La-Net

EHS202

FUNDAMENTALS OF EPIDEMIOLOGY

COURSE CODE: EHS 202

COURSE TITLE: Fundamentals of Epidemiology

COURSE UNIT LOAD: (2 Units C: LH 30)

SERIES LIST

- **Series 1: Foundations and Historical Development of Epidemiology**
- **Series 2: Models of Disease Causation and Occurrence**
- **Series 3: Time, Transmission, and Patterns in Epidemiology**
- **Series 4: Study Designs and Measurement in Epidemiology**
- **Series 5: Applications of Epidemiology in Disease, Injury, and Health Problems**

Suggested Outline – Series 1: Foundations and Historical Development of Epidemiology

1.1 Historical Development of Epidemiology

- 1.1.1 Early origins of epidemiology
- 1.1.2 Milestones in the growth of epidemiology
- 1.1.3 Contributions of key figures in epidemiology

1.2 Definition, Scope, and Application of Epidemiology

- 1.2.1 Definition of epidemiology
- 1.2.2 Scope of epidemiology in health sciences
- 1.2.3 Applications of epidemiology in disease control and prevention

1.3 Basic Principles and Methods of Epidemiology

- 1.3.1 Principles of disease investigation
- 1.3.2 Methods of epidemiological analysis
- 1.3.3 Role of epidemiology in public health practice

1.4 Epidemiologic Models of Disease Occurrence

- 1.4.1 Unifactorial model
- 1.4.2 Multifactorial model
- 1.4.3 Web of causation

Introduction – Series 1: Foundations and Historical Development of Epidemiology

Epidemiology is the cornerstone of public health practice. It provides the scientific basis for understanding how diseases occur, spread, and can be controlled. The **foundations of epidemiology** lie in its historical development, where early observations of disease patterns gradually evolved into systematic methods of investigation. By studying these origins, learners gain insight into how epidemiology became a discipline that informs health policy and guides interventions.

The **aim of this Series** is to introduce learners to the historical roots, definitions, scope, and applications of epidemiology. It will also highlight the basic principles and models of disease occurrence that underpin the discipline.

The Series follows a sequential path:

- We begin with the **historical development of epidemiology**, tracing its milestones and contributions of key figures.
- Next, we examine the **definition, scope, and application of epidemiology**, clarifying its role in health sciences.
- We then explore the **basic principles and methods of epidemiology**, focusing on how disease investigation is conducted.
- Finally, we study the **epidemiologic models of disease occurrence**, including unifactorial, multifactorial, and web of causation approaches.

By the end of this Series, learners will appreciate how epidemiology has evolved, understand its scope and applications, and be able to explain the models that guide disease investigation and control.

Series Learning Outcomes – Series 1: Foundations and Historical Development of Epidemiology

By the end of this Series, learners should be able to:

- **SLO 1.1**: **Describe** the historical development of epidemiology and identify key milestones in its evolution.
- **SLO 1.2**: **Define** epidemiology and **explain** its scope and applications in health sciences.
- **SLO 1.3**: **Analyse** the basic principles and methods of epidemiology used in disease investigation and control.
- **SLO 1.4**: **Evaluate** epidemiologic models of disease occurrence, including unifactorial, multifactorial, and web of causation approaches.

These outcomes align directly with the four Parts outlined for Series 1, ensuring learners progress from historical foundations through definitions and methods, and finally to models of disease occurrence.

1.1 Historical Development of Epidemiology

1.1.1 Early origins of epidemiology

The word **epidemiology** comes from the Greek words *epi* (upon), *demos* (people), and *logos* (study). It originally meant the study of what befalls populations. Early origins can be traced to ancient civilisations where observations were made about disease outbreaks. For example, Hippocrates in 400 BC suggested that environmental factors such as air, water, and food influenced health.

Fill in the blank: The word epidemiology comes from the Greek words *epi*, *demos*, and ______.

Figure 1.1 Placeholder: Diagram showing the Greek roots of the word epidemiology. Caption: Origins of the term epidemiology.

1.1.2 Milestones in the growth of epidemiology

Several milestones mark the growth of epidemiology as a discipline. In the 17th century, John Graunt analysed mortality data in London and produced the first life tables. In the 19th century, John Snow investigated cholera outbreaks in London, linking them to contaminated water sources. These milestones established epidemiology as a scientific method for studying disease occurrence.

Fill in the blank: John Snow investigated outbreaks of ______ in London, linking them to contaminated water sources.

Figure	Period	Key Concept	Shift in Thinking
Hippocrates	**Ancient Greece**	**Environmental factors**	**Superstition $\rightarrow$ Observation**
John Graunt	**17th Century**	**Quantifying health**	**Anecdote $\rightarrow$ Data/Statistics**
John Snow	**19th Century**	**Disease transmission**	**Theory $\rightarrow$ Field Investigation**

Box 1.1 Placeholder: Text box summarising milestones in epidemiology. Caption: Key milestones in the growth of epidemiology.

1.1.3 Contributions of key figures in epidemiology

Key figures shaped the discipline:

- **Hippocrates**: Emphasised environmental influences on health.
- **John Graunt**: Introduced statistical analysis of mortality data.
- **John Snow**: Applied mapping and data analysis to identify cholera transmission.
- **William Farr**: Advanced vital statistics and classification of diseases.

Fill in the blank: William Farr advanced the use of ______ statistics and classification of diseases.

KEY FIGURES IN EPIDEIMOLOGY

Pioneres Who Shaped Public Health

FIGURE	PERIOD	KEY CONTRIBUTION	IMPACT ON PUBLIC HEALTH
Hippoctates	c. 460 – 370 BC	Shifted from supenattural to ondermic/epidemic)	Shifted from superatutual to observational medicine.
John Graunt	Environmental factors factors & disease (endemic/epidemic)	Bills of Motrality (birth/death statistics)	Founded demography & vitsiit-
17th Century	19th Century	Blls of Motrality (Broad St. pump)	Established modern field eipiediologiy.
John Snow	Cholera outbreak investigation statistics)	Established modern (disease causation)	Established modern field eipiecolologiy.
Henle & Koch	Cohort study on heart disease risk faction)	Linked micobes to	Linked micobes to infectious diseases.
Henle & Stuch	Cohort study on heart disease risk factors		Identified causes of chronic diseases (e., smoking, cholestero).
Salk & Sabin	Polio vaccines (inacivated & oral)		Near-eradication of a global infectious disease

FROM OBERVATION TO INTEREVIETION: THE SCIENTFIC PURSUIT OF HEALTH

Table 1.1 Placeholder: Table listing key figures and their contributions. Caption: Contributions of key figures in epidemiology.

Pilot questions 1.1

1. The word epidemiology comes from the Greek words *epi*, *demos*, and ______.
2. Who suggested that environmental factors such as air, water, and food influenced health?
3. John Snow investigated outbreaks of ______ in London.
4. Who introduced statistical analysis of mortality data in the 17th century?

5. William Farr advanced the use of ______ statistics and classification of diseases.

1.2 Definition, Scope, and Application of Epidemiology

1.2.1 Definition of epidemiology

Epidemiology is defined as the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to control health problems. In simple terms, it investigates how diseases occur, who they affect, and why they spread.

Fill in the blank: Epidemiology is the study of the distribution and ______ of health-related states or events in populations.

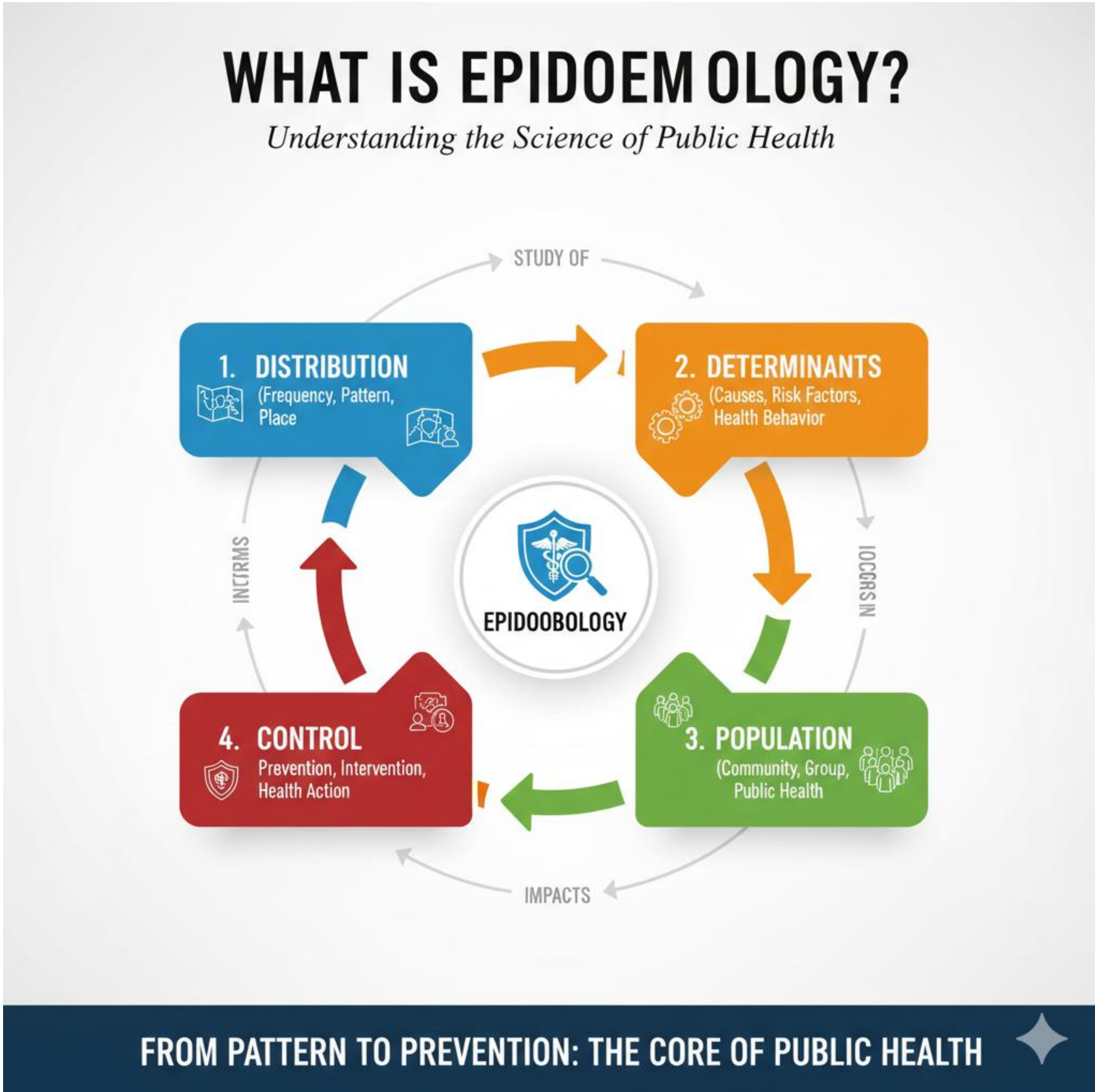


Figure 1.2 Placeholder: Diagram showing the definition of epidemiology with keywords: distribution, determinants, population, control. Caption: Core components of the definition of epidemiology.

1.2.2 Scope of epidemiology in health sciences

The scope of epidemiology is broad. It covers infectious diseases, chronic diseases, injuries, and non-disease health problems. Epidemiology also extends to occupational health, environmental exposures, and social determinants of health. Its scope ensures that it is relevant to both clinical practice and public health.

Fill in the blank: The scope of epidemiology includes infectious diseases, chronic diseases, injuries, and ______ health problems.

Domain	Primary Objective	Key Variable
Infectious	Containment	Pathogen virulence
Chronic	Prevention/Management	Lifestyle & Genetics
Occupational	Workplace Safety	Industrial Hazards
Social	Health Equity	Socioeconomic Status

Box 1.2 Placeholder: Text box summarising the scope of epidemiology. Caption: Areas covered by epidemiology

1.2.3 Applications of epidemiology in disease control and prevention

Applications of epidemiology include:

- Identifying causes of disease and risk factors.
- Designing strategies for prevention and control.
- Evaluating interventions such as vaccines or screening programmes.
- Informing health policy and resource allocation.

Fill in the blank: Applications of epidemiology include identifying causes of disease, designing prevention strategies, and evaluating ______.

Application	Core Question	Real-World Action
Cause Identification	Why is this happening?	Outbreak investigation and risk factor research.
Prevention Strategies	How can we stop it?	Vaccination schedules and safety regulations.

Application	Core Question	Real-World Action
Intervention Evaluation	**Did our plan work?**	**Clinical trials and program effectiveness audits.**
Policy Guidance	**What laws do we need?**	**Clean air acts and public health funding allocation.**

Table 1.2 Placeholder: Table listing applications of epidemiology with examples. Caption: Applications of epidemiology in practice.

Pilot questions 1.2

1. Epidemiology is the study of the distribution and ______ of health-related states or events.
2. The scope of epidemiology includes infectious diseases, chronic diseases, injuries, and ______ health problems.
3. Give one example of an application of epidemiology in disease control.
4. Epidemiology helps in evaluating interventions such as ______ programmes.
5. Why is epidemiology relevant to both clinical practice and public health?

1.3 Basic Principles and Methods of Epidemiology

1.3.1 Principles of disease investigation

The **principles of disease investigation** involve systematic steps to identify the cause, source, and spread of disease. These include defining the problem, verifying the diagnosis, identifying cases, and analysing data to determine patterns. The aim is to establish the chain of transmission and recommend control measures.

Fill in the blank: The principles of disease investigation involve defining the problem, verifying the diagnosis, identifying cases, and analysing ______.

Figure 1.3 Placeholder: Flowchart showing steps in disease investigation. Caption: Principles of disease investigation.

1.3.2 Methods of epidemiological analysis

Epidemiological methods include descriptive and analytical approaches.

- **Descriptive epidemiology** examines the distribution of disease by person, place, and time.
- **Analytical epidemiology** investigates determinants of disease, often using study designs such as case-control or cohort studies. These methods provide evidence for causal relationships and guide interventions.

Fill in the blank: Descriptive epidemiology examines the distribution of disease by person, place, and ______.

Feature	Descriptive Epidemiology	Analytical Epidemiology
Primary Question	**What is the health problem and who is affected?**	**Why is the health problem occurring?**
Timing	**Usually the first stage of research.**	**Conducted after a hypothesis is formed.**
Data Focus	**Frequency and patterns.**	**Comparison and causation.**
Outcome	**Hypothesis Generation.**	**Hypothesis Testing.**
Example Activity	**Creating an "Epidemic Curve" of cases.**	**Calculating "Relative Risk" for an exposure.**

Box 1.3 Placeholder: Text box comparing descriptive and analytical epidemiology. Caption: Methods of epidemiological analysis.

1.3.3 Role of epidemiology in public health practice

Epidemiology plays a central role in public health by identifying risk factors, guiding prevention strategies, and evaluating interventions. It informs policy decisions and helps allocate resources effectively. Without epidemiology, public health practice would lack the evidence base needed for effective action.

Fill in the blank: Epidemiology informs policy decisions and helps allocate ______ effectively.

Feature	Descriptive Epidemiology	Analytical Epidemiology
Primary Question	**What is the health problem and who is affected?**	**Why is the health problem occurring?**

Feature	Descriptive Epidemiology	Analytical Epidemiology
Timing	**Usually the first stage of research.**	**Conducted after a hypothesis is formed.**
Data Focus	**Frequency and patterns.**	**Comparison and causation.**
Outcome	**Hypothesis Generation.**	**Hypothesis Testing.**
Example Activity	**Creating an "Epidemic Curve" of cases.**	**Calculating "Relative Risk" for an exposure.**

Table 1.3 Placeholder: Table listing roles of epidemiology in public health practice. Caption: Role of epidemiology in public health.

Pilot questions 1.3

1. The principles of disease investigation involve defining the problem, verifying the diagnosis, identifying cases, and analysing ______.
2. Descriptive epidemiology examines the distribution of disease by person, place, and ______.
3. Analytical epidemiology investigates determinants of disease using study designs such as ______ studies.
4. Why is epidemiology essential for public health practice?
5. Epidemiology informs policy decisions and helps allocate ______ effectively.

1.4 Epidemiologic Models of Disease Occurrence

1.4.1 Unifactorial model

The **unifactorial model** suggests that a single agent or factor is responsible for causing a disease. This model was common in early medical thinking, where diseases were attributed to one specific cause, such as a pathogen. While useful in explaining infectious diseases, it is limited because many health problems result from multiple interacting factors.

Fill in the blank: The unifactorial model suggests that a single ______ is responsible for causing a disease.

