magnitude and meaning;
- **Explain the public health relevance of morbidity associated with temporary and long-term disability**, including impacts on workforce participation and social systems;
- **Describe composite indicators of disease burden**, such as DALYs and QALYs, and explain their role in health policy, priority setting, and economic evaluation;
- **Recognize the contribution of broader development indicators**, including the Human Development Index (HDI), to understanding population health beyond clinical morbidity;
- **Explain the importance of disease classification systems**, particularly ICD, in morbidity measurement, surveillance, and health system management;
- **Apply morbidity data to clinical and public health decision-making**, including disease monitoring, resource allocation, and evaluation of interventions;
- **Analyze key determinants shaping morbidity distribution**, including demographic, socioeconomic, behavioral, environmental, genetic, and healthcare-related factors;
- **Discuss future challenges in morbidity patterns**, considering population ageing, epidemiologic transition, and global demographic change.

Morbidity represents the frequency and distribution of diseases within a population over a defined period of time. It is a broader concept than mortality, as it captures not only fatal outcomes, but also non-fatal health conditions that affect functional capacity, quality of life, and healthcare needs. High levels of morbidity place pressure on health systems, increase healthcare expenditures, and highlight the need for preventive programmes and health education.

6.1. Morbidity Measures of Morbidity

6.1.1. Incidence

Incidence quantifies the appearance of **new cases** of a disease in a defined population over a specific period of time. It reflects the *risk of developing* the disease and is therefore closely related to exposure patterns, population behaviour, and the effectiveness of primary prevention measures.

Types of incidence

Cumulative Incidence – expresses the cumulative probability (risk) of developing the disease during a specified period.

Incidence Density (Incidence Rate) – relates new cases to **person-time at risk** (e.g., person-years), accounting for varying follow-up times.

A commonly used expression is the **incidence rate (incidence density)**:

$$\text{Incidence rate} = \frac{\text{Number of new cases during a period}}{\text{Total person-time at risk}} \times 1.000 \text{ (or } 10.000, 100.000 \text{ etc.)}$$

In situations where person-time data are not available, the **cumulative incidence (risk)** is applied:

$$\text{Cumulative incidence} = \frac{\text{Number of new cases during a period}}{\text{Population at risk at the beginning of the period}} \times 1{,}000$$

Example:
In a community of 10,000 people, 50 individuals develop type 2 diabetes in one year:

Incidence = 50 / 10,000 × 1,000 = 5 new cases per 1,000 persons per year

Incidence is particularly important for conditions that arise suddenly or evolve rapidly because it captures changes in exposure, behaviour, or environmental determinants. For example, a reduction in the incidence of acute myocardial infarction after the introduction of tobacco control legislation or statin therapy suggests the success of primary prevention strategies. In contrast, increases in the incidence of type 2 diabetes in urban populations may reflect lifestyle changes, including decreased physical activity and dietary changes.

From an analytical perspective, incidence is also central to **causal inference**, because it incorporates the *temporal sequence* between exposure and disease onset. In infectious disease epidemiology, incidence informs transmission modelling and epidemic forecasting, while in chronic disease epidemiology, it supports the evaluation of risk factor interventions, screening programmes, and cohort-based longitudinal research.

In the context of **epidemiological transition**, incidence patterns provide an early signal of population change. As infectious diseases decline due to vaccination, sanitation, and improved living conditions, the incidence of non-communicable diseases tends to increase, driven by ageing populations, urbanisation, and lifestyle determinants. Monitoring incidence is therefore essential to anticipate future morbidity and plan appropriate health-system responses.

6.1.2. Prevalence

Prevalence describes the **total number of people living with a disease** in a population at a given point in time (point prevalence) or over a defined period (period prevalence). Unlike incidence, which reflects *new occurrences*, prevalence is influenced by both **the onset and duration**, including survival, treatment results, and chronicity.

Types of prevalence

Point prevalence – cases that exist at a specific moment.

Period prevalence – cases present at any time during a defined interval.

Lifetime prevalence – individuals who have ever had the condition during their lifetime.

The standard expression for point prevalence is:

$$\text{Prevalence} = \frac{\text{All existing cases (new and pre-existing)}}{\text{Total population at the same time}} \times 1{,}000$$

Example:
If 200 individuals in a population of 10,000 have diabetes:

Prevalence = 200 / 10,000 × 1,000 = 20 persons with diabetes per 1,000 population

Prevalence is particularly useful for quantifying the **overall burden of chronic disease** and for planning health care resources. For example, the prevalence of chronic kidney disease or diabetes can increase even when the incidence stabilises, because advances in treatment enable patients to live longer with the condition. Similarly, improvements in early cancer detection can increase prevalence by extending survival, while the number of newly diagnosed cases remains constant or even decreases.

In public health practice, prevalence is a key indicator of **service demand**, including the supply of medications, the needs of the workforce, rehabilitation services and the long-term care infrastructure. It also highlights the cumulative impact of disease on functional status, disability, and quality of life, complementing incidence-based measures that focus on risk and onset.

Within **epidemiological transition frameworks**, rising prevalence of non-communicable diseases is a defining feature of ageing populations with declining mortality. However, in many low- and middle-income contexts, the high prevalence of chronic disease can coexist with persistent infectious morbidity, creating a 'double burden of disease." This coexistence underscores persistent socioeconomic disparities and an uneven progression through the stages of transition.

Together, incidence and prevalence provide complementary insights: **incidence describes how fast new disease is occurring**, while **prevalence reflects how much disease is present at a given time**. Interpreting both measures in parallel is essential to understand population health dynamics, prioritise interventions, and evaluate the performance of health systems undergoing epidemiological transition.

6.1.3. Differences between Incidence and Prevalence

Incidence

- Measures **new cases**;
- Reflects the **risk of disease onset**;
- Most useful for **acute or rapidly spreading diseases**.

Prevalence

- Measures **all existing cases**;
- Reflects the **total burden of disease**;
- Most useful for **chronic or long-duration diseases**.

Illustrative example (diabetes) in a population of 10.000 inhabitants:

Incidence: 50 new cases in one year → 5 per 1,000 persons/year.

Prevalence: 200 total cases at a given time → 20 per 1,000 persons.

6.1.4. Relationship between Incidence, Prevalence, and Disease Duration

Conceptually, prevalence can be understood as a function of incidence and duration of the disease.

Prevalence ≈ Incidence × Average duration of disease

- The prevalence is **high** when the incidence is high **or the** duration is long (chronic diseases).
- Prevalence is **low** when incidence is low **or** duration is short (self-limited infections or high-mortality diseases).

Examples

Diabetes: moderate incidence + long duration → **high prevalence**.

Influenza: high seasonal incidence + short duration → **low prevalence**.

Important caution: The approximation holds best when:

- disease rates are stable;
- the population is closed and stable;
- the disease is relatively rare.

Migration, treatment breakthroughs, demographic ageing, or epidemics can alter this relationship.

6.1.5. Clarification of the Determinants and Interpretation

Factors influencing incidence:

- Exposure to **risk factors** (smoking, pollution, diet);
- **Behaviour and lifestyle** changes;
- Preventive interventions and **public health programmes**;
- **Diagnostic capacity and intensity of surveillance**.
- Access to health services.

Screening programmes may temporarily **increase incidence** by detecting previously undiagnosed cases, followed later by a real decline.

Factors influencing prevalence:

- **Duration and survival** of the disease;
- **Effectiveness of treatment** and remission rates;
- **Mortality associated with the condition**;
- **Migration patterns** and population composition;
- Improvements in **early detection and diagnosis**.

Situations where the two indicators diverge:

- **High prevalence, low incidence** – chronic diseases with long survival (HIV under treatment, hypertension);
- **High incidence, low prevalence** – acute, short-duration illnesses (respiratory infections);
- **Rising prevalence without increasing incidence** – improved survival rather than worsening risk;
- **Rising incidence without real risk increase** – improved detection or expanded screening.

Therefore, the interpretation must be **context-sensitive** and supported by clinical, demographic and social information.

Public Health Relevance

The combined analysis of incidence and prevalence enables the following:

- prioritisation of **prevention and screening strategies**;
- accurate **resource planning and budgeting**;
- evaluation of **intervention effectiveness**;
- estimation of the **social and economic burden of disease**.

Together, these measures constitute foundational tools in epidemiology and evidence-based public health decision making.

6.1.6. Morbidity with Temporary Work Disability

Temporary work-disability morbidity complements general morbidity analysis by describing diseases that result in **temporary absence from work** among the active population. It reflects both the health status and productivity losses.

The unit of observation is the **episode of temporary incapacity**, defined as each episode of illness that leads to absence from the work, from the onset until the return, regardless of cause recurrence.

Key indicators include **structural indices** (by causes and days lost) and **dynamic indices** (frequency, severity, and average duration), which support occupational health planning, prevention strategies, and comparative monitoring across time and enterprises.

6.1.5.1. Structural Indices

These indices express either the number of illness cases or the number of days of work incapacity caused by a specific disease, relative to the total number of cases or the total days of incapacity.

• Structure by causes:

$I_{sc} = \frac{nc}{Tnc}$ x 100

where:
Isc = index of structure by causes
nc = number of new cases with temporary work incapacity (TWI) due to a specific cause
Tnc = total number of new cases of TWI from all causes

• Structure by incapacity days:

Isd = = $\frac{Did}{Dit}$ x 100

where:
Isd = structure index by incapacity days
Did = number of TWI days generated by a specific disease
Dit = total number of incapacity days

These indices allow for the identification of the most frequent conditions among workers and of those generating the highest number of days of incapacity, thus providing information on the severity of the disease and conditions of the work environment.

For example, influenza may show **a high number of cases but few days of incapacity,** whereas tuberculosis may generate **fewer cases but long durations of absence.**

6.1.5.2. Dynamic Indices

These indicators highlight the **frequency and severity of the disease** and are used to compare the health status between time periods or between companies.

• Frequency Index of Temporary Work Incapacity (FITWI):

$F_{TWI} = \frac{Isl}{Ie}$ x 100

where:
Isl = number of initial sick-leave certificates
Ie = average number of insured employees

→This index reflects the **intensity of morbidity**, indicating the level of illness between personnel and the general working conditions.

• Severity Index (Se TWI):

$Se_{TWI} = \frac{D(i+c)}{Ie}$ x 100

where:
D(i+c) = number of sick-leave days (initial + continuation)
Ie = average number of insured employees

→This index reflects the **severity of the disease** and the **average duration of episodes of incapacity**.

• **Average Duration Index (Id):**

Id = $\frac{D(i+c)}{Ie}$ x 100 or I_d = = $\frac{Se\ TWI}{F\ TWI}$ x 100

where:
D(i+c) = number of sick-leave days (initial + continuation)
Ie = average number of insured employees

→This index shows the **average number of days of incapacity per case**, providing information on the effectiveness of treatment and the quality of medical care.

For accurate interpretation, indicators should be calculated **by sex and age group**, since morbidity (with or without work incapacity) is generally higher among women and increases with age.

The interpretation is **comparative**, as there are no universal threshold values. The results must be compared with similar companies or previous years.

Practical Example: In an enterprise with **1,000 employees**, there were **150 new TWI cases**, totalling **1,200 absence days**:

- Case rate = 150 / 1,000 × 100 = 15 cases per 100 employees
- Days rate = 1,200 / 1,000 × 100 = 120 days per 100 employees
- Average duration per case = 1,200 / 150 = 8 days per case

High severity or average-duration values can indicate **severe diseases, slow recovery**, or **limited access to medical services**.

Public Health and Occupational Medicine Relevance

These indices are useful because they:

- Highlight the **burden of disease** among the active population and the **economic impact of absenteeism**;
- Support **health care resource planning** and the design of workplace prevention measures;
- Contribute to the evaluation of the **performance of the health care system** and to the identification of occupational diseases or work-related conditions;
- Enable **longitudinal monitoring** of workforce health status over time.

6.2. Additional Indicators

6.2.1. Disability-Adjusted Life Years (DALY)

Disability-Adjusted Life Years (DALY) measure the **total burden of disease** by combining the years of life lost due to premature mortality with the years lived with disability or illness. Therefore, DALY captures the joint impact of both **mortality and morbidity** within a population.

DALY = YLL (Years of Life Lost) + YLD (Years Lived with Disability)

DALY Components

Years of Life Lost (YLL) This represents the number of years lost due to premature mortality and is calculated as the difference between the **standard life expectancy** and the **age at death** (equivalent to YPLL).

YLL = Target life expectancy − Age at death

Years Lived with Disability (YLD) YLD measures the years lived with a disease or disability, weighted according to the **severity of the condition**.

YLD = Prevalence of disease × Disability weight

Disability weights range from **0** (perfect health) to **1** (complete disability or death).

Practical Example YLL: A man dies from a myocardial infarction at the age of 50, while the standard life expectancy is 75.

YLL=75−50=25 years lost

YLD: Before his death, he lived with diabetes for 10 years. If the disability weight for diabetes is 0.2:

YLD = 10×0.2 = 2 years lived with disability

Total DALY:

DALY=25+2=27 DALY

Public Health Relevance

DALY is a key indicator to quantify the **overall burden of disease** in a population.

It supports **the establishment of priorities in health policy**, highlighting diseases that substantially affect both life expectancy and quality of life.

It is widely used by international institutions, including the **World Health Organisation (WHO)**, to monitor global disease patterns and evaluate population health trends over time.

6.2.2. Quality-Adjusted Life Years (QALY)

Quality-Adjusted Life Years (QALY) is an indicator that measures both **quantity and quality of life**. QALY integrates length of survival with a **quality-of-life weight** ranging from 0 (death) to 1 (perfect health).

One QALY represents **one year lived in perfect health**, whereas a year lived with impaired health contributes proportionally fewer QALY.

QALY = Duration of life lived × Quality-of-life weight

Duration of life lived: The number of years gained after a treatment or intervention.

Quality of life: A health status assessment on a scale of 0 to 1.

Practical Example: A patient receives treatment for a chronic disease that prolongs life by **10 years**, but the health-related quality of life during this period is assessed at **0.7**.

$QALY = 10 \times 0.7 = 7$

This means that although the individual lives 10 additional years, the **adjusted health outcome** is equivalent to 7 years of perfect health.

Using QALY to Compare Interventions

QALY enables a comparison of the **effectiveness of different medical interventions**. For example:

A cancer treatment adds **3 QALY**.

A cardiovascular intervention adds **5 QALY**.

When combined with cost data, QALY supports **cost-effectiveness analysis and guides** resource allocation decisions within healthcare systems.

Public Health Relevance

QALY is a fundamental tool in the evaluation of **health economics** and cost-utility analysis.

Interventions that produce more QALY at a lower cost are considered more efficient.

Governments and health insurers use QALY-based assessments to support **evidence-based funding and reimbursement decisions**.

6.2.3. Human Development Index (HDI).

The Human Development Index (HDI) is a composite indicator used worldwide to assess countries' progress in **human development**. Developed by the **United Nations Development Programme (UNDP)**, HDI integrates three fundamental dimensions of human well-being:

Life expectancy at birth. Reflects population health and longevity; higher life expectancy indicates a better overall health status.

Educational attainment, measured through:

- Mean years of schooling (average years of education among adults), and
- Expected years of schooling (years of education that a child entering school is expected to complete).
  This dimension reflects **access to and quality of education**.

Gross National Income (GNI) per capita, expressed in international dollars adjusted for **purchasing power parity (PPP)**, capturing **standard of living and economic access to resources**.

HDI Scoring

Each dimension is standardised on a **scale of 0 to 1**. The final HDI value is the **geometric mean** of the three components. Countries are grouped into four development categories:

- Very High (HDI ≥ 0.800);
- High (0.700–0.799);
- Medium (0.550–0.699);
- Low (HDI < 0.550).

Importance of HDI

HDI provides a broader perspective on national well-being than purely economic indicators such as GNI alone. Integrating **health, education, and income** allows a more comprehensive assessment of **quality of life and development opportunities**.

For example, a country may have a high GNI but a low HDI if education and health outcomes are poor.

Critiques and Limitations

- **Oversimplification:** HDI does not fully capture all aspects of human development, such as inequality, human rights, or environmental sustainability.
- **Neglect of inequality:** To address this, the **Inequality-Adjusted HDI (IHDI)** was introduced, which reduces HDI values in proportion to inequalities in education, health, and income.

HDI remains a valuable comparative tool for evaluating and monitoring human development across countries and regions, offering a broader analytical lens than economic metrics alone.

6.3. Classification of Diseases and Morbidity Management

The classification of diseases and the management of morbidity are essential for the organisation and evaluation of health data at the global level. The World Health Organisation (WHO) developed the **International Classification of Diseases (ICD)** to enable the standardised recording of all conditions and diseases. This classification allows countries to collect and interpret health data in a uniform way, supporting the monitoring of health trends, the evaluation of intervention effectiveness, and the improvement of public health planning.

The ICD is a standardised coding system divided into **21 chapters (in ICD-10)** and multiple subdivisions, each alphanumeric code corresponding to a specific condition or disease. Disease coding enables accurate identification and documentation of diagnoses, facilitates international medical communication, and provides a common basis for the analysis of morbidity and mortality.

Examples of Classified Diseases

In ICD-10, each disease or condition is assigned a specific code that reflects its category and subcategory:

- **Essential (primary) hypertension — I10.** This condition is classified as circulatory system diseases. It is a common chronic disorder that requires continuous monitoring in high-risk populations.
- **Malignant neoplasm of the lower-inner quadrant of the breast — C50.18.** Malignant tumours are classified according to location and histology, and their coding supports the surveillance of cancer types and distribution within populations.
- **Marfan syndrome — Q87.4.** Congenital malformations, deformities, and chromosomal abnormalities are included in codes Q00–Q99.

Evolution of ICD and Importance of Updates

Over time, the ICD has been revised to reflect new medical discoveries and evolving health system needs. The most recent version, **ICD-11**, released in 2019 and available since January 1, 2022 (although not yet fully implemented in many systems), introduces significant improvements for data precision and usability. These include additional codes for new diseases, mental health conditions, genetic disorders, emerging infectious diseases, and antimicrobial resistance.

6.3.1. The Importance of Classification in Morbidity Management

Standardised disease classification enables structured morbidity management and provides a solid foundation for clinical and public health decision making. Morbidity management involves monitoring, treating, and preventing diseases, and accurate classification improves the efficiency of these processes.

Benefits of Classification for Morbidity Management

- **Epidemiological analysis.** The ICD classification supports the monitoring of disease incidence and prevalence between regions and population groups. The resulting data enable the identification of public health patterns and inform preventive strategies and policy development.
- **Monitoring chronic diseases.** Chronic diseases such as diabetes, hypertension, and respiratory diseases can be tracked more effectively using ICD codes, facilitating access to information on the evolution of the disease and treatment outcomes at national and international levels.
- **Setting of priorities for public health.** Morbidity data help identify the most significant health problems that affect the population, allowing resources to be allocated to prevention and treatment. For example, in areas with a high incidence of hypertension, resources can be directed toward screening and health education.
- **Economic impact assessment.** ICD coding supports the analysis of costs associated with various diseases and treatments, which is essential for budgeting and financial planning in health systems.
- **Clinical research and development of guidelines.** ICD-based data is used in research to identify disease trends and to support the development of evidence-based treatment guidelines.

6.3.2. Use of ICD in Different Aspects of Patient Care

The ICD is used not only for statistical purposes, but also in daily clinical and administrative practice:

- **Billing and health insurance.** ICD codes are used in medical billing and to validate payments made by insurance providers, which reimburse services only when associated with specific diagnostic codes.
- **Classification of disease severity.** ICD codes allow for detailed categorisation of diseases, including subcategories that describe severity and type. For example, respiratory diseases have different codes for acute and chronic bronchitis, allowing more granular monitoring.

6.3.3. Morbidity Management in Clinical Practice

Morbidity management involves organising and coordinating care to reduce the impact of disease on patients and improve their quality of life. The ICD facilitates this process in several ways:

Risk stratification. Using ICD classification, patients can be grouped according to risk based on chronic conditions, allowing better allocation of resources and earlier preventive interventions.

Personalised care. Detailed classification enables clinicians to tailor care plans according to the type and severity of a patient's condition, improving monitoring and ensuring that treatment strategies are adapted to individual needs.

Comorbidity management. ICD codes support the identification of patients with multiple conditions, which is essential in coordinating care and preventing complications in different medical specialities.

Challenges and Limitations of ICD Use in Morbidity Management

Despite its considerable utility, the use of ICD also presents certain challenges:

Coding complexity. With thousands of codes, some conditions may be difficult to classify accurately and require specialised knowledge and training.

Continuous update. Emerging diseases and evolving medical knowledge require regular updates. The transition between ICD versions can be complex and requires staff training.

Limited specificity in some categories. Although highly detailed, certain new or rare disease subtypes may not be fully represented, which requires additional clinical specification.

The **International Classification of Diseases (ICD)** is an invaluable tool in public health and clinical care. It not only facilitates global analysis of morbidity data, but also supports individualised patient management and coordination of care for comorbid conditions. The ICD provides a solid foundation for monitoring and controlling chronic diseases, optimising resource allocation, advancing clinical research, and setting public health priorities. Students and healthcare professionals must develop a complete understanding of this classification and its applications to improve quality of care and improve patient outcomes.

6.4. Factors Influencing the Distribution of Morbidity

Morbidity refers to the presence of diseases, disorders, or poor health conditions within a population. The distribution of morbidity is not uniform; rather, it varies according to multiple determinants that influence the occurrence, spread, and severity of diseases. This chapter examines the main factors driving variations in morbidity between different populations and geographic regions.

6.4.1. Demographic Factors

6.4.1.1. Age

Age is one of the most important factors that influence the distribution of morbidity. The incidence and prevalence of many diseases vary considerably between age groups:

Infants and children. This age group is more vulnerable to infectious diseases (e.g., measles, bronchiolitis, acute respiratory infections) and developmental disorders. Malnutrition and infectious diseases are particularly common among children in low-income and developing countries.

Adolescents and young adults. In this group, sexually transmitted infections (e.g., HIV, gonorrhoea), mental health disorders, and conditions associated with risk-taking behaviours (e.g., traffic accidents, substance use) are more common.

Middle-aged adults. Non-communicable diseases such as hypertension, type 2 diabetes, and obesity are becoming increasingly prevalent. Stress-related and psychosomatic conditions also occur more frequently.

Older adults. Among the elderly, the incidence of chronic and degenerative diseases increases substantially, including cardiovascular disease, diabetes, osteoporosis, and dementia. Morbidity in this age group is characterised by long-term conditions and disability.

6.4.1.2. Sex

Biological sex and gender-related behavioural differences influence morbidity patterns through both biological and social mechanisms:

Women experience higher morbidity associated with pregnancy and childbirth, as well as sex-specific conditions such as breast cancer and osteoporosis. They are also more likely to experience affective disorders (e.g., depression, anxiety) and autoimmune diseases.

Men tend to have higher morbidity associated with risk behaviours such as smoking, excessive alcohol consumption, and participation in hazardous activities, increasing the incidence of cardiovascular disease, lung cancer, and fatal injuries.