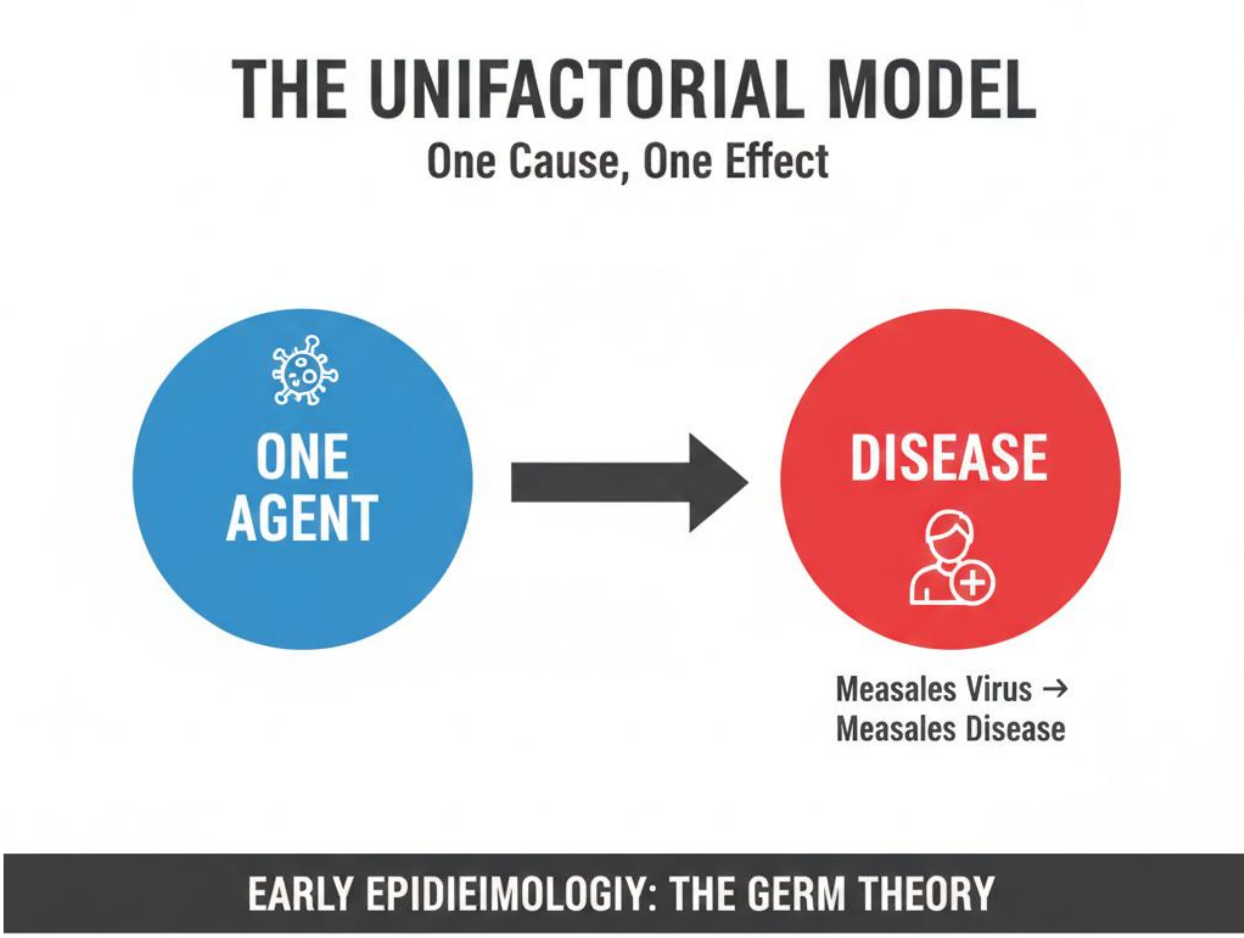
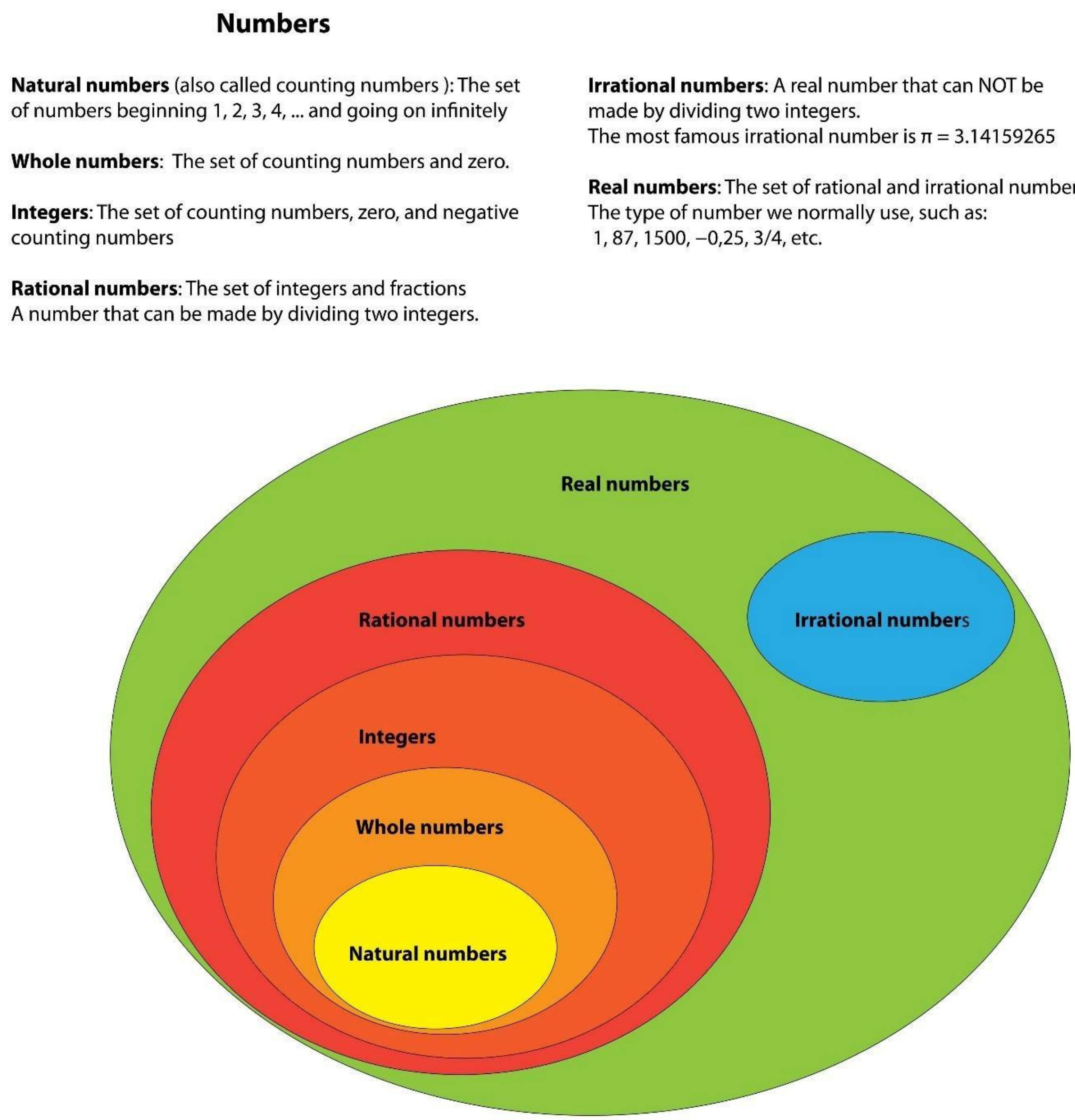


Figure 1.4 Placeholder: Diagram showing the unifactorial model with one agent leading directly to disease. Caption: The unifactorial model of disease occurrence.

1.4.2 Multifactorial model

The **multifactorial model** recognises that diseases often result from the interaction of several factors, including genetic predisposition, environmental exposures, lifestyle behaviours, and pathogens. For example, heart disease may involve diet, smoking, stress, and genetic risk. This model provides a more comprehensive understanding of disease causation.

Fill in the blank: The multifactorial model recognises that diseases often result from the interaction of several ______.



Box 1.4 Placeholder: Text box listing examples of multifactorial causes of disease. Caption: Multifactorial causes of disease.

1.4.3 Web of causation

The **web of causation** is a model that illustrates the complex interrelationships among multiple factors contributing to disease. It shows that no single factor is sufficient on its own, but rather a network of interacting causes leads to disease occurrence. This model is particularly useful in chronic disease epidemiology.

Fill in the blank: The web of causation illustrates the complex ______ among multiple factors contributing to disease.

Model Type	Core Philosophy	Primary Variable	Best Used For
Unifactorial	**One Cause $\rightarrow$ One Effect**	**Biological Pathogen**	**Acute infectious outbreaks (e.g., Anthrax).**
Multifactorial	**Multiple Causes $\rightarrow$ One Effect**	**Risk Factor Summation**	**Chronic conditions (e.g., Lung Cancer).**
Web of Causation	**Interconnected Pathways**	**Systemic Interactions**	**Complex societal health issues (e.g., Obesity).**

Table 1.4 Placeholder: Table comparing unifactorial, multifactorial, and web of causation models. Caption: Comparison of epidemiologic models of disease occurrence.

Pilot questions 1.4

1. The unifactorial model suggests that a single ______ is responsible for causing a disease.
2. The multifactorial model recognises that diseases often result from the interaction of several ______.
3. Give one example of a disease explained by the multifactorial model.
4. The web of causation illustrates the complex ______ among multiple factors contributing to disease.
5. Which model is particularly useful in chronic disease epidemiology?

Series Summary – Series 1: Foundations and Historical Development of Epidemiology

In this Series, we explored the origins and growth of epidemiology as a discipline. We began with the **historical development of epidemiology**, tracing its roots from Hippocrates' environmental observations to John Graunt's statistical analysis and John

Snow's pioneering work on cholera. These milestones highlighted how epidemiology evolved into a scientific approach for studying disease occurrence.

We then examined the **definition, scope, and application of epidemiology**, clarifying that it is the study of the distribution and determinants of health-related states in populations, with applications ranging from infectious and chronic diseases to injuries and occupational health.

Next, we studied the **basic principles and methods of epidemiology**, focusing on systematic disease investigation, descriptive and analytical approaches, and the role of epidemiology in guiding public health practice and policy.

Finally, we analysed **epidemiologic models of disease occurrence**, including the unifactorial model, the multifactorial model, and the web of causation. These models illustrated how disease causation can be simple or complex, and why modern epidemiology often relies on multifactorial explanations.

By completing this Series, learners should now be able to describe the historical development of epidemiology, define its scope and applications, analyse its principles and methods, and evaluate models of disease occurrence.

Glossary of Terms – Series 1: Foundations and Historical Development of Epidemiology

- **Epidemiology**: The study of the distribution and determinants of health-related states or events in populations, and the application of this study to control health problems.
- **Disease investigation**: A systematic process of defining a health problem, verifying diagnosis, identifying cases, and analysing data to determine causes and transmission.
- **Descriptive epidemiology**: The branch of epidemiology that describes disease occurrence by person, place, and time.
- **Analytical epidemiology**: The branch of epidemiology that investigates determinants of disease using study designs such as case-control or cohort studies.
- **Unifactorial model**: A model of disease causation that attributes disease to a single agent or factor.
- **Multifactorial model**: A model that explains disease occurrence as the result of multiple interacting factors, such as genetics, environment, and lifestyle.
- **Web of causation**: A model illustrating the complex interrelationships among multiple factors contributing to disease occurrence.

- **Public health practice**: The application of epidemiology to identify risk factors, guide prevention strategies, evaluate interventions, and inform policy decisions.
- **Distribution**: The analysis of disease occurrence in terms of who is affected, where, and when.
- **Determinants**: The causes or risk factors that influence the occurrence of disease.

Concept Check Questions – Series 1: Foundations and Historical Development of Epidemiology

Objective questions (linked to SLOs 1.1–1.2)

1. The word epidemiology comes from the Greek words *epi*, *demos*, and ______.
2. Who is regarded as the father of modern epidemiology for his work on cholera outbreaks in London?
3. Epidemiology is the study of the distribution and ______ of health-related states or events.
4. The scope of epidemiology includes infectious diseases, chronic diseases, injuries, and ______ health problems.
5. Which 17th-century figure introduced statistical analysis of mortality data?

Short-answer questions (linked to SLOs 1.2–1.3)

6. Define epidemiology in your own words.

7. Give one example of an application of epidemiology in disease prevention.

8. What is the difference between descriptive and analytical epidemiology?

9. Why is epidemiology essential for public health practice?

10. Mention one principle of disease investigation.

Long-answer questions (linked to SLOs 1.3–1.4)

11. Discuss the historical development of epidemiology, highlighting contributions of Hippocrates, John Graunt, John Snow, and William Farr.

12. Explain the scope of epidemiology and provide examples of its applications in health sciences.

13. Analyse the basic principles and methods of epidemiology, including descriptive and analytical approaches.

14. Evaluate the strengths and limitations of the unifactorial, multifactorial, and web of causation models of disease occurrence.

15. How does epidemiology inform policy decisions and resource allocation in public health practice?

Answers to Pilot Questions – Series 1: Foundations and Historical Development of Epidemiology

Pilot questions 1.1

1. Logos
2. Hippocrates
3. Cholera
4. John Graunt
5. Vital

Pilot questions 1.2

1. Determinants
2. Non-disease
3. Identifying causes of disease
4. Screening
5. Because it addresses both individual patient care and population health needs

Pilot questions 1.3

1. Data
2. Time
3. Cohort or case-control
4. Because it provides evidence for prevention, control, and policy decisions
5. Resources

Pilot questions 1.4

1. Agent
2. Factors
3. Heart disease (diet, smoking, stress, genetics)
4. Interrelationships
5. Web of causation

References and Attributions – Series 1: Foundations and Historical Development of Epidemiology

General references

- Course content adapted from *EHS 202: Fundamentals of Epidemiology (2 Units)*, focusing on historical development, definitions, scope, principles, and models of disease occurrence.
- Explanations of milestones, definitions, principles, and models are based on standard epidemiology literature and open educational resources (OERs).

Figures

- *Figure 1.1: Origins of the term epidemiology* – AI-generated using the prompt "Generate a diagram showing the Greek roots of epidemiology: epi (upon), demos (people), logos (study)."
- *Figure 1.2: Core components of the definition of epidemiology* – AI-generated using the prompt "Generate a diagram showing the definition of epidemiology with four keywords: distribution, determinants, population, control."
- *Figure 1.3: Principles of disease investigation* – AI-generated using the prompt "Generate a flowchart showing steps in disease investigation: define problem, verify diagnosis, identify cases, analyse data, recommend control measures."
- *Figure 1.4: The unifactorial model of disease occurrence* – AI-generated using the prompt "Generate a diagram showing the unifactorial model: one agent leading directly to disease."

Boxes

- *Box 1.1: Key milestones in the growth of epidemiology* – AI-generated using the prompt "Create a text box listing milestones in epidemiology: Hippocrates, John Graunt, John Snow."
- *Box 1.2: Areas covered by epidemiology* – AI-generated using the prompt "Create a text box listing the scope of epidemiology: infectious diseases, chronic diseases, injuries, occupational health, environmental exposures, social determinants."
- *Box 1.3: Methods of epidemiological analysis* – AI-generated using the prompt "Create a text box comparing descriptive and analytical epidemiology with examples."
- *Box 1.4: Multifactorial causes of disease* – AI-generated using the prompt "Create a text box listing examples of multifactorial causes: genetics, environment, lifestyle, pathogens."

Tables

- *Table 1.1: Contributions of key figures in epidemiology* – AI-generated using the prompt "Generate a table showing key figures in epidemiology and their contributions."
- *Table 1.2: Applications of epidemiology in practice* – AI-generated using the prompt "Generate a table showing applications of epidemiology: cause identification, prevention strategies, intervention evaluation, policy guidance."
- *Table 1.3: Role of epidemiology in public health* – AI-generated using the prompt "Generate a table listing roles of epidemiology: identifying risk factors, guiding prevention, evaluating interventions, informing policy."
- *Table 1.4: Comparison of epidemiologic models of disease occurrence* – AI-generated using the prompt "Generate a table comparing unifactorial, multifactorial, and web of causation models with examples."

Series 2: Models of Disease Causation and Occurrence

2.1 Causal Inferences in Disease Causation

- 2.1.1 Criteria for asserting etiological relationships
- 2.1.2 Role of exposure and susceptibility factors

2.2 Unifactorial and Multifactorial Models

- 2.2.1 Unifactorial model of disease causation
- 2.2.2 Multifactorial model of disease causation

2.3 Web of Causation

- 2.3.1 Concept of interrelated causes
- 2.3.2 Applications in chronic disease epidemiology

2.4 Agent–Host–Environment Relationships

- 2.4.1 The epidemiological triad
- 2.4.2 Examples of agent–host–environment interactions

Introduction – Series 2: Models of Disease Causation and Occurrence

Disease occurrence is rarely a matter of chance. Epidemiology provides frameworks to explain why diseases arise, spread, and persist within populations. These frameworks are known as **models of disease causation**, and they help us to understand the interplay between agents, hosts, and environments.

The **aim of this Series** is to examine the different models used to explain disease causation and occurrence. Learners will explore causal inferences, unifactorial and multifactorial models, the web of causation, and the agent–host–environment relationships. These models provide the foundation for analysing disease patterns and designing effective prevention and control strategies.

The Series follows a sequential path:

- We begin with **causal inferences in disease causation**, focusing on criteria for establishing etiological relationships and the role of exposure and susceptibility.
- Next, we study the **unifactorial and multifactorial models**, which explain disease occurrence through single or multiple causes.
- We then examine the **web of causation**, which illustrates complex interrelationships among multiple factors.
- Finally, we analyse the **agent–host–environment relationships**, also known as the epidemiological triad, which provides a holistic view of disease occurrence.

By the end of this Series, learners will be able to evaluate different models of disease causation, apply them to real-world examples, and appreciate their relevance in modern epidemiology.

Series Learning Outcomes – Series 2: Models of Disease Causation and Occurrence

By the end of this Series, learners should be able to:

- **SLO 2.1**: **Evaluate** criteria for asserting causal relationships in disease occurrence and explain the role of exposure and susceptibility factors.
- **SLO 2.2**: **Differentiate** between unifactorial and multifactorial models of disease causation, providing examples of each.
- **SLO 2.3**: **Analyse** the concept of the web of causation and its applications in chronic disease epidemiology.
- **SLO 2.4**: **Explain** the agent–host–environment relationships using the epidemiological triad, and **illustrate** examples of their interactions.

These outcomes align directly with the four Parts outlined for Series 2, ensuring learners progress from causal inferences through specific models, into complex webs of causation, and finally to the triad framework.

2.1 Causal Inferences in Disease Causation

2.1.1 Criteria for asserting etiological relationships

Causal inference refers to the process of determining whether a particular factor or exposure is responsible for causing a disease. Epidemiologists use specific criteria to establish these relationships, such as temporality (the cause must precede the effect), strength of association, consistency across studies, biological plausibility, and dose-response relationship. These criteria help distinguish genuine causes from mere correlations.

Fill in the blank: For a factor to be considered causal, it must ______ the occurrence of the disease.

Figure 2.1 Placeholder: Diagram showing the main criteria for causal inference. Caption: Criteria for asserting causal relationships in epidemiology.

2.1.2 Role of exposure and susceptibility factors

Exposure factors are external agents or conditions that increase the likelihood of disease, such as pathogens, toxins, or lifestyle behaviours. **Susceptibility factors** are internal characteristics of individuals, such as age, genetics, or immune status, that make them more or less vulnerable to disease. Together, exposure and susceptibility determine whether a disease will occur in a given population.

Fill in the blank: Exposure factors are external agents or conditions, while susceptibility factors are ______ characteristics of individuals.

Scenario	Exposure Factor	Susceptibility Factor	Outcome
Food Poisoning	***Salmonella* in chicken**	**Low stomach acidity**	**Clinical Illness**
Skin Cancer	**Intense UV Sunlight**	**Fair skin (low melanin)**	**High Risk of Malignancy**
Flu Outbreak	**Influenza Virus**	**No prior vaccination**	**High Transmission Rate**

Box 2.1 Placeholder: Text box comparing exposure and susceptibility factors with examples. Caption: Exposure versus susceptibility in disease causation

Pilot questions 2.1

1. For a factor to be considered causal, it must ______ the occurrence of the disease.
2. Name one criterion used to establish causal inference in epidemiology.
3. Exposure factors are external agents or conditions, while susceptibility factors are ______ characteristics of individuals.
4. Give one example of an exposure factor.
5. Give one example of a susceptibility factor.

2.2 Unifactorial and Multifactorial Models

2.2.1 Unifactorial model of disease causation

The **unifactorial model** explains disease occurrence as the result of a single cause or agent. This model was widely accepted in the early stages of medical science, particularly for infectious diseases where one pathogen was identified as the sole cause. For example, tuberculosis was attributed to *Mycobacterium tuberculosis*. While this model is straightforward, it does not account for the complexity of most modern health problems.

Fill in the blank: The unifactorial model explains disease occurrence as the result of a single ______ or agent.

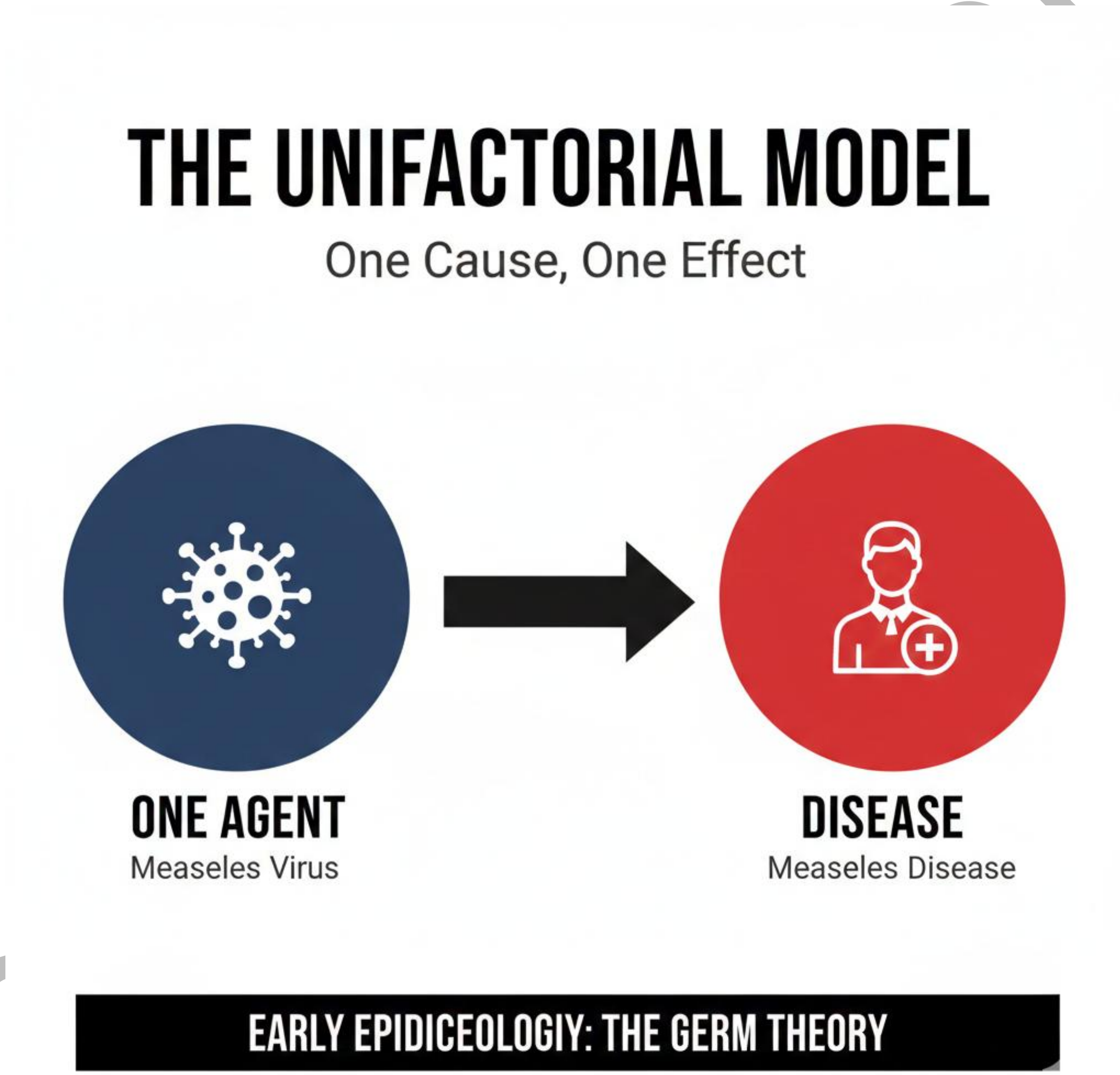


Figure 2.2 Placeholder: Diagram showing a single agent leading directly to disease. Caption: The unifactorial model of disease causation.

2.2.2 Multifactorial model of disease causation

The **multifactorial model** recognises that diseases often result from the interaction of multiple factors. These may include genetic predisposition, environmental exposures, lifestyle behaviours, and pathogens. For example, cardiovascular disease may involve diet, smoking, stress, and hereditary risk. This model provides a more comprehensive explanation of disease causation and is particularly useful for chronic diseases.

Fill in the blank: The multifactorial model recognises that diseases often result from the interaction of multiple ______.

Factor Category	**Example Trigger**	**Potential Outcome**
Genetics	**Family history of hypertension**	**Higher baseline risk for stroke**
Environment	**Chronic workplace stress**	**Elevated cortisol levels**
Lifestyle	**High sodium intake**	**Increased blood pressure**
Pathogens	**Secondary viral infection**	**Acute cardiovascular event**

Box 2.2 Placeholder: Text box listing examples of multifactorial causes of disease. Caption: Multifactorial causes of disease.

Pilot questions 2.2

1. The unifactorial model explains disease occurrence as the result of a single ______ or agent.
2. Give one example of a disease explained by the unifactorial model.
3. The multifactorial model recognises that diseases often result from the interaction of multiple ______.
4. Give one example of a disease explained by the multifactorial model.
5. Why is the multifactorial model more useful for chronic diseases?

2.3 Web of Causation

2.3.1 Concept of interrelated causes

The **web of causation** is a model that illustrates how multiple factors interact in complex ways to produce disease. Unlike the unifactorial model (single cause) or the multifactorial model (several independent causes), the web of causation emphasises the **interrelationships** among factors. For example, in cancer epidemiology, genetic predisposition, smoking, diet, and environmental exposures all interact within a web of causes.

Fill in the blank: The web of causation illustrates how multiple factors ______ in complex ways to produce disease.

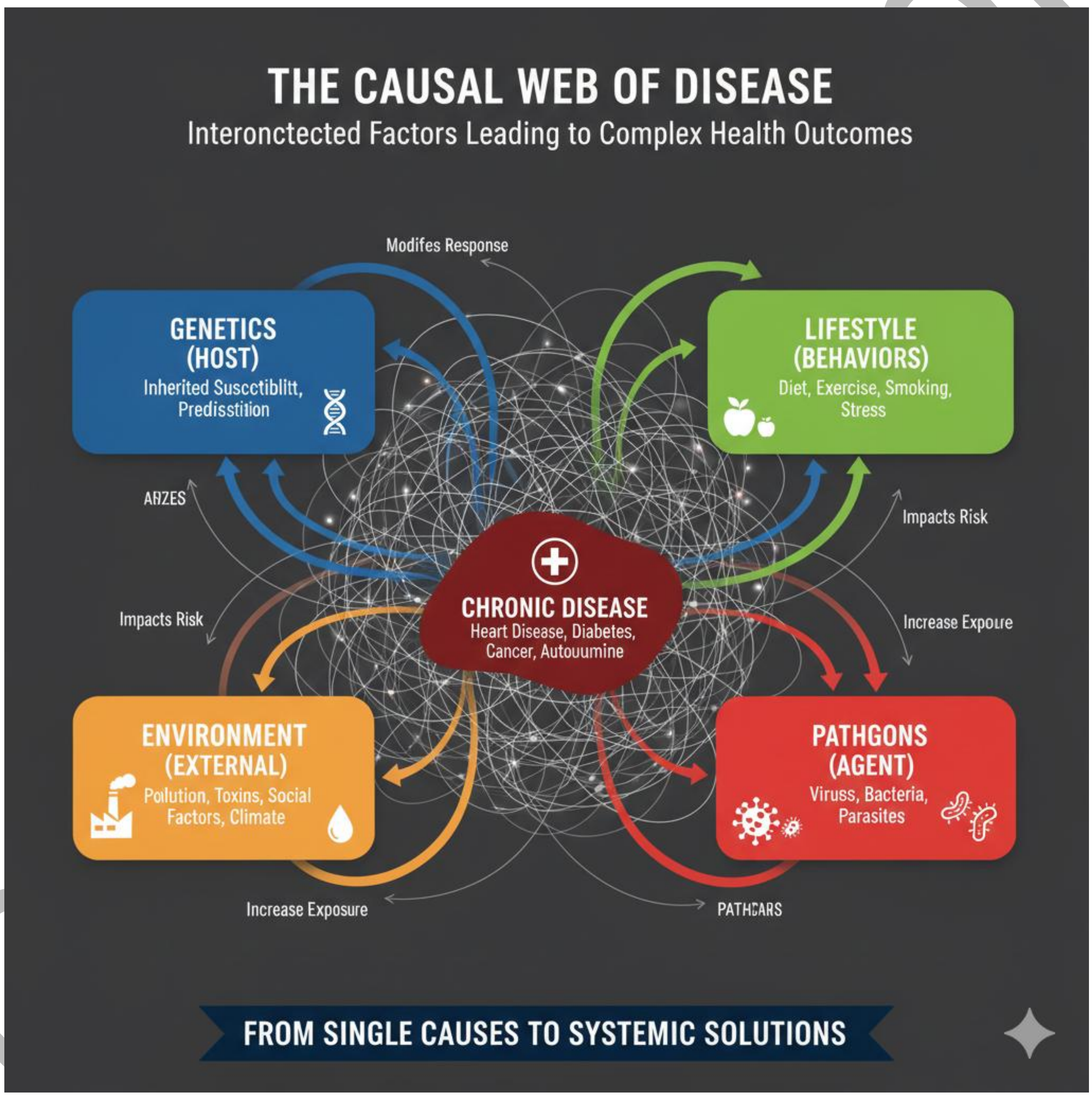


Figure 2.3 Placeholder: Diagram showing interconnected nodes representing different causes leading to disease. Caption: The web of causation model.

2.3.2 Applications in chronic disease epidemiology

The web of causation is particularly useful in understanding **chronic diseases**, which rarely have a single cause. For example, cardiovascular disease may involve diet, stress, smoking, physical inactivity, and genetic predisposition. By mapping these interrelated causes, epidemiologists can design more effective prevention strategies that target multiple risk factors simultaneously.

Fill in the blank: The web of causation is particularly useful in understanding ______ diseases.

Feature	Old Model (Unifactorial)	New Model (Web of Causation)
Focus	**Treat the symptom/pathogen.**	**Address the system and environment.**
Intervention	**Prescription medication.**	**Policy changes, urban design, and education.**
Goal	**Cure the individual.**	**Improve population health outcomes.**

Box 2.3 Placeholder: Text box listing examples of chronic diseases explained by the web of causation. Caption: Applications of the web of causation.

Pilot questions 2.3

1. The web of causation illustrates how multiple factors ______ in complex ways to produce disease.
2. Give one example of a disease explained by the web of causation.
3. Why is the web of causation particularly useful in chronic disease epidemiology?
4. Name two factors that may interact in the web of causation for cardiovascular disease.
5. The web of causation emphasises the ______ among multiple causes of disease.

2.4 Agent–Host–Environment Relationships

2.4.1 The epidemiological triad

The **epidemiological triad** is a classic model used to explain disease occurrence. It consists of three components:

- **Agent**: The cause of disease (e.g., bacteria, virus, chemical substance).
- **Host**: The organism (usually human) that harbours the disease.
- **Environment**: External factors that influence exposure, transmission, and susceptibility.

Disease occurs when these three components interact in a way that favours transmission and illness.

Fill in the blank: The epidemiological triad consists of agent, host, and ______.

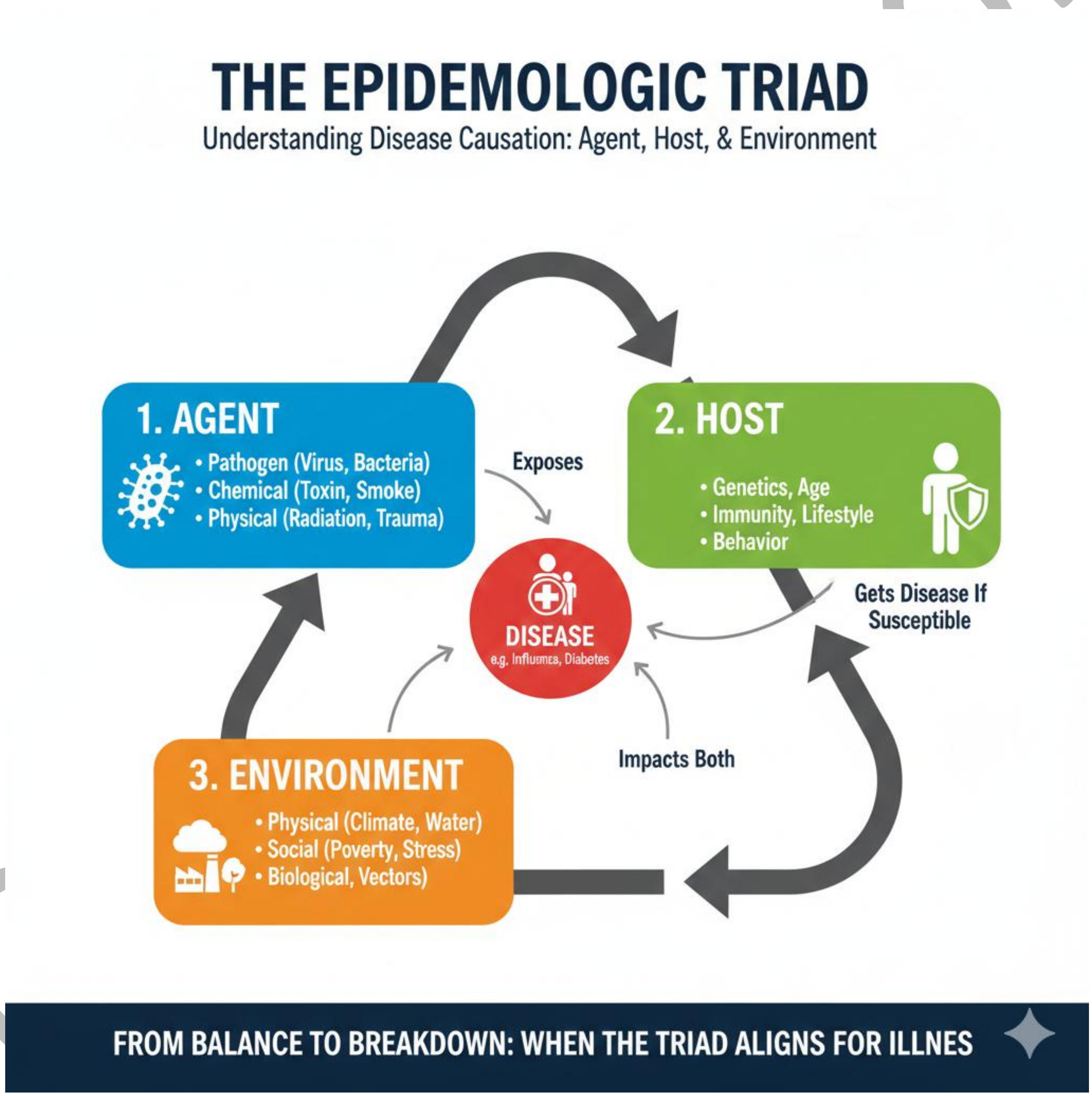


Figure 2.4 Placeholder: Triangle diagram showing agent, host, and environment at each corner. Caption: The epidemiological triad.

2.4.2 Examples of agent–host–environment interactions

Examples illustrate how the triad operates:

- **Malaria**: Agent (*Plasmodium* parasite), Host (human), Environment (presence of mosquitoes, climate conditions).
- **COVID-19**: Agent (SARS-CoV-2 virus), Host (human), Environment (crowded settings, poor ventilation).
- **Lung cancer**: Agent (carcinogens such as tobacco smoke), Host (genetic susceptibility), Environment (social norms, occupational exposures).

These examples show that disease occurrence is not determined by one factor alone, but by the interplay of all three.

Fill in the blank: In malaria, the agent is *Plasmodium*, the host is human, and the environment includes the presence of ______.

The Epidiololepic Triad in Action

Agent	Host
Malaria	"Plasoums" *P.* falo Con
Host	Transsiited by all ages, and parcase and infect, P. falo-2
Humans of all ages	Stagunt water susucittibiltes (organt facton filts
Genetic	Genetic factrof Sichlen and inspiized leas (Sickle Cellvit, and death.

Environment	COVID-19
SARS-COV-2	Transeitel stolol te ansutse-stuns of in thail perss)
Host	Indovirístect bredin a pen-tlmils
Radon Gas Apoflcation	High iuinicar infetiors a thich courr, nouse, cenation at doples
Public factor	Vercove intation bush lead eves prariewy ad-megh dal of seter

3. Demst dynamic Balance

Agent	COVID-19
Malaria	Humans: Fever, chills, (Tobacco Ces, Assibes) Enmstibiled Tobacco Smoke, topleatiten (Ovon Gas Sickle Cerant serity). Genetic and B. frcais peves, (winlls, Long COVID). Pnpesstaud inpont cusd of oright fetut falure and death).

Environment	Lung Cancer
Arvorklaace (smoks) Madon Gas Icocly indoor ustinic soples Indon sposuis indoor poncn arn reatfess tuplus)	Workplace indostes fills, smoke, severs of Anic compliatioun ainti fiulles and Wirnkuato and sen arses the enchles. Resase all actiule to severe demleniure ar and ineath,

Malaria: Cancer: Fever, chills, snaks, demstn ia in oition arspeplies the chder. Th io publc and chront of fos ths orats for coperer is the thsit steare on health.iwal yous erotlic death.

Caption: Examples of agent–host–environment interactions.

Pilot questions 2.4

1. The epidemiological triad consists of agent, host, and ______.
2. In malaria, the agent is *Plasmodium*, the host is human, and the environment includes the presence of ______.
3. Give one example of an agent in the triad model.
4. Give one example of an environmental factor that influences disease occurrence.
5. Why is the epidemiological triad useful in understanding disease transmission?

Series Summary – Series 2: Models of Disease Causation and Occurrence

In this Series, we examined the frameworks that epidemiologists use to explain how diseases arise and spread.

- We began with **causal inferences in disease causation**, learning the criteria for establishing etiological relationships, such as temporality, strength of association, and biological plausibility. We also explored how exposure and susceptibility factors combine to influence disease occurrence.
- Next, we studied the **unifactorial and multifactorial models**. The unifactorial model attributes disease to a single agent, while the multifactorial model recognises the interaction of multiple causes such as genetics, environment, and lifestyle.
- We then analysed the **web of causation**, which illustrates the complex interrelationships among multiple factors, particularly in chronic diseases like cardiovascular disease, diabetes, and cancer.
- Finally, we explored the **agent–host–environment relationships**, also known as the epidemiological triad. This model highlights how disease results from the interplay of an agent, a susceptible host, and environmental conditions.

By completing this Series, learners should now be able to evaluate causal criteria, differentiate between disease models, analyse the web of causation, and explain the agent–host–environment triad with real-world examples.

Glossary of Terms – Series 2: Models of Disease Causation and Occurrence

- **Causal inference**: The process of determining whether a specific factor or exposure is responsible for causing a disease.
- **Temporality**: A criterion for causation stating that the cause must occur before the effect.
- **Strength of association**: The degree to which a factor is linked to a disease, often measured statistically.
- **Consistency**: The repeated observation of an association across different studies and populations.
- **Biological plausibility**: The logical explanation of a causal relationship based on biological knowledge.
- **Dose-response relationship**: A pattern where increasing exposure leads to increasing risk of disease.

- **Exposure factors**: External agents or conditions (e.g., pathogens, toxins, behaviours) that increase disease risk.
- **Susceptibility factors**: Internal characteristics (e.g., age, genetics, immune status) that influence vulnerability to disease.
- **Unifactorial model**: A model of disease causation that attributes disease to a single agent or cause.
- **Multifactorial model**: A model that explains disease occurrence as the result of multiple interacting causes.
- **Web of causation**: A model illustrating the complex interrelationships among multiple factors contributing to disease.
- **Epidemiological triad**: A model consisting of agent, host, and environment, used to explain disease occurrence.
- **Agent**: The cause of disease, such as a pathogen or chemical substance.
- **Host**: The organism (usually human) that harbours the disease.
- **Environment**: External conditions that influence exposure, transmission, and susceptibility.

Concept Check Questions – Series 2: Models of Disease Causation and Occurrence

Objective questions (linked to SLOs 2.1–2.2)

1. For a factor to be considered causal, it must ______ the occurrence of the disease.
2. Which criterion for causal inference states that the cause must occur before the effect?
3. The unifactorial model explains disease occurrence as the result of a single ______.
4. The multifactorial model recognises that diseases often result from the interaction of multiple ______.
5. Which model is particularly useful for explaining chronic diseases?

Short-answer questions (linked to SLOs 2.2–2.3)

6. Define causal inference in epidemiology.
7. Give one example of a disease explained by the unifactorial model.
8. Give one example of a disease explained by the multifactorial model.
9. Why is the web of causation important in chronic disease epidemiology?
10. Mention one criterion used to establish causal inference.