6.4.1.3. Ethnicity and Race

Ethnicity and race influence the distribution of morbidity through genetic, cultural, and socio-economic mechanisms:

African-American populations. In the United States, these populations are at increased risk of hypertension, type 2 diabetes, and cardiovascular disease. Genetic predisposition, combined with barriers to access to healthcare, plays a significant role.

Indigenous populations. In many countries, indigenous groups experience higher rates of infectious diseases and malnutrition, along with a growing burden of chronic diseases due to limited access to health services.

6.4.2. Socio-economic Factors

6.4.2.1. Income Level and Living Conditions

Low-income individuals and poor living conditions are more exposed to infectious diseases, malnutrition, and health problems related to inadequate hygiene and limited access to clean water.

Poverty. People living in poverty have reduced access to healthcare and preventive services, leading to increased morbidity from conditions that could otherwise be treated or prevented (for example, infectious and respiratory diseases).

Housing conditions. Overcrowded and unsanitary housing facilitates the spread of infectious diseases such as tuberculosis, pneumonia, and skin infections.

6.4.2.2. Education

Education influences the distribution of morbidity through health literacy, health-seeking behaviour, and the ability to make informed decisions.

Education and prevention. Individuals with higher levels of education are more likely to adopt preventive behaviours such as vaccination, healthy nutrition, and regular medical check-ups, reducing the risk of chronic and infectious diseases.

Occupation and Work Environment

Certain occupations pose higher morbidity risks due to exposure to specific hazards, such as toxic chemicals, strenuous physical labour, or psychological stress.

Mining and construction. Workers in these sectors face a higher risk of occupational accidents and pulmonary diseases (e.g. silicosis, asbestosis).

Office-based occupations. Sedentary work is associated with a higher risk of obesity and cardiovascular disease.

6.4.3. Behavioural and Lifestyle Factors

6.4.3.1. Nutrition

Dietary habits play a major role in morbidity distribution, particularly in the development of non-communicable chronic diseases:

Diets high in fats and sugars increase the risk of obesity, diabetes, hypertension, and cardiovascular disease.

Malnutrition remains a major source of morbidity in low-income regions, weakening immunity and increasing susceptibility to infection and chronic disease.

6.4.3.2. Smoking and Alcohol Consumption

Smoking is a major risk factor for lung cancer, COPD, and cardiovascular disease, while excessive alcohol consumption is associated with liver disease, cancers, and trauma resulting from accidents.

6.4.3.3. Physical Activity and Sedentary Behaviour

Physical inactivity is associated with an increased risk of obesity, diabetes, cardiovascular disease, and certain cancers. Sedentary lifestyles are an increasingly important determinant of morbidity, particularly among urban populations and office workers.

6.4.4. Environmental Factors

6.4.4.1. Pollution

Air, water, and soil pollution is the main contributor to morbidity, especially in urban environments.

Air pollution increases the risk of respiratory diseases (for example, asthma, COPD) and cardiovascular disease. In cities with high pollution levels, morbidity and mortality are significantly higher among children and the elderly.

6.4.4.2. Climate Change

Climate change contributes to an increased incidence of infectious diseases such as malaria and dengue fever, as warmer and more humid climates favour the spread of pathogens and vectors such as mosquitoes.

Heat waves can increase morbidity related to cardiovascular and respiratory diseases, particularly among vulnerable populations such as older adults.

6.4.5. Genetic Factors and Hereditary Predispositions

Genetic inheritance influences susceptibility to certain diseases. Some conditions are caused by inherited genetic mutations, while others arise from gene–environment interactions.

Rare genetic diseases. Conditions such as cystic fibrosis, sickle cell disease, and Huntington's disease are caused by pathogenic gene variants and show morbidity patterns linked to hereditary transmission.

Genetic predisposition to chronic diseases. Some populations have a higher genetic susceptibility to chronic diseases such as type 2 diabetes or hypertension.

6.4.6. Access to Healthcare and Health System Performance

Unequal access to quality healthcare is a key determinant of morbidity distribution. Populations lacking access to treatment and prevention experience higher morbidity and more severe complications of otherwise treatable diseases.

Access to preventive care. Limited access to vaccination and screening programmes leads to a higher incidence of preventable or late-detected diseases (e.g., cervical cancer, breast cancer).

Quality of health services. Regions with underdeveloped health systems experience a higher prevalence of treatable and preventable diseases, including infectious and maternal conditions.

The distribution of morbidity is shaped by a complex interaction of demographic, socioeconomic, behavioural, genetic, and environmental factors. Understanding these determinants supports the identification of vulnerable populations and the design of targeted public health policies that aim to reduce the burden of disease. The unequal distribution of morbidity underscores the importance of focused interventions to reduce health inequities and improve access to prevention and treatment.

6.5. Implications for the Future: Global Demographic Change

The ageing of the population is one of the most significant global demographic transformations. In high-income countries, the proportion of older adults is increasing rapidly, putting increasing pressure on healthcare and pension systems. Chronic diseases associated with ageing, such as dementia and cardiovascular disease, are emerging as major public health challenges.

Urbanisation represents another major demographic trend. By 2050, approximately **68% of the global population** is estimated to live in urban areas. This shift generates challenges related to pollution, access to healthcare services, and the increasing incidence of lifestyle-related diseases such as obesity and type 2 diabetes.

7. Family Health

Learning Objectives

By the end of this chapter, students should be able to:

- **Recognize the family as a key social determinant of health** across the life course;
- **Identify major family structures and life-cycle stages** relevant to public health;
- **Describe common family-level health risks and protective factors**, including intergenerational effects;
- **Understand the public health role of family planning and family-oriented health programs;**
- **Integrate family health considerations into prevention and health promotion strategies.**

7.1. The Family as a Key Social Determinant of Health

From a public health perspective, the family represents one of the most influential social determinants of health. It is the primary social environment in which health-related behaviours, attitudes, and coping mechanisms are formed and reinforced throughout the course of life.

Families shape **early life exposures** that have long-term effects on health, including nutrition, housing conditions, emotional security, and access to education and healthcare. Evidence shows that health trajectories established in childhood—such as dietary patterns, physical activity, and stress regulation—are strongly influenced by family norms and resources and tend to persist into adulthood.

The family also plays a central role in the transmission of **health behaviour.** Behaviours such as smoking, alcohol consumption, dietary habits, and healthcare-seeking practices often cluster within families, reflecting shared environments as well as social learning processes. In this way, families can function both as **protective settings** that promote healthy behaviours and as **risk environments** that increase exposure to harmful factors.

From a life-course and intergenerational perspective, the family mediates the transmission of **social advantage and disadvantage**. Socioeconomic position, educational attainment, and living conditions within the family influence health literacy, access to preventive services, and resilience to illness. These influences extend beyond one generation, contributing to persistent health inequalities at the population level.

In public health practice, recognising the family as a social determinant shifts the focus from isolated individuals to **households and social units**. This perspective supports family-centred prevention strategies, such as maternal and child health programmes, family planning services, and interventions addressing domestic environments. Integrating family-level considerations into public health policy and primary care is therefore essential for effective disease prevention, health promotion, and equity-orientated action.

7.2. Family Structures and Their Public Health Relevance

Family structure influences health outcomes by shaping social support, caregiving capacity, economic stability, and exposure to risk or protection throughout the life course. From a public health perspective, understanding family structures is important because preventive interventions and health services often operate at the household level rather than the individual alone.

The **nuclear family**, typically made up of parents and their children, is common in many modern societies. This structure allows for more direct coordination of health-related decisions, such as vaccination, nutrition, and utilisation of healthcare. However, limited internal support can increase vulnerability during periods of illness, disability, or economic stress, particularly when external social services are weak.

The **extended family**, which includes additional relatives such as grandparents or other relatives, often provides broader social and practical support. This structure can improve childcare, elder care, and emotional resilience and may buffer the impact of illness or socioeconomic hardship. At the same time, extended families can face challenges related to overcrowding, resource distribution, and complex decision making, which can affect health behaviours and access to care.

Family structures also interact with **socioeconomic and cultural contexts**, influencing health equity. Single-parent households, families affected by migration, or families caring for dependent older adults may experience increased health risks and barriers to healthcare. These structural vulnerabilities are particularly relevant for public health planning, as they help identify populations that may benefit from targeted prevention and social support.

For public health practice, the key implication is that **family structure modifies both risk and resilience**. Effective health promotion, disease prevention, and primary care strategies must therefore be adaptable to diverse family forms. Family-sensitive policies and programmes, such as maternal and child health services, home care, and community support initiatives, are essential to address health needs equitably and effectively at the population level.

7.3. The Family Life Cycle and Health across the Life Course

The family life cycle describes the predictable stages through which families evolve over time, from formation to dissolution. Each stage is associated with specific biological, psychological, social, and economic changes that influence health risks, health behaviours, and healthcare needs. From a public health perspective, the family life cycle is highly relevant because **health risks and prevention opportunities cluster in particular stages of life** and often affect multiple family members simultaneously.

Understanding the family life cycle allows public health systems to design **timely, targeted, and proportionate interventions**, aligned with the life-course approach. Health outcomes in later life are strongly influenced by the exposures, behaviours, and social conditions experienced earlier within the family context.

7.3.1. Family Formation

Family formation marks the transition to a shared household and often coincides with reproductive decision-making. This stage is critical for establishing long-term health behaviours and access to preventive care.

Public health relevance:

- Reproductive and preconception health;
- Prevention of unintended pregnancies;
- Screening for genetic, infectious, and chronic diseases;
- Mental health support during major life transitions.

Health interventions at this stage focus on **primary prevention**, including family planning services, sexual and reproductive health education, and early mental health support.

7.3.2. Family Expansion (Early Parenthood)

This stage includes pregnancy, childbirth, and early child-rearing. It represents a **high-impact window** for public health, as early life conditions strongly shape health trajectories throughout life.

Public health relevance:

- Maternal and infant health;
- Antenatal and postnatal care;
- Childhood vaccination programmes;
- Injury prevention and safe home environments;
- Early childhood nutrition and development.

Adverse exposures during this stage—such as poverty, stress, or inadequate access to care—can produce **long-lasting biological and social effects**, reinforcing health inequalities across generations.

7.3.3. Families with Children and Adolescents

As children grow, families face new health challenges related to education, socialisation, and emerging risk behaviours. Adolescence is a particularly sensitive period for both physical and mental health.

Public health relevance:

- Prevention of risk behaviours (tobacco, alcohol, drugs);
- Mental health promotion and suicide prevention;
- Nutrition, physical activity, and obesity prevention;
- Sexual and reproductive health education.

Family support and supervision during this stage play a protective role, while family dysfunction or instability may increase vulnerability to mental health problems and risky behaviours.

7.3.4. Family Contraction (Children Leaving Home)

This stage occurs when children reach adulthood and become independent. Although often overlooked, it is associated with significant psychosocial changes for parents.

Public health relevance:

- Midlife health risks (cardiovascular disease, metabolic disorders);
- Mental health challenges related to role change;
- Reinforcement of preventive behaviours (screening, lifestyle modification).

Public health strategies emphasise **secondary prevention**, including screening programmes and reducing the risk of chronic diseases.

7.3.5. Ageing Families and Caregiving

As family members age, the family often becomes the primary context for caregiving, particularly for chronic diseases, disabilities, or cognitive decline.

Public health relevance:

- Management of chronic diseases;
- Prevention of disability and frailty;
- Support for informal caregivers;
- Care for dementia and prevention of social isolation.

Families play a central role in long-term care, highlighting the importance of **integrated health and social care systems** and community-based support.

7.3.6. Family Dissolution and Bereavement

Family dissolution may occur due to death, separation, or a major structural change. This stage is associated with increased health vulnerability, particularly among older adults.

Public health relevance:

- Increased risk of depression, loneliness, and functional decline;
- Higher healthcare utilisation;
- Need for social support and community integration.

Public health responses focus on mental health services, social inclusion, and protection of vulnerable individuals.

Public Health Implications

In all stages, the family life cycle illustrates how **health risks accumulate, interact, and transmit across generations**. Early interventions yield long-term benefits to the population, while failures to act can establish health inequities.

From a public health perspective, the family life cycle:

- Supports the **life-course approach;**
- Justifies early and sustained prevention;

- Emphasis on intergenerational health effects;
- Reinforces the need for family-centred policies and services.

7.4. Indicators of Family Health

Family health indicators are measurable characteristics used to assess the health status, needs, and vulnerabilities of families as functional social units. In public health, these indicators support **population monitoring**, **risk identification**, **planning of targeted interventions**, and **evaluation of family-centred policies**.

Because families shape health behaviours, resource distribution, and risk exposure, family-level indicators complement individual and population indicators.

7.4.1. Demographic Indicators

Demographic indicators describe the basic structure of the family and help predict health needs throughout life.

Key indicators include:

- Family size and composition;
- Age distribution of members;
- Presence of dependent children or older adults;
- Sex structure and generational overlap.

Public health relevance: These indicators inform planning for maternal and child health services, age-related care, dependency ratios, and social support needs.

7.4.2. Health and Medical Indicators

Medical indicators reflect the burden of disease and health risks clustered within families.

Key indicators include:

- Presence of chronic diseases within the family;
- Aggregation of non-communicable diseases (e.g., diabetes, hypertension);
- Shared mental health conditions;
- Disability or long-term care needs.

Public health relevance: The aggregation of family diseases highlights **shared genetic, behavioural, and environmental determinants**, supporting targeted prevention and early detection strategies.

7.4.3. Behavioural and Lifestyle Indicators

These indicators assess health-related behaviours commonly shared among family members.

Key indicators include:

- Dietary patterns;
- Physical activity levels;

- Tobacco, alcohol, and substance use;
- Health-seeking behaviours (use of preventive services, screening, vaccination).

Public health relevance: Family environments strongly influence behaviour adoption, making families a key unit for lifestyle-based prevention programmes.

7.4.4. Psychosocial and Relational Indicators

Psychosocial indicators capture the quality of relationships and the emotional climate within the family.

Key indicators include:

- Level of emotional support;
- Presence of conflict, violence, or neglect;
- Social cohesion and communication patterns.

Public health relevance: Strong family support protects mental health, while dysfunctional family dynamics are associated with greater risks of depression, substance use, and poor health outcomes.

7.4.5. Socioeconomic Indicators

Socioeconomic indicators reflect the material conditions that affect family health.

Key indicators include:

- Household income and financial stability;
- Employment status of adult members;
- Education level;
- Housing conditions.

Public health relevance: Socioeconomic disadvantage at the family level is a major driver of health inequalities and limited access to preventive and curative services.

7.4.6. Access to Health and Social Services

These indicators evaluate the ability of the family to receive appropriate care and support.

Key indicators include:

- Health insurance coverage;
- Access to primary care;
- Utilisation of preventive services;
- Availability of social support programmes.

Public health relevance: Access barriers increase preventable morbidity and perpetuate intergenerational disadvantage.

7.5. Family Planning

Family planning enables families to control the number and timing of children, contributing to economic stability and well-being.

Prevention of unwanted pregnancies: access to modern contraceptive methods reduces unwanted pregnancies and abortions, protecting women's health.

Reduction of maternal and infant risks: appropriate spacing of pregnancies improves maternal and child health and helps decrease mortality in these vulnerable groups.

Impact on child development: families that plan births generally have better resources for education and care, offering children greater opportunities for optimal development.

7.5. Family Health Programmes

To support family health, there are several types of dedicated programmes, including:

Health education: programmes on nutrition, physical activity, and prevention in all stages of family development.

Reproductive health and family planning services: improved access to contraceptive information and methods, as well as prenatal and postnatal care.

Psychological and social support programmes: counselling services for family relationships and mental health, helping families better manage conflict and stress.

Family health represents an interdependent system in which the health of each member is linked to the well-being of the entire structure. Families move through various stages of formation and dissolution, each associated with specific health challenges. Public health interventions focused on family health are essential for building healthy and balanced communities. Family health indicators support monitoring and assistance efforts, while appropriate programmes allow families to positively influence the health of all their members.

8. Types of Epidemiological Studies

Learning Objectives

By the end of this chapter, students should be able to:

- **Define and describe** the major epidemiologic study designs, including descriptive, analytical, observational, and experimental studies;
- **Explain** the methodological principles underlying cohort, case-control, cross-sectional, and randomized controlled trials;
- **Differentiate and compare** study designs in terms of purpose, structure, temporality, cost, feasibility, and strength of evidence;
- **Interpret** key epidemiologic measures (incidence, prevalence, risk, odds, and effect estimates) within the context of specific study designs;
- **Apply** inclusion and exclusion criteria to construct an appropriate study population aligned with a defined research question;
- **Identify and analyze** potential sources of bias, confounding, and chance, and **assess** their implications for internal validity;
- **Evaluate** causal inference using Bradford Hill criteria and **judge** whether observed associations are likely to be causal;
- **Critically appraise** the methodological quality of published studies, including systematic reviews and meta-analyses;
- **Synthesize** evidence across multiple studies to formulate balanced, evidence-based interpretations relevant to public health and clinical practice;
- **Design and justify** an appropriate study framework (including hypothesis, PICO formulation, and design choice) for a given epidemiologic problem.

8.1. Formulating Research Hypotheses

A research hypothesis is a clear and testable statement about the relationship between two or more variables that researchers aim to confirm or refute. In epidemiology and public health, a hypothesis is typically formulated to explore a relationship between an exposure factor (for example, smoking or diet) and an outcome (such as the occurrence of a disease). A well-formulated hypothesis is essential to define the study objectives and select the appropriate study design.

8.1.1. Steps in Formulating a Hypothesis

To correctly formulate a hypothesis, the following stages are taken:

Observation of a phenomenon. A research hypothesis often begins with an observation. For example, a higher prevalence of diabetes can be observed among people with a sedentary lifestyle. This observation raises questions about a possible causal relationship.

Review of the existing literature. Researchers review previously published studies to understand what is already known about the observed relationship. This helps to identify the knowledge gaps that the new study may address.

Formulation of the research question. Based on observations and literature review, a research question can be formulated, for example: "Is there an association between lack of physical activity and the risk of developing diabetes?"

Formulation of the hypothesis. The hypothesis must be clear and testable. For example: "Individuals with a sedentary lifestyle are at greater risk of developing diabetes compared to those who are physically active."

8.1.2. Characteristics of a Good Hypothesis

Clarity. The hypothesis must clearly state what is being investigated.

Specificity. It must be specific enough to be tested using available research methods. A good example is a hypothesis that specifies the exact relationship between exposure (smoking) and outcome (lung cancer).

Testability. The hypothesis must be empirically verifiable, which means that there must be a methodological approach through which it can be tested.

8.1.3. What Do PICO/PECO Mean?

PICO and PECO are frameworks used to structure research questions, especially in clinical studies and meta-analyses. They help break down a complex problem into clear components and focus on comparing the effects of an intervention or exposure.

PICO is used in interventional or treatment-focused research:

P = Population: the specific group of individuals under study (e.g., patients with hypertension).

I = Intervention: the treatment or action applied (e.g., administration of a new antihypertensive drug).

C = Comparison: the control condition (standard treatment, placebo, or no intervention).

O = Outcome: the effect measured to evaluate the success of the intervention (e.g., reduction in blood pressure).

PECO is mainly used in studies on exposure and risk factors:

P = Population: the study population.

E = Exposure: risk factor (e.g., smoking, unhealthy diet, pollution).

C = Comparison: the non-exposed group or the group with a different exposure level.

O = Outcome: the investigated health outcome (e.g., onset of the disease or development of symptoms).

8.2. The Hierarchy of Evidence in Scientific Studies

Not all scientific studies provide the same level of reliability. Some designs generate stronger and more convincing evidence than others, which is reflected in the **evidence pyramid**. This structure classifies studies according to their ability to produce strong, reliable and generalisable findings.

8.2.1. Structure of the Evidence Pyramid

From the base (weaker evidence) to the top (stronger evidence), the studies are organised as follows:

- Expert opinion (without empirical evidence);
- Case reports and case series;
- Observational studies (cross-sectional, cohort, case-control);
- Non-randomised controlled clinical trials;
- Randomised controlled clinical trials (RCTs);
- Systematic reviews and meta-analyses.

8.2.2. Why Evidence Hierarchy Matters

This hierarchy is important because not all study designs are equally rigorous or reliable. For example, when evaluating the effectiveness of a therapy, a randomised clinical trial provides much more convincing evidence than expert opinion or a case report. Furthermore, systematic reviews and meta-analyses synthesise results from multiple studies, reducing the likelihood that findings are random or biased.

8.3. Observational Studies

In observational studies, researchers observe and analyse relationships between variables **without intervening**. These studies are essential to understand the distribution of diseases and associated risk factors.

8.3.1. Expert Opinion (Without Empirical Evidence)

Expert opinion consists of recommendations or guidelines issued by highly experienced professionals in the medical field, without being based on strong empirical data. It is most common when there are no clear studies or when the available findings are contradictory.

8.3.1.1 Characteristics:

- Based on professional experience and expertise;
- May include an informal literature review;
- Used when empirical evidence is limited or the field is emerging.

Advantages:

- Easy to obtain and useful in urgent situations;
- Valuable in new or poorly researched domains.

Disadvantages:

- High risk of bias due to lack of supporting data;
- It cannot be used to draw firm conclusions or guide large-scale policies.

8.3.1.2. Example
During the early phases of the COVID-19 pandemic, many clinical recommendations were based on expert opinion due to limited evidence from randomised or observational studies.

8.3.2. Descriptive Studies (Case Reports and Case Series)

Case reports and case series are detailed descriptions of a single patient or a small group of patients who have a disease, undergo a procedure, or receive a specific treatment.

8.3.2.1. Characteristics:

- Focus on one case or a small number of cases;
- Lack a control group, therefore, cannot establish causality;
- Useful to report rare or new clinical phenomena.

Advantages:

- Allow detailed documentation of unusual cases or innovative treatments;
- Help generate hypotheses for future research.

Disadvantages:

- Limited generalisability due to small sample size;
- Cannot demonstrate cause-and-effect relationships.

8.3.2.2. Example:
A case report may describe a rare condition that occurs after the administration of a new drug, such as a reported case of myocarditis following COVID-19 vaccination, which may later lead to larger studies.

8.3.2.3. Methodology:

- Detailed description of patient history;
- Clinical evaluation, diagnosis, treatment, and outcomes;
- Literature discussion to contextualise the case.

8.3.3. Cross-Sectional Studies

Cross-sectional studies measure both exposure and outcome **at the same time**, providing a "snapshot" of disease or risk factor prevalence in a population.

8.3.3.1. Characteristics:

- Data collected at a single moment;
- Cannot determine causality but may suggest associations;
- Common in epidemiology for prevalence assessment.

Advantages:

- Relatively low cost and easy to carry out;
- Useful to estimate the prevalence of diseases and risk factors.

Disadvantages:

- Do not provide temporal information (cannot determine whether exposure preceded outcome);
- Subject to selection and reporting bias.

8.3.3.2. Example:

A cross-sectional study can assess the prevalence of arterial hypertension in an urban adult population, measuring blood pressure, and analysing associated risk factors (e.g., diet, physical activity).

PECO-Based Hypothesis Example:

P: Urban adult population

E: Low dietary fibre intake (< 25 g/day)

C: Adequate fibre intake (≥ 25 g/day)

O: Prevalence of hypertension

Hypothesis:

"In the urban adult population (P), low consumption of plant-based dietary fibre (E) is associated with a higher prevalence of hypertension (O), compared to individuals who consume a sufficient daily intake of fibre (≥ 25 g/day) (C)."