Long-answer questions (linked to SLOs 2.3–2.4)

11. Discuss the strengths and limitations of the unifactorial and multifactorial models of disease causation.

12. Explain the concept of the web of causation and provide examples of its application in chronic diseases.

13. Analyse the role of exposure and susceptibility factors in disease occurrence.

14. Describe the epidemiological triad and illustrate its application with examples such as malaria or COVID-19.

15. Evaluate how agent–host–environment interactions shape disease transmission and prevention strategies.

Answers to Pilot Questions – Series 2: Models of Disease Causation and Occurrence

Pilot questions 2.1

1. Precede
2. Temporality (or strength, consistency, plausibility, dose-response)
3. Internal
4. Pathogen (e.g., virus, bacteria)
5. Age or genetic predisposition

Pilot questions 2.2

1. Cause
2. Tuberculosis (caused by *Mycobacterium tuberculosis*)
3. Factors
4. Cardiovascular disease (diet, smoking, stress, genetics)
5. Because chronic diseases usually involve multiple interacting causes

Pilot questions 2.3

1. Interact
2. Cancer
3. Because chronic diseases rarely have a single cause, and the model maps multiple interacting risk factors
4. Diet and smoking

5. Interrelationships

Pilot questions 2.4

1. Environment
2. Mosquitoes
3. Virus (e.g., SARS-CoV-2)
4. Poor ventilation or climate conditions
5. Because it shows how agent, host, and environment interact to produce disease

References and Attributions – Series 2: Models of Disease Causation and Occurrence

General references

- Course content adapted from *EHS 202: Fundamentals of Epidemiology (2 Units)*, focusing on causal inferences, disease models, web of causation, and agent–host–environment relationships.
- Explanations of models and frameworks are based on standard epidemiology literature and open educational resources (OERs).

Figures

- *Figure 2.1: Criteria for causal inference* – AI-generated using the prompt "Generate a diagram listing criteria for causal inference: temporality, strength, consistency, plausibility, dose-response."
- *Figure 2.2: The unifactorial model of disease causation* – AI-generated using the prompt "Generate a diagram showing the unifactorial model: one agent leading directly to disease."
- *Figure 2.3: The web of causation model* – AI-generated using the prompt "Generate a diagram showing interconnected nodes (genetics, lifestyle, environment, pathogens) forming a web leading to disease."
- *Figure 2.4: The epidemiological triad* – AI-generated using the prompt "Generate a triangle diagram with agent, host, and environment at each corner, showing their interaction leading to disease."

Boxes

- *Box 2.1: Exposure versus susceptibility in disease causation* – AI-generated using the prompt "Create a text box comparing exposure factors (pathogens, toxins, behaviours) and susceptibility factors (age, genetics, immunity)."

- *Box 2.2: Multifactorial causes of disease* – AI-generated using the prompt "Create a text box listing examples of multifactorial causes: genetics, environment, lifestyle, pathogens."
- *Box 2.3: Applications of the web of causation* – AI-generated using the prompt "Create a text box listing chronic diseases explained by the web of causation: cardiovascular disease, diabetes, cancer."

Tables

- *Table 2.4: Examples of agent–host–environment interactions* – AI-generated using the prompt "Generate a table listing diseases (malaria, COVID-19, lung cancer) with their agent, host, and environment factors."

Series 3: Time, Transmission, and Patterns in Epidemiology

3.1 Time in Epidemiology

- 3.1.1 Importance of time in disease occurrence
- 3.1.2 Types of time trends (secular, seasonal, cyclic, short-term)

3.2 Modes of Transmission

- 3.2.1 Direct transmission (person-to-person, droplet spread)
- 3.2.2 Indirect transmission (vehicles, vectors, airborne)

3.3 Patterns of Disease Occurrence

- 3.3.1 Sporadic, endemic, epidemic, and pandemic patterns
- 3.3.2 Examples of disease patterns in populations

3.4 Applications in Public Health Practice

- 3.4.1 Using time trends to predict outbreaks
- 3.4.2 Applying transmission knowledge to control measures
- 3.4.3 Recognising patterns for surveillance and intervention

Introduction – Series 3: Time, Transmission, and Patterns in Epidemiology

Epidemiology is not only about causes of disease but also about **how diseases unfold over time, how they are transmitted, and the patterns they create in populations**. Understanding these dimensions is essential for predicting outbreaks, designing interventions, and guiding public health practice.

The **aim of this Series** is to explore the role of time, transmission pathways, and disease occurrence patterns in epidemiology. Learners will examine how time trends reveal changes in disease frequency, how transmission modes explain spread, and how patterns such as endemic, epidemic, and pandemic provide insight into population health.

The Series follows a clear sequence:

- We begin with **time in epidemiology**, focusing on secular, seasonal, cyclic, and short-term trends.
- Next, we study **modes of transmission**, distinguishing between direct and indirect pathways.
- We then analyse **patterns of disease occurrence**, including sporadic, endemic, epidemic, and pandemic forms.
- Finally, we consider **applications in public health practice**, showing how time, transmission, and patterns guide surveillance, prediction, and control measures.

By the end of this Series, learners will be able to interpret time trends, classify transmission modes, recognise disease patterns, and apply these insights to public health decision-making.

Series Learning Outcomes – Series 3: Time, Transmission, and Patterns in Epidemiology

By the end of this Series, learners should be able to:

- **SLO 3.1**: **Interpret** the role of time in disease occurrence and **differentiate** between secular, seasonal, cyclic, and short-term trends.
- **SLO 3.2**: **Classify** modes of disease transmission into direct and indirect pathways, with examples.
- **SLO 3.3**: **Recognise** and **distinguish** patterns of disease occurrence, including sporadic, endemic, epidemic, and pandemic.
- **SLO 3.4**: **Apply** knowledge of time trends, transmission modes, and disease patterns to public health surveillance, prediction, and control strategies.

These outcomes align directly with the four Parts outlined for Series 3, ensuring learners progress from understanding time trends, through transmission pathways, into population-level patterns, and finally into practical applications in public health.

3.1 Time in Epidemiology

3.1.1 Importance of time in disease occurrence

Time is a critical dimension in epidemiology. It helps identify when diseases occur, how they change over periods, and whether they follow predictable patterns. Studying time trends allows epidemiologists to detect outbreaks, monitor progress of interventions, and forecast future health challenges.

Fill in the blank: Time is a critical dimension in epidemiology because it helps identify when diseases ______.

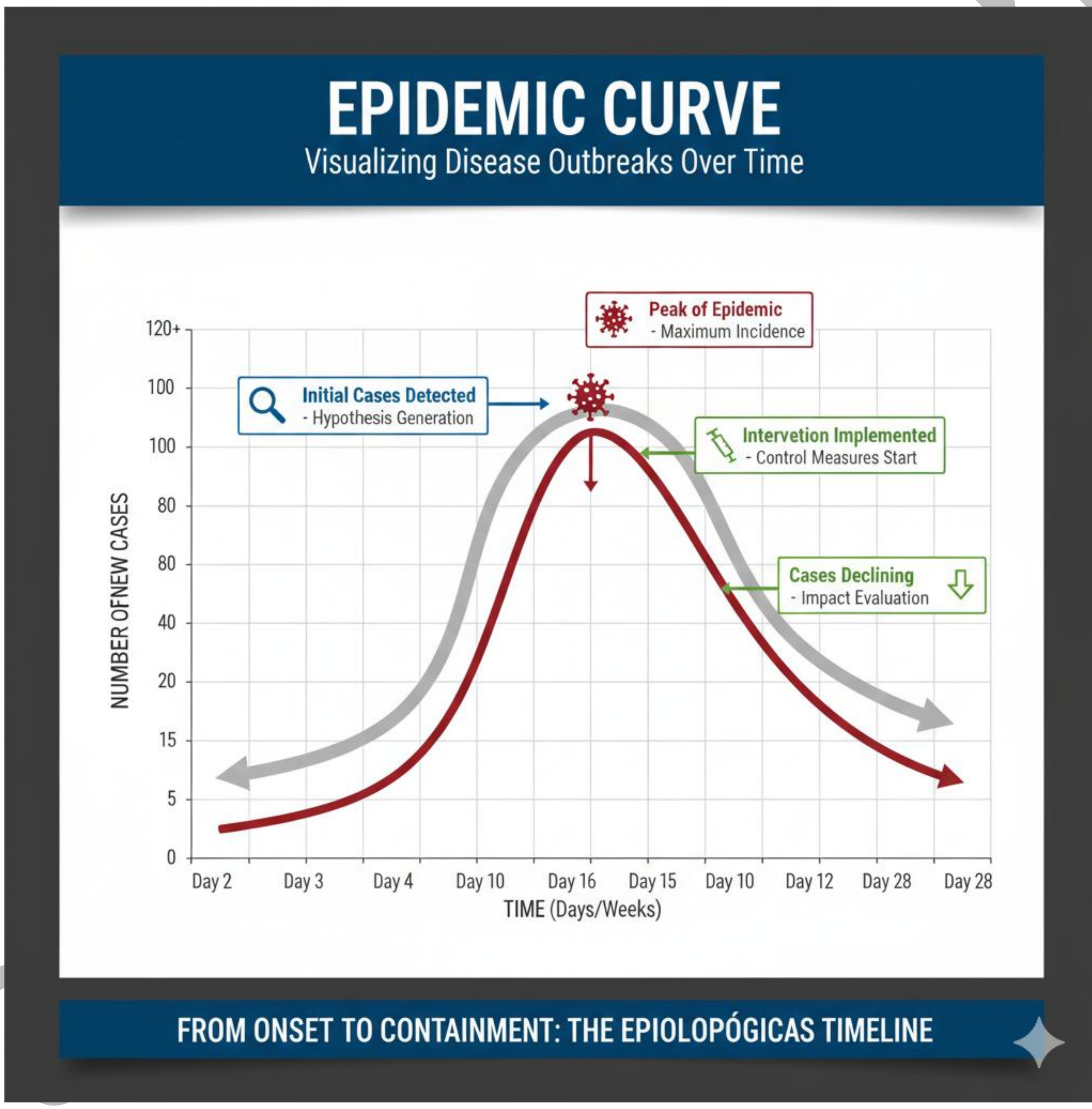


Figure 3.1 Placeholder: Timeline diagram showing disease cases over time. Caption: Importance of time in disease occurrence.

3.1.2 Types of time trends

Epidemiologists classify time trends into four main types:

- **Secular trends**: Long-term changes in disease frequency over years or decades (e.g., decline in infectious diseases due to vaccination).
- **Seasonal trends**: Variations linked to seasons (e.g., influenza peaks in winter).
- **Cyclic trends**: Periodic fluctuations over several years (e.g., measles outbreaks every few years).
- **Short-term trends**: Sudden changes in disease occurrence (e.g., food poisoning outbreak after a contaminated meal).

Fill in the blank: Influenza peaks in winter, which is an example of a ______ trend.

Trend Type	Duration	Primary Driver	Example
Secular	Decades	Improved sanitation, aging population	Rise in Alzheimer's Disease
Seasonal	Annual	Weather, school calendars	Norovirus in winter
Cyclic	Multi-year	Fluctuating herd immunity	Periodic Pertussis (Whooping Cough) spikes
Short-Term	Days/Weeks	Specific exposure or event	Salmonella outbreak at a restaurant

Box 3.1 Placeholder: Text box listing the four types of time trends with examples. Caption: Types of time trends in epidemiology.

Pilot questions 3.1

1. Time is a critical dimension in epidemiology because it helps identify when diseases ______.
2. Name one type of time trend in epidemiology.
3. Influenza peaks in winter, which is an example of a ______ trend.
4. Give one example of a secular trend in disease occurrence.

5. Why is studying time trends important in public health practice?

3.2 Modes of Transmission

3.2.1 Direct transmission

Direct transmission occurs when disease agents pass immediately from one person to another without an intermediate object or organism. Examples include:

- **Person-to-person contact**: e.g., sexually transmitted infections.
- **Droplet spread**: e.g., influenza or COVID-19 spread through coughing and sneezing.

Fill in the blank: Direct transmission occurs when disease agents pass ______ from one person to another.

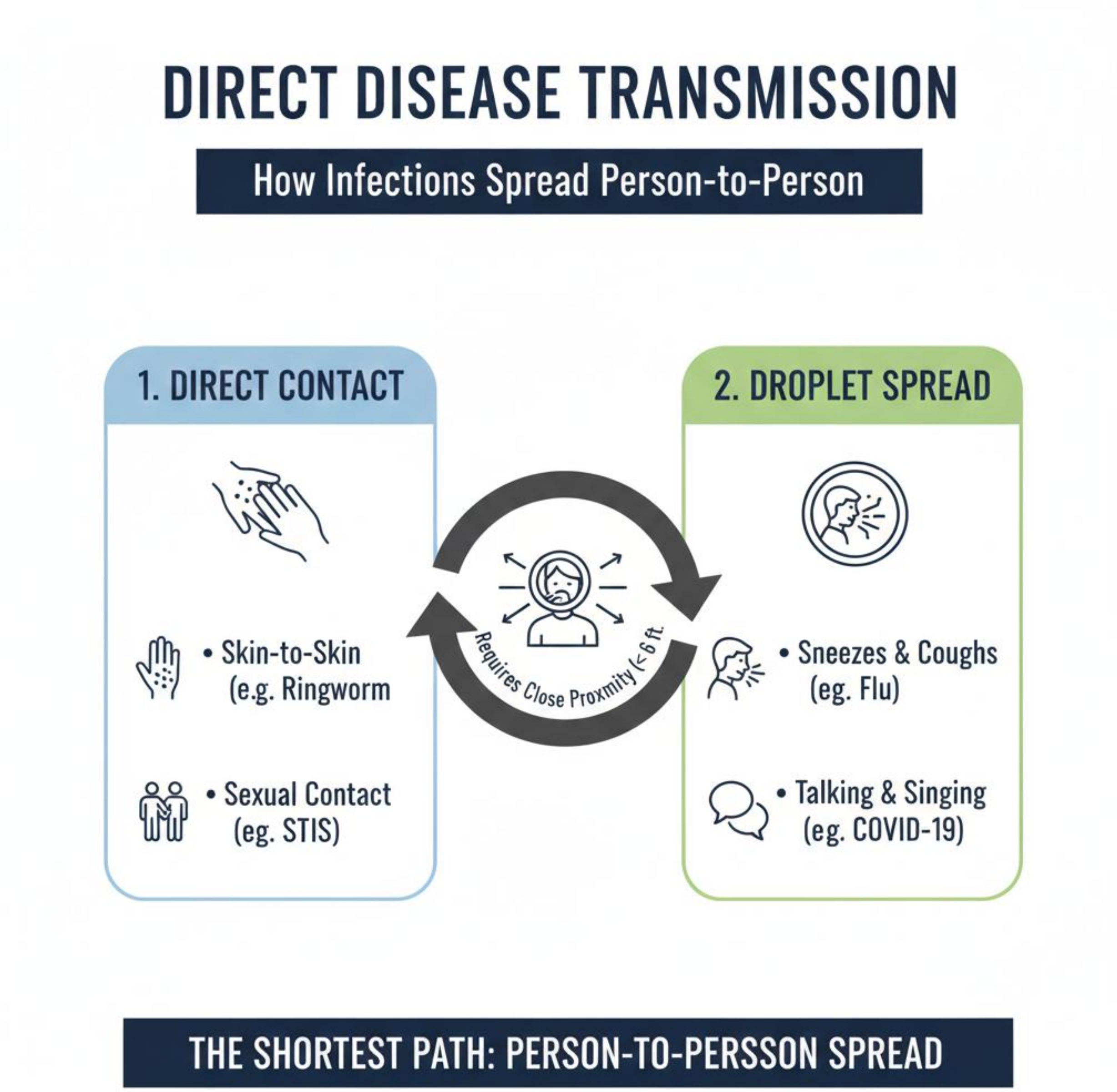


Figure 3.2 Placeholder: Diagram showing person-to-person and droplet transmission. Caption: Direct transmission pathways.

3.2.2 Indirect transmission

Indirect transmission involves disease agents passing through an intermediate medium or organism before reaching the host. Examples include:

- **Vehicles**: contaminated food, water, or objects (fomites).
- **Vectors**: insects or animals that carry pathogens (e.g., mosquitoes transmitting malaria).
- **Airborne spread**: pathogens carried by dust or droplet nuclei over long distances.

Fill in the blank: Indirect transmission involves disease agents passing through an ______ medium or organism.

Route	Type of Intermediary	Key Characteristic	Common Example
Vehicle	**Inanimate (Food/Water/Fomite)**	**Often leads to "common source" outbreaks.**	***Salmonella***
Vector	**Living (Insect/Arachnid)**	**Highly dependent on climate and geography.**	***West Nile Virus***
Airborne	**Suspended Particles**	**Can travel far and bypass simple physical distancing.**	***Chickenpox***

Box 3.2 Placeholder: Text box listing indirect transmission routes with examples. Caption: Indirect transmission pathways.

Pilot questions 3.2

1. Direct transmission occurs when disease agents pass ______ from one person to another.
2. Give one example of direct transmission.
3. Indirect transmission involves disease agents passing through an ______ medium or organism.
4. Name one example of a vector in indirect transmission.
5. Why is understanding transmission modes important in epidemiology?

3.3 Patterns of Disease Occurrence

3.3.1 Sporadic, endemic, epidemic, and pandemic patterns

Epidemiologists classify disease occurrence into distinct patterns:

- **Sporadic**: Occurs irregularly and infrequently (e.g., tetanus cases).
- **Endemic**: Constant presence of a disease within a population or region (e.g., malaria in parts of Africa).

- **Epidemic**: Sudden increase in disease cases above expected levels in a community or region (e.g., cholera outbreak).
- **Pandemic**: Epidemic that spreads across countries or continents, affecting large populations (e.g., COVID-19).

Fill in the blank: A disease that is constantly present in a population is described as ______.

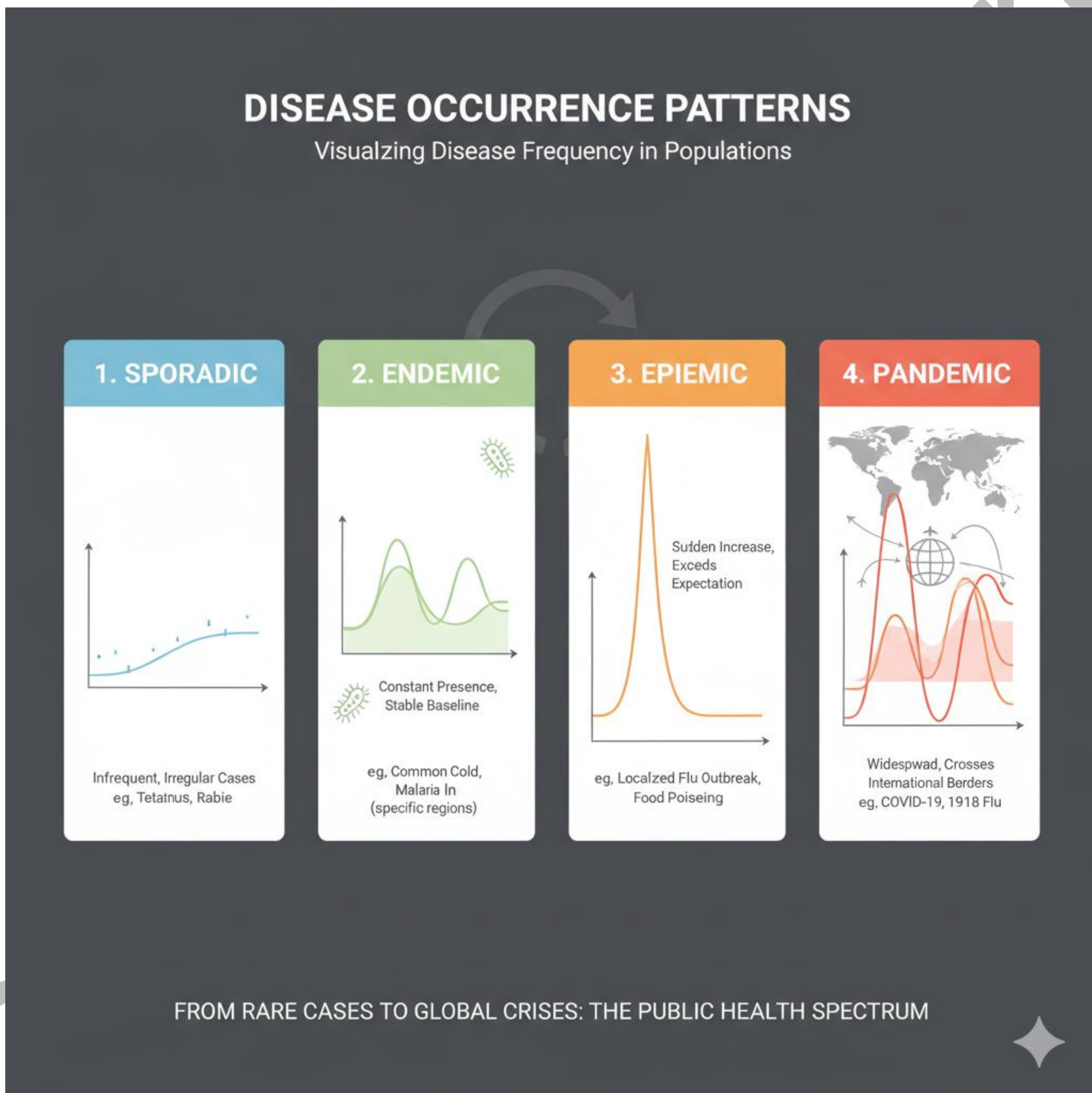


Figure 3.3 Placeholder: Diagram showing four boxes labelled sporadic, endemic, epidemic, pandemic with examples. Caption: Patterns of disease occurrence.

3.3.2 Examples of disease patterns in populations

Examples help illustrate these categories:

- **Sporadic**: Rabies cases in humans.
- **Endemic**: Tuberculosis in certain regions.
- **Epidemic**: Ebola outbreak in West Africa (2014).
- **Pandemic**: COVID-19 (2020 onwards).

Fill in the blank: The Ebola outbreak in West Africa in 2014 is an example of an ______.

Classification	Frequency	Geographic Scope	Predictability
Sporadic	Rare/Irregular	Isolated/Local	Very Low
Endemic	Constant	Localized/Regional	High (Baseline)
Epidemic	Sudden Spike	Localized/Regional	Low (Outbreak)
Pandemic	Massive Surge	Global/International	Very Low (Emergency)

Box 3.3 Placeholder: Text box listing diseases under each pattern category. Caption: Examples of disease occurrence patterns

Pilot questions 3.3

1. A disease that is constantly present in a population is described as ______.
2. Give one example of a sporadic disease.
3. The Ebola outbreak in West Africa in 2014 is an example of an ______.
4. What term describes an epidemic that spreads across countries or continents?
5. Why is recognising disease patterns important in epidemiology?

3.4 Applications in Public Health Practice

3.4.1 Using time trends to predict outbreaks

Epidemiologists monitor **time trends** to anticipate disease outbreaks. For example, seasonal influenza peaks in winter, so vaccination campaigns are timed before the season begins. Secular trends, such as the decline in polio cases, help evaluate long-term intervention success.

Fill in the blank: Monitoring time trends allows epidemiologists to ______ disease outbreaks.

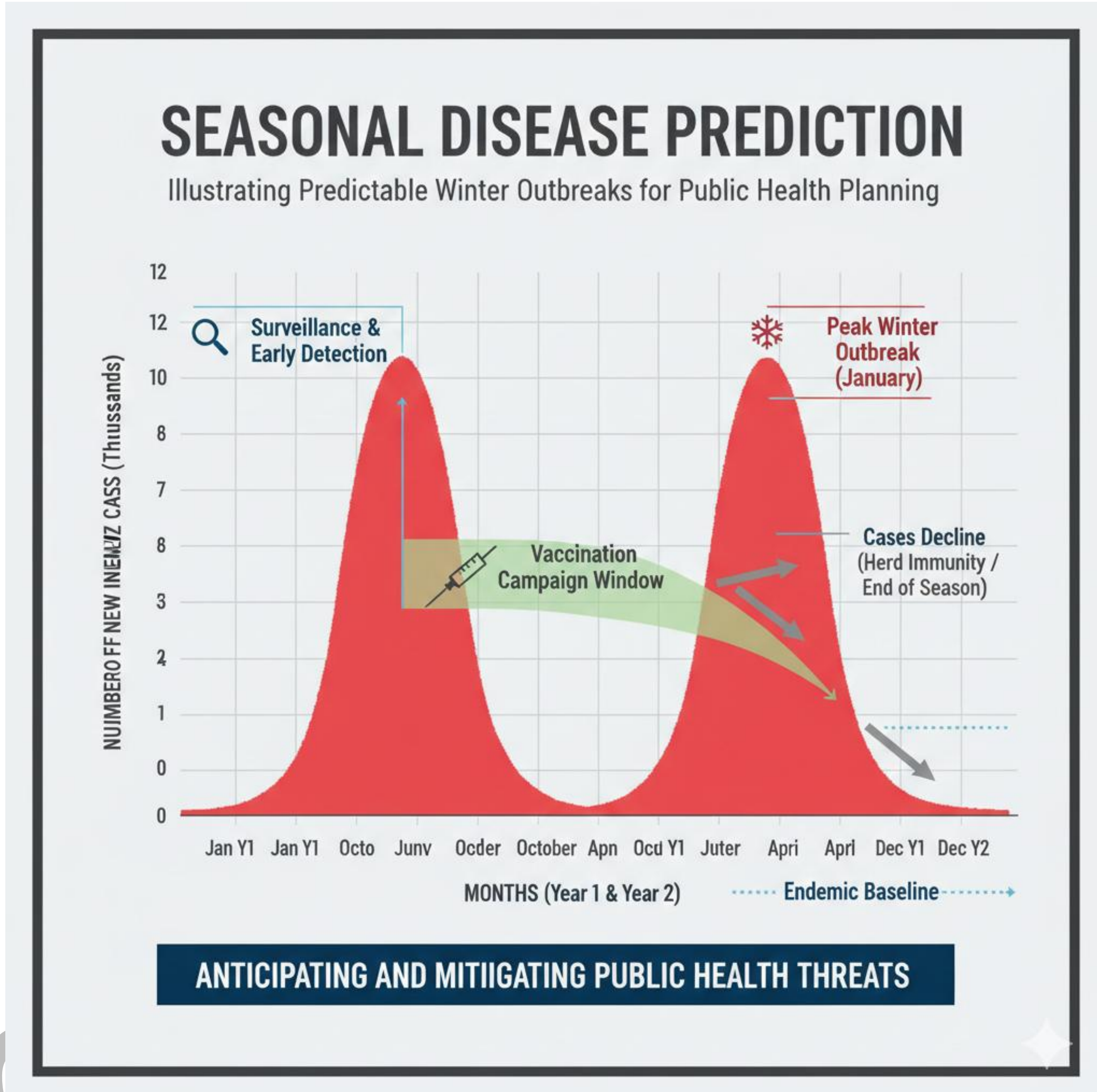


Figure 3.4 Placeholder: Graph showing influenza cases peaking in winter. Caption: Using time trends to predict outbreaks.

3.4.2 Applying transmission knowledge to control measures

Understanding **modes of transmission** guides prevention strategies.

- Direct transmission → interventions like hand hygiene, mask use, safe sexual practices.

- Indirect transmission → interventions like safe water supply, vector control, food safety.

  Fill in the blank: Knowledge of transmission modes guides ______ strategies in public health.

  Box 3.4 Placeholder: Text box linking transmission modes to control measures. Caption: Transmission knowledge applied to prevention.

  3.4.3 Recognising patterns for surveillance and intervention

  Recognising **patterns of disease occurrence** helps public health authorities allocate resources and design interventions.

- Endemic diseases → require sustained control programs.
- Epidemics → demand rapid response and containment.
- Pandemics → call for global coordination and surveillance.

  Fill in the blank: Endemic diseases require sustained ______ programs.

Pattern	Definition	Typical Example	Public Health Response
Sporadic	**Occurs infrequently and irregularly; cases are not connected.**	**Tetanus, Rabies**	**Routine Surveillance: Monitoring for unusual clusters; individual case management.**
Endemic	**The constant, expected presence of a disease in a specific area.**	**Malaria (in tropical regions), Seasonal Flu**	**Long-term Control: Routine vaccination, public education, and environmental management (e.g., stagnant water drainage).**

Pattern	Definition	Typical Example	Public Health Response
Epidemic	**A sudden increase in cases above the "normal" baseline for a population.**	**Ebola (2014), Measles (in unvaccinated clusters)**	**Outbreak Investigation: Contact tracing, "ring" vaccination, and emergency containment measures to find the source.**
Pandemic	**An epidemic that has spread across several countries or continents.**	**COVID-19, 1918 Influenza**	**Global Coordination: International travel restrictions, mass vaccination, and large-scale social distancing policies.**

Table 3.4 Placeholder: Table showing disease patterns and corresponding public health responses. Caption: Linking disease patterns to interventions.

Pilot questions 3.4

1. Monitoring time trends allows epidemiologists to ______ disease outbreaks.
2. Give one example of a control measure for direct transmission.
3. Knowledge of transmission modes guides ______ strategies in public health.
4. Endemic diseases require sustained ______ programs.
5. Why is recognising disease patterns important for public health surveillance?

Series Summary – Series 3: Time, Transmission, and Patterns in Epidemiology

In this Series, we explored how time, transmission pathways, and disease occurrence patterns shape the practice of epidemiology:

- We began with **time in epidemiology**, learning how secular, seasonal, cyclic, and short-term trends reveal changes in disease frequency and help forecast outbreaks.
- We then studied **modes of transmission**, distinguishing between direct pathways (person-to-person, droplet spread) and indirect pathways (vehicles, vectors, airborne).
- Next, we analysed **patterns of disease occurrence**, including sporadic, endemic, epidemic, and pandemic forms, with real-world examples such as influenza, malaria, Ebola, and COVID-19.
- Finally, we applied these insights to **public health practice**, showing how time trends guide prediction, transmission knowledge informs control measures, and recognition of patterns supports surveillance and intervention strategies.

By completing this Series, learners should now be able to interpret time trends, classify transmission modes, recognise disease occurrence patterns, and apply these concepts to public health decision-making.

Glossary of Terms – Series 3: Time, Transmission, and Patterns in Epidemiology

- **Secular trend**: Long-term change in disease frequency over years or decades.
- **Seasonal trend**: Variation in disease occurrence linked to seasons (e.g., influenza in winter).
- **Cyclic trend**: Periodic fluctuations in disease occurrence over several years.
- **Short-term trend**: Sudden change in disease occurrence, often linked to specific events.
- **Direct transmission**: Immediate transfer of disease agents from one person to another (e.g., droplet spread).
- **Indirect transmission**: Transfer of disease agents through an intermediate medium or organism (vehicles, vectors, airborne).
- **Vehicle**: Inanimate medium (food, water, fomites) that carries pathogens.
- **Vector**: Living organism (e.g., mosquito, tick) that transmits pathogens.
- **Airborne transmission**: Spread of pathogens via dust or droplet nuclei over long distances.
- **Sporadic occurrence**: Irregular and infrequent disease cases.
- **Endemic occurrence**: Constant presence of a disease within a population or region.

- **Epidemic occurrence**: Sudden increase in disease cases above expected levels in a community or region.
- **Pandemic occurrence**: Epidemic that spreads across countries or continents, affecting large populations.
- **Surveillance**: Continuous monitoring of disease occurrence to guide public health action

Concept Check Questions – Series 3: Time, Transmission, and Patterns in Epidemiology

Objective questions (linked to SLOs 3.1–3.2)

1. Time is a critical dimension in epidemiology because it helps identify when diseases ______.
2. Which type of time trend refers to long-term changes in disease frequency?
3. Direct transmission occurs when disease agents pass ______ from one person to another.
4. Indirect transmission involves disease agents passing through an ______ medium or organism.
5. Which transmission route involves mosquitoes carrying malaria parasites?

Short-answer questions (linked to SLOs 3.2–3.3)

6. Define seasonal trend in epidemiology.
7. Give one example of a disease spread by direct transmission.
8. Give one example of a disease spread by indirect transmission.
9. What term describes a disease that is constantly present in a population?
10. Provide one example of a pandemic disease.

Long-answer questions (linked to SLOs 3.3–3.4)

11. Discuss the differences between sporadic, endemic, epidemic, and pandemic patterns of disease occurrence, with examples.
12. Explain the importance of studying time trends in epidemiology and how they inform public health interventions.
13. Analyse the role of transmission modes in designing effective control measures.
14. Describe how recognising disease patterns supports surveillance and resource allocation in public health.

15. Evaluate how time, transmission, and patterns together shape strategies for outbreak prediction and control.

Answers to Pilot Questions – Series 3: Time, Transmission, and Patterns in Epidemiology

Pilot questions 3.1

1. Occur
2. Secular, seasonal, cyclic, or short-term
3. Seasonal
4. Decline in polio cases over decades
5. Because they help detect outbreaks and forecast interventions

Pilot questions 3.2

1. Immediately
2. Sexually transmitted infections or droplet spread of influenza
3. Intermediate
4. Mosquitoes
5. Because it guides prevention and control strategies

Pilot questions 3.3

1. Endemic
2. Rabies cases in humans
3. Epidemic
4. Pandemic
5. Because it supports surveillance and resource allocation

Pilot questions 3.4

1. Predict
2. Hand hygiene or mask use
3. Prevention
4. Control
5. Because it informs timely interventions and global coordination

References and Attributions – Series 3: Time, Transmission, and Patterns in Epidemiology

General references

- Course content adapted from *EHS 202: Fundamentals of Epidemiology (2 Units)*, focusing on time trends, transmission pathways, and disease occurrence patterns.
- Explanations of concepts are based on standard epidemiology literature and open educational resources (OERs).

Figures

- *Figure 3.1: Importance of time in disease occurrence* – AI-generated using the prompt "Generate a timeline diagram showing disease cases rising and falling over time."
- *Figure 3.2: Direct transmission pathways* – AI-generated using the prompt "Generate a diagram showing direct transmission: person-to-person contact and droplet spread."
- *Figure 3.3: Patterns of disease occurrence* – AI-generated using the prompt "Generate a diagram showing sporadic, endemic, epidemic, and pandemic patterns with examples."
- *Figure 3.4: Using time trends to predict outbreaks* – AI-generated using the prompt "Generate a graph showing influenza cases peaking in winter to illustrate prediction of outbreaks."

Boxes

- *Box 3.1: Types of time trends in epidemiology* – AI-generated using the prompt "Create a text box listing secular, seasonal, cyclic, and short-term trends with examples."
- *Box 3.2: Indirect transmission pathways* – AI-generated using the prompt "Create a text box listing indirect transmission routes: vehicles, vectors, airborne spread."
- *Box 3.3: Examples of disease occurrence patterns* – AI-generated using the prompt "Create a text box listing examples of sporadic, endemic, epidemic, and pandemic diseases."
- *Box 3.4: Transmission knowledge applied to prevention* – AI-generated using the prompt "Create a text box linking direct transmission to hygiene/mask use, and indirect transmission to safe water/vector control."

Tables

- *Table 3.4: Linking disease patterns to interventions* – AI-generated using the prompt "Generate a table showing sporadic, endemic, epidemic, pandemic patterns with corresponding public health responses."

Series 4: Study Designs and Measurement in Epidemiology

4.1 Observational Study Designs

- 4.1.1 Descriptive studies (case reports, case series, cross-sectional)
- 4.1.2 Analytical studies (case-control, cohort)

4.2 Experimental Study Designs

- 4.2.1 Randomized controlled trials (RCTs)
- 4.2.2 Field trials and community interventions

4.3 Measurement in Epidemiology

- 4.3.1 Measures of disease frequency (incidence, prevalence)
- 4.3.2 Measures of association (risk ratio, odds ratio, attributable risk)

4.4 Applications and Limitations

- 4.4.1 Choosing appropriate study designs
- 4.4.2 Strengths and weaknesses of observational vs. experimental studies
- 4.4.3 Practical considerations in measurement and interpretation

Introduction – Series 4: Study Designs and Measurement in Epidemiology

Epidemiology relies on carefully designed studies and precise measurements to generate valid evidence about health and disease. Without robust study designs and accurate measures, it would be impossible to identify risk factors, evaluate interventions, or guide public health policy.

The **aim of this Series** is to introduce learners to the major study designs used in epidemiology and the key measures of disease frequency and association. Learners will explore how observational and experimental studies differ, how incidence and prevalence are calculated, and how measures such as risk ratios and odds ratios are interpreted.

The Series follows a logical sequence:

- We begin with **observational study designs**, including descriptive and analytical approaches.

- Next, we examine **experimental study designs**, focusing on randomized controlled trials and community interventions.
- We then study **measurement in epidemiology**, covering disease frequency and measures of association.
- Finally, we consider **applications and limitations**, highlighting how to choose appropriate designs and interpret results responsibly.

By the end of this Series, learners will be able to identify study designs, calculate and interpret epidemiologic measures, and evaluate the strengths and weaknesses of different approaches in real-world contexts.

Series Learning Outcomes – Series 4: Study Designs and Measurement in Epidemiology

By the end of this Series, learners should be able to:

- **SLO 4.1**: **Identify and differentiate** between observational study designs, including descriptive (case reports, case series, cross-sectional) and analytical (case-control, cohort).
- **SLO 4.2**: **Explain and evaluate** experimental study designs, such as randomized controlled trials (RCTs), field trials, and community interventions.
- **SLO 4.3**: **Calculate and interpret** measures of disease frequency (incidence, prevalence) and measures of association (risk ratio, odds ratio, attributable risk).
- **SLO 4.4**: **Assess** the applications, strengths, and limitations of different study designs and measurement tools in epidemiologic research and public health practice.

These outcomes align directly with the four Parts outlined for Series 4, ensuring learners progress from understanding study designs, through experimental methods, into measurement, and finally into practical applications and limitations.

4.1 Observational Study Designs

4.1.1 Descriptive studies

Descriptive studies aim to describe the occurrence of disease without testing hypotheses. They provide information on *who*, *where*, and *when* disease occurs.

- **Case reports**: Detailed description of a single patient's disease.
- **Case series**: Collection of case reports on patients with similar conditions.
- **Cross-sectional studies**: Assess disease and exposure at a single point in time.

Fill in the blank: A detailed description of a single patient's disease is called a ______.

Study Type	Number of Subjects	Main Metric	Clinical Value
Case Report	**1**	**Clinical detail**	**Discovery**
Case Series	**2–10+**	**Clinical patterns**	**Hypothesis Generation**
Cross-Sectional	**Hundreds/Thousands**	**Prevalence**	**Identifying Associations**

Figure 4.1 Placeholder: Diagram showing case report → case series → cross-sectional study. Caption: Types of descriptive studies.

4.1.2 Analytical studies

Analytical studies test hypotheses about associations between exposures and outcomes.

- **Case-control studies**: Compare people with disease (cases) to those without (controls) to identify past exposures.
- **Cohort studies**: Follow groups with and without exposure over time to measure disease occurrence.

Fill in the blank: A study that compares people with disease to those without disease is called a ______ study.