8.3.3.3. Methodology:

- Selection of a target population
- Simultaneous measurement of exposure (e.g., fibre intake) and outcome (e.g., hypertension)
- Statistical analysis to identify associations

8.3.4. Case-Control Studies

Case-control studies are retrospective studies that compare patients who have a disease (cases) with people who do not have the disease (controls) and investigate their prior exposure to potential risk factors (Figure 6).

8.3.4.1. Characteristics:

- They are ideal for rare diseases or diseases with long latency periods.
- They compare previous exposures among cases versus controls.

Advantages:

- Suitable for studying rare diseases;
- Can be conducted relatively quickly and at low cost.

Disadvantages:

- Vulnerable to selection bias and recall bias (patients may remember past exposures differently);
- Cannot clearly demonstrate causality.

8.3.4.2. Examples of Use

A case-control study can compare women with breast cancer with women without breast cancer to evaluate whether they had previously been exposed to hormone replacement therapy.

Formulating the hypothesis (PECO):

Example:

P (Population): Women of the general population

E (Exposure): Hormone replacement therapy (HRT)

C (Comparison): No hormone replacement therapy

O (Outcome): Risk of breast cancer

Hypothesis:
"Women who use hormone replacement therapy (E) are at higher risk of developing breast cancer (O) compared to women who do not use HRT (C)."

8.3.4.3. Methodology

Cases (patients with the disease) and controls (without the disease) are selected.

Past exposures are investigated, and the **odds ratio (OR)** is calculated to assess the associated risk.

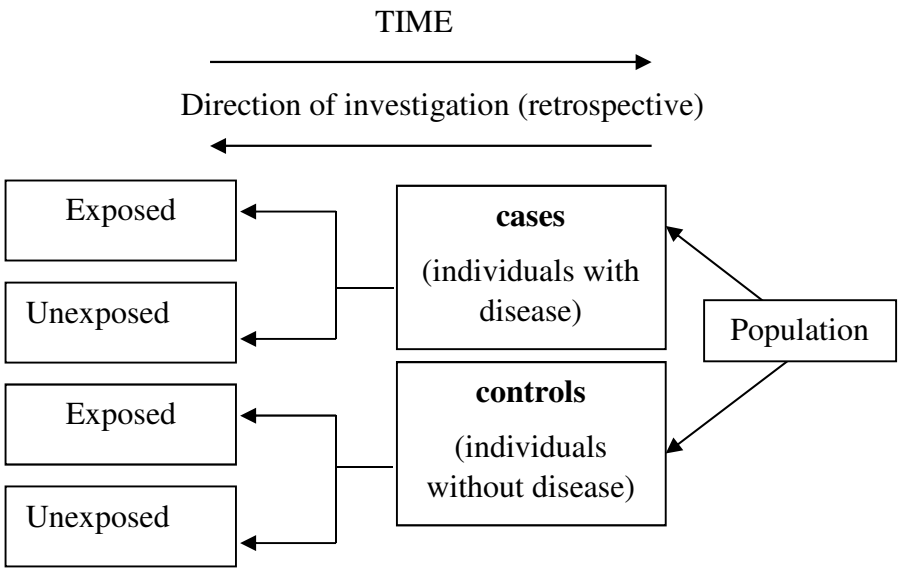

Figure 6. Diagram of a Case-Control Study

Selection of the Case Group

The first step in selecting cases is to define diagnostic criteria. For some diseases, standardised, widely accepted criteria exist; for others, the researcher must formulate clear and precise criteria based on clinical, histological, or coding systems (e.g., ICD-10).

It is also important to define **where and when** cases are collected and the source population must be clearly identified. The case group may consist of:

- hospitalised patients;
- a specific population (for example, patients from a defined region);
- cases belonging to special categories, such as occupational diseases.

Case-control studies usually include **incident cases** (newly diagnosed disease) to avoid confusion related to survival effects or reverse causality. This approach helps prevent the inclusion of patients who may have had a better prognosis and who could alter the relationship between exposure and disease.

In rare diseases, **prevalent cases** can sometimes be included; however, this must be explicitly stated in the study. Prevalent cases may introduce selection bias, as certain exposures or risk factors may not be directly related to the disease itself, but rather to survival, treatment received, or comorbidities. Therefore, researchers must remain transparent and acknowledge the potential limitations associated with including prevalent cases to avoid erroneous conclusions.

Selection of the Control Group

The control group must be similar to the case group, except that the controls do not have the disease being studied. When cases are drawn from a sample of the general population, the control group should be selected from the **same population**.

A well-chosen control group should not have other conditions related to the risk factor under investigation. For example, in a study that examined the association between alcohol consumption and a specific disease, controls should not have diseases related to alcohol intake.

Cases and controls can be **matched** on factors such as age and sex. Matching facilitates a more accurate comparison between groups; however, excessive matching criteria may complicate the study design.

Composition of the Control Group

The control group may consist of the following:

- individuals from the general population: easy to access, but some may never have been at risk of exposure;

- hospital patients: medically similar to cases, but may introduce bias related to causes of hospitalisation;

- friends or relatives: may share environmental or genetic characteristics with cases, but are not representative of the general population.

In some situations, the use of **two control groups** may be beneficial in testing multiple hypotheses. For example, in a liver cancer study, a control group may consist of patients with cirrhosis and another of healthy individuals, helping to clarify whether the disease is associated with a direct or indirect risk factor.

Including more than one control per case (e.g., two controls per case) increases study power; however, beyond four controls per case, the statistical benefit becomes minimal.

8.3.4.4. Methods for Assessing Exposure

To collect information on participant exposure, researchers may use:

- questionnaires;
- medical records and registries;
- biological samples;
- interviews with relatives or proxies.

At this stage, it is essential to minimise **systematic errors (bias)**. For example:

- participants may incorrectly recall past exposures (**recall bias**);
- if the interviewers know who is a case and who is a control, their assessments may be unintentionally influenced (**observer bias**).

Data must therefore be collected carefully to avoid these issues.

Sometimes, the disease itself may alter the exposure information (**misclassification bias**). The only exception is genetic exposure, which does not change over time.

Data collected are typically organised into a **2 × 2 contingency table (Table 3):**

Table 3. Contingency Table for Case-Control Studies

Example	**Cases**	**Controls**	**Total**
Exposed	a	b	a + b
Non-exposed	c	d	c + d
Total	a + c	b + d	a + b + c + d

The starting samples are **a + c** (case group) and **b + d** (control group). The objective is to determine **a** and **b**, that is, the frequency of exposure among cases and controls.

In this situation, the strength of association is expressed using the **Odds Ratio (OR).**

8.3.4.5. Odds Ratio and Interpretation

Case-control studies do not allow for a direct calculation of risk or incidence rates because the population is not followed over time; instead, cases and controls are selected. Therefore, the **Odds Ratio (OR)** is used to evaluate the association between exposure and outcome.

Odds Ratio formula:

$$OR=\frac{a*d}{b*c}$$

Example

Assume that we investigate the association between smoking and lung cancer (Table 4).

Table 4. Example of a Contingency Table

Example	Cases (Lung cancer)	Controls (No cancer)	Total
Smokers (E)	150	50	200
Non-smokers (NE)	100	200	300
Total	250	250	500

Using the OR formula:

OR = (150×200) / (50×100) = 6

Interpretation of Results

Case-control studies retrospectively assess whether there is an association between exposure (e.g., smoking) and outcome (e.g., lung cancer). Instead of directly estimating disease risk, they use the **Odds Ratio (OR)** to quantify the strength of association.

OR > 1: exposure is associated with a higher likelihood of disease;

OR = 1: no association between exposure and disease;

OR < 1: exposure is associated with a lower likelihood of disease (potential protective factor).

Example:
Suppose that a case-control study on alcohol consumption and liver cancer yields **OR = 2.5**.

Interpretation:

OR = 2.5 suggests a strong association: people who consume alcohol have **2.5 times higher odds** of developing liver cancer compared to non-drinkers.

However, this result **does not prove causality**.

8.3.4.6. Confidence Interval (CI)

Ideally, the OR should be accompanied by a **95% confidence interval (CI)**. If the CI does not include 1, the association is statistically significant.

Example:

OR = 2.5; 95% CI: **1.8–3.5** → statistically significant association.

OR = 2.5; 95% CI: **0.8–3.5** → cannot draw firm conclusions, as 1 is within the CI.

Limitations:
Case-control studies are prone to **recall bias**, as participants must remember past exposures. Additionally, selection of cases and controls can introduce **selection bias**.

8.3.5. Cohort Studies

Cohort studies follow a group of individuals over time to observe the occurrence of a specific outcome. They may be **prospective** (future-orientated) or **retrospective** (based on historical records) (Figure 7).

8.3.5.1. Characteristics:

- They compare the groups **exposed and unexposed** to a risk factor and follow them over time to determine the **incidence of the disease**.
- They establish a **clear temporal sequence** between exposure and outcome, which makes them stronger than cross-sectional studies.

Advantages

- They are useful for establishing temporal relationships and assessing the incidence of the disease.
- They can assess **multiple outcomes** associated with a single exposure.

Disadvantages

- They are expensive and time-consuming, especially when performed prospectively.
- They may be affected by **selection bias and confounding**, particularly if the exposed and unexposed groups are not comparable.

Methodology

- A cohort of exposed subjects and a cohort of unexposed subjects are selected (e.g., smokers vs. non-smokers).
- Participants are followed over time to determine the **incidence of outcomes** (e.g., lung cancer).
- Statistical analyses are applied to adjust for confounding factors and estimate the **relative risk**.

8.3.5.2. Examples of Use

A prospective cohort study can follow, over a defined period, a group of adults aged 50 to 64 years to assess whether specific dietary patterns influence the incidence of chronic inflammatory diseases (Crohn's disease, ulcerative colitis, psoriasis, psoriatic arthritis rheumatoid arthritis, and multiple sclerosis).

Formulating the hypothesis (PECO)

Example:

P (Population): Adults aged 50 to 64 years

E (Exposure): Adequate dietary patterns (fibre, fruits and vegetables, omega-3 intake)

C (Comparison): Inadequate dietary patterns

O (Outcome): Incidence of chronic inflammatory diseases

Hypothesis:
"Are adequate dietary patterns (E) associated with a lower incidence of chronic inflammatory diseases (O) among adults aged 50 to 64 years (P), compared to participants who follow inadequate dietary patterns (C)?"

8.3.5.3. Types of cohort studies

Cohort studies may take several forms, depending on the time at which data are collected:

Retrospective Cohort Studies These are based on past information on exposure and disease occurrence, using existing medical records. A limitation is the potential for **exposure misclassification**, as historical data may be incomplete or inaccurate. However, they reduce the waiting time for disease development, which is particularly advantageous for slowly progressing conditions such as cancer.

Prospective Cohort Studies In these studies, participants are followed in real time from the point of exposure through to disease onset. They offer more precise data collection but require a **longer follow-up period**.

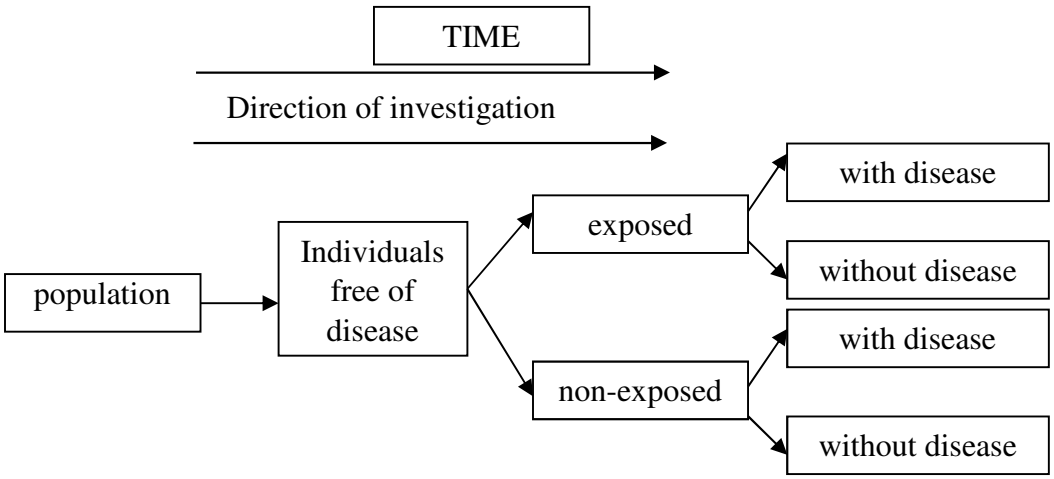

Figure 7. Timeline of prospective cohort studies

The data obtained are entered into a **2 × 2 contingency table** (Table 5).

Table 5. Contingency Table for Cohort Studies

	With disease	**Without disease**	**Total**
Exposed	a	b	a+b
Unexposed	c	d	c+d
Total	a+c	b+d	a+b+c+d

Where:
a = exposed individuals who develop disease;
b = exposed individuals who do not develop disease;
c = unexposed individuals who develop disease;
d = unexposed individuals who do not develop disease.

Risk among exposed subjects: R□ = a / (a + b)

Risk among unexposed subjects: R□ = c / (c + d)

Relative Risk (RR): RR = R□ / R□

This expresses how much higher the risk is in exposed individuals compared to unexposed individuals.

Example

A study includes 1,000 people aged 50 to 64 years:

Exposed group (inappropriate diet): 450 persons

Comparison group (adequate diet): 550 persons

After 10 years of follow-up:

Exposed group: 150 develop chronic inflammatory disease

Comparison group: 100 develop disease (Table 6)

Table 6. Example Contingency Table

	With disease	**Without disease**	**Total**
Inappropriate diet	150	300	450
Adequate diet	100	450	550
Total	250	750	1000

Risk in the exposed group: R□ = 150 / 450 = 0.33

Risk in the unexposed group: R□ = 100 / 550 = 0.18

Relative Risk: RR = 0.33 / 0.18 = **1.83**

8.3.5.4. Interpretation of Results

Cohort studies compare the **incidence of disease** among exposure groups. The main measure of association is the **Risk Ratio (Relative Risk, RR).**

RR > 1: Exposure increases the risk of disease

RR = 1: No association

RR < 1: Exposure is protective

Interpretation example:
RR = 1.83 indicates that inadequate dietary patterns are associated with almost **double the risk** of chronic inflammatory diseases compared to adequate diets.

Because exposure precedes the onset of the disease, cohort studies provide **stronger evidence of causality** than case-control studies.

Confidence Intervals (CI): RR should ideally be reported with a **95% CI**. If the CI does not include 1, the result is statistically significant.

8.3.5.5. Attributable Risk (AR)

AR represents the **absolute excess risk** due to exposure:

$AR = R_{\square} - R_0$

Using the example: $AR = 0.33 - 0.18 =$ **0.15 (15%)**

This indicates that exposure increases the risk of disease by **15 percentage points** among exposed individuals.

8.3.5.6. Attributable Risk Percentage (AR%)

AR% represents the **proportion of risk among the exposed that is due to the exposure**:

$AR\% = (R_{\square} - R_0) / R_1$

Using prior values → $AR\% \approx$ **45%**

This means that nearly half of the cases among the exposed group could be prevented if the exposure were eliminated.

8.3.5.7. Population Attributable Fraction (PAF)

The PAF applies to the **entire population** (exposed + unexposed) and estimates the proportion of cases that could be prevented if exposure were eliminated.

$PAF = (R\_total - R_0) / R\_total$

Using the example:

$R\_total = 0.25$ $R_{\square} = 0.18$ $PAF \approx$ **27.2%**

This means that approximately **27% of all cases in the population** are attributable to inadequate diet patterns.

8.3.5.8. Cohorts with Rare Exposures

When exposure of interest is rare, population-based cohort sampling becomes inefficient. In such cases, **special cohorts composed of exposed individuals** and a comparable unexposed group are constructed.

This design is especially valuable for studying **occupational, environmental or toxic exposures**, allowing estimation of RR and examination of **dose–response relationships**.

Examples include the following:

Workers exposed to aniline dyes and an increased risk of bladder cancer;

The Life Span Study of atomic-bomb survivors in Hiroshima and Nagasaki;

Occupational cohorts exposed to asbestos that demonstrate links with mesothelioma and lung cancer.

Although highly informative, these studies can be limited by a **small sample size, selection bias, and long-term follow-up challenges**. However, they remain essential to understand rare biologically significant exposures and inform **occupational safety standards and public health policy**.

8.4. Experimental Studies

8.4.1. Non-Randomised Controlled Clinical Trials

These studies involve an intervention, but the study groups are not randomly allocated, which can introduce bias. In a non-randomised clinical trial, researchers decide which participants receive the treatment and which do not, without using a random allocation process. Such studies are useful when randomisation is not ethical or feasible.

Characteristics:

- In the absence of randomisation, there is a risk of selection bias, which means that the study groups can differ in ways other than the treatment received.
- They can provide useful evidence but are considered weaker than randomised clinical trials.

Advantages:

- They can be used when randomisation is not ethical or practical.
- They may provide valuable information in the absence of a randomised controlled trial (RCT).

Disadvantages:

They may be affected by bias and confounders due to the lack of randomisation.

Example of use: A non-randomised study may evaluate the effectiveness of surgical treatment compared to pharmacological therapy for peripheral arterial disease, selecting patients based on the severity of the disease rather than by random allocation.

Formulating the hypothesis (PICO):

Example:

P (Population): Patients with peripheral arterial disease;

I (Intervention): Surgical treatment;

C (Comparison): Conventional pharmacological therapy;

O (Outcome): Reduction of pain and improvement in mobility.

Hypothesis:
"In patients with peripheral arterial disease (P), surgical treatment (I) reduces pain and increases mobility (O), compared with conventional pharmacological therapy (C)."

Methodology:

The intervention is applied to one group and the results are compared with a control group, but without patient randomisation;

Statistical analysis must adjust for differences between groups.

8.4.2. Randomised Controlled Clinical Trials (RCTs)

Randomised clinical trials are considered the gold standard in research. In an RCT, patients are randomly assigned to the intervention group or the control group to reduce bias and obtain robust results (Figure 8).

8.4.2.1. Randomisation

Randomisation consists of assigning study participants to groups in a random manner, usually to a treatment group and a control group. The process ensures that each participant has an equal chance of being allocated to any group, thus avoiding researcher influence or preference.

Randomisation methods:

Simple randomisation: Each participant is randomly assigned to a group, for example, by drawing lots, using a random-number generator, or flipping a coin. It is the simplest method, but may lead to unequal group sizes when the sample is small.

Block randomisation: To ensure balance between groups, especially in small studies, participants are divided into blocks of equal size (e.g., 4 or 6 participants). Each block is randomised so that an equal number of participants are assigned to each group within every block (for example, 2 in the treatment group and 2 in the control group in a block of 4). A random allocation sequence is generated for each block.

Stratified randomisation: This approach is used when researchers want to balance important characteristics between groups, such as age, sex, or disease stage. Participants are divided into strata based on these characteristics, and within each stratum the allocation is random. This ensures that each group contains a similar number of participants with key characteristics.

Why is randomisation important? Randomisation eliminates selection bias, increases study credibility, and ensures that outcomes are attributable to the intervention and not to pre-existing differences between groups.

Example:
An RCT can evaluate the effectiveness of a new diabetes therapy compared to a conventional treatment.

Advantages: Randomised trials provide the highest level of evidence to establish cause-and-effect relationships. Randomisation minimises confounding bias, and blinding methods (single-blind, double-blind) reduce observation bias.

Disadvantages:
RCTs are expensive and may require long periods to complete. They may also raise ethical concerns if one group is deprived of effective treatment.

8.4.2.2. Blinding Methods

To eliminate systematic errors, several blinding strategies are used:

Single-blind: only the patient does not know whether they receive active treatment or placebo;

Double-blind: neither the patient nor the investigator administering the treatment knows which treatment is administered, preventing influence on outcomes;

Triple-blind: the patient, the treating investigator and the data analyst do not know about treatment allocation;

Quadruple-blind: even those writing the final report do not know which treatment was administered until the study was completed.

8.4.2.3. Characteristics of Randomised Controlled Trials

Randomisation minimises bias and ensures comparability between groups;

This can be performed under double-blind conditions, so that neither researchers nor patients know which treatment each group receives.

Advantages:

- The best design for establishing causal relationships;
- Randomisation and blinding minimise bias.

Disadvantages:

- Expensive and difficult to implement;
- It may be unethical in some situations (e.g., when withholding a proven effective treatment).

8.4.2.4. Example of use:

A double-blind RCT can evaluate the effectiveness of a new diabetes medication by comparing a group receiving the drug with a group receiving another treatment or placebo.

Formulating the hypothesis (PICO):

Example:

P (Population): Patients with type 2 diabetes mellitus;

I (Intervention): Administration of a new hypoglycaemic drug;

C (Comparison): Administration of metformin;

O (Outcome): Reduction in glycated haemoglobin (HbA1c).

Hypothesis:
"The administration of a new hypoglycaemic drug (I) reduces HbA1c (O) more effectively than metformin (C) in patients with type 2 diabetes mellitus (P)."

Methodology:

Patients are randomly assigned to treatment and control groups;

Outcomes are measured and compared using rigorous statistical methods to evaluate treatment effectiveness.

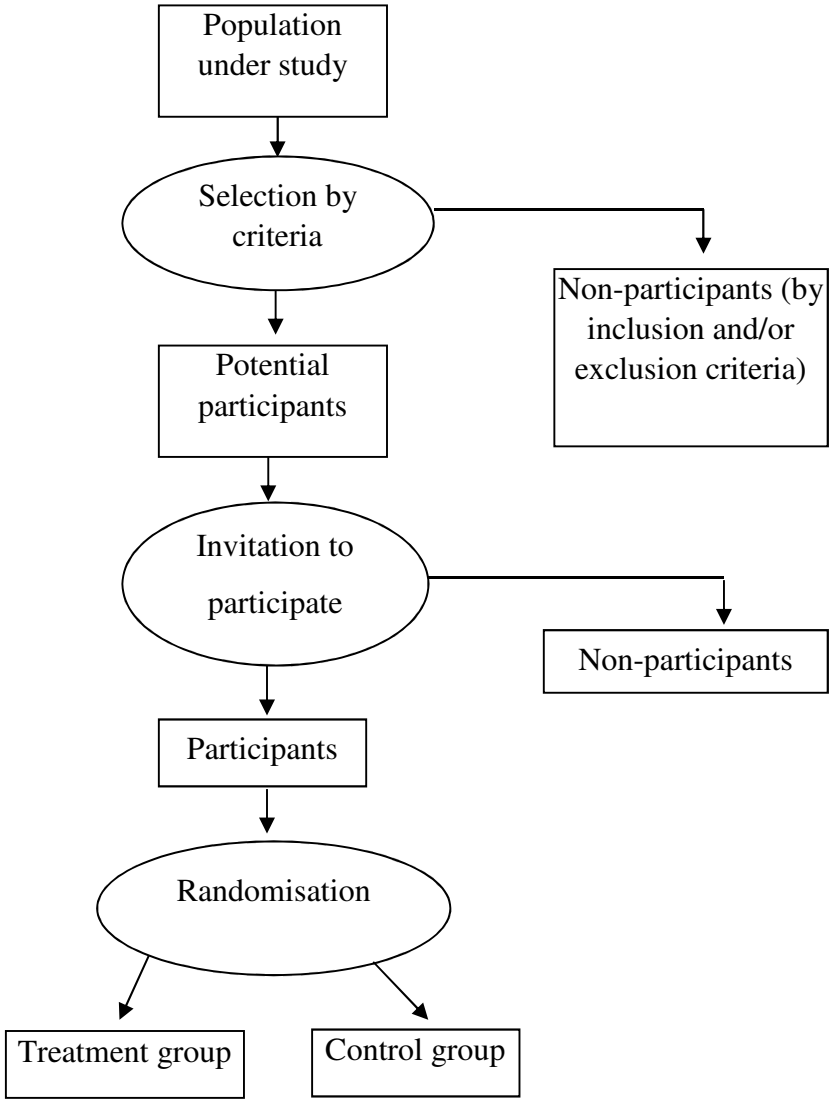

Figure 8. Diagram of randomised controlled trials

The effects of an intervention are measured by comparing the outcomes obtained in the treatment group with those in the control group. Interventions must follow a strict protocol and ethics play a crucial role. For example, patients cannot be denied necessary treatment within an experimental study, and the treatment being tested must be acceptable according to current scientific knowledge.