Feature	Case-Control Study	Cohort Study
Starting Point	**The Disease (Outcome)**	**The Risk Factor (Exposure)**
Direction	**Retrospective (Looking Back)**	**Prospective (Looking Forward)**
Key Metric	**Odds Ratio (OR)**	**Relative Risk (RR)**

Feature	Case-Control Study	Cohort Study
Cost & Time	**Cheaper and Faster**	**Expensive and Time-Consuming**
Weakness	**Recall Bias (People forget past habits)**	**Loss to Follow-up (People drop out)**

Box 4.1 Placeholder: Text box comparing case-control and cohort studies. Caption: Analytical study designs.

Pilot questions 4.1

1. A detailed description of a single patient's disease is called a ______.
2. What type of study assesses disease and exposure at a single point in time?
3. A study that compares people with disease to those without disease is called a ______ study.
4. Which study design follows groups with and without exposure over time?
5. Why are observational studies important in epidemiology?

4.2 Experimental Study Designs

4.2.1 Randomized Controlled Trials (RCTs)

Randomized controlled trials (RCTs) are considered the gold standard in epidemiology. Participants are randomly assigned to intervention or control groups, ensuring comparability and reducing bias.

- **Intervention group**: receives the treatment or preventive measure.
- **Control group**: receives placebo or standard care.
- Randomization ensures differences in outcomes are due to the intervention, not confounding factors.

Fill in the blank: In an RCT, participants are randomly assigned to ______ or control groups.

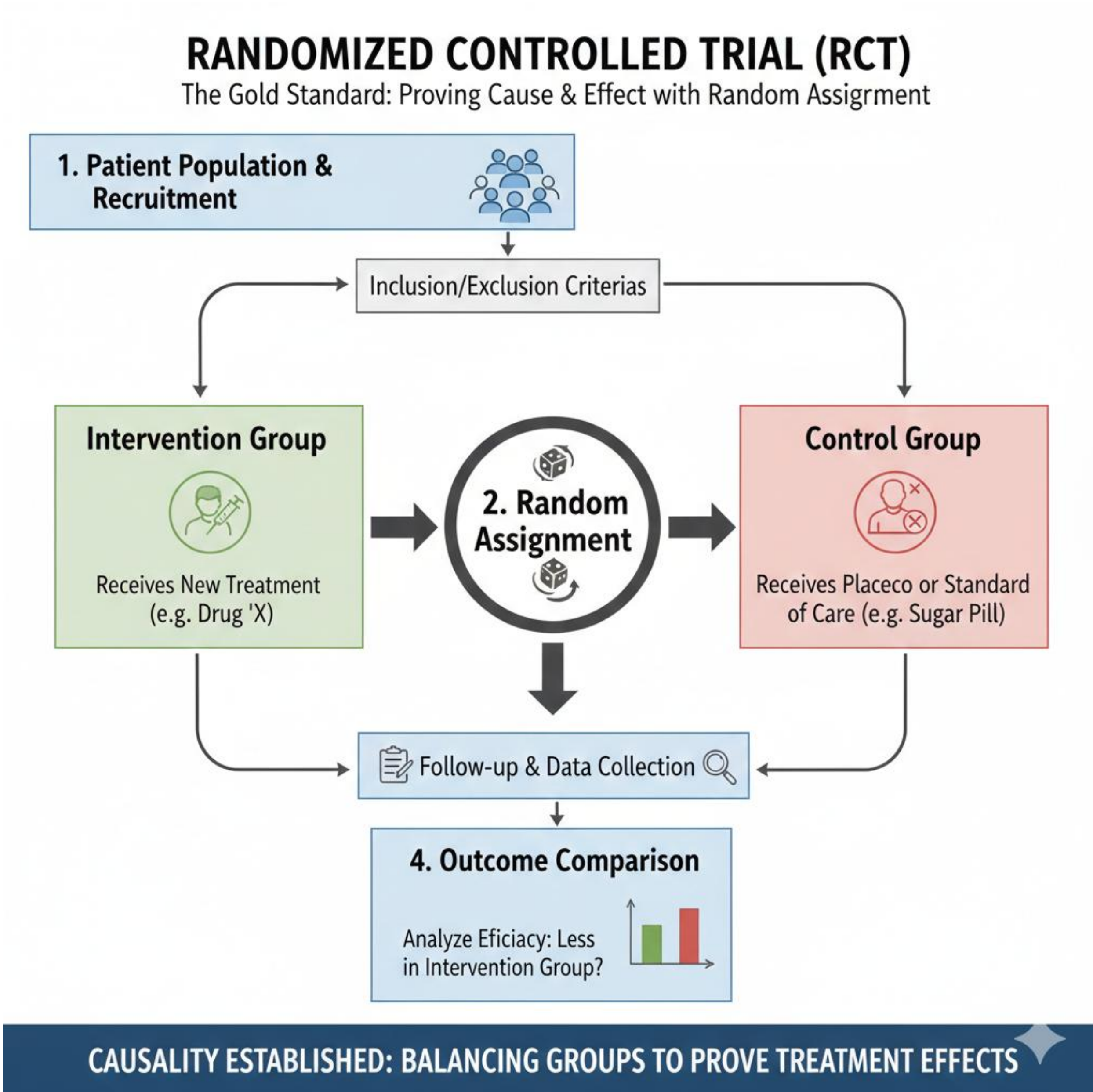


Figure 4.2 Placeholder: Flowchart showing randomization into intervention and control groups. Caption: Structure of a randomized controlled trial.

4.2.2 Field trials and community interventions

Field trials test preventive measures in healthy populations (e.g., vaccine trials). **Community interventions** evaluate public health programs at the community level (e.g., water fluoridation to prevent dental caries).

- Both designs assess effectiveness in real-world settings.
- They often require large sample sizes and long follow-up periods.

Fill in the blank: Field trials test preventive measures in ______ populations.

Feature	Field Trial	Community Intervention
Study Unit	**Individual Person**	**Entire Group / Population**
Participants	**Healthy (at-risk) individuals**	**General population (mixed)**
Focus	**Biological Protection**	**Social/Environmental Change**
Randomization	**Individual-level**	**Cluster-level (Group-wide)**
Common Example	**Vaccines (e.g., Salk Polio Trial)**	**Policies (e.g., Sodium reduction in bread)**

Box 4.2 Placeholder: Text box comparing field trials and community interventions.
Caption: Experimental study designs beyond RCTs.

Pilot questions 4.2

1. In an RCT, participants are randomly assigned to ______ or control groups.
2. What is considered the gold standard study design in epidemiology?
3. Field trials test preventive measures in ______ populations.
4. Give one example of a community intervention study.
5. Why are experimental studies important in epidemiology?

4.2 Experimental Study Designs

4.2.1 Randomized Controlled Trials (RCTs)

Randomized controlled trials (RCTs) are considered the gold standard in epidemiology. Participants are randomly assigned to intervention or control groups, ensuring comparability and reducing bias.

- **Intervention group**: receives the treatment or preventive measure.
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- Randomization ensures differences in outcomes are due to the intervention, not confounding factors.

Fill in the blank: In an RCT, participants are randomly assigned to ______ or control groups.

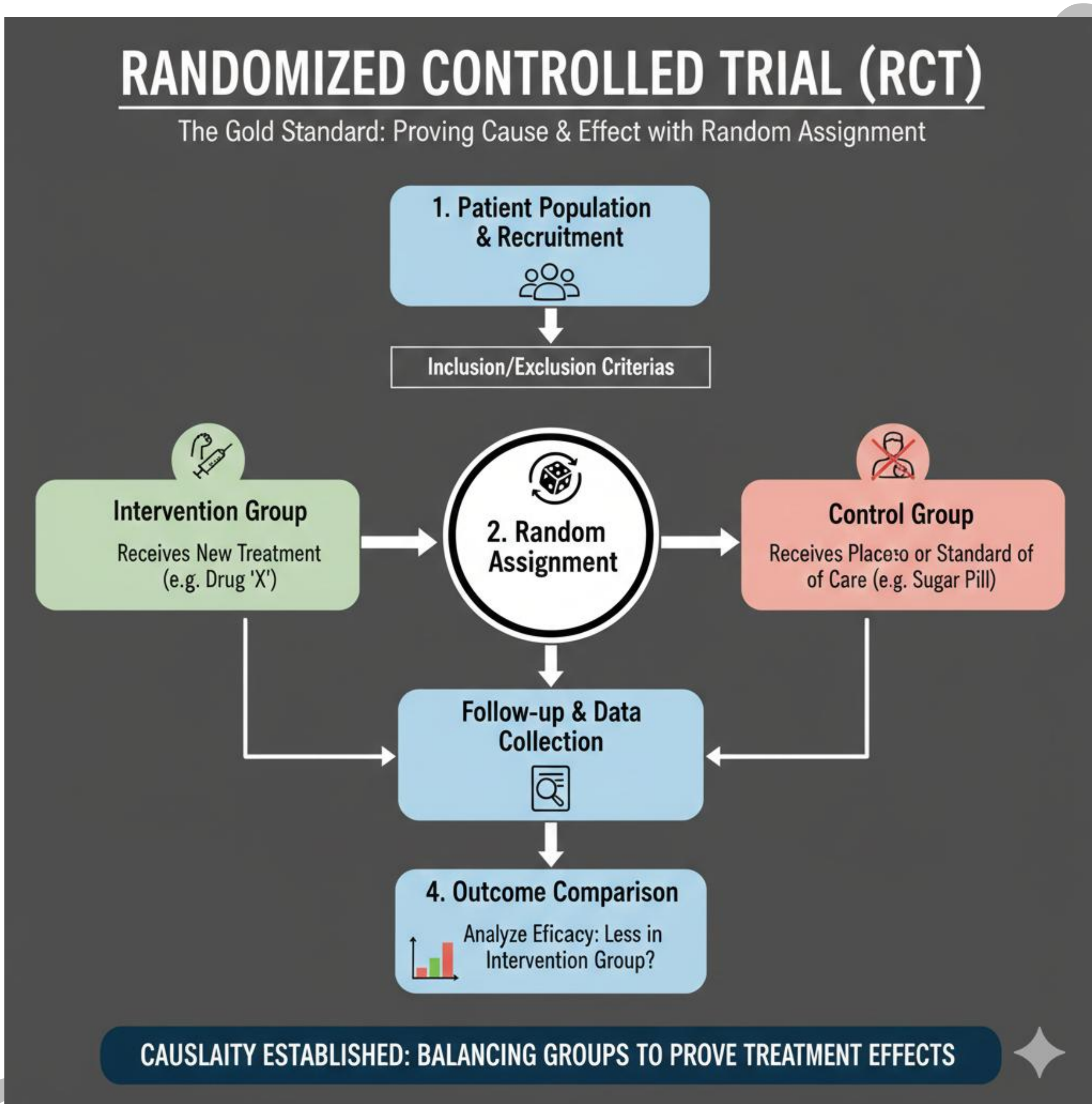

Figure 4.2 Placeholder: Flowchart showing randomization into intervention and control groups. Caption: Structure of a randomized controlled trial.

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- Both designs assess effectiveness in real-world settings.
- They often require large sample sizes and long follow-up periods.

Fill in the blank: Field trials test preventive measures in ______ populations.

Feature	Field Trial	Community Intervention
Study Unit	**Individual**	**Entire Group / Population**
Participants	**Healthy (at-risk) individuals**	**General population (mixed status)**
Focus	**Individual Protection (Biological)**	**Systemic/Environmental Change**
Analysis	**Comparison of individual outcomes**	**Comparison of group-wide rates**
Typical Example	**Vaccines, Prophylactic Drugs**	**Water Safety, Public Health Policy**

Box 4.2 Placeholder: Text box comparing field trials and community interventions.
Caption: Experimental study designs beyond RCTs.

Pilot questions 4.2

1. In an RCT, participants are randomly assigned to ______ or control groups.
2. What is considered the gold standard study design in epidemiology?
3. Field trials test preventive measures in ______ populations.
4. Give one example of a community intervention study.
5. Why are experimental studies important in epidemiology?

4.4 Applications and Limitations

4.4.1 Choosing appropriate study designs

Selecting the right study design depends on the research question, resources, and ethical considerations.

- **Observational studies** are useful when experiments are impractical or unethical.
- **Experimental studies** provide stronger evidence of causality but require more resources and strict ethical oversight.

Fill in the blank: Observational studies are useful when experiments are ______ or unethical.

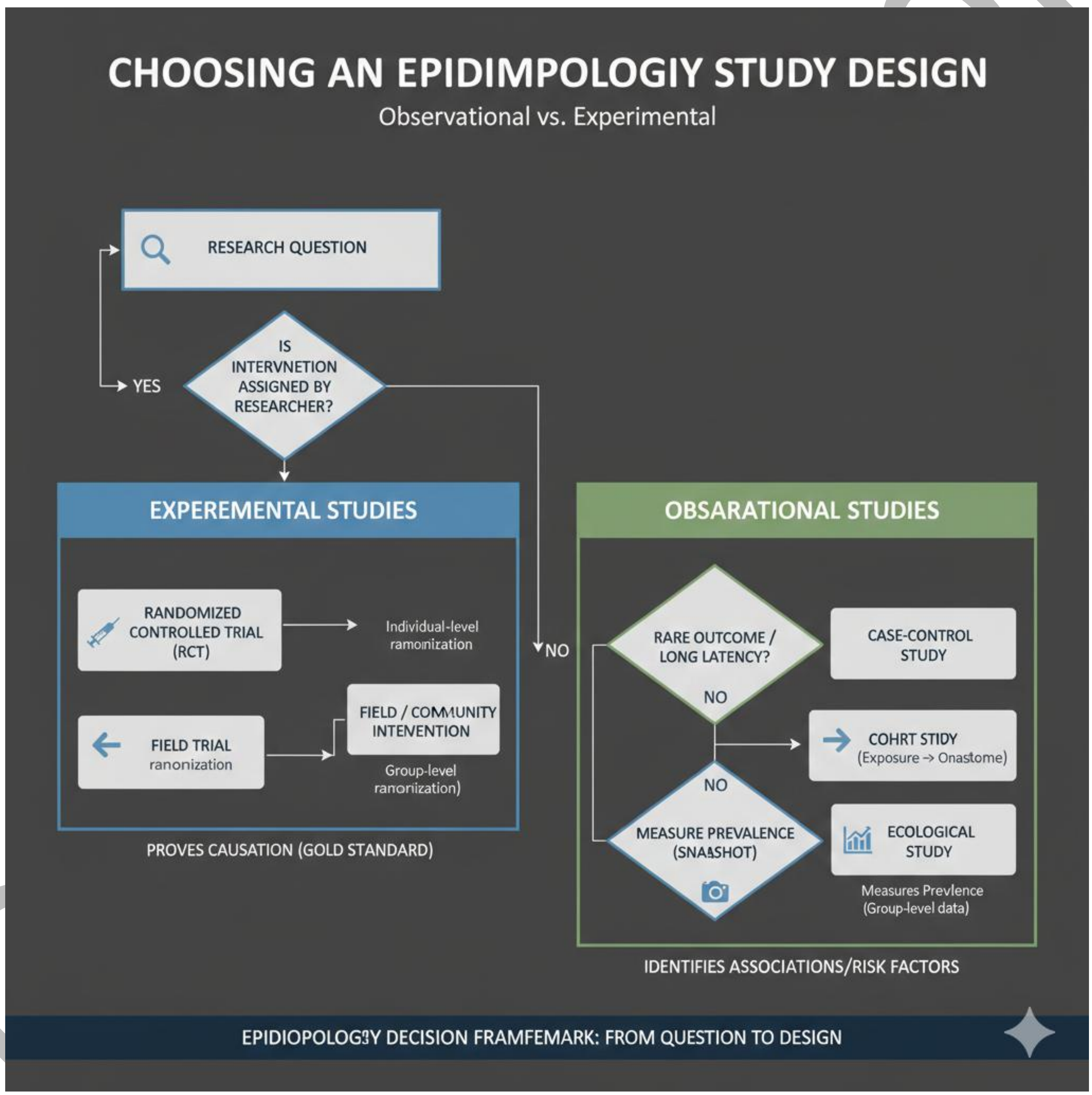

Figure 4.4 Placeholder: Flowchart showing decision process for choosing study designs. Caption: Choosing appropriate study designs.

4.4.2 Strengths and weaknesses of study designs

Each design has advantages and limitations:

- **Case-control studies**: efficient for rare diseases, but prone to recall bias.
- **Cohort studies**: good for studying incidence, but expensive and time-consuming.
- **RCTs**: strongest evidence for causality, but costly and sometimes ethically challenging.

Fill in the blank: Case-control studies are efficient for studying ______ diseases.

Feature	Case-Control	Cohort	RCT
Primary Goal	**Identify risk factors**	**Measure incidence/risk**	**Prove efficacy/causality**
Direction	**Backward (Past)**	**Forward (Future)**	**Forward (Future)**
Key Metric	**Odds Ratio (OR)**	**Relative Risk (RR)**	**Efficacy**
Best For	**Rare Diseases**	**Rare Exposures**	**New Treatments/Vaccines**

Box 4.4 Placeholder: Text box listing strengths and weaknesses of case-control, cohort, and RCTs. Caption: Strengths and weaknesses of study designs.

4.4.3 Practical considerations in measurement and interpretation

Measurement tools must be applied carefully:

- **Incidence and prevalence** depend on accurate case definitions and reliable data sources.
- **Risk ratios and odds ratios** must be interpreted in context, considering confounding and bias.
- Misinterpretation can lead to flawed public health decisions.

Fill in the blank: Misinterpretation of epidemiologic measures can lead to flawed ______ decisions.

Metric	Definition	Practical Consideration	Main Limitation
Incidence	**The number of new cases that develop in a population during a specific time period.**	**Best for tracking the spread of infectious diseases or the "attack rate" of an outbreak.**	**Requires following a healthy population over time (expensive and slow).**
Prevalence	**The total number of existing cases (old and new) in a population at a single point in time.**	**Best for resource planning (e.g., how many hospital beds or dialysis machines a city needs).**	**Does not show "cause and effect" because it doesn't track when the disease started.**
Risk Ratio (RR)	**Compares the probability of an event in an exposed group vs. an unexposed group.**	**Used in Cohort Studies and RCTs to show how much a risk factor increases the chance of disease.**	**Cannot be calculated in Case-Control studies because you don't know the total population at risk.**
Odds Ratio (OR)	**Compares the odds of exposure among those with a disease vs. those without.**	**The standard measure for Case-Control Studies; used to study rare diseases or fast-moving outbreaks.**	**Often overestimates the risk if the disease is common in the population.**

Table 4.4 Placeholder: Table linking measures (incidence, prevalence, risk ratio, odds ratio) to practical considerations. Caption: Practical considerations in measurement and interpretation.

Pilot questions 4.4

1. Observational studies are useful when experiments are ______ or unethical.
2. Case-control studies are efficient for studying ______ diseases.
3. What is one limitation of cohort studies?
4. Misinterpretation of epidemiologic measures can lead to flawed ______ decisions.

5. Why is it important to consider strengths and weaknesses when choosing a study design?

Series Summary – Series 4: Study Designs and Measurement in Epidemiology

In this Series, we examined how epidemiologists design studies and measure disease occurrence and associations:

- We began with **observational study designs**, distinguishing descriptive approaches (case reports, case series, cross-sectional) from analytical approaches (case-control, cohort).
- We then explored **experimental study designs**, focusing on randomized controlled trials (RCTs), field trials, and community interventions as tools for testing interventions under controlled or real-world conditions.
- Next, we studied **measurement in epidemiology**, learning how incidence and prevalence describe disease frequency, and how risk ratios, odds ratios, and attributable risk quantify associations between exposures and outcomes.
- Finally, we considered **applications and limitations**, highlighting how to choose appropriate study designs, weigh their strengths and weaknesses, and interpret measures responsibly to avoid flawed public health decisions.

By completing this Series, learners should now be able to identify and differentiate study designs, calculate and interpret measures of frequency and association, and critically assess the applications and limitations of epidemiologic methods in practice

Glossary of Terms – Series 4: Study Designs and Measurement in Epidemiology

- **Case report**: Detailed description of a single patient's disease.
- **Case series**: Collection of case reports on patients with similar conditions.
- **Cross-sectional study**: Observes disease and exposure at a single point in time.
- **Case-control study**: Compares people with disease (cases) to those without disease (controls) to identify past exposures.
- **Cohort study**: Follows groups with and without exposure over time to measure disease occurrence.
- **Randomized controlled trial (RCT)**: Experimental study where participants are randomly assigned to intervention or control groups.
- **Field trial**: Tests preventive measures in healthy populations.
- **Community intervention**: Evaluates public health programs at the community level.

- **Incidence**: Number of new cases of disease in a population over a specified period.
- **Prevalence**: Total number of cases (new and existing) in a population at a given time.
- **Risk ratio (relative risk)**: Ratio of disease risk in exposed vs. unexposed groups.
- **Odds ratio**: Ratio of odds of exposure among cases vs. controls.
- **Attributable risk**: Difference in disease risk between exposed and unexposed groups.
- **Bias**: Systematic error that can distort study results.
- **Confounding**: Distortion of the association between exposure and outcome by a third variable.

Concept Check Questions – Series 4: Study Designs and Measurement in Epidemiology

Objective questions (linked to SLOs 4.1–4.3)

1. A study that observes disease and exposure at a single point in time is called a ______ study.
2. Case-control studies are especially efficient for studying ______ diseases.
3. In an RCT, participants are randomly assigned to ______ or control groups.
4. The number of new cases of disease in a population over a specified period is called ______.
5. The ratio of disease risk in exposed vs. unexposed groups is called the ______.

Short-answer questions (linked to SLOs 4.1–4.3)

6. Define a cohort study and give one example.

7. What is the main difference between incidence and prevalence?

8. Give one advantage and one limitation of case-control studies.

9. What type of study design is considered the "gold standard" for establishing causality?

10. Provide one example of a community intervention study.

Long-answer questions (linked to SLOs 4.2–4.4)

11. Compare and contrast case-control and cohort studies, including their strengths, weaknesses, and appropriate applications.

12. Explain the structure of a randomized controlled trial and discuss why randomization is important.

13. Discuss the importance of incidence and prevalence in public health planning, with examples.

14. Analyse the role of risk ratios and odds ratios in identifying associations between exposures and outcomes.

15. Evaluate the practical considerations and limitations in choosing study designs and interpreting epidemiologic measures.

Answers to Pilot Questions – Series 4: Study Designs and Measurement in Epidemiology

Pilot questions 4.1 (Observational designs)

1. Case report
2. Cross-sectional study
3. Case-control study
4. Cohort study
5. Because they help describe and analyse disease occurrence when experiments are impractical or unethical

Pilot questions 4.2 (Experimental designs)

1. Intervention
2. Randomized controlled trial (RCT)
3. Healthy
4. Water fluoridation to prevent dental caries
5. Because they provide stronger evidence of causality and test interventions directly

Pilot questions 4.3 (Measurement)

1. Incidence
2. Prevalence
3. Risk ratio (relative risk)
4. Odds ratio
5. Because they quantify disease occurrence and associations, guiding public health decisions

Pilot questions 4.4 (Applications and limitations)

1. Impractical
2. Rare
3. They are expensive and time-consuming
4. Public health
5. Because each design has strengths and weaknesses that affect validity and applicability

References and Attributions – Series 4: Study Designs and Measurement in Epidemiology

General references

- Course content adapted from *EHS 202: Fundamentals of Epidemiology (2 Units)*, focusing on study designs and measurement.
- Explanations of concepts are based on standard epidemiology literature and open educational resources (OERs).

Figures

- *Figure 4.1: Types of descriptive studies* – AI-generated using the prompt "Generate a diagram showing progression from case report to case series to cross-sectional study."
- *Figure 4.2: Structure of a randomized controlled trial* – AI-generated using the prompt "Generate a flowchart showing random assignment of participants into intervention and control groups."
- *Figure 4.3: Measures of disease frequency* – AI-generated using the prompt "Generate a diagram comparing incidence (new cases) and prevalence (total cases)."
- *Figure 4.4: Choosing appropriate study designs* – AI-generated using the prompt "Generate a flowchart showing decision process for choosing observational vs. experimental study designs."

Boxes

- *Box 4.1: Analytical study designs* – AI-generated using the prompt "Create a text box comparing case-control and cohort studies with definitions and examples."
- *Box 4.2: Experimental study designs beyond RCTs* – AI-generated using the prompt "Create a text box comparing field trials and community interventions with definitions and examples."

- *Box 4.3: Measures of association in epidemiology* – AI-generated using the prompt "Create a text box listing risk ratio, odds ratio, and attributable risk with definitions."
- *Box 4.4: Strengths and weaknesses of study designs* – AI-generated using the prompt "Create a text box listing strengths and weaknesses of case-control, cohort, and RCTs."

Tables

- *Table 4.4: Practical considerations in measurement and interpretation* – AI-generated using the prompt "Generate a table linking incidence, prevalence, risk ratio, odds ratio to practical considerations and limitations."

Series 5: Applications of Epidemiology in Disease, Injury, and Health Problems

5.1 Applications in Communicable Diseases

- Surveillance and outbreak investigation
- Control measures (vaccination, isolation, contact tracing)
- Case examples: malaria, tuberculosis, HIV

5.2 Applications in Non-Communicable Diseases (NCDs)

- Chronic disease epidemiology (cancer, cardiovascular disease, diabetes)
- Lifestyle and behavioral risk factors
- Screening programs and evaluation of interventions

5.3 Applications in Injury Epidemiology

- Road traffic injuries, occupational injuries, violence
- Identifying risk factors and high-risk groups
- Designing prevention strategies (seat belts, workplace safety, legislation)

5.4 Applications in Other Health Problems

- Maternal and child health
- Environmental and occupational health
- Mental health epidemiology
- Emerging health issues (climate change, global health threats)

Introduction – Series 5: Applications of Epidemiology in Disease, Injury, and Health Problems

Epidemiology is not only about theory and measurement; it is fundamentally about *application*. The discipline provides tools to investigate, prevent, and control health problems across diverse domains — from infectious diseases to chronic conditions, injuries, and emerging global threats.

The **aim of this Series** is to demonstrate how epidemiology is applied in real-world contexts to address disease, injury, and other health problems. Learners will see how epidemiologic principles guide surveillance, prevention, intervention, and policy decisions.

The Series follows a practical sequence:

- We begin with **applications in communicable diseases**, focusing on surveillance, outbreak investigation, and control measures.
- Next, we examine **applications in non-communicable diseases (NCDs)**, highlighting chronic disease epidemiology, lifestyle risk factors, and screening programs.
- We then explore **applications in injury epidemiology**, including road traffic, occupational injuries, and violence prevention.
- Finally, we consider **applications in other health problems**, such as maternal and child health, environmental and occupational health, mental health, and emerging global issues.

By the end of this Series, learners will be able to apply epidemiologic concepts to diverse health problems, evaluate interventions, and appreciate the role of epidemiology in shaping public health practice and policy.

Series Learning Outcomes – Series 5: Applications of Epidemiology in Disease, Injury, and Health Problems

By the end of this Series, learners should be able to:

- **SLO 5.1**: **Apply epidemiologic principles** to communicable diseases, including surveillance, outbreak investigation, and control measures.
- **SLO 5.2**: **Explain and evaluate** the role of epidemiology in non-communicable diseases (NCDs), focusing on chronic disease patterns, lifestyle risk factors, and screening programs.
- **SLO 5.3**: **Analyse** injury epidemiology, identifying risk factors, high-risk groups, and prevention strategies for road traffic, occupational, and violence-related injuries.

- **SLO 5.4**: **Assess** applications of epidemiology in other health problems, including maternal and child health, environmental and occupational health, mental health, and emerging global issues.

These outcomes align directly with the four Parts outlined for Series 5, ensuring learners progress from communicable diseases, through NCDs, into injury epidemiology, and finally into broader health problems.

5.1 Applications in Communicable Diseases

5.1.1 Surveillance and outbreak investigation

Epidemiology plays a central role in monitoring communicable diseases.

- **Surveillance**: Continuous, systematic collection and analysis of health data to detect changes in disease patterns.
- **Outbreak investigation**: Rapid response to unusual increases in cases, involving case definition, data collection, hypothesis generation, and control measures.

Fill in the blank: Continuous, systematic collection and analysis of health data is called ______.

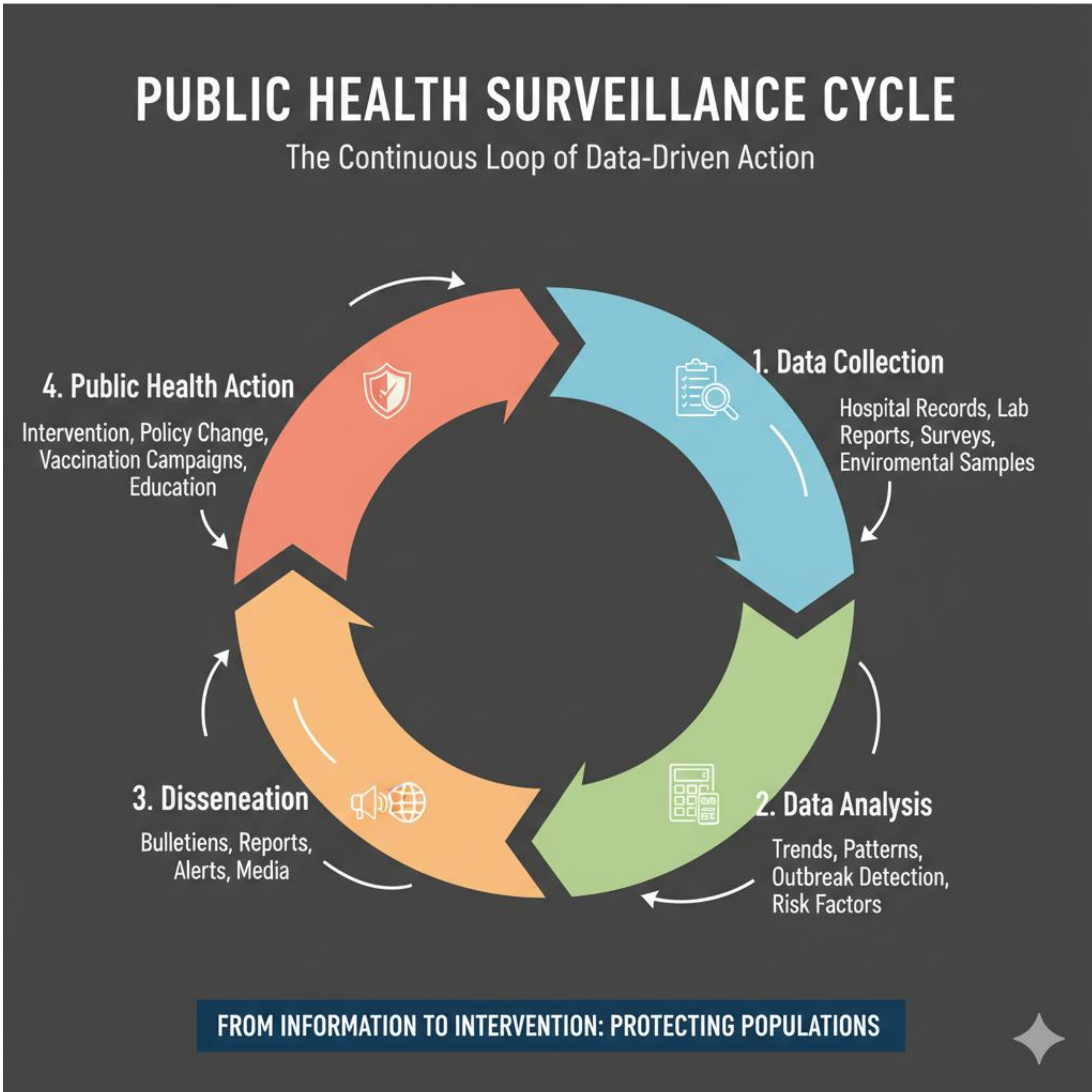

Figure 5.1 Placeholder: Diagram showing surveillance cycle (data collection → analysis → dissemination → action). Caption: The surveillance cycle in communicable diseases

5.1.2 Control measures

Epidemiology informs interventions to reduce transmission:

- **Vaccination**: Prevents susceptible individuals from infection.
- **Isolation and quarantine**: Limits spread from infected or exposed individuals.
- **Contact tracing**: Identifies and monitors people exposed to cases.

Fill in the blank: Identifying and monitoring people exposed to cases is called ______.

Strategy	Primary Target	Timing	Main Barrier
Vaccination	Susceptible population	Pre-exposure	Biological immunity
Quarantine	Exposed (but healthy)	Post-exposure	Physical distance
Isolation	Confirmed sick	Post-infection	Physical distance
Contact Tracing	Network of contacts	Post-diagnosis	Information/Communication

Box 5.1 Placeholder: Text box listing vaccination, isolation/quarantine, and contact tracing. Caption: Control measures in communicable disease epidemiology.

5.1.3 Case examples

- **Malaria**: Surveillance guides distribution of insecticide-treated nets and antimalarial drugs.
- **Tuberculosis**: Case finding and contact tracing are essential for control.
- **HIV**: Epidemiology informs prevention strategies such as safe sex campaigns and antiretroviral therapy programs.

Fill in the blank: Distribution of insecticide-treated nets is a key control measure for ______.

Disease	Primary Transmission	Key Epidemiologic Metric	Specific Application / Intervention
Malaria	Vector-borne (Anopheles mosquito)	Entomological Inoculation Rate (EIR): Measures the number of infectious bites per person per year.	Environmental Control: Distribution of Insecticide-Treated Nets (ITNs) and Indoor Residual Spraying (IRS).

Disease	Primary Transmission	Key Epidemiologic Metric	Specific Application / Intervention
Tuberculosis	Airborne (Respiratory droplets)	Case Detection Rate: The proportion of estimated new cases that are actually diagnosed and treated.	Contact Tracing: Identifying "close contacts" of an active case to provide preventative therapy (Latent TB treatment).
HIV/AIDS	Direct Contact (Blood, sexual, vertical)	Viral Suppression Rate: The percentage of people on ART whose viral load is undetectable.	Behavioral Surveillance: Tracking high-risk behaviors and promoting Pre-Exposure Prophylaxis (PrEP).

Table 5.1 Placeholder: Table linking diseases (malaria, TB, HIV) to epidemiologic applications. Caption: Applications of epidemiology in communicable diseases.

Pilot questions 5.1

1. Continuous, systematic collection and analysis of health data is called ______.
2. What is the purpose of outbreak investigation?
3. Identifying and monitoring people exposed to cases is called ______.
4. Which control measure prevents susceptible individuals from infection?
5. Give one example of how epidemiology is applied in malaria control.

5.2 Applications in Non-Communicable Diseases (NCDs)

5.2.1 Chronic disease epidemiology

Epidemiology helps identify patterns and determinants of chronic diseases.

- **Cancer**: Studies identify risk factors such as smoking, diet, and genetics.
- **Cardiovascular disease**: Epidemiology links hypertension, cholesterol, and lifestyle to heart disease.
- **Diabetes**: Surveillance tracks prevalence and guides prevention programs.

Fill in the blank: Epidemiology links hypertension and cholesterol to ______ disease.

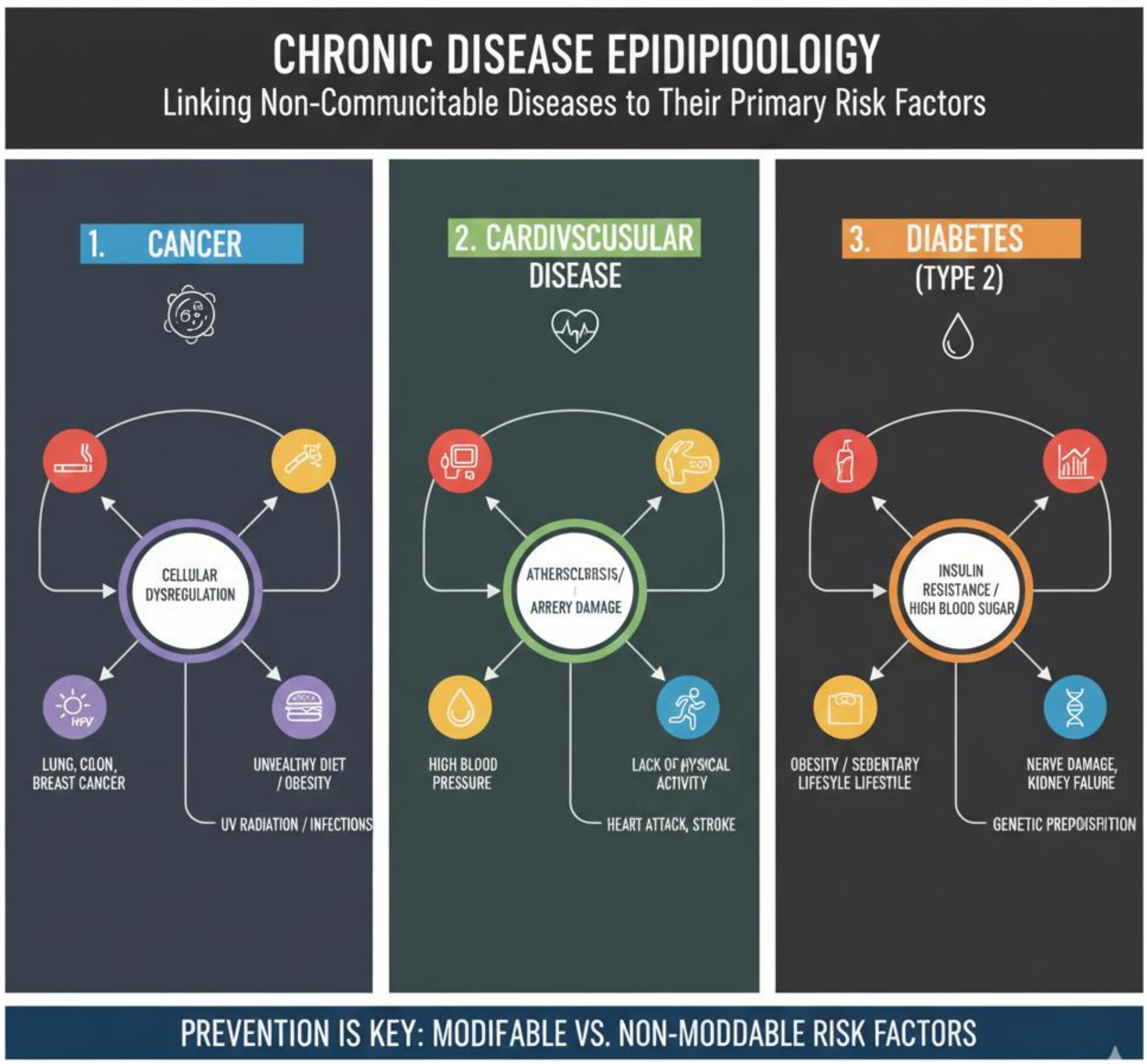

Figure 5.2 Placeholder: Diagram showing chronic diseases and their risk factors. Caption: Epidemiology in chronic disease.