All participants must be monitored until the end of the study. **The intention-to-treat analysis** involves evaluating the results of all patients, including those who did not follow the treatment exactly as originally planned. This preserves the objectivity and validity of the results.

8.4.2.5. Effectiveness of an Intervention

When experimental treatment reduces the probability of an unfavourable outcome (deterioration of a condition), the effectiveness of the intervention becomes a key measure for assessing how well a given intervention (for example, a medical treatment) works in reducing the risk of an adverse event in a group of patients.

Effectiveness can be measured using indicators such as **Relative Risk Reduction (RRR)** and **Number Needed to Treat (NNT)**, which help us understand the clinical impact of the intervention on patient health.

Relative Risk Reduction (RRR)

Relative Risk Reduction represents the proportional decrease in unfavourable outcomes between the experimental group and the control group. The difference is calculated in absolute terms, but expressed proportionally, and it is always positive.

The formula for RRR is:

$$\text{RRR} = \frac{\textbf{Risk in control group} - \textbf{Risk in treated group}}{\textbf{Risk in control group}}$$

or

$$\text{RRR} = 1 - \frac{\text{Risk in treated group}}{\text{Risk in control group}}$$

What is Relative Risk Reduction (RRR)? The RRR shows the proportion by which the intervention reduces the risk of an adverse event compared to the control group. It is expressed as a percentage and indicates how effective the intervention is relative to standard treatment or placebo.

Example:
If in the treatment group the risk of an adverse event is 20% and in the control group it is 40%, then:

RRR = (40%−20%) / 40% = 0.5

Therefore, the intervention reduces the relative risk of the adverse event by 50% compared to the control group.

Limitation of RRR

RRR does not express the magnitude of the effect in absolute terms — it does not show how much the risk changes in practical, clinical terms. Two treatments may have the same RRR (e.g., 50%), but very different clinical relevance if absolute risks are low (Table 7).

Table 7. Example of situations with differences between RRR and ARR

Situation	R_control	R_treatment	RRR	ARR (Absolute Risk Reduction)
A	20%	10%	50%	10%
B	2%	1%	50%	1%
C	0.002%	0.001%	50%	0.001%

Absolute Risk Reduction (ARR)

ARR=R_control – R_treatment

ARR is the arithmetic difference between the adverse event rates in the two groups, usually reported together with a 95% confidence interval. ARR provides a more clinically meaningful and realistic estimate of the effect of treatment.

Examples:

R_control = 20%, R_treatment=10% → RRR = 50%, ARR = 10%

R_control = 2%, R_treatment=1% → RRR = 50%, ARR = 1%

R_control = 0.002%, R_treatment=0.001% → RRR = 50%, ARR = 0.001%

RRR expresses relative effectiveness, but may be misleading when the baseline risk is low. The ARR offers a more practical perspective and serves as a basis for calculating the **Number Needed to Treat (NNT)** — the number of patients who must be treated to prevent one adverse event.

Relationship between NNT and Intervention Effectiveness

The **Number Needed to Treat (NNT)** indicates how many patients need to be treated to prevent a single adverse event.

An **NNT of 1** means that every treated patient benefits directly, indicating extremely high effectiveness.

A **higher NNT** (for example, 50 or 100) suggests that treatment has a smaller clinical impact, as many patients must be treated to prevent an adverse event.

$$\text{NNT} = \frac{1}{\text{ARR}}$$

where ARR is the absolute difference between the risk in the control group and the risk in the treatment group.

Example:
Consider a clinical trial of a new drug that reduces the risk of myocardial infarction. In the control group, 10% of the patients experience an event, while in the treatment group only 5% do.

ARR=10%−5% = 5% (0.05 in decimal form)

NNT= 1/0.05 = 20, which means that **20 patients must be treated to prevent one heart attack**

RRR = (10%−5%) / 10% = 0.5, that is, treatment reduces the relative risk by 50%

Interpreting Effectiveness Based on NNT and RRR

A **low NNT (for example, <10)** indicates high clinical effectiveness, which means that treatment provides a significant and meaningful benefit.

A **high NNT** suggests that the benefits of treatment apply to a smaller proportion of patients, implying lower effectiveness or limited preventive impact in the treated population.

Therefore, the effectiveness of an intervention can be evaluated both from the perspective of relative risk reduction (how much the risk decreases proportionally) and from the perspective of NNT (how many patients must be treated to achieve one beneficial outcome).

8.5. Meta-analysis and Systematic Reviews

Systematic reviews and meta-analyses represent advanced methodological approaches used to synthesise scientific evidence on a clearly defined research question. A **systematic review** identifies, selects, evaluates, and summarises all relevant studies on a specific topic using a rigorous and transparent protocol designed to minimise selection bias. A **meta-analysis** goes one step further by statistically combining the quantitative results of these individual studies to produce an overall pooled estimate of effect, thereby increasing precision and robustness of conclusions.

8.5.1. Key Characteristics

- Integrate data collected in multiple independent studies conducted in different populations and contexts.
- Follow predefined, explicit inclusion criteria, and standardised methodological procedures (e.g., PRISMA guidelines).
- Employ critical appraisal tools to assess the methodological quality and risk of bias before inclusion in the synthesis.

Advantages

- The aggregate of data increases **statistical power** and provides a more precise estimate of the effect of an intervention, exposure, or diagnostic method.
- Allow researchers to identify **consistent patterns** across heterogeneous studies and reconcile conflicting findings.
- Subgroup analyses and meta-regression can reveal **sources of variability** (e.g., demographics, study design).
- Support evidence-based decision-making by translating dispersed research findings into coherent conclusions.

Limitations

- Validity depends on the **quality of the primary studies** included; weak studies may distort pooled estimates (‘garbage in, garbage out”).
- **Publication bias** can occur if negative or null studies are under-represented.
- **Clinical and methodological heterogeneity** can limit comparability.
- Inappropriate pooling of heterogeneous studies can lead to misleading conclusions.

8.5.2. Formulating the Review Question: PICO Framework

P (Population): Patients with atrial fibrillation

I (Intervention): Novel oral anticoagulants

C (Comparator): Warfarin

O (Outcome): Reduction in ischemic stroke risk

Hypothesis:
"Novel oral anticoagulants (I) reduce the risk of stroke (O) more effectively than warfarin (C) in patients with atrial fibrillation (P)."

8.5.3. Methodological Process

- **Systematic Literature Search** – across databases, using keywords, Boolean operators, reference lists, and grey literature.
- **Study Selection** – screening of titles/abstracts, followed by full-text review using inclusion/exclusion criteria.
- **Critical Appraisal and Quality Assessment** – standardized instruments (Cochrane Risk of Bias, Newcastle-Ottawa Scale).
- **Data Extraction** – collecting effect sizes, confidence intervals, sample sizes, and outcome frequencies.
- **Statistical Synthesis** – fixed-effect or random-effects models; heterogeneity assessed with **I^2 statistic**.
- **Interpretation and Sensitivity Analyses** – robustness of conclusions tested; subgroup analyses performed.

8.5.4. Effect Measures in Meta-analysis

Depending on the type of outcome, different statistical measures are used (Table 8).

Table 8. Outcome type and common effect measure in Meta-analysis

Outcome Type	Common Effect Measure
Dichotomous (event/no event)	Risk Ratio (RR), Odds Ratio (OR), Risk Difference (RD)
Continuous (quantitative)	Mean Difference (MD), Standardized Mean Difference (SMD)
Time-to-event	Hazard Ratio (HR)

Risk Ratio (RR): Ratio of risk in the intervention group to the risk in the control group.

Odds Ratio (OR): Ratio of odds of an event occurring in the intervention vs. control group.

Mean Difference (MD): Difference in average outcomes between groups.

Standardised Mean Difference (SMD): Used when studies measure the same outcome using different scales.

8.5.5. Forest Plots

A **forest plot** is a graphical representation of a meta-analysis:

Each study is represented as a horizontal line (confidence interval) and a square (effect estimate).

The overall pooled estimate is represented as a diamond.

Forest plots allow quick visualisation of effect size, confidence intervals, and heterogeneity across studies.

They also indicate whether the confidence intervals of individual studies cross the line of no effect (e.g., RR = 1).

8.5.6. Funnel Plots

A **funnel plot** is used to detect potential **publication bias**:

Plot effect estimates (x-axis) against a measure of study size or precision (y-axis).

In the absence of bias, the studies scatter symmetrically around the pooled effect (forming a funnel shape).

Asymmetry may indicate missing studies (e.g., unpublished negative results), suggesting bias.

8.5.7. Network Meta-analysis

A **network meta-analysis (NMA)** allows comparison of multiple interventions simultaneously:

- Combines both **direct comparisons** (head-to-head trials) and **indirect comparisons** (via a common comparator).
- It is useful when there are multiple treatments but few or no direct trials that compare all of them.
- Provides a **ranking of interventions** based on effectiveness and safety.
- Particularly valuable for clinical decision making when head-to-head evidence is limited.

8.5.8. Systematic Review vs. Meta-analysis

- If the data are **qualitative or not numerically comparable**, the synthesis remains a **systematic review**.
- If comparable numeric outcomes exist, the systematic review may be complemented by a **meta-analysis** for a pooled quantitative estimate.

Systematic reviews and meta-analyses are cornerstones of evidence-based medicine and epidemiology:

- Integrate the findings of multiple studies to increase the confidence in the conclusions.
- Guide clinical, public health, and policy decisions.
- Identify knowledge gaps and prioritise future research.
- Understanding their methodology is essential for students and researchers who wish to contribute to scientific progress and public health advancement.

8.6. Inclusion and Exclusion Criteria

An essential part of designing an epidemiological study is defining **inclusion and exclusion criteria**. These criteria determine who can participate in the study and who must be excluded, ensuring that the study results are valid and representative.

8.6.1. Inclusion Criteria

The inclusion criteria are the characteristics that participants must have to be eligible for the study. Properly defining these criteria ensures consistency of data and comparability of results between groups.

Examples of inclusion criteria:

Age: Participants must fall within a certain age range (e.g., 18 to 65 years).

Diagnosis: For a study on diabetes, only patients officially diagnosed with the disease should be included.

Exposure: In cohort studies, participants may be required to have been exposed to a certain risk factor (e.g., smokers).

Role of inclusion criteria:

Maximising homogeneity: These criteria help create a uniform study group, reducing variability not relevant to the study objectives.

Relevance: Ensures that the participants are the most appropriate to answer the research question.

8.6.2. Exclusion Criteria

Exclusion criteria refer to characteristics that might introduce errors or confounding in the study results or compromise participant safety.

Examples of exclusion criteria:

Comorbidities: Participants with other diseases that could influence outcomes (e.g., terminal cancer) may be excluded.

Medication use: Individuals taking drugs that could alter the outcomes (e.g., steroids in a metabolism study) should be excluded.

Disease history: In a study on the prevention of myocardial infarction, patients who have already had a heart attack would be excluded.

8.6.3. Importance of Inclusion and Exclusion Criteria

- **Ensuring internal validity:** Carefully defining inclusion and exclusion criteria helps prevent confounders (factors that may distort the cause-effect relationship), improving the validity of the study.
- **Generalisability (external validity):** If inclusion criteria are too restrictive, the results may not generalise to the broader population. For example, a diabetes study that includes only young healthy individuals may not reflect the results for older patients with multiple comorbidities.
- **Avoiding bias:** Inclusion and exclusion criteria help prevent biases, such as **selection bias**, which occurs when the groups compared in a study are not equivalent.

8.7. Causality in Epidemiology

Causality represents the relationship between a factor (exposure) and an outcome (disease or health condition), where changing the exposure affects the likelihood of the outcome. Identifying causality is a fundamental goal of epidemiological studies, but establishing a causal relationship is complex and requires multiple steps of analysis.

8.7.1. Causal Relationships and Types of Causes

It is important to understand not just that a factor can cause an outcome but also **how and under what circumstances** this occurs.

8.7.1.1. Necessary and Sufficient Causes

Necessary cause: A cause is necessary if the disease cannot occur without it. *Example:* Exposure to the hepatitis B virus is necessary to develop hepatitis B.

Sufficient cause: A cause is sufficient if its presence inevitably leads to disease. In practice, causes are rarely sufficient on their own.

Example: A specific genetic mutation may be sufficient to cause a genetic disease, but this is rare for most diseases.

8.7.1.2. Contributory Causes (Risk Factors)

Contributory cause: A factor that increases the probability of disease, but is neither necessary nor sufficient on its own.

Example: Smoking is a contributory cause of lung cancer; not all smokers develop the disease, and some non-smokers may develop it.

8.7.1.3. Direct and Indirect Causal Relationships

Direct cause: Immediately influences the occurrence of the outcome. *Example:* Inhalation of a toxic gas directly causes acute respiratory poisoning.

Indirect cause: Influences the outcome through other factors. *Example:* Poverty does not directly cause malnutrition, but affects access to food and healthcare, contributing to malnutrition.

8.7.2. Criteria for Establishing Causality

To evaluate whether a relationship between exposure and disease is causal, researchers use a set of criteria. The **Bradford Hill criteria** are applied most frequently in epidemiology:

8.7.2.1. Strength of Association

The stronger the statistical link between exposure and disease, the more likely it is to be causal. *Example:* The relationship between smoking and lung cancer is strong; smokers have a much higher relative risk than non-smokers.

8.7.2.2. Consistency

A causal relationship is supported when the results are repeatedly observed across different studies and populations.

Example: Epidemiological studies in multiple countries show that smoking is associated with lung cancer, suggesting a consistent causal relationship.

8.7.2.3. Specificity

This criterion requires that a single exposure leads to a specific outcome. In practice, this is rarely absolute, as many exposures can cause multiple diseases and vice versa.
Example: Smoking causes not only lung cancer but also COPD; therefore, specificity is not always strictly met.

8.7.2.4. Temporality

Exposure must precede the outcome.

Example: To claim that smoking causes lung cancer, people must have started smoking before developing the disease.

8.7.2.5. Biological Gradient (Dose-Response Relationship)

A dose-response relationship strengthens causality if higher exposure levels correspond to greater risk.
Example: The more cigarettes smoked per day, the higher the risk of lung cancer.

8.7.2.6. Biological Plausibility

There must be a plausible biological mechanism explaining how exposure leads to disease.
Example: Carcinogens in tobacco smoke cause mutations in lung cells, providing biological plausibility for the link between smoking and lung cancer.

8.7.2.7. Coherence

The causal relationship is coherent if it does not conflict with existing knowledge from other scientific fields, such as biology and physiology.

Example: The smoking-lung cancer relationship aligns with the biological evidence of cellular damage caused by carcinogens.

8.7.2.8. Experimentation

If the removal of exposure reduces the incidence of the disease, this supports causality.
Example: People who quit smoking have a lower risk of lung cancer, reinforcing causality.

8.7.2.9. Analogy

Causality can be inferred by analogy to other established causal relationships.

Example: Asbestos exposure causes lung cancer; by analogy, other respiratory exposures (e.g., smoking) can produce similar effects.

8.7.3. Application of Causality in Epidemiological Studies

8.7.3.1. Observational Studies

In observational studies, such as cohort or case-control studies, causality is more difficult to demonstrate because exposure cannot be directly controlled. However, these studies provide important evidence on associations and can generate hypotheses for further research.

Example:
The *Framingham Heart Study*, one of the most renowned cohort studies, demonstrated that arterial hypertension and elevated cholesterol levels are associated with an increased risk of cardiovascular disease.

8.7.3.2. Experimental Studies

Experimental studies, such as randomised controlled trials (RCTs), are more effective in establishing causality because researchers manipulate exposure and control other variables. This allows a clearer demonstration of the cause-and-effect relationship.

Example:
A randomised controlled trial that tests the effectiveness of a new drug for the prevention of cardiovascular disease can demonstrate that the treatment reduces the incidence of the disease, thus providing clear causal evidence.

8.7.4. Confounding and Bias in the Assessment of Causality

One of the main challenges in establishing causality is the presence of **confounding** and **bias**.

8.7.4.1. Confounding Factors (Confounding)

In epidemiological studies, confounding refers to a phenomenon that can distort the relationship between exposure to a risk factor and the disease of interest, potentially leading to erroneous conclusions. A confounding factor is a variable that meets two key conditions:

- **It is a risk factor for disease B.** This means that factor X is associated with an increased probability of developing disease B.

Example: Smoking can act as a confounder in a study investigating the relationship between a high-fat diet and lung cancer, because smoking is a risk factor for lung cancer and may also correlate with unhealthy dietary habits.

- **It is associated with factor A (exposure) but is not a consequence of that exposure.** In this case, factor X is not a direct effect of exposure to factor A, but is related to it.

Example: In a study that analyses the relationship between low physical activity (factor A) and cardiovascular disease (disease B), the body mass index (BMI) can represent a confounding factor (factor X). Individuals with a higher BMI tend to be less physically active (association between BMI and exposure), and obesity is a recognised risk factor for cardiovascular disease (association between BMI and disease). However, increased BMI is not a direct result of the low physical activity measured in the study, but rather a pre-existing characteristic, which qualifies it as a confounder.

How do confounders influence the study results? The presence of a confounder can cause the relationship between exposure (A) and disease (B) to be overestimated, underestimated, or even appear absent. If confounders are not properly controlled, incorrect conclusions may be drawn about the cause and effect.

Examples of confounding factors:

- **Age and cardiovascular disease:** In a study that evaluated the relationship between physical activity and cardiovascular risk, age may be a confounder. Older people are at higher risk for cardiovascular disease, and physical activity tends to decrease with age. Without controlling for age, one might erroneously conclude that lack of activity is fully responsible for cardiovascular disease.

- **Diet and diabetes:** In a study that examined the association between high sugar intake and diabetes, obesity can act as a confounder. Obesity is a risk factor for diabetes and can be associated with sugar consumption, but is not necessarily caused directly by it. If obesity is not controlled, the relationship between sugar and diabetes may be overestimated.

Controlling confounding factors

To eliminate or reduce the effect of confounders, researchers can use several methods, including the following:

- **Stratification:** Dividing participants into subgroups based on confounding variables, allowing the exposure–disease relationship to be examined within more homogeneous groups.
- **Regression analysis:** Using statistical techniques such as multivariate regression to adjust for confounders and obtain more accurate estimates of exposure–disease relationships.
- **Cohort studies and randomised trials:** Study designs such as cohort studies and especially randomised trials help control confounding, as random allocation reduces the likelihood that confounders are unevenly distributed between groups.

Confounding factors must be identified and controlled in epidemiological studies because their presence can distort causal relationships and influence the interpretation of results, making it difficult to draw correct and reliable conclusions.

8.7.4.2. Bias

In the assessment of causality, biases can influence the interpretation of the relationship between a risk factor and a disease, affecting the degree to which that relationship is judged to be causal or merely associative. The main types of bias that affect causal evaluation include:

- **Selection bias**

Selection bias occurs when study groups are not representative of the target population, thus distorting the estimated relationship between exposure and disease. In causal inference, selection bias can lead to conclusions in which an apparent causal relationship is actually the result of structural differences between groups.

Examples:

Case-control studies: If the cases and controls are not drawn from comparable populations, the results may suggest a causal relationship that is, in fact, a distorted association.

Cohort studies: If participants who remain in the study differ systematically from those who drop out, conclusions regarding causality may be affected.

- **Information bias (or misclassification bias)**

This form of bias occurs when information on exposure or disease is measured incorrectly. In causal evaluation, information bias can exaggerate or underestimate the exposure–disease relationship, as measurement errors can artificially create or obscure apparent causal associations.

- **Recall bias:** Common in case-control studies, where cases (e.g., cancer patients) may recall past exposures more accurately or intensely than controls.
- **Observer/interviewer bias:** If researchers are aware that a participant is a case, they may probe differently than when interviewing a control, thus influencing the results.
- **Reverse causality bias**

Reverse causality occurs when the temporal sequence between exposure and disease is unclear, making causal interpretation difficult. This type of bias is common in cross-sectional studies, where exposure and disease are measured at the same time.

Example:
In a cross-sectional study evaluating depression and physical activity, an observed association may reflect either reduced activity caused by depression, or the reverse situation in which lack of activity contributes to depression.

- **Survivor bias**

Survivor bias may distort causal evaluation because only individuals who survive long enough after exposure are included in the analysis. This may underestimate the strength of the exposure–disease relationship, particularly in high-mortality conditions.

Example:

Studies that evaluate cancer therapies may include only people who survived long enough to enter follow-up, who are already healthier than those who died early, making treatment effects appear better than they truly are.

- **Healthy worker effect**

This bias occurs in observational studies involving employed populations, which are generally healthier than the general population. In causal evaluation, this bias can lead to erroneous conclusions because the observed associations are influenced by better baseline health among workers.

Example:
In studies that assess occupational exposure to toxins, workers may appear less affected than the general population simply because they are healthier at baseline.

Controlling and reducing bias in causal evaluation
To reduce the impact of bias on causal interpretation, researchers may apply strategies such as:

- **Randomisation:** Reduces selection bias and confounding by balancing characteristics between groups.
- **Blinding:** Prevents information bias by ensuring that participants and/or investigators are unaware of group allocation.
- **Statistical adjustment:** Controls for potential confounders in analytical models.
- **Clear temporal sequencing:** Defining the timing of exposure relative to disease occurrence, particularly in cohort and case-control studies, strengthens causal inference.

To ensure a valid causal evaluation, researchers must identify, control and adjust study-specific sources of bias and apply appropriate analytical methods to minimise their impact. Causality is a central concept in epidemiology, but establishing a robust causal relationship requires careful analysis of observed associations and adherence to rigorous evaluative criteria. Observational and experimental studies provide complementary evidence for understanding how exposures influence health, and eliminating confounding and bias is essential to draw sound conclusions.

9. Health Promotion

Learning Objectives

By the end of this chapter, students should be able to:

- **Define** health promotion and distinguish it from health education and disease prevention;
- **Explain** the determinants of health and the rationale for population-level interventions;
- **Describe** major health promotion frameworks and levels of action (individual, community, policy);
- **Summarize** key models and theories of behavior change used in public health practice;
- **Identify** strategies that support healthy environments, empowerment, and community participation;
- **Apply** theoretical models to the design of simple health promotion interventions;
- **Recognize** ethical, cultural, and equity considerations in health promotion programs;
- **Evaluate** the strengths and limitations of behavior-focused versus structural approaches;
- **Describe** the role of multidisciplinary collaboration and policy in sustainable health outcomes.

Health promotion is a broad concept that encompasses all actions aimed at improving the health and well-being of individuals and communities. According to the Ottawa Charter (1986), health promotion is defined as *"the process of enabling people to increase control over, and to improve, their health and its determinants."* It goes beyond disease prevention, representing an active process of education, support, and participation of individuals and communities in maintaining and improving their health.

It is important to emphasise that health is not merely the absence of disease. According to the World Health Organisation (WHO), *"health is a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity"* (WHO, 1948).

Thus, a person may not have a diagnosed disease and still not be in a state of full health if there are emotional, psychological, or social imbalances. This holistic approach highlights that health promotion involves interventions aimed not only at reducing disease risk, but also at improving quality of life, working conditions, the environment, and health equity.

9.1. Definition and Importance of Health Promotion

Definition and Key Areas

Health promotion is an active, complex process that involves:

Health education – This area focusses on providing accurate and clear health information so that people can make informed choices. For example, passive smoking education campaigns have led to better understanding of the dangers of smoking in enclosed spaces.

Health protection – This includes measures that protect people from potential hazards. Examples include food safety regulations or air pollution standards.

Disease prevention – This refers to interventions that directly prevent the onset of diseases, such as vaccination campaigns or screening programmes for early cancer detection.

In addition, health promotion plays a key role in preventing chronic diseases such as cardiovascular disease and diabetes, conditions that can be largely prevented through education and lifestyle changes. For example, a health education programme that promotes balanced nutrition and regular physical activity can significantly reduce the risk of type 2 diabetes.

9.2. Historical Perspectives on Health Promotion

Understanding the evolution of health promotion helps contextualise its current practice:

1970s: the focus was primarily on disease prevention through measures like vaccinations and routine medical check-ups, emphasising direct medical interventions.

1980s: Significant changes occurred with the Alma-Ata Declaration (1978) and the Ottawa Charter (1986), establishing a holistic approach to health, including social and environmental determinants of well-being.

2000-present: Health promotion has become an interdisciplinary field that includes not only physical but also mental and social health. Technology plays an increasingly important role through mobile health applications, telemedicine, and access to online educational resources.

9.3. Health Models

Understanding how health can be effectively promoted requires examining three major health models that guide interventions:

Biomedical model – Views health strictly as the absence of disease. Health is improved by preventing and treating disease using medical methods such as medications, surgical interventions, and disease screening. This traditional approach still dominates in many parts of the world.

Behavioural model – Health is seen as the result of lifestyle choices. Individuals are educated and motivated to make healthy choices, such as quitting smoking, eating a balanced diet, and engaging in regular physical activity. This model emphasises individual responsibility while recognising unequal access to opportunities for healthy choices.

Socio-ecological model – Health is influenced by the social and economic environment. Health promotion focusses on improving living and working conditions to reduce health inequities. Policies supporting access to healthy foods or safe workplaces are examples of socio-ecological interventions.

9.4. Chronic Diseases and Health Promotion

Chronic diseases, including cardiovascular disease, cancer, respiratory disease, and diabetes, are the leading causes of mortality and morbidity worldwide. According to the WHO, chronic diseases account for more than 70% of global deaths, highlighting the urgent need for effective prevention and management strategies.

A major goal of health promotion is to prevent chronic diseases by reducing risky behaviours. Key behavioural risk factors include the following:

Smoking – The primary cause of multiple diseases, including chronic lung disease, certain cancers, and cardiovascular disease.

Excessive alcohol consumption – Associated with liver disease, cancers, and cardiovascular damage.

Unhealthy diet – High consumption of processed foods, sugar, and unhealthy fats is associated with obesity, type 2 diabetes, and hypertension.

Physical inactivity – A major risk factor for obesity, diabetes, and cardiovascular disease.

Responsibility for chronic disease prevention does not fall solely on individuals; environmental and social factors significantly impact public health:

Air pollution – Contributes to respiratory and cardiovascular conditions and can worsen pre-existing diseases.

Limited access to healthy foods – Communities with restricted access to healthy options show a higher prevalence of poor diet, increasing the risk of chronic disease.

Socioeconomic conditions – Economic insecurity, limited access to healthcare, and low health literacy increase the likelihood of unhealthy behaviours and reduce preventive opportunities.

9.4.1. Behaviour Change for the Prevention and Management of Chronic Diseases

Behaviour change is key in preventing and managing chronic diseases:

Adopting a healthy diet – A balanced diet rich in fruits, vegetables, and unprocessed foods can prevent diabetes and cardiovascular disease and help manage weight.

Regular physical activity – Moderate exercise for at least 150 minutes per week reduces the risk of obesity, hypertension, and diabetes.

Smoking cessation and reduced alcohol intake – These changes significantly reduce the risk of cancer, lung disease, and cardiovascular disease.

Implementing behavioural interventions requires collaboration among health professionals, authorities, and communities.

9.4.2. The Role of Health Promotion at Individual, Community, and National Levels

Health promotion requires interventions at all levels:

Individual level – Health education, nutritional counselling, and behavioural support are essential to help people adopt a healthy lifestyle.

Community level – Community interventions, such as promoting physical activity in schools, ensuring access to healthy foods, and public awareness campaigns, effectively improve health at the population level. Workplaces, educational institutions, and public spaces shape health behaviours.

National level – Public health policies are fundamental for health promotion. These may include regulations on advertising for unhealthy products, antismoking policies, pollution reduction, and subsidies for healthy foods. Public health strategies should address health inequities to ensure that all citizens have access to resources and living conditions that support long-term health.

Health promotion aims not only to prevent disease but also to create environments that support healthy living. Combating the increasing prevalence of chronic diseases requires a holistic approach that involves change at the individual level and interventions at the community and national levels. Collaboration between institutions, health professionals, and communities is essential to build a resilient health system capable of responding to the challenges of chronic disease.

9.5. Models and Theories in Health Promotion

Models and theories are fundamental in health promotion, contributing to understanding human behaviours and the implementation of effective interventions. The following section reviews the main theoretical models used in public health. These theories explain why people respond differently to health advice and how these responses can be influenced to support behavioural change.

9.5.1. The Importance of Theories and Models in Health Promotion

Theories and models in health promotion provide a structured framework to understand health-related behaviours, anticipating reactions to interventions, and creating effective strategies for behavioural change. In public health and nutrition, these frameworks serve as guides for structuring programmes and developing methods tailored to different population groups.

- **Understanding Human Health Behaviour.** A key function of theories and models is to explain the factors that influence health decisions. Healthy behaviours, such as diet, exercise, or sleep habits, are influenced by psychological, social, and environmental factors. Without a theoretical framework, it would be difficult to identify and understand these factors.

- **Structuring Health Interventions.** Models allow for a clear and systematic structuring of interventions, facilitating the planning of public health programmes. They provide a solid basis for setting objectives, selecting implementation methods, and adjusting interventions to respond to the behaviour and needs of the target population.
- **Improving Intervention Effectiveness by Identifying Key Factors.** Through models, key factors influencing health behaviours can be identified, directing efforts towards them to maximise the impact of the intervention. Identifying these factors is essential, as each behavioural change can be affected by specific barriers and facilitators within the target population.
- **Measurement and Evaluation of Interventions.** Health models and theories provide criteria and indicators to evaluate the success of interventions. They help measure whether the objectives of a programme's objectives are achieved and verify if the desired behavioural changes are maintained over time.
- **Adapting Interventions to Different Demographic Groups.** Theories allow messages and strategies to be tailored to the demographic, cultural, and psychological characteristics of target groups. This is particularly important in nutrition, where dietary preferences and habits vary significantly between groups. Theory-based personalization increases the likelihood of success and supports long-term behavioural change.
- **Guiding Decisions and Public Policy.** Health promotion theories and models can guide policy decisions, providing a theoretical basis for nationwide interventions. Policies grounded in theoretical evidence are more effective and sustainable, as they reflect a deep understanding of human behaviour and the factors that influence health.
- **Supporting Sustainable Behavioural Change.** A central role for theories and models in health promotion is to support long-term behavioural changes. These theories do not merely induce temporary change but aim to develop lasting habits and attitudes, reduce chronic disease, and improve quality of life.

Theories and models are indispensable for understanding, planning, implementing, and evaluating public health interventions, providing a scientific perspective on human behaviour and allowing targeted approaches to individual or community barriers.

9.5.2. Core Models in Health Promotion

9.5.2.1. The Health Belief Model (HBM)

The Health Belief Model (HBM) was developed in the 1950s to explain and predict people's health-related behaviours. This model helps to understand why people choose to adopt or not adopt preventive behaviours, such as vaccination or screening for certain conditions. HBM is one of the oldest and most widely used theories in public health, especially applicable in disease prevention and management.

HBM is based on the idea that health behaviours are influenced by people's perceptions of health threats and the benefits of preventive actions. It includes six main components: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy.

Key Components of the HBM

Each HBM component contributes to understanding how people perceive their health and determines the likelihood of adopting a preventive behaviour (Figure 9):

- **Perceived susceptibility:** The degree to which a person feels vulnerable to a particular condition, influencing preventive behaviour. For example, someone who perceives a high risk of diabetes due to family history will be more motivated to adopt healthy habits.
- **Perceived severity:** Personal assessment of the seriousness of a disease and its consequences. For example, someone who views obesity as a serious problem will be more motivated to maintain a healthy weight.
- **Perceived benefits:** Beliefs about the effectiveness of a preventive behaviour influence the likelihood of adoption. For example, if a person believes that reducing sugar intake will reduce the risk of diabetes, they are more likely to adopt such behaviours.
- **Perceived barriers:** Obstacles a person identifies in adopting a healthy behaviour. For example, someone who considers healthy foods expensive may face difficulties in following a balanced diet.
- **Cues to action:** Factors that trigger health behaviours, such as awareness campaigns or physician advice.
- **Self-efficacy:** The confidence of a person in his/her ability to adopt and maintain a healthy behaviour. For example, a person confident in his/her ability to quit smoking is more likely to sustain that decision long-term.

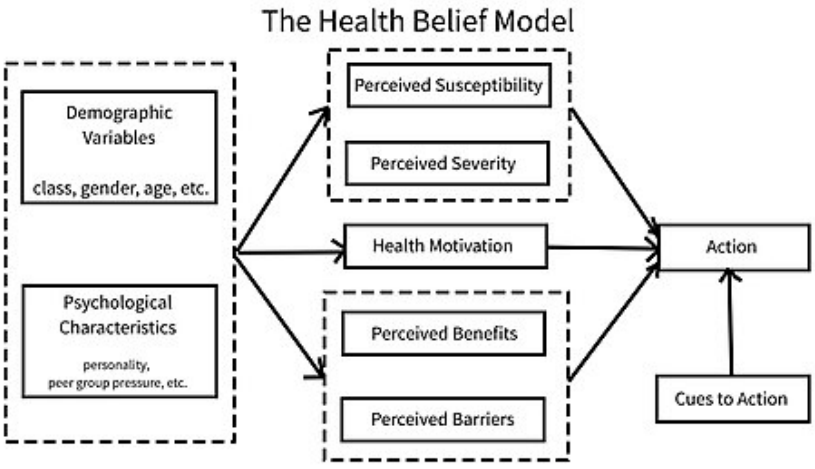

Figure 9. Schematic representation of the HBM model

Applications of HBM in Health Promotion

HBM is frequently used in health promotion campaigns to change perceptions about the risks and benefits of health behaviours. In nutrition, HBM encourages healthy eating habits and helps people understand the risks of an unbalanced diet.

- **Nutritional awareness campaigns:** HBM supports campaigns that reduce sugar and fat consumption, emphasizing risks and benefits, which can motivate behavioural change.

- **Obesity prevention and management:** HBM helps people understand the risks of obesity and the benefits of weight reduction, offering solutions to overcome barriers.

Limitations of the HBM

Although valuable, HBM has some limitations:

- **Lack of social and environmental focus:** HBM is individual-oriented and omits social and environmental influences, such as family support or access to resources.
- **Limited cognitive approach:** HBM assumes that health decisions are rational and consciously influenced, ignoring emotional influences.
- **Focus on singular behaviours:** It explains isolated behaviours well, but is less effective for repetitive behaviours, such as regular exercise.

HBM is a valuable tool in health promotion, providing a solid theoretical foundation for public health and nutrition interventions aimed at reducing risk and improving quality of life.

9.5.2.2. Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour, developed by psychologist Icek Ajzen in the 1980s, explains the link between a person's attitudes, intentions, and the resulting behaviours. This theory extends previous models by adding perceived behavioural control, reflecting an individual's confidence in their ability to perform a specific behaviour. TPB is widely used in public health to analyse and modify unhealthy behaviours, offering a solid theoretical framework for understanding behavioural intentions and influencing factors.

Key Elements of TPB

TPB suggests that the intention to adopt a behaviour is the main predictor of actually performing it, and the intention is influenced by three key factors: attitudes towards the behaviour, subjective norms, and perceived behavioural control (Figure 10).

- **Attitudes towards behaviour:** A person's positive or negative perception of the targeted behaviour. The more favourable the attitude, the stronger the intention to adopt the behaviour. *Example:* Believing that healthy eating improves health increases the intention to adopt such behaviours.
- **Subjective norms:** Individual perceptions of social pressure to adopt or not adopt the behaviour.
  Example: If a family promotes healthy eating, an individual is more likely to reduce sugar intake due to social support.
- **Perceived behavioural control:** Confidence in performing the desired behaviour, considering resources, skills, and potential obstacles.
  Example: Limited access to healthy foods reduces perceived control and weakens the intention to eat healthily.

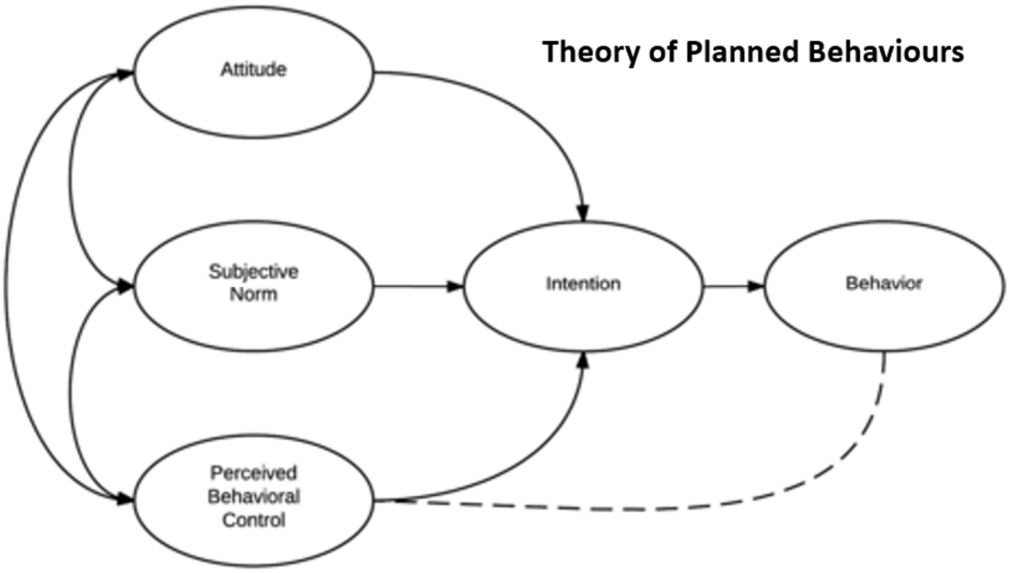

Figure 10. Schematic representation of the TPB model

Applications of TPB in Health Promotion and Nutrition

TPB is used to develop interventions in health and nutrition, helping identify factors that influence intentions and healthy behaviours:

- **Increasing fruit and vegetable intake:** Campaigns can use TPB to improve attitudes, social norms, and perceived control.
- **Reducing sugary drinks in adolescents:** TPB helps address factors influencing consumption, including social norms and perceived alternatives.
- **Reducing ultra-processed food consumption:** TPB identifies attitudes, norms, and perceived control related to processed food intake, guiding intervention strategies.

Limitations of TPB

While effective in predicting intentional behaviours, TPB has limitations:

- **Does not account for emotional influences:** Focusses on rational intentions, ignoring stress or cravings.
- **Ignores environmental influences:** Does not fully address external barriers, even though perceived control is included.
- **Less effective for spontaneous behaviours:** Better for planned behaviours than impulsive actions.

9.5.2.3. The Trans-Theoretical Model (TTM) or Stages of Change Model

The Trans-Theoretical Model, developed by researchers James Prochaska and Carlo DiClemente, describes behaviour change as a multistage process rather than a single event. Widely used in health promotion, this model supports interventions such as smoking cessation, weight loss, and

the adoption of healthy eating behaviours, helping tailor interventions and adapt the type of support according to each stage of change.

Stages of Behavioural Change in TTM

The model proposes five stages of change, each with specific characteristics (Figure 11):

- **Pre-contemplation:** The individual has no intention of changing their behaviour, often due to a lack of awareness regarding associated risks. **Interventions:** Information and education through awareness campaigns.
- **Contemplation:** The individual is aware of the problem and is considering change but experiences ambivalence. **Interventions:** Motivational counselling to address ambivalence and support decision-making.
- **Preparation:** The person is determined to change and begins planning concrete actions. **Interventions:** Providing resources and strategies to implement change, such as healthy meal plans or professional support.
- **Action:** The person begins to implement the desired behaviours. **Interventions:** Monitoring progress and supporting motivation through access to support groups and reinforcement of benefits.
- **Maintenance:** The desired behaviour has been integrated into daily life, although there remains a risk of relapse. **Interventions:** Relapse-prevention strategies, counselling, and social support.

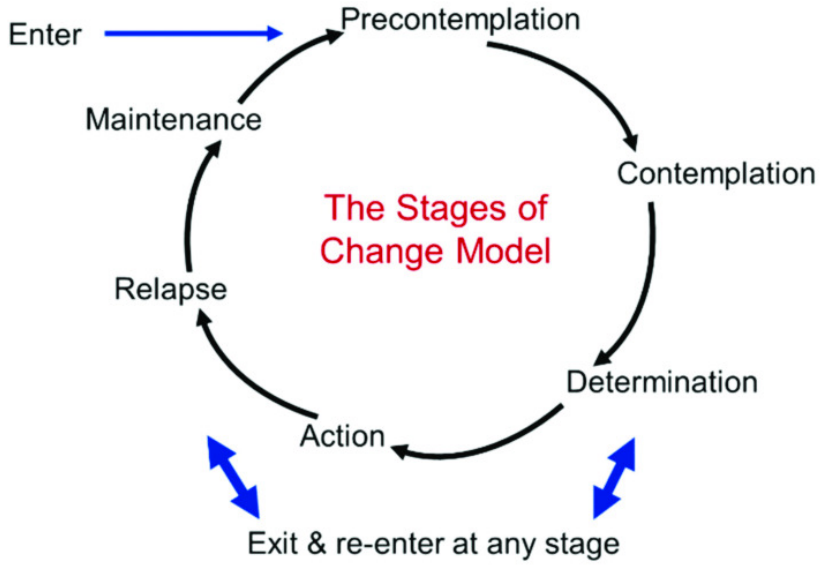

Figure 11. Schematic representation of the Trans-Theoretical Model

Practical Application of TTM in Health

TTM facilitates the development of personalised interventions by allowing support to be adjusted according to the stage in which each individual is currently in.

Adopting a Healthy Diet: Intervention can be customised across stages:

In pre-contemplation — increasing awareness of risks.

In contemplation — emphasising benefits.

In preparation — highlighting available resources for meal planning.

In action — support for monitoring progress.

In maintenance — relapse-prevention strategies.

Smoking Cessation: TTM supports each stage, from awareness and counselling to assistance in managing withdrawal symptoms.

Advantages and Limitations of TTM

Advantages:

- Enables a personalised approach and recognises change as a staged process, useful for long-term interventions.
- Applicable across multiple health domains, allowing adaptation to individual needs.

Limitations:

- Social and environmental influences are only partially addressed.
- Does not fully explain why some individuals remain in a stage or experience relapse.

TTM is essential for interventions requiring long-term behavioural change, providing a framework for tailored support adaptable to diverse needs and contexts.

9.5.3.3. Social Cognitive Theory (SCT)

Developed by Albert Bandura, Social Cognitive Theory (SCT) is one of the most influential theories for understanding and modifying human behaviour. It emphasises the constant interaction between the individual, his behaviour, and the surrounding environment, a process known as reciprocal determinism. SCT is widely applied in public health, education, and health promotion to facilitate positive behavioural change such as smoking cessation, adopting a balanced diet, or increasing physical activity. By examining cognitive and social processes, the theory provides a framework for designing interventions that improve health and quality of life (Figure 12).

Core Elements of Social Cognitive Theory

SCT identifies several key components necessary for behavioural change and essential when designing effective interventions.

- **Reciprocal Determinism**

This concept refers to the interdependence between the individual, behaviour, and environment. Each element influences and is influenced by the others, forming a continuous interaction cycle.

Example: Living in a community where physical activity is popular can encourage a person to exercise, increasing self-esteem and motivation, eventually turning them into a role model for others.

- **Self-Efficacy**

A central concept in SCT, self-efficacy refers to the belief of an individual in his/her ability to perform and sustain a behaviour. It is strengthened through positive prior experiences and is an important predictor of success in behavioural change.

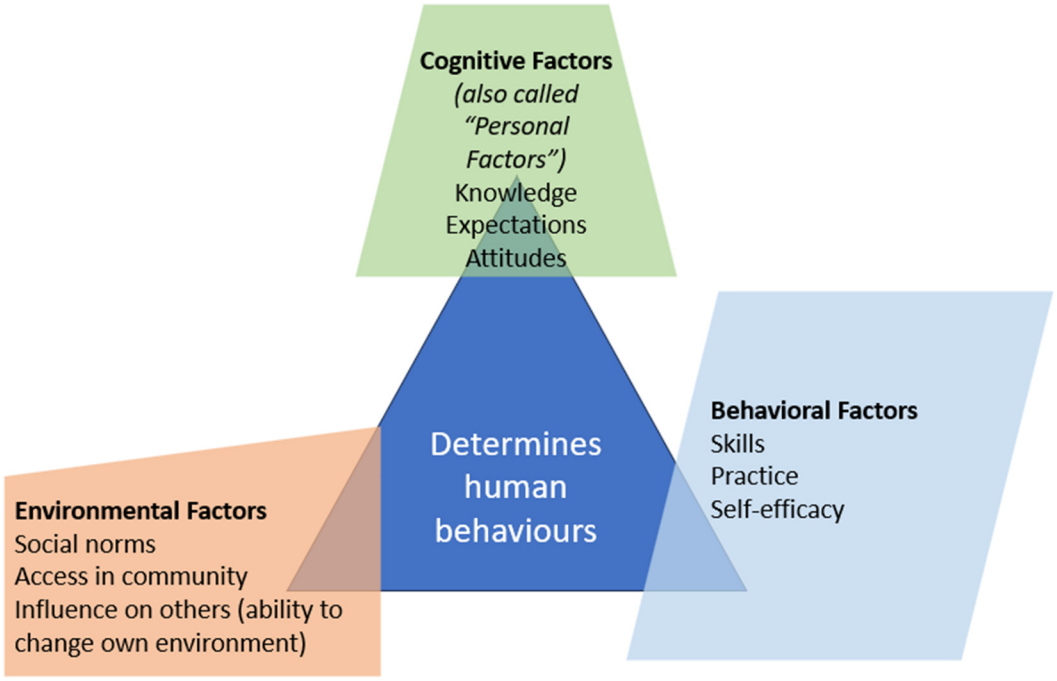

Figure 12. Schematic representation of the SCT model

Example: Someone who has partially succeeded in reducing processed-food intake may initially have low self-efficacy, but support and new strategies can strengthen confidence.

- **Observational Learning (Modelling)**

Individuals can learn by observing the actions of others and the consequences of those actions.

Example: A young person exposed to a positive role model—such as an influencer who promotes exercise and healthy eating—is more likely to adopt similar behaviours.

- **Rewards and Punishments**

These influence whether a behaviour is repeated or avoided. Rewards may be personal (sense of achievement) or social (praise or recognition).

Example: A person who receives positive feedback after adopting a healthy lifestyle is more motivated to maintain those behaviours.

- **Behavioural Capability**

Refers to the skills and knowledge required to perform a specific behaviour. SCT highlights the importance of developing these competencies to support successful change.

Example: In a healthy-nutrition campaign, participants can learn to read food labels to avoid unhealthy ingredients.

Practical Applications of SCT in Health Promotion

SCT is frequently applied in public health programmes, combining individual education with social support and resource access.

- **Promoting Physical Activity** SCT supports the design of programmes that help people overcome psychological and social barriers to exercise.
    - Strengthen self-efficacy through progressive goals.
    - Observational learning via trainers and mentors as role models.
    - Rewards such as group recognition or participation certificates.
- **Reducing Intake of Ultra-Processed Foods**
    - Modelling through nutrition educators or influencers demonstrating simple healthy recipes.
    - Strengthening behavioural capability through label-reading education.
    - Social reinforcement through family and peer encouragement.
- **Smoking Cessation**
    - Increasing self-efficacy through support groups.
    - Observational learning from people who successfully quit.
    - Positive reinforcement at each milestone.

Advantages and Limitations of SCT

Advantages:

- Integrated perspective that combines cognitive, social, and environmental factors.
- Broad applicability across contexts, using social support and resources.
- Emphasis on self-efficacy as a key determinant of long-term behavioural success.

Limitations:

- The complexity of interactions may be difficult to analyse and operationalise.
- Self-efficacy can be challenging to measure accurately.
- Limited attention to emotional influences such as stress or anxiety.

Social Cognitive Theory provides a well-grounded framework for understanding and changing health-related behaviours. It highlights the importance of self-efficacy, observational learning, and social support, all essential for promoting and sustaining healthy behaviours over time. This complex approach is necessary to design durable and effective interventions.

9.5.3.4. The COM-B Model (Capability, Opportunity, Motivation, Behaviour) in Health Promotion

The COM-B model is a theoretical framework developed to understand and modify behaviour by analysing three key elements—Capability, Opportunity, and Motivation—that directly determine

Behaviour. Developed by Professor Susan Michie and her team, COM-B is a core component of the *Behaviour Change Wheel*, widely used in the design of public health interventions.

The COM-B model is especially applied in lifestyle change programmes, such as improving diet, increasing physical activity, reducing smoking, and reducing alcohol consumption. By identifying the factors that support or hinder healthy behaviours, the model provides a practical structure for designing effective interventions.

Components of the COM-B Model

The COM-B model includes three essential components, each with specific subcategories that influence behaviour and behaviour change (Figure 13):

- **Capability**

Refers to the individual's skills and competencies required to perform a behaviour and includes the following:

Physical capability: Physical abilities needed to carry out the behaviour, e.g., basic cooking skills to prepare healthy meals.

Psychological capability: Knowledge and mental processes required to understand and apply the behaviour, such as knowledge of balanced nutrition.

Applied example: A healthy-eating campaign may provide cooking classes (physical capability) and nutrition education sessions (psychological capability).

- **Opportunity**

Encompasses external conditions that facilitate or constrain behaviour:

Physical opportunity: Access to resources and environments that enable the behaviour, e.g., availability of healthy foods.

Social opportunity: Social influences such as family support, cultural norms, and media messages.

Applied example: Creating access points for fresh foods in underserved communities and fostering social norms that support healthy eating.

- **Motivation**

Includes psychological processes that drive behaviour:

Reflective motivation: Conscious intentions and evaluation of costs and benefits.

Automatic motivation: Habits, impulses, and emotional responses that operate subconsciously.

Applied example: Educational messages that reinforce the benefits of healthy eating (reflective motivation) and replace unhealthy snacks with healthy habits (automatic motivation).

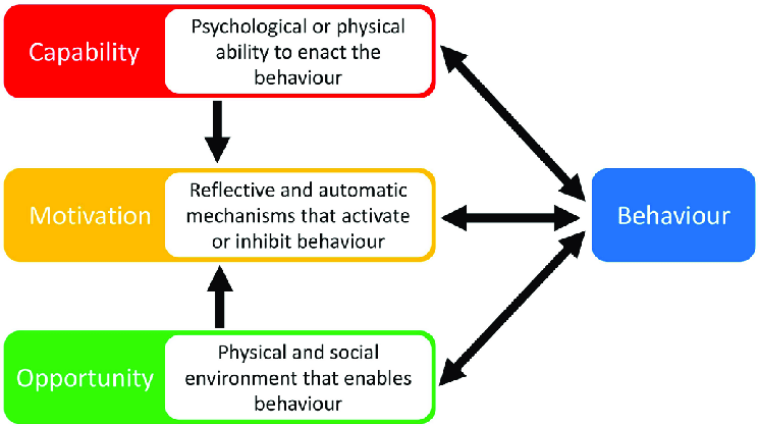

Figure 13. Schematic representation of the COM-B model

Applying the COM-B Model in Health and Nutrition Promotion

COM-B is systematically applied to plan and implement effective health interventions by identifying barriers and facilitators related to the target behaviour.

Step 1: Capability Analysis. Includes assessment of physical and psychological capacity and provision of nutrition workshops and cooking classes where needed.

Step 2: Opportunity Analysis. Evaluates access to healthy resources and introduces environmental or social norm interventions at the community level where gaps exist.

Step 3: Motivation Analysis. Strengthens reflective and automatic motivation through educational messaging and reinforcement of healthy habits.

Benefits of Using COM-B in Health-Intervention Design

- Comprehensive approach addressing skills, environment, and motivation.
- Ability to personalise interventions according to identified barriers.
- Increased programme effectiveness through systematic, multicomponent strategies.

The COM-B model provides an essential structure for designing public health and behaviour-change interventions. By evaluating capability, opportunity, and motivation, COM-B supports a deep understanding of the determinants of health behaviour and offers an effective framework for implementing personalised and community-adapted interventions. This integrated approach is fundamental to developing high-impact, sustainable health programmes that support beneficial behavioural change.

9.6. Effective communication for health promotion

9.6.1. The Fundamental Role of Communication in Health Promotion

Communication plays a crucial role in health promotion, serving as the primary channel through which the public receives essential information for prevention, diagnosis, and treatment. Through clear and well-targeted messages, health professionals can positively influence health-related

choices at both individual and community levels, thus supporting the adoption of healthier lifestyles.

- **Education through communication for a healthy lifestyle.** Structured and well-formulated messages support understanding of the importance of prevention and healthy choices. For example, anti-smoking campaigns not only explain the risks of smoking, but also provide solutions and resources for individuals who wish to quit. This approach increases awareness and encourages sustained positive behavioural change.
- **Disease prevention through healthy habits.** Clear and accessible messages help people adopt behaviours that reduce the risk of chronic diseases. For instance, promoting daily consumption of fruits and vegetables contributes to the prevention of obesity, diabetes, and cardiovascular disease, thus reducing the need for complex treatments.
- **Combating misinformation and strengthening trust.** In the digital era, where information is distributed rapidly and often without control, clear communication is essential to combat misinformation. During the COVID-19 pandemic, transparency and well-structured messaging were critical to strengthening public trust in official sources, supporting adherence to protective measures, and mitigating the impact of unfounded rumours.
- **Stimulating behavioural change.** Emotional messages and real-life stories have the ability to motivate behavioural change. Anti-smoking campaigns that use testimonials from individuals affected by smoking generate a strong emotional impact, encouraging people to give up this harmful habit through an empathetic and humanised approach.
- **Community support for health.** Effective communication contributes to the building of a culture of health at the community level by engaging organisations and institutions to promote beneficial norms. For example, locally organised physical activity events encourage people to adopt an active lifestyle collectively, fostering a sense of belonging and mutual support.
- **Reducing health system costs.** Prevention is more efficient and cost-effective than treatment, and communication plays an essential role in this regard. Screening campaigns, such as cancer screening programmes, enable early diagnosis and reduce the costs of advanced treatments, while improving chances of recovery and supporting a more efficient allocation of health resources.
- **Equitable access to health information.** Accessible messages targeting all social categories help reduce health inequalities. Educational programmes implemented in vulnerable or remote communities ensure that everyone has access to essential information on disease prevention and health care, regardless of geographic location.
- **Supporting public health policies.** Communication can play a decisive role in the acceptance and implementation of public health measures. For example, campaigns explaining the risks associated with excessive salt consumption can increase public support for regulations that limit salt in foods, thereby contributing to the adoption of long-term beneficial measures.

Communication is essential for health promotion, providing a framework in which accurate information is effectively transmitted, inspiring positive change, and supporting improvements in health at both the individual and community levels.

9.6.2. Key elements for effective communication in health

Effective communication requires clarity, well-defined strategies, and a sound understanding of the audience. It not only informs, but also educates and motivates.

- **Credibility of the communicator.** The public is more receptive to information transmitted by trusted sources, such as recognised health institutions. Messages from health professionals have a particularly strong impact.
- **Target audience.** Adapting messages to the characteristics and needs of the audience increases their relevance. Messages directed at adolescents, for example, should differ from those directed at older adults, reflecting the specificities of each group.
- **Appropriate communication channels.** Communication channels influence how messages are received. For younger audiences, social media is highly effective, while for older adults, brochures and face-to-face communication are more appropriate.
- **Cultural sensitivity.** Adapting messages to the cultural values and traditions of each community improves receptiveness and ensures respect for the identity of the group, creating a deeper and more sustainable impact.

The message in health communication. The message is the central element in health communication. An effective message educates, influences, and motivates the public to adopt healthy behaviours. Therefore, it must be clear, appropriate for the audience, and expressed in accessible language.

- **Clarity and accessible language:** Messages must be direct, simple, and easy to understand to avoid misinterpretation.
- **Supportive and friendly tone:** An empathetic and positive tone facilitates the connection with the audience and prevents defensive reactions. Avoiding critical language is essential for a favourable reception.

What makes a message effective?

An effective health promotion message is based on several key elements:

- **An engaging title:** A short and relevant title captures attention and prepares the public for the message.
- **Emphasis on benefits:** Highlighting concrete advantages—such as improved health or a longer life—provides motivation for behavioural change.
- **A clear call to action:** Every message should clearly indicate what the public is encouraged to do. For example: “Drink a glass of water every hour to remain adequately hydrated.”

Example of an effective message: “Walk 30 minutes a day for a healthier heart and a longer life.” It is short, clear, positive, and suggests a simple but beneficial action.

9.6.3. Evaluating message effectiveness

It is important to assess how well a message performs so that adjustments can be made when necessary.

- **Direct feedback:** Reactions on social media or comments provide immediate insight into message reception.
- **Surveys and questionnaires:** These help measure changes in perception and behaviour.
- **Behavioural indicators:** Increased participation in health programmes, such as screening campaigns, can confirm positive impact.

9.6.4. Recommendations for Effective Communication in Health

Effective communication in health requires a strategic approach grounded in audience understanding, message clarity, appropriate channels, and strong motivational calls to action. These principles are fundamental to successful health promotion initiatives and contribute to improved quality of life.

- **Know your audience**

Understanding the audience is essential to tailor messages to their characteristics and values.
• Demographic segmentation

• Analysis of interests and behaviours

• Empathy and respect for cultural norms

- **Create clear messages**

• Simple language

• Direct formulation

• Emotional resonance to strengthen engagement

- **Choose the appropriate channels**

• Traditional versus digital media

• Interpersonal communication

• Multichannel strategies for a wider reach

- **Include clear calls to action**

• Specific and realistic behavioural guidance

• Audience-appropriate framing

• Supporting resources, such as educational materials or professional contacts

Impact of these recommendations

Implementing these principles improves the effectiveness of the message, improves public understanding, and increases the likelihood of health-promoting behaviour change. Clear and tailored communication contributes to better informed individuals and healthier communities.

9.7. Health Education

Health education is a planned, systematic, and continuous process through which individuals and communities acquire knowledge, attitudes, and skills that enable them to maintain, protect, and improve their health status. It does not limit itself to the transmission of theoretical information, but rather seeks to develop the capacity to make informed and responsible decisions regarding lifestyle behaviours and habits that influence health.

According to the definition provided by the World Health Organisation (WHO), "Health education comprises consciously constructed learning opportunities, designed to facilitate favourable changes in the health-related behaviours of individuals and communities." Therefore, its purpose is not only to inform the population, but also to change attitudes and behaviours and to develop an authentic culture of health, grounded in prevention, responsibility, and active participation

9.7.1. Objectives of Health Education

Health education is a complex and continuous process that aims to positively shape the knowledge, attitudes, and behaviours of individuals and communities to maintain and improve health. Its objectives go beyond the transmission of information and focus on building a culture of health based on personal responsibility, social solidarity, and respect for one's own body and the surrounding environment.

The objectives of health education are divided into general objectives, reflecting the strategic directions of educational action, and specific objectives, which describe the concrete results pursued through public health programmes and interventions.

Among the most important objectives are:

- **Increasing knowledge about the determinants of health and disease** — Health education seeks to help people understand the influence of diet, physical activity, personal hygiene, environmental factors, stress, and the use of harmful substances on their health. A solid understanding of these determinants enables early identification of risks and the adoption of effective preventive measures.
- **Fostering positive attitudes toward healthy behaviour and disease prevention** — Through educational messages and positive behavioural models, health education contributes to the development of beliefs and values that support a healthy lifestyle. Thus, prevention becomes a conscious choice integrated into daily life.
- **Strengthening personal motivation to adopt a balanced lifestyle** — A key role of health education is to reinforce intrinsic motivation to maintain health. By cultivating self-control, emotional balance, and informed decision making, people become more responsible and engaged in managing their own health.
- **Developing self-care skills and the responsible use of health services** — Health education promotes awareness of early signs of illness, basic first-aid measures, and appropriate use of health services. This objective aims to increase individual autonomy in the management of health and reduce risk behaviours.
- **Promoting community participation and social responsibility for health** — Health is not only an individual matter, but also a collective one. Health education encourages active

participation in community programmes, volunteer activities, and public health initiatives. Collaboration between individuals, authorities, educational institutions, and non-governmental organisations strengthens a culture of health at the societal level.

Through the achievement of these objectives, health education acquires a dual dimension — individual and social. At the individual level, it strengthens responsibility and autonomy in maintaining health; at the collective level, it creates the foundation for a society in which health is perceived as a fundamental value and an essential resource for development.

In this sense, health education is not only a field of intervention, but also a strategic instrument for promoting well-being and quality of life.

9.7.2. Principles of Health Education

Health education is based on several essential principles that ensure the effectiveness and sustainability of the educational process. These principles represent methodological and ethical benchmarks that guide interventions designed to build healthy behaviours and strengthen individual and collective responsibility for health.

- **Active participation**

The educational process becomes effective only when the beneficiaries are directly involved. People truly learn when they actively participate, when they discuss, reflect, experiment, and analyse their own behaviours. Active participation stimulates interest, supports internalisation of messages, and facilitates the transformation of knowledge into attitudes and concrete actions.

- **Adaptation to audience needs**

To be relevant and effective, health education must be adapted to the characteristics of the target group: age, educational level, values, beliefs, and cultural and socioeconomic context. The content, language, and methods must be accessible and appropriate. Inappropriate or overly technical communication can reduce impact and even generate resistance to change.

- **Continuity of the educational process**

Health education is not a one-time activity, but a continuous process supported through coherent, planned, and recurring actions. Behavioural change requires time, repetition, and positive reinforcement. Continuity consolidates knowledge, increases awareness, and maintains motivation for healthy behaviour in the long term.

- **Multidisciplinarity**

Health promotion requires an integrated approach that brings together perspectives from medicine, psychology, education, sociology, social work, communication, and behavioural sciences. Collaboration among professionals and institutions — physicians, psychologists, teachers, social workers, public authorities, NGOs, and the media — ensures a comprehensive approach adapted to the needs of various community.

- **Emphasis on action and behavioural change**

The ultimate goal of health education is not merely the transmission of information, but the transformation of knowledge into sustainable healthy behaviours. Theoretical understanding is only the first step; real impact occurs when individuals modify their lifestyle and consistently apply what they have learned. Therefore, effective education includes elements of motivation, social support, and self-efficacy to facilitate the transition from intention to action.

By adhering to these principles, health education becomes a dynamic, participatory and transformative process capable of generating lasting change at both the individual and collective levels.

9.7.3. Main Areas of Application

Health education has a wide field of application and is implemented in diverse contexts that reflect the multiple dimensions of social life. Through its interdisciplinary nature, it can be integrated into the educational system, community activities, the workplace, and media and digital environments, with the aim of developing a culture of health across all levels of society.

In schools

Schools represent one of the most important settings for health education, as childhood and adolescence are critical periods for shaping health-related habits and values. Through formal and non-formal activities, students learn about balanced nutrition, personal hygiene, prevention of communicable diseases, responsible sexual education, mental health, and the importance of regular physical activity. Integrating health education into the curriculum supports responsible attitudes towards health and strengthens long-term preventive behaviour.

In the community

At the community level, health education is delivered through information, counselling, and support activities carried out in health centres, local institutions, NGOs, churches, and community centres. These programmes often target vulnerable groups — rural populations, people with low education, older adults or persons at high risk for disease — and aim to reduce inequities in access to health information and services. Through active participation and local engagement, communities become key actors in promoting health and preventing disease.

In the workplace

The workplace provides significant opportunities for promoting adult health. Workplace health education programmes include training in the prevention of accidents and occupational diseases, ergonomics, stress management, balanced nutrition, and work-life balance. Such interventions protect employee health while also increasing productivity, reducing absenteeism, and improving the organisational climate.

In mass media and the digital environment

Traditional media and digital platforms play a crucial role in the rapid dissemination of health information to the public. Television campaigns, educational videos, podcasts, online articles, social media content, and interactive platforms can make health messages accessible and engaging.

However, the digital environment requires the responsibility to prevent the spread of misinformation; therefore, partnerships between health professionals and communication experts are essential to ensure the quality and credibility of messages.

Through these complementary fields of action, health education becomes an instrument of social and cultural transformation, promoting a preventive, participatory, and informed approach to health at the population level.

9.7.4. Methods Used in Health Education

The choice of health education methods depends on the objectives of the programme, the context of the intervention, and the characteristics of the target audience. An effective method must facilitate not only information transfer, but also understanding, motivation, and behavioural change.

Depending on the level of interaction and participant involvement, several main categories of methods can be distinguished:

Direct (interpersonal) education

This method is based on face-to-face communication between the health educator and the beneficiary and is one of the most effective means to influence behaviour. It is implemented through medical consultations, individual counselling, group discussions, interactive lessons, Q&A sessions, and educational activities in schools and community centres. Its main advantage lies in the personalization of the message and the development of a trust relationship, which increases receptiveness and the likelihood of behavioural adoption.

Mass education

Mass education uses public communication channels to disseminate health messages to large segments of the population — national campaigns, radio and television spots, press articles, posters, leaflets, brochures, and thematic events. It has the advantage of having a rapid and extensive impact, contributing to the formation of collective awareness about health. However, for maximum effectiveness, it must be complemented by direct and participatory educational activities that facilitate a deeper understanding and application of messages.

Participatory education

This approach emphasises active participation of the beneficiaries in the learning process. Through interactive methods — workshops, role play, simulations, thematic competitions, practical demonstrations, preventive activities, and first aid exercises — participants develop concrete skills and strengthen positive attitudes toward health. Participatory education stimulates reflection, cooperation, and responsibility and is among the most effective approaches to behavioural change.

Digital education

Technological progress has significantly expanded the opportunities for communication and learning in health. Digital education uses on-line platforms, mobile applications, video courses, webinars, educational games, and social media campaigns. These tools support content personalization, rapid access to information, and broad engagement — especially among young

people — in an interactive and attractive way. The digital environment also facilitates continuity, monitoring, feedback, and ongoing knowledge updates.

In practice, maximum effectiveness is achieved by combining methods so that cognitive learning, emotional involvement, and behavioural practice develop simultaneously.

9.7.5. The Role of Health Education in Health Promotion

Health education is the central pillar of health promotion and one of the most effective instruments for prevention and sustainable social development. It does not simply convey information; it facilitates the development of the competencies, attitudes, and values required to adopt healthy, responsible, and sustainable behaviours.

Through its integrated actions, health education contributes to:

• Increasing **health literacy**, allowing people to understand, interpret, and use health information to make appropriate decisions for themselves and their families.

• Reducing the incidence of **preventable diseases** by raising awareness of risk factors and promoting preventive behaviours such as balanced nutrition, regular physical activity, and periodic medical checks.

• Improving **quality of life and longevity** through the maintenance of optimal physical, mental and social well-being.

• Reducing **health inequities** by ensuring equitable access to information, education, and support resources, including for vulnerable or marginalised groups.

Therefore, health education is not only a communication activity but a strategic component of public policy, with direct impact on the sustainability of health systems and population well-being.

9.7.6. Applied Example

A relevant example of a health education programme is represented by educational campaigns for the prevention and control of type 2 diabetes in high-risk communities (for example, urban areas with high rates of obesity and sedentary lifestyle).

The programme seeks to change risk behaviours through planned educational actions implemented both in primary care settings and in the community. Activities include the following:

• information sessions on risk factors for diabetes (unbalanced diet, sedentary lifestyle, chronic stress);

• practical workshops on reading food labels and planning balanced meals;

• training participants in weight and blood-glucose monitoring;

• psychological and group counselling to support lifestyle change.

For example, a family physician or community health worker can organise monthly educational sessions for patients with metabolic risk, helping them learn to self-monitor their health status and prevent progression to diabetes. In parallel, adapted educational materials (brochures, posters, and digital messages) are distributed and patients are encouraged to actively participate in their own care.

The results of such interventions are reflected not only in a reduction in the incidence of diabetes, but also in higher levels of health literacy, improved adherence to treatment, and lower costs associated with complications such as retinopathy, neuropathy, and renal failure.

Through such applied programmes, health education confirms its value as a practical instrument of preventive medicine and an essential means of reducing the burden of chronic diseases on individuals and society.

9.8. Literacy and Health Literacy

9.8.1. Literacy

Contemporary literacy extends beyond the ability to read, write, and understand written and spoken language. It encompasses not only technical skills related to reading and meaning-making, but also the ability to critically interact with texts, interpret information, and communicate ideas effectively.

It includes:

- **Numeracy:** the ability to understand and work with quantitative information.
- **Digital literacy:** competencies required to navigate and use digital technologies and online platforms.
- **Media literacy:** the capacity to critically analyse media content and understand its influence.
- **Financial literacy:** understanding financial concepts to support informed economic decisions.

9.8.2. Health Literacy

Health literacy refers to an individual's ability to obtain, understand, evaluate and use health-related information in order to make informed decisions about personal and community health. It includes both basic skills (for example, interpreting medication labels or provider instructions) and more complex competencies, such as navigating health care systems, understanding treatment options, and participating in preventive behaviours.

Core components of health literacy include:

- **Health knowledge:** understanding fundamental aspects of health and disease, including determinants such as nutrition, physical activity, and hygiene.
- **Access to information:** the ability to identify reliable evidence-based sources.
- **Information appraisal:** critically evaluating information to distinguish accurate content from misinformation.
- **Decision making:** applying information to treatment choices, prevention, and behaviour change.
- **Navigation of the health system:** understanding and using health-care services, including appointments, insurance procedures, and community resources.

Public Health Importance of Health Literacy

High levels of health literacy allow people to prevent disease, recognise early symptoms, adhere to treatment plans, and communicate effectively with health professionals. It also reduces inequities in access to care and contributes to better population health outcomes.

Conversely, limited health literacy may result in poor decision-making, mistrust of health professionals, inappropriate use of medication, and negative health outcomes. For these reasons, strengthening health-education initiatives is essential for the well-being of both individuals and community.

10. Health Management

Learning Objectives
After completing this chapter, students should be able to:

- **Explain** the basic structure and functioning of health systems and their relevance for population and family health;
- **Differentiate** between mandatory and private health insurance models and their implications for access to care;
- **Understand** core principles of health-care financing and cost-effectiveness in public health decision-making;
- **Identify** key health-system performance indicators relevant to primary and family health care;
- **Describe** the role of health policies and regulations in ensuring access, equity, and quality of health services;
- **Recognize** fundamental leadership and management principles applicable to multidisciplinary healthcare teams;
- **Understand** the importance of patient safety and continuous quality improvement in health-care delivery;
- **Appreciate** the role of healthcare marketing in improving service utilization and patient-centered care.

10.1. Health Systems

The health of a population is a fundamental pillar of societal development, and health systems have evolved to respond to both collective and individual needs. Population health is closely connected to the way a health system is organised and financed. Depending on its structure, a system may provide accessible and equitable services, or it may generate inequalities that worsen existing problems.

10.1.1. The Origin and Evolution of Health Systems

Health systems did not emerge overnight; instead, they evolved in parallel with societal development. The earliest public health initiatives were driven by the need to control epidemics, particularly during the Industrial Revolution, when poor sanitary conditions facilitated the spread of disease.

10.1.1.1. Early Organised Models

In the nineteenth century, Germany, under Chancellor Otto von Bismarck, introduced the first social health insurance system, financed through employer and employee contributions. This model, known as the **Bismarck system**, influenced the structure of many modern systems, including Romania.

In the United Kingdom, in 1948, the **National Health Service (NHS)** was created, financed through general taxation — a classic example of the **Beveridge model**, which provides universal access to free care at the point of service.

The **National Health Service** (NHS) is the publicly funded healthcare system of the United Kingdom, providing medical care to residents that is largely free at the point of use. It was established in 1948 following the recommendations of William Beveridge, a British economist and social reformer whose 1942 Beveridge Report proposed a comprehensive welfare state to combat social problems such as poverty, disease, and unemployment. The NHS is a key example of the "Beveridge model" of healthcare, in which health services are funded through taxation and delivered primarily by public institutions to ensure universal access to care.

10.1.1.2. The Romanian Context

In Romania, the health system has been shaped by political and economic developments. During the communist period, public health was centralised and access to services was free, although resources were limited. After 1990, the transition to a mixed system brought both benefits and challenges, including physician migration and under-funding of public hospitals.

10.1.2. The Global Architecture of Health Systems

An effective health system brings together several components: financing, service providers, infrastructure, and public policy. However, depending on the socio-economic context, the way these components interact may vary significantly.

Global health system models are distinct structures designed to organise and provide medical care to populations. They differ in terms of their sources of funding, organisation of services, and citizen access.

10.1.2.1. The Beveridge Model: Tax-Funded Health Care for All

The Beveridge Model, created in 1948, is based on the principle that health is a fundamental right and that access to medical care should be universal and free at the point of delivery. The system is financed through general taxation and most healthcare providers are publicly employed.

Key characteristics:

- **Universal access:** All citizens receive free services at the point of care.
- **Public providers:** Hospitals, clinics, and physicians are generally state employed, limiting the role of profit in the delivery of services.
- **Centralised planning:** Resources are allocated by the state according to population needs, allowing the prioritisation of public health interventions.

Advantages:

- Full access regardless of income;
- Low administrative costs due to a single-payer structure.

Disadvantages:

- Long waiting lists caused by underfunding and high demand;
- Potential decreases in quality when resources are limited.

Case study: The United Kingdom

The British NHS is the classic Beveridge model. Since 1948, it has transformed access to health care for millions of citizens. However, it frequently faces financing constraints. **Example:** In 2023, the average waiting time for elective surgery in the UK was eight weeks and 14% of patients turned to the private sector for faster services.

10.1.2.2. The Bismarck Model: Social Insurance-Based Health Care

Introduced by Otto von Bismarck in Germany in 1883, the Bismarck model emphasises financing through mandatory contributions to social health insurance funds. Unlike the Beveridge model, this system allows significant participation of private providers.

Key characteristics:

- **Mandatory contributions:** Employees and employers contribute to insurance funds with contributions proportional to income.
- **Public and private providers:** Patients may choose from multiple providers, stimulating competition and improving quality.
- **Strict regulation:** The state supervises insurance funds to prevent inequities and abuse.

Advantages:

- Freedom to choose providers;
- Higher quality of services through competition.

Disadvantages:

- Higher administrative costs due to multiple entities;
- Potential exclusion of uninsured or vulnerable groups.

Case study: Germany

Germany represents one of the most advanced Bismarck-type systems. Insured citizens have access to a wide range of services, and the state guarantees universal coverage. **Example:** A German patient with hypertension can access unlimited specialist consultations fully covered by insurance.

10.1.2.3. The Private Model: Access Based on Insurance Purchase

The private model predominates in the United States, where services are delivered and financed primarily through private sources. Patients pay for health insurance that covers part of the costs, while uninsured individuals must pay directly out of pocket.

Key characteristics:

- **Private financing:** Most of the resources come from the insurance premiums paid by employers and employees.
- **Extensive freedom of choice:** Patients may select physicians, hospitals, and treatments according to their insurance plans.
- **Lack of centralised control:** Prices are market-driven, leading to wide cost variations.

Advantages:

- Rapid access and high-quality services for those who can afford them;
- Rapid technological innovation in private hospitals.

Disadvantages:

- High costs, especially for uninsured individuals;
- Lack of equity, with many citizens excluded.

Case study: The United States

Before the Affordable Care Act (2010), **16% of the population was uninsured**. Coverage increased after reform, but inequalities persist. **Example:** An uninsured patient with appendicitis paid **$35,000** for emergency surgery — a cost that is inaccessible to many middle-income families.

10.1.2.4. The Mixed System: Public–Private Combination

Mixed systems attempt to balance universal accessibility with the efficiency of private providers. Canada, Australia, and Romania are examples of such systems.

Key characteristics:

- **Combined financing:** Essential services are publicly funded, while additional care is covered by private insurance.
- **Variable accessibility:** Rapid or specialised care often depends on the financial capacity of the patients.

Advantages:

- Guarantees a basic service package for all citizens;
- Integrates private resources to improve quality.

Disadvantages:

- May generate inequities between those who can afford private care and those who cannot.

Case study: Canada

Public insurance covers essential consultations and treatments, while many patients purchase private insurance for dental or physiotherapy. **Example:** A patient with a sports injury may receive hospital treatment free of charge, but must pay privately for intensive rehabilitation.

Global health models reflect economic, cultural, and political differences between countries. Each system has advantages and limitations, yet all seek to address the same universal need: health care.

10.1.2.5. Models of Health Care Delivery

Health care delivery refers to the mechanisms through which services are planned and implemented in practice. These models reflect patient flow, institutional structure, and integration across care levels.

Levels of care

Primary care:

- The first point of contact with the healthcare system.
- Includes family medicine and community health centres.
- Essential for prevention, early diagnosis, and referral.

Secondary care:

- Specialised outpatient and hospital services.
- Examples: cardiology consultations, advanced imaging, moderate-complexity surgery.

Tertiary care:

- Highly specialised interventions provided in centres of excellence.
- Examples: organ transplantation, advanced oncology, and high-tech surgery.

Regional models and accessibility

- **Centralized models:**

Decisions and resources coordinated by central authorities.

Example: UK NHS, where primary care acts as a gatekeeper.

- **Decentralised models:**

Services coordinated locally or regionally, allowing adaptation to community needs.

Example: in Canada, each province organises its own system.

Innovations in service delivery

- **Telemedicine:**

Improves access in remote areas;

Example: Online consultations in Norway reduced rural waiting times by 20%.

- **Integrated care pathways:**

Collaboration between family physicians, specialists, and hospitals.

Example: In the Netherlands, family physicians collaborate with specialist teams for the management of chronic diseases.

- **Integration within system structures**

In the Beveridge model, primary care functions as a gatekeeper to reduce hospital pressure.

In the Bismarck model, a wider choice of providers stimulates competition and quality.

In private models, access to higher-level care often depends on financial resources.

These delivery models significantly influence accessibility, efficiency, and quality of care. Understanding them is essential for future physicians, who must navigate complex structures while ensuring continuity of care.

10.1.3. The Romanian Health System

Romania follows a primarily Bismarck-type structure with Beveridge-like elements. The mixed model is shaped by socio-economic challenges and the growth of the private sector.

10.1.3.1. Organisation and Structure

The system is managed by the **Ministry of Health** in collaboration with the **National Health Insurance House (CNAS)**. Key components include:

Primary care:

- Family physicians are the main entry point into the system, responsible for basic consultations, prevention, and referrals.
- In 2023, Romania had more than **11,000 family physicians**, unevenly distributed, with shortages in rural areas.

Secondary and tertiary care:

- Provided through hospitals and specialised clinics;
- Hospitals are classified into competence categories (I–IV);
- Major cities host Category I hospitals that offer complex treatments.

Private sector:

- Provides faster, personalised services, often through private insurance.
- More than **70% of the population perceives private care to be more attractive** (2022 report).

Emergency services:

- SMURD and ambulance services are essential, free of charge, and universally available.

10.1.3.2. Financing the Health System

Romania applies a Bismarck-style financing mechanism through **mandatory social health insurance contributions (CASS)** collected by CNAS.

Sources of financing:

- Mandatory contributions: **10% of gross income;**
- Allocations of state budget for national health programmes and infrastructure;
- **Co-payments** for services included in the basic package.

Financial challenges:

- **Chronic underfunding:** ~5% of GDP spent on health vs. 9–10% EU average;
- Administrative inefficiencies and excessive bureaucracy.

Case example — Patient costs

A patient with diabetes receives free consultations and subsidised medication, but may have to pay for additional tests or modern equipment. For example, an advanced glucometer can exceed **300 lei**, a substantial cost for low-income patients.

10.1.3.3. The Integrated Unique Information System (SIUI)

SIUI is the national digital platform used by CNAS to manage records on insured individuals and reimbursed services.

Main functions:

- Verification of insurance status in real time;
- Monitoring of medical services and prescriptions;
- Automating reporting and reimbursement;
- Reduction of fraud through service validation;
- Integration of electronic prescriptions;
- Reduction of paperwork and administrative burden.

Benefits: improved transparency, efficiency, and data availability.

Challenges: technical failures, unequal access capacity, and continuous data security risks.

10.1.3.4. The Private Sector: Growth and Impact

The private sector has expanded rapidly, reaching a market value of more than **€3 billion in 2023**. It complements the public system, but it can draw physicians and patients away from public institutions.

Advantages:

- Shorter waiting times;
- Modern technology and personalised services;
- More attractive working conditions for physicians.

Problems:

- Exclusion of low-income populations;
- Increased pressure on the public sector, which manages severe and emergency cases.

Case study: Medical subscriptions

Companies such as MedLife, Regina Maria, and Sanador provide subscription-based services. By 2024, approximately **2.5 million Romanians** would have benefited from employer-provided medical subscriptions.

10.1.3.5. Current Challenges

Inequalities in access:

- More than **50% of rural localities lack access to specialists.**
- In some counties, patients travel more than 50 km for a consultation.

Migration of medical professionals:

- More than **15,000 physicians** left Romania in the past decade.

Technology integration:

- SIUI improves record access, but still faces technical instability.

10.1.3.6. Economic and Social Perspectives

The Romanian health system has a significant impact on productivity and quality of life. However, inequalities and under-funding generate significant indirect costs.

Example: A 2020 analysis estimated economic losses from untreated diseases at **more than 5% of GDP annually**.

Romania's health system reflects a fragile balance between the public and private sectors, each with strengths and weaknesses. For future physicians, understanding this system is essential for managing administrative demands, providing quality care, and reducing inequities. The future of the system depends on sustained reforms, strategic investment, and a patient-centred approach.

10.2. Types of Health Insurance

Health insurance represents a financial mechanism that facilitates access to medical care by providing financial protection against the costs associated with illness and injury. Depending on the social and economic context, health insurance systems may be structured into several categories, each with specific roles and characteristics. In Romania, as well as internationally, health insurance is generally divided into two main categories: **mandatory** and **private** insurance.

10.2.1. Mandatory Health Insurance

These schemes are administered and regulated by the state, with the purpose of ensuring a minimum package of medical care for the entire population. In Romania, this type of insurance is managed by the **National Health Insurance House (CNAS).**

The CNAS is the central institution responsible for managing the funds collected from health insurance contributions. Under CNAS operate **43 health insurance houses**: 42 county-level houses (including the **Bucharest Health Insurance House — CASMB**) and one institution with special status, the **Health Insurance House for the Army, Public Order, National Security and the Judiciary (CASA OPSNAJ).**

Each county has its own health insurance house and the relationships between healthcare providers (hospitals, clinics, medical practices) and CNAS are regulated through contracts that specify the types of covered services, rates, and reimbursement mechanisms.

10.2.1.1. Key Characteristics

• **Financing:** Based on mandatory contributions from employees and other categories of taxpayers. In Romania, the contribution to the Social Health Insurance Fund (CASS) is currently **10% of an individual's gross income** and is mandatory for various categories of contributors. Employers no longer pay CASS contributions on behalf of employees; instead, contributions are paid exclusively by employees through payroll deduction.

Other categories required to pay CASS include:

- **Self-employed persons (PFA):** They contribute 10% of net income, subject to a minimum threshold equivalent to **six gross minimum wages**, even if income is lower than this amount.

- **Individuals earning income from other sources,** such as:
  - Independent activities, liberal professions, or sports contracts;
  - Intellectual property rights;
  - Rental income;
  - Investment income (interest, dividends);
  - Agricultural, forestry, and fisheries activities.
- **Individuals submitting the Single Tax Declaration:** They must report income from multiple sources, and CASS is owed if annual net income exceeds the minimum threshold of six gross minimum wages.

Exemptions and waivers:

- Children and students up to 26 years of age;
- Persons with disabilities and individuals included in national health programmes;
- Pregnant women and postpartum women, for certain categories of income.

As of **September 2025**, the 'co-insured' category no longer exists; individuals previously insured through a spouse or family member must pay their own contribution to the CASS to maintain insured status.

The contributions collected from these sources finance public medical services and national health programmes, ensuring access to care for insured population groups.

- **Coverage:** Includes a basic benefits package that provides access to services such as consultations, laboratory tests, hospitalisation, treatment, and subventioned medications.
- **Universality:** All citizens and residents who contribute receive the same rights, while emergency care is provided free of charge to the entire population regardless of insurance status.

10.2.1.2. Advantages

- Ensures access to essential healthcare services for the entire population.
- Based on solidarity and redistribution of resources, allowing individuals with lower incomes to benefit from the same level of services as those with higher incomes.

10.2.1.3. Limitations

- In practice, the available funds may not be sufficient to cover all population health needs of the population.
- Long waiting times for consultations and procedures in public hospitals.
- Administrative restrictions, such as the requirement for a referral to access specialist care.

Example:
Maria, a patient with diabetes, receives free consultations with an endocrinologist, subsidised medication, and periodic laboratory tests, all covered by the CNAS. However, for a necessary MRI scan, she must wait several months due to limited funding allocations.

10.2.2. Private Health Insurance

Private insurance is provided by commercial insurance companies and supplements services offered by the public system. Policies may be purchased individually or offered as corporate benefit packages through employers.

10.2.2.1. Key Characteristics

- **Financing:** Through insurance premiums paid by individuals or by companies on behalf of employees.
- **Coverage:** Includes services such as rapid consultations, advanced investigations, access to private clinics, and, in some cases, treatment abroad.
- **Flexibility:** Offers customised packages tailored to individual or organisational needs.

10.2.2.2. Advantages

- Rapid access to services and higher-quality care conditions.
- Access to additional services not covered by public insurance (dental care, physiotherapy, psychotherapy).
- Free choice of healthcare providers.

10.2.2.3. Limitations

- High costs can exclude people with low income.
- Some policies contain restrictive clauses for pre-existing medical conditions.

Example:
An employee in Bucharest receives a corporate medical subscription to a private clinic. The package includes unlimited consultations, direct access to specialists without referral, and discounts for complex investigations.

10.2.3. Differences between Mandatory and Private Insurance

In Table 9 below are presented the differences about different aspects such as financing, access, coverage, out-of-pocket costs.

Table 9. Differences between Mandatory and Private Insurance

Aspect	**Mandatory Insurance**	**Private Insurance**
Financing	Legally regulated contributions	Voluntary premium payments
Access	Referral-based and budget-limited	Direct and rapid access
Coverage	Basic benefits package	Supplementary services
Out-of-pocket costs	Minimal	Higher, depending on package

10.2.4. Private Medical Subscriptions in Romania

A specific form of private coverage is represented by employer-funded **medical subscription plans**, which are highly popular, particularly in the corporate sector.

Characteristics:

- Employers cover the cost, while employees benefit from unlimited consultations and investigations.
- Packages often include rapid testing, periodic check-ups, and screening programmes for common conditions.

Example:
MedLife and **Regina Maria** are two of the largest providers of corporate medical subscriptions, serving major companies in the IT, banking, and other industries.

10.2.5. Challenges of the Health Insurance System in Romania

- **Inequitable access:** Individuals without stable income, such as the unemployed or informal-sector workers, have limited access to public insurance.
- **Underfunding of the public sector:** Insufficient resources place pressure on mandatory insurance and increase reliance on private services.
- **Insufficient regulation of the private market:** In some cases, policy clauses may disadvantage patients.

Health insurance systems — whether mandatory or private — reflect both the needs and financial capacities of the population. In Romania, the complementarity between these two mechanisms may support broader access to medical services; however, this requires clear regulation, increased public funding, and patient education about available options. Physicians play a key role in guiding patients through this complex system.

10.3. Health Economics: Fundamentals of Health-Care Financing

Health economics examines how financial resources are allocated and used within the health sector in the context of limited resources. It is an essential field to ensure that health care systems function efficiently and provide appropriate medical services to the population.

10.3.1. Cost-Effectiveness in Health Care

Cost-effectiveness in health care is a critical analytical approach that ensures that limited resources are used in the most efficient way possible, delivering the best achievable outcomes for patients at the lowest feasible cost. This concept is particularly important in a sector where the demand for medical services is generally very high, while financial, material, and human resources are finite.

To explore this concept, we will discuss the basic principles of cost-effectiveness, evaluation methods, practical examples, and its strategic role in health-system management.

10.3.1.1. What Is Cost-Effectiveness in Health Care?

Cost-effectiveness represents the relationship between the positive outcomes obtained from a treatment or medical intervention and the costs it generates. In simple terms, the goal is to achieve the maximum possible health benefit for patients using the minimum necessary resources.

A classic example is the comparison between two medications that treat the same condition:

Drug A is more expensive but offers additional health benefits (for example, faster recovery).

Drug B is less costly and equally effective but may produce minor side effects.

Cost-effectiveness evaluates whether the higher cost of Drug A is justified by its additional benefits or whether Drug B represents a better balance between cost and outcome.

10.3.1.2. How Is Cost-Effectiveness Evaluated?

Several methods are used to evaluate cost-effectiveness in health care. These methods analyse both **direct costs** (such as the price of medication or a surgical intervention) and **health outcomes** (such as life expectancy, quality of life, or reduction in symptoms). The most widely used approaches include the following:

a) Cost-Minimisation Analysis (CMA)

Cost-minimisation analysis is the simplest form of economic evaluation. It applies in situations where the outcomes produced by different interventions are identical or equivalent in terms of clinical effectiveness and patient benefit. Since outcomes are equivalent, the analysis focusses solely on comparing costs, with the objective of identifying the option that achieves the same result at the lowest total cost.

The key distinction between CMA and a simple cost comparison is the requirement to **demonstrate the equivalence of the outcomes** before comparing costs. Only once this equivalence is established, the most economically advantageous alternative can be identified. CMA is often used to compare treatments, drugs, or therapeutic methods that provide the same level of efficacy, but differ in cost.

b) Cost-Effectiveness Analysis (CEA)

Cost-effectiveness analysis compares the cost of an intervention with its outcomes, measured in clinical units such as:

- number of lives saved,
- years of life gained,
- reduction in hospitalisations or severity of symptoms.

CEA allows for the comparison of two or more therapeutic options with the same objective but different levels of cost and effectiveness.

Example: Comparison of the costs and outcomes of kidney transplantation versus dialysis in patients with renal failure. Both extend life, but with different costs and efficiencies.

c) Cost-Benefit Analysis (CBA)

Cost-benefit analysis expresses both **costs and benefits in monetary terms**, helping decision-makers answer the question: “Is this intervention worth the investment?” Benefits may include

- regained productivity after treatment (e.g., return to work),
- future cost savings from prevented complications.

The CBA provides a broader economic perspective and is useful in the evaluation of large-scale public health interventions.

Example: Investing in cardiovascular prevention programmes that reduce future treatment costs associated with heart disease.

d) Cost-Utility Analysis (CUA)

Cost-utility analysis accounts for both **extension of life and quality of life** after treatment. Outcomes are expressed using composite indicators such as:

- **QALY (Quality-Adjusted Life Years)** – combining life expectancy with health-related quality of life,
- **DALY (Disability-Adjusted Life Years)** – quantifying disease burden by accounting for premature death and disability.

CUA is particularly useful when treatments extend life but affect quality of life in different ways.

Example: Comparison of aggressive chemotherapy that prolongs life but has severe side effects with palliative care that improves comfort, but has less impact on survival.

10.3.1.3. Practical Applications of Cost-Effectiveness

- **Generic versus brand-name drugs -** generics often deliver the same therapeutic benefit at a significantly lower cost, making them a cost-effective alternative.
- **Vaccination programmes** - Although initial costs may be high, they prevent substantial future treatment costs and disease burden, representing one of the most cost-effective public health strategies.
- **Cancer screening programmes** - Early detection allows less costly treatment and improves survival rates, generating long-term economic and clinical benefits.

10.3.1.4. Importance of Cost-Effectiveness in Health-Policy Planning

In the context of budgetary constraints, cost-effectiveness analysis supports:

- **resource prioritisation**, focussing investments on interventions with the greatest public health impact;
- **long-term sustainability** of health systems, particularly in the face of population ageing and increasing demand for care.

Cost-effectiveness is therefore a cornerstone of modern health system management, ensuring that clinical and policy decisions maximise health benefits while using limited resources responsibly.

10.3.2. Health System Performance Indicators

To evaluate the efficiency and impact of health policies and medical interventions, health economics uses performance indicators that support monitoring and continuous improvement.

a) Access indicators;

Measure the degree to which populations can obtain medical services, such as:

- vaccination coverage rates,
- population coverage by primary care physicians,
- waiting times for consultations and treatment.

b) Quality indicators

Evaluate the safety and quality of care, including:

- hospital-acquired infection rates,
- postoperative mortality and complication rates,
- patient satisfaction with the care received.

c) Efficiency indicators

Assess resource use within the health system, such as:

- cost per patient for specific procedures,
- number of consultations per physician,
- bed-occupancy and resource-utilisation rates.

Performance indicators inform evidence-based decisions on resource allocation, service delivery processes, and the long-term strategic direction of health care policy.

10.4. Health Policies and Regulations

Health policies and regulations are essential to govern the way medical services are provided within a country. They establish the legal and administrative framework that ensures equitable access to care, the quality of services provided, and efficient use of resources. Policies and regulations are fundamental to protect public health, standardise clinical practice, and ensure patient safety.

10.4.1. What Are Health Policies?

Health policies represent a set of principles, directives, and actions that regulate the provision of health services and are developed by governments, international organisations, and public health institutions. They cover all aspects of medical care, from prevention to curative treatment and rehabilitation.

The objectives of health policies include the following:

- Improving population health through disease prevention and control;
- Ensuring universal access to health services so that all citizens receive medical care regardless of socioeconomic status;
- Promoting efficient use of financial and human resources in the health sector;

Reducing health inequities by addressing disparities in access and quality of care in social or geographic groups.

10.4.2. Health Regulations

Health regulations are binding rules established by government authorities that define the legal framework within which the health system must operate. Their purpose is to standardise procedures, guarantee the safety and quality of medical services, and protect patients' rights.

a) Legislation on the Protection of Patient Data

One of the most important regulated domains in health care is the protection of patients' personal data. In Europe, the General Data Protection Regulation (GDPR) establishes strict standards on how medical information is collected, used, and stored. In the United States, a comparable framework is HIPAA (Health Insurance Portability and Accountability Act), which regulates the confidentiality and security of patient information.

These regulations aim to ensure data confidentiality and restrict access to sensitive medical information to authorised persons only, preventing misuse or data breaches, and reinforcing public trust in the health system.

b) Standardisation of Health Care Quality

Regulations on service quality impose standards for hospitals, clinics, and other health care providers. These include requirements related to:

- Accreditation of medical institutions by national or international bodies (e.g., national quality authorities or the Joint Commission International);
- Professional certification and continuing medical education for physicians, nurses, and other health professionals;
- Compliance with clinical protocols to reduce errors and ensure consistency of care.

Examples include hospital sterilisation protocols to prevent nosocomial infections and surgical safety checklists that have been shown to significantly reduce intraoperative errors.

c) Access to Drugs and Pharmaceutical Regulation

Pharmaceutical regulations govern how medicines are authorised, distributed, and prescribed. National regulatory authorities evaluate:

- Market authorisation based on a rigorous assessment of safety and efficacy;
- Post-marketing surveillance and reporting of adverse reactions;

Regulation of the price of essential medicines to ensure affordability, including reimbursement or subsidisation mechanisms for patients.

10.4.3. Public Health Policies

Public health policies are a subset of health policies that focus on protecting community health and preventing disease. They include national and local strategies aimed at reducing the incidence of disease and improving quality of life.

a) Vaccination Programmes

Vaccination programmes are among the most effective public health policy tools. They prevent the spread of infectious diseases and protect vulnerable populations. Examples include routine childhood immunisation programmes and seasonal influenza vaccination campaigns. Mass vaccination contributes not only to individual protection but also to herd immunity, thereby reducing epidemic risk.

b) Programmes for the Prevention and Control of Chronic Diseases

Public health policies also include programmes targeting chronic diseases such as diabetes, cardiovascular disease, and cancer. These initiatives promote:

- Public awareness campaigns addressing risk factors and preventive behaviours (e.g., smoking cessation, healthy diet, physical activity);
- Screening programmes for early detection, when treatment is more effective (e.g., mammography for breast cancer or colonoscopy for colorectal cancer).

c) Control of Infectious Diseases and Management of Pandemic

Public health policies play a crucial role in the management of infectious diseases and the response to pandemics. Measures include:

- Quarantine and isolation of infected individuals;
- Mandatory reporting of communicable diseases to public health authorities;

Public information and education campaigns on preventive behaviours such as mask use, social distancing, and hygiene.

A recent example is the management of the COVID-19 pandemic, which required the rapid implementation of quarantine, travel restrictions, social distancing, and mass vaccination strategies.

10.4.4. Policies on Access and Equity in Health Care

A central objective of health policies is to ensure equitable access to medical services for all citizens, regardless of income, social status, or geographic location.

a) Universal Health Coverage

Public health insurance systems provide access to a core package of essential services, such as consultations, hospitalisation, and reimbursement of medications, ensuring that financial barriers do not prevent individuals from receiving the necessary care.

b) Reducing Health Inequities

Policies that aim to reduce inequality focus on improving access for vulnerable groups, including rural populations, ethnic minorities, and people with very low income. Examples include subsidised medical costs, investment in rural health infrastructure, and mobile health care services deployed to underserved communities.

10.4.5. International Health Policies

Health policies are also shaped by the activities of international organisations such as the World Health Organisation (WHO) and the European Union.

a) The Role of WHO in Global Health Policy

The WHO plays a key role in setting international standards and coordinating global responses to public health challenges. It develops guidelines and recommendations for pandemic preparedness and response, control of infectious diseases, and improvement of maternal and child health.

b) Health Policies in the European Union

The European Union supports national health systems through:

- Funding for public health, research, and innovation projects;
- Common quality and safety standards for medicines and medical devices;
- Policies enabling cross-border health care and reimbursement of medical services received in other member states.

Therefore, health policies and regulations are fundamental to ensure an efficient and equitable health care system. They encompass all aspects of medical care—from patient protection and access to treatment, to quality standards and pandemic response—and contribute to a more sustainable and better performing health system.

10.5. Leadership and Management of Medical Teams

Leadership and management in healthcare represent two essential competencies for any medical institution. They are necessary to ensure effective coordination of medical teams, improvement in the quality of the services provided, and creation of a harmonious working environment that promotes patient safety and staff satisfaction. This aspect of medical management is particularly important since hospitals and other healthcare institutions rely on collaboration among various professions and specialities.

10.5.1. The Difference between Leadership and Management

Although leadership and management are often used interchangeably, there are important differences between them in the context of medical teams.

Leadership

Leadership is based on inspiration, motivation, and vision. A good leader helps team members understand long-term goals, develop their skills, and remain motivated to achieve high performance.

An effective leader:

- Inspires the team and creates a shared vision aimed at improving patient health.
- Empathises with staff and helps them overcome emotional or professional challenges.
- Ensures that the team is orientated toward innovation and continuous development.

Management

Management, in contrast, is focused on the organisation, planning and efficient execution of daily tasks. An effective manager ensures that the resources (financial, material, and human) are used optimally and that the team's operational activities run smoothly.

An effective manager:

- Coordinates resources and processes to ensure that all tasks are completed correctly and on time.

- Monitors team performance and identifies ways to improve efficiency.
- Ensures compliance with rules and protocols to guarantee the safety of both patients and staff.

In the medical environment, a good leader must also be a competent manager capable of keeping the team motivated while effectively handling the complex processes involved in medical care.

10.5.2. The Role of Leadership in Medical Teams

In a medical setting, where patients' health and lives are at stake, leadership is essential to ensure harmonious collaboration among all staff categories. Medical teams are often interdisciplinary and include physicians, nurses, pharmacists, therapists, and technicians, each with clearly defined roles.

a) Transformational Leadership

An effective leadership style in healthcare is transformational leadership, which focusses on the personal and professional development of team members. Transformational leaders motivate others to exceed expectations and contribute to the overall goals of the institution.

Characteristics of transformational leadership include:

- **Inspiration:** Transformational leaders motivate their teams by providing a clear vision of the ultimate goal—improving patients' health outcomes.
- **Support and personal development:** Leaders support individual development by offering learning opportunities and encouraging team members to improve their skills.
- **Autonomy:** They give greater autonomy to the team, helping members take responsibility for their own decisions and increasing engagement.

b) Effective Communication in Medical Leadership

In medical teams, clear and effective communication is essential. A medical leader must be able to communicate decisions, protocols, and critical information clearly and directly to prevent errors and ensure high-quality care.

Example: During a surgical procedure, the team leader (the lead surgeon) must be able to communicate quickly and effectively with the entire team, including nurses and anesthesiologists, to prevent complications.

c) Team Motivation and Satisfaction

Successful medical leadership also involves maintaining a high level of motivation and job satisfaction among healthcare personnel. This is challenging due to the daily stress and pressures of the medical environment. A good leader recognises and rewards team efforts, supports work–life balance, and pays attention to the individual needs of team members.

10.5.3. The Role of Management in Medical Teams

Effective management of medical teams involves the efficient use of resources and proper organisation of workflows to ensure the daily functioning of healthcare institutions. Unlike

leadership, which focusses on vision and motivation, management is closely related to practical aspects and operational processes.

a) Planning and Organising Resources

A medical team manager must be able to plan and organise hospital or clinic resources. This includes:

- **Staff management:** Fair distribution of tasks within the team, scheduling, and coverage of shifts.
- **Management of materials and equipment:** Ensuring that all medical equipment is functional and available in a timely manner for necessary interventions.
- **Monitoring the stocks of medications and consumables** to prevent shortages.

Example: A good manager ensures that there is enough medical staff for each shift, thus avoiding overload and errors that can result from fatigue.

b) Performance Monitoring and Quality Evaluation

A medical manager is responsible for monitoring team performance and identifying areas that need improvement. This includes assessing the quality of care provided, waiting times, treatment success rates, and patient satisfaction.

Examples of monitoring tools include:

- **Clinical audits:** Periodic review of medical cases to assess whether treatments and protocols have been followed correctly.
- **Patient feedback:** Evaluation of patient satisfaction to improve the services provided.

c) Managing Change and Crises

In the medical environment, change and crises are frequent. Managers must be prepared to handle emergency situations and rapidly adapt the team to unexpected changes. An example is the management of an epidemic outbreak in a hospital, where the manager must quickly allocate resources to isolate patients, protect healthcare workers, and prevent the spread of the disease.

Example: During the COVID-19 pandemic, many healthcare managers had to completely rethink team structures, reorganise patient pathways, and manage shortages of medical equipment and personnel.

10.5.4. Collaboration and Teamwork

Effective collaboration is key to success in medical teams. Leadership and management must promote a work environment in which all team members feel involved, respected, and committed to working together for the patient's benefit.

a) Promoting Interdisciplinary Work

In the modern healthcare system, many health problems require a multidisciplinary approach that involves physicians from different specialities, nurses, therapists, and pharmacists. Medical leaders must encourage interdisciplinary collaboration, eliminate barriers between specialities, and ensure efficient information flow among all involved professionals.

b) Conflict Resolution

In a stressful environment such as healthcare, conflicts can often arise due to heavy workloads or differences of opinion between professionals. An effective manager must be able to identify these conflicts and implement strategies to resolve them, preventing damage to team morale or adverse effects on patient care.

10.5.5. Leadership and Innovation in Healthcare

Another important aspect of medical leadership is the ability to innovate. Healthcare systems are continuously evolving due to new technologies, treatments, and care methodologies. An effective leader must be open to innovation and encourage the team to implement new practices and technologies that can improve the quality of care provided.

a) Promoting Digitalisation

Healthcare leaders and managers must support the digitalisation of medical processes, such as the use of electronic health records (EHRs) or the implementation of telemedicine, which can increase efficiency and improve patient access to care.

b) Implementing Evidence-Based Protocols

Evidence-based medicine is another key element of innovation. Medical leaders must encourage the use of updated clinical protocols and support teams in adopting the latest research-based practices.

Effective leadership and management in medical teams are fundamental to improving the quality of care and ensuring a productive and harmonious working environment. A medical leader is not only a resource manager, but also a visionary, capable of inspiring and motivating the team, promoting innovation, and creating a culture of collaboration and safety. Effective management, on the other hand, is essential to organise daily activities, ensure optimal use of resources, and rapidly adapt to changes and challenges within the healthcare sector.

10.6. Patient Safety and Continuous Quality Improvement in the Healthcare System

Patient safety and continuous quality improvement are essential components of any modern healthcare system. Their primary goal is to prevent medical errors and reduce risks associated with healthcare delivery, while ensuring that medical services are effective, evidence-based and patient-centred.

10.6.1. What Does Patient Safety Mean?

Patient safety refers to the prevention of errors and adverse events that can occur during the delivery of healthcare services. It is a fundamental concept to protect the health and well-being of patients and involves the implementation of protocols, practices, and systems that minimise risks.

Medical errors can include the following:

- **Medication errors:** administration of the wrong medication or an incorrect dose.
- **Surgical errors:** performing surgery on the wrong organ (e.g., right kidney instead of left) or leaving a surgical instrument inside the patient's body.
- **Healthcare-associated infections (nosocomial infections):** infections acquired in hospitals due to failure to comply with hygiene protocols.

10.6.2. Essential Principles and Practices for Patient Safety

Several core principles and practices contribute to patient safety in hospitals and other healthcare facilities. These include the development of standardised protocols, the use of technology to reduce errors, and the cultivation of an organisational culture that encourages the reporting and prevention of errors.

a) Standardised Protocols and Checklists

One of the most effective tools for ensuring patient safety is standardisation of medical procedures through protocols and checklists. These are guidelines that describe the correct steps for various procedures and ensure that all essential details are verified before and during treatment.

Examples:

- **The Surgical Safety Checklist**, introduced by the World Health Organisation (WHO), is used before, during, and after surgery to verify the identity of the patient, the type of procedure, and the availability of the necessary equipment.
- **Medication administration protocols:** Proper verification of the medication, dose, and patient prior to administration reduces the risk of medication errors.

b) Technology and Patient Safety

The use of modern technology in healthcare is essential to improve patient safety. Information systems, electronic health records (EHRs), and other technological solutions allow for better monitoring and coordination of treatments.

Examples:

- **Electronic Health Records (EHRs):** These allow rapid access to the complete medical history of a patient, reducing the risk of errors caused by incomplete or outdated information.
- **Medication barcodes:** The use of barcode systems to verify medications before administration ensures that the patient receives the correct drug, at the correct dose, at the correct time.

c) An Open and Transparent Organisational Culture

Another important component of patient safety is the creation of an organisational culture that promotes transparency and reporting of errors without fear of punishment. This approach allows medical teams to learn from mistakes and prevent their recurrence.

- **Reporting of adverse events:** Healthcare staff should be encouraged to report any error or near miss so that they can be analysed and corrected before harming patients.
- **Learning from mistakes:** Successful hospitals implement regular case review sessions in which errors are analysed, root causes identified, and preventive measures adopted for the future.

10.6.3. Continuous Quality Improvement

Continuous quality improvement is a systematic and ongoing process for evaluating and improving medical processes and patient outcomes. It is based on data collection, data analysis, and the implementation of measures that lead to improved service quality.

a) The PDSA (Plan–Do–Study–Act) or PDCA (Plan–Do–Check–Act) Cycle

One of the most widely used tools for continuous quality improvement is the PDSA cycle. It is used to test and implement improvements based on data and practical observations.

- **Plan:** Identify a problem and plan a solution to address it.
- **Do:** Implement the solution on a small scale to test it.
- **Study:** Analyse the results and evaluate whether the solution is effective.
- **Act:** If the solution is effective, expand the implementation to a larger scale; if not, adjust the plan and repeat the cycle.

Example: In a hospital, a PDSA cycle may be used to reduce waiting times in the emergency department by adjusting the patient triage process.

b) Monitoring Quality Indicators

Continuous monitoring of performance indicators is essential to measure quality of care and identify opportunities for improvement. These indicators may include the following:

- The rate of healthcare-associated infections.
- Postoperative mortality rates.
- Waiting times for consultations and treatments.
- Patient satisfaction levels.

The collected data are analysed to identify trends and anomalies, and corrective actions are implemented to improve processes.

c) Evidence-Based Medicine

Another fundamental element of continuous quality improvement is the implementation of evidence-based protocols. Evidence-based medicine involves applying the best available scientifically validated practices to ensure the most effective and safest treatments.

- **Reviewing the scientific literature and clinical studies** is essential to update therapeutic guidelines so that patients benefit from the most recent and effective interventions.
- **Continuous education of healthcare professionals** in new practices and technologies is essential to maintain a high level of quality.

10.6.4. Tools and Processes to Improve Patient Safety and Quality

Numerous tools and processes are used in hospitals and clinics to ensure continuous improvement in quality and patient safety. These are designed to reduce risks and improve communication, collaboration, and efficiency in healthcare delivery.

a) Clinical Audits

A clinical audit is a process of evaluating medical practices against predefined standards with the aim of improving outcomes. Audits are used to assess whether protocols are being followed and whether discrepancies exist that could be corrected.

Example: A clinical audit may examine whether the treatment of stroke patients follows national standards and whether interventions are delivered within optimal time frames.

b) Safety and Quality Committees

In many healthcare institutions, safety and quality committees are established to monitor and coordinate continuous quality improvement activities. These committees are responsible for the following:

- Analysing adverse events and medical errors.
- Periodically reviewing performance indicators.
- Recommending corrective actions and implementing new practices to improve patient safety.

c) Continuous Education and Feedback

An essential component of quality improvement is continuous education of healthcare professionals. This includes participation in training courses, conferences, and workshops to keep skills and knowledge up to date.

Patient feedback is also crucial to identify areas where services can be improved. Many patients provide feedback after treatment, and these data are used to implement corrective measures where necessary.

10.6.5. Challenges and Solutions to Implement Patient Safety and Quality Improvement

Although improving patient safety and service quality is a key objective in any healthcare system, implementation often faces significant challenges.

a) Resistance to Change

One common obstacle to quality improvement is resistance to change among healthcare professionals, who may be reluctant to adopt new protocols or practices. This can be addressed by actively involving medical teams in the change process and demonstrating the benefits of new practices.

b) Lack of Resources

Implementing continuous improvement initiatives requires significant financial and human resources. A lack of resources can delay or limit the effectiveness of improvement programmes.

The solution lies in a more efficient allocation of resources and the identification of additional funding sources to support these initiatives.

c) Creating a Culture of Continuous Improvement

For a healthcare system to thrive in terms of quality and safety, it is necessary to create an organisational culture that supports these long-term goals. This involves the commitment of healthcare leaders to continuous improvement and the promotion of an atmosphere of accountability and collaboration among all members of the medical team.

Patient safety and continuous quality improvement are essential elements to provide high-quality healthcare services. By implementing standardised protocols, using technology, continuously monitoring performance indicators, and cultivating an open organisational culture, healthcare institutions can prevent errors, improve patient safety, and achieve better patient outcomes. Continuous improvement is a dynamic process that requires the commitment of the entire medical team to maintain and increase standards of care.

10.7. Marketing in Healthcare

Healthcare marketing refers to a set of activities and strategies that aim to identify, meet, and anticipate the health needs of the population. Rather than promoting products, healthcare marketing focusses on health promotion and optimising patient experience.

10.7.1. The Role of Marketing in Healthcare

In healthcare, marketing is not profit-orientated, but is focused on increasing awareness and access to health services, as well as improving quality of life. Effective healthcare marketing involves the following:

- **Identifying population health needs:** Through market research and surveys, healthcare organisations can determine which services are in demand and where there are gaps.
- **Promoting health and prevention:** Through educational and preventive campaigns, social marketing can help reduce disease risk and improve overall population health.
- **Patient-centred orientation:** Healthcare marketing aims to create a friendly and accessible environment for patients, ensuring that they are accurately informed and have access to high-quality services.

10.7.2. Components of Healthcare Marketing

- **Analysis of patient needs:** In healthcare, meeting the needs of the patient is paramount. Healthcare marketing includes research and analysis to identify patients' expectations and problems.
- **Educational advertising:** Unlike commercial advertising, healthcare advertising is educational and aims to inform the population about health issues, available treatments, and preventive behaviours. For example, anti-smoking campaigns and diabetes prevention campaigns promote health and reduce risks.

- **Patient relationship management:** This refers to all activities that improve interactions between patients and healthcare institutions. Through patient feedback and surveys, institutions can better understand expectations and improve satisfaction.
- **Branding in healthcare:** Branding is important in creating a positive image of a clinic, hospital, or healthcare institution. A strong brand builds patient trust and enhances reputation within the community, directly influencing the choice of healthcare providers.

Management of the healthcare system requires a deep understanding of how medical services are financed and delivered, as well as leadership and decision-making skills that prioritise patient safety. The role of physicians and healthcare managers extends beyond providing medical care to optimising processes and resources in order to achieve the best possible outcomes.

10.7.3. Marketing Techniques and Strategies Applied in Healthcare

Several marketing techniques and strategies are adapted for use in healthcare to improve the accessibility, quality, and efficiency of services.

a) Audience Segmentation

Segmentation involves identifying different categories of patients and their specific needs. Through segmentation, healthcare institutions can tailor messages and services to each group.

Example: Older adults have different needs compared to younger people who use preventive services, such as blood pressure checks or glucose monitoring. Therefore, hospitals and clinics can develop screening programmes tailored to each segment.

b) Branding of Medical Services

Branding contributes to improving the image of a healthcare institution. A strong brand, based on values such as quality of care, empathy, and professionalism, can attract more patients and earn the trust of the community.

Example: Private clinics or large hospitals invest in branding to be recognised for excellence and innovation, ensuring that patients know what to expect in terms of quality and professionalism.

c) Promotional and Educational Campaigns

Promotional campaigns are focused on informing and educating patients. Unlike commercial campaigns, their purpose is prevention and awareness.

Examples:

- Seasonal influenza vaccination campaigns that promote the benefits of vaccination.
- Educational campaigns to reduce smoking, alcohol consumption, or unhealthy eating habits.

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