5.2.2 Lifestyle and behavioral risk factors

Non-communicable diseases are strongly influenced by lifestyle choices:

- **Smoking**: Major risk factor for cancer and cardiovascular disease.
- **Diet**: High fat and sugar intake linked to obesity and diabetes.
- **Physical inactivity**: Increases risk of cardiovascular disease and diabetes.

Fill in the blank: High fat and sugar intake is linked to ______.

Risk Factor	Primary Biological Mechanism	Main NCD Outcome
Smoking	**Systemic Inflammation / DNA Damage**	**Lung Cancer / Heart Disease**
Poor Diet	**Insulin Resistance / Plaque Buildup**	**Diabetes / Stroke**
Inactivity	**Metabolic Slowdown / Weight Gain**	**Obesity-related Cancers**

Box 5.2 Placeholder: Text box listing lifestyle risk factors for NCDs. Caption: Lifestyle and behavioral risk factors.

5.2.3 Screening programs and interventions

Epidemiology guides screening and prevention strategies:

- **Cancer screening**: Pap smears, mammography, colonoscopy.
- **Cardiovascular screening**: Blood pressure and cholesterol checks.
- **Diabetes screening**: Blood glucose monitoring.
- Evaluating effectiveness of interventions ensures resources are used efficiently.

Fill in the blank: Pap smears are used for screening ______ cancer.

Screening Test	Targeted Disease	Frequency/Population	Impact on Outcomes
Pap Smear	**Cervical Cancer**	**Women (typically ages 21–65)**	**Detects precancerous cell changes; has reduced cervical cancer deaths by 70%.**
Mammography	**Breast Cancer**	**Women (typically ages 40–50+)**	**Uses low-energy X-rays to find tumors too small**

Screening Test	Targeted Disease	Frequency/Population	Impact on Outcomes
			to be felt during a physical exam.
Blood Pressure Check	Hypertension	All Adults	Identifies the "Silent Killer"; prevents Stroke and Heart Failure.
Glucose Monitoring	Type 2 Diabetes	Adults with risk factors (e.g., BMI >25)	Detects "Prediabetes," allowing for lifestyle changes to reverse the condition.

Table 5.2 Placeholder: Table linking screening programs to diseases. Caption: Screening programs in NCD epidemiology.

Pilot questions 5.2

1. Epidemiology links hypertension and cholesterol to ______ disease.
2. Name one lifestyle risk factor for cancer.
3. High fat and sugar intake is linked to ______.
4. Pap smears are used for screening ______ cancer.
5. Why are screening programs important in NCD epidemiology?

5.3 Applications in Injury Epidemiology

5.3.1 Road traffic injuries

Epidemiology identifies risk factors and evaluates interventions for road traffic injuries.

- Risk factors: speeding, alcohol use, lack of seat belts or helmets.
- Interventions: road safety laws, seat belt campaigns, helmet use promotion.

Fill in the blank: Lack of ______ is a major risk factor for road traffic injuries.

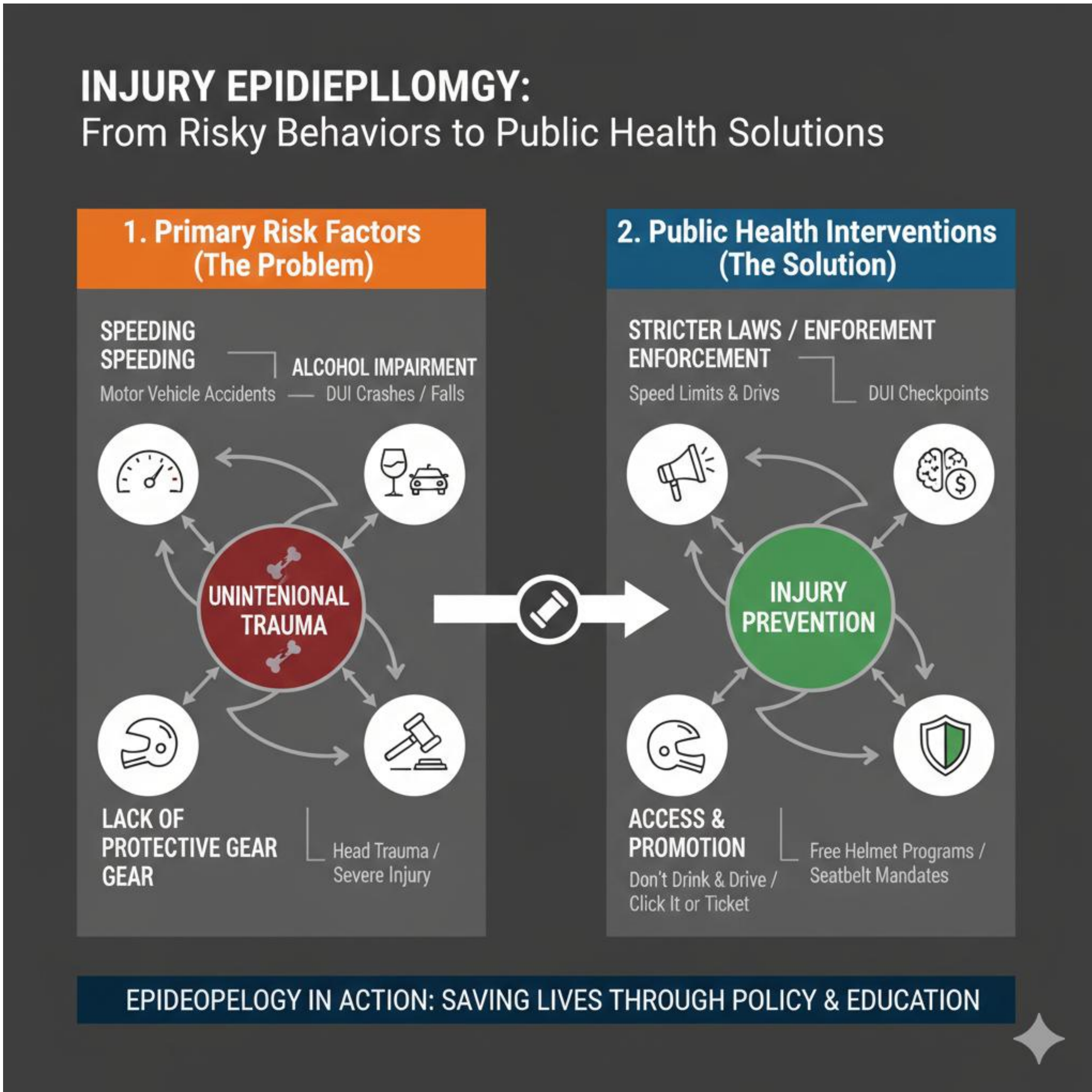

Figure 5.3 Placeholder: Diagram showing risk factors and interventions for road traffic injuries. Caption: Epidemiology in road traffic injury prevention.

5.3.2 Occupational injuries

Epidemiology helps identify hazards in workplaces and design safety measures.

- Common hazards: machinery accidents, chemical exposure, repetitive strain.
- Prevention: safety training, protective equipment, workplace regulations.

Fill in the blank: Safety training and protective equipment are examples of ______ strategies.

Term	Definition	Workplace Example
Hazard	**Anything with the *potential* to cause harm.**	**A pool of water on the warehouse floor.**
Risk	**The *likelihood* that the hazard will cause harm.**	**High if workers are running; Low if the area is cordoned off.**

Box 5.3 Placeholder: Text box listing occupational hazards and prevention strategies. Caption: Occupational injury epidemiology.

5.3.3 Violence and intentional injuries

Epidemiology examines patterns of violence and designs prevention programs.

- Risk factors: poverty, substance abuse, social inequality.
- Prevention: community programs, legislation, counseling services.

Fill in the blank: Poverty and substance abuse are risk factors for ______ injuries.

Injury Category	Key Risk Factors	Epidemiologic Metric	Specific Application / Intervention
Road Traffic	**Speeding, alcohol, lack of seatbelts/helmets.**	**Fatality Rate per 100k Population**	**Haddon Matrix: Analyzing the pre-event, event, and post-event factors to improve car safety and road design.**
Occupational	**Repetitive motion, chemical exposure, faulty machinery.**	**Incidence Rate of Work-Related Injuries**	**Surveillance Systems: Using OSHA or workers' comp data to identify high-risk industries for targeted safety audits.**

Injury Category	Key Risk Factors	Epidemiologic Metric	Specific Application / Intervention
Violence	**Socioeconomic status, access to firearms, substance abuse.**	**Years of Potential Life Lost (YPLL)**	**Secondary Prevention: Hospital-based violence intervention programs (HVIP) to prevent "retaliatory" injury cycles.**

Table 5.3 Placeholder: Table linking types of injuries (road traffic, occupational, violence) to epidemiologic applications. Caption: Applications of epidemiology in injury prevention

Pilot questions 5.3

1. Lack of ______ is a major risk factor for road traffic injuries.
2. Name one intervention to reduce road traffic injuries.
3. Safety training and protective equipment are examples of ______ strategies.
4. Poverty and substance abuse are risk factors for ______ injuries.
5. Why is epidemiology important in injury prevention?

5.4 Applications in Other Health Problems

5.4.1 Maternal and child health

Epidemiology supports programs to reduce maternal and child morbidity and mortality.

- Monitoring maternal mortality rates.
- Tracking child growth and immunization coverage.
- Evaluating interventions such as antenatal care and safe delivery practices.

Fill in the blank: Monitoring ______ mortality rates is a key application in maternal health.

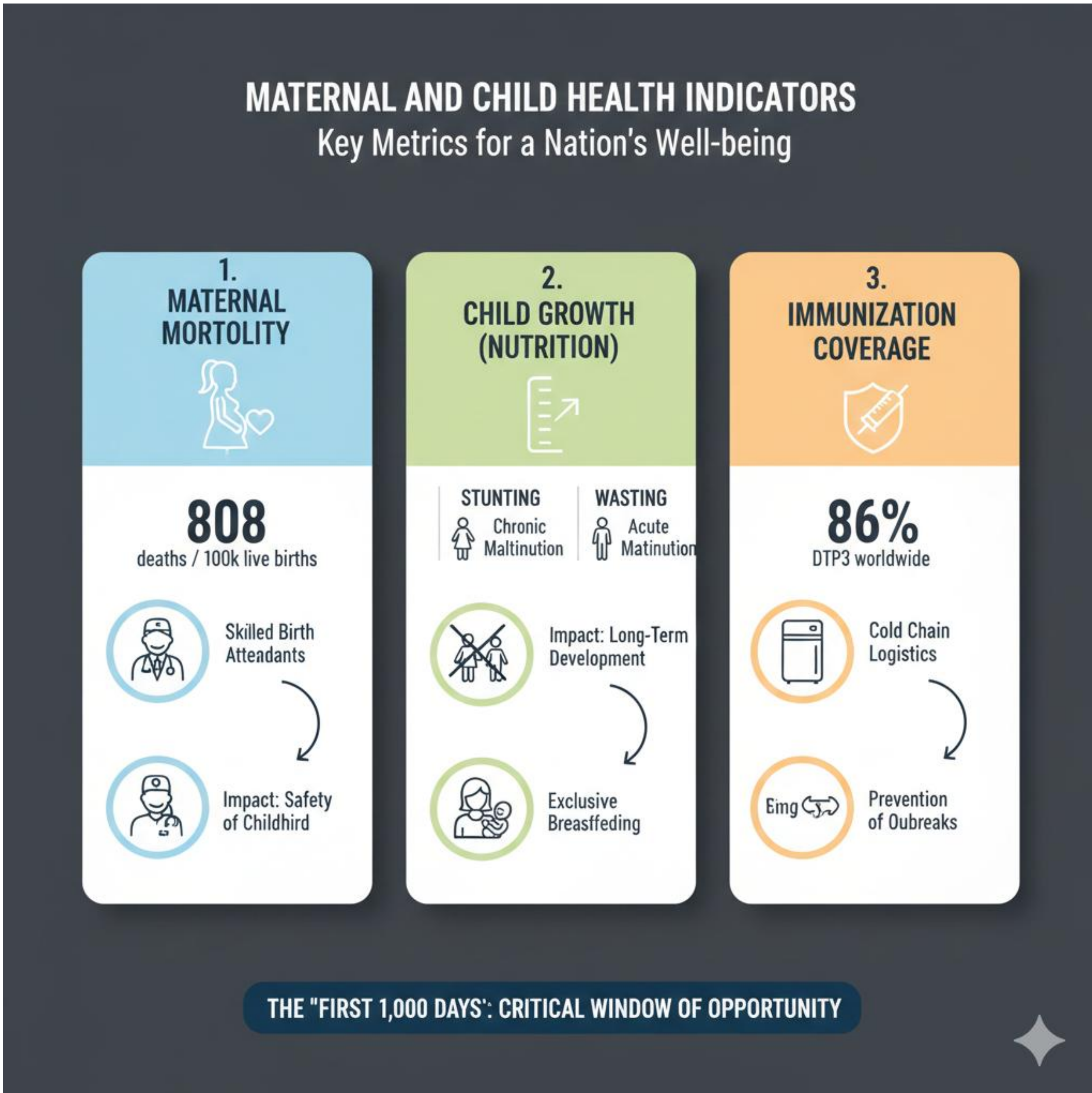

Figure 5.4 Placeholder: Diagram showing maternal and child health indicators. Caption: Epidemiology in maternal and child health.

5.4.2 Environmental and occupational health

Epidemiology identifies health risks from environmental exposures.

- Air pollution linked to respiratory diseases.
- Occupational exposures to chemicals or noise.
- Epidemiologic studies guide regulations and workplace safety standards.

Fill in the blank: Air pollution is linked to ______ diseases.

Risk Factor	Primary Pathway	Major Health Outcome
Air Pollution	**Respiratory / Circulatory**	**Heart Disease & Lung Cancer**
Chemicals	**Ingestion / Dermal / Inhalation**	**Neurological & Endocrine Damage**
Noise	**Auditory / Nervous System**	**Hypertension & Stress Disorders**

Box 5.4 Placeholder: Text box listing environmental and occupational health risks. Caption: Environmental and occupational health applications.

5.4.3 Mental health epidemiology

Epidemiology helps quantify mental health problems and evaluate interventions.

- Prevalence of depression, anxiety, and substance use disorders.
- Identifying social determinants of mental health.
- Evaluating effectiveness of counseling and community programs.

Fill in the blank: Epidemiology helps quantify the prevalence of ______ disorders.

Disorder	Primary Focus	Key Epidemiologic Metric	Specific Application / Intervention
Depression	**Disability & Function**	**DALYs (Disability-Adjusted Life Years): Measures years of "healthy" life lost due to the condition.**	**Screening in Primary Care: Using standardized tools (like the PHQ-9) to identify high-risk groups in the general population.**
Anxiety	**Comorbidity**	**Prevalence: The proportion of the population experiencing symptoms at a specific time.**	**Workplace Wellness Programs: Identifying environmental stressors in high-pressure industries to**

Disorder	Primary Focus	Key Epidemiologic Metric	Specific Application / Intervention
			reduce the incidence of anxiety disorders.
Substance Use	**Mortality & Risk**	**Overdose Mortality Rate: Number of deaths per 100k people.**	**Harm Reduction: Using data to deploy Naloxone (reversal agents) and Needle Exchange Programs in "hot spot" neighborhoods.**

Table 5.4 Placeholder: Table linking mental health conditions to epidemiologic applications. Caption: Mental health epidemiology.

5.4.4 Emerging global health issues

Epidemiology is vital in addressing new and complex health challenges.

- Climate change impacts (heat waves, vector-borne diseases).
- Global pandemics (COVID-19, influenza).
- Preparedness and response strategies guided by epidemiologic evidence.

Fill in the blank: Climate change increases the risk of ______-borne diseases.

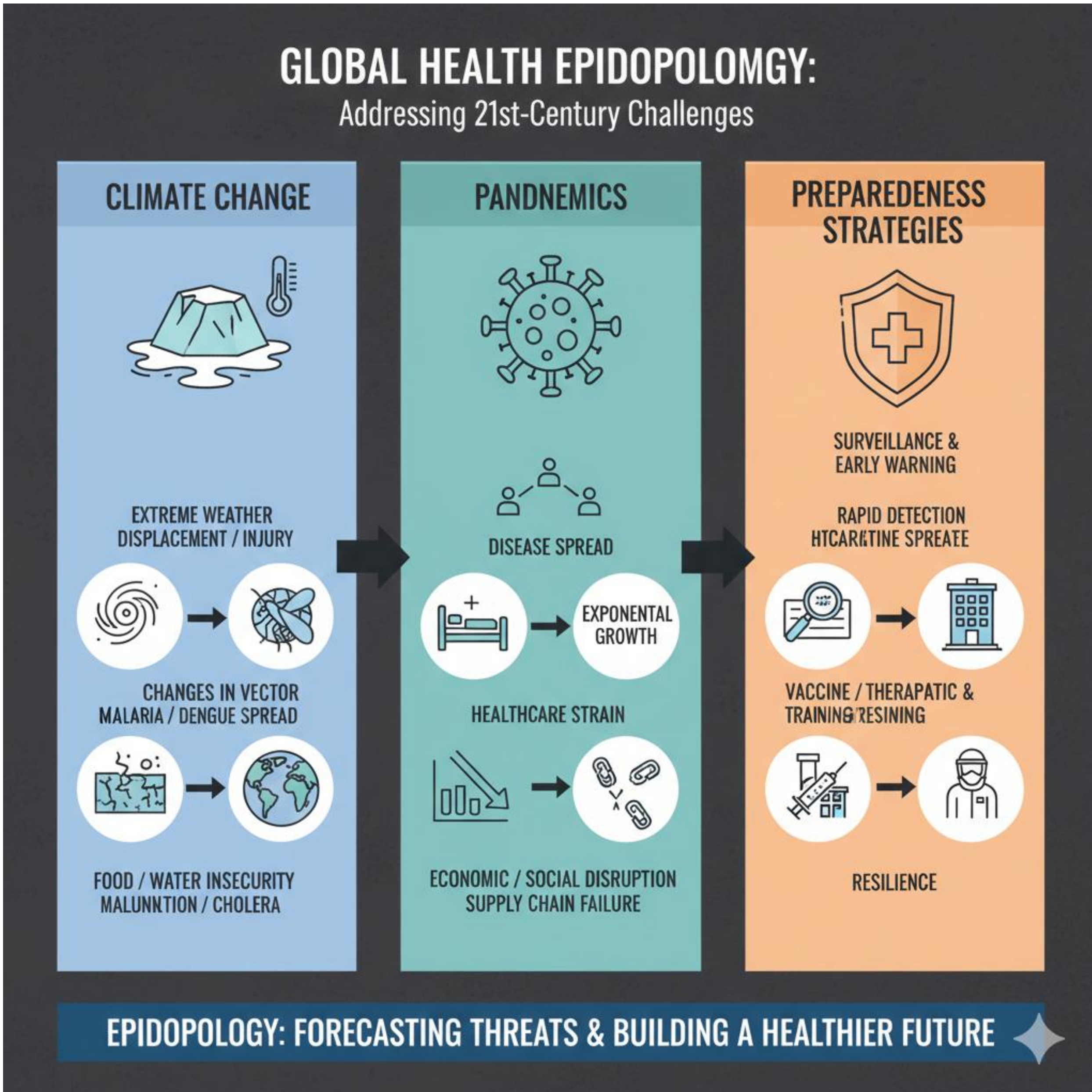

Figure 5.5 Placeholder: Diagram showing emerging global health issues. Caption: Epidemiology in emerging global health challenges.

Pilot questions 5.4

1. Monitoring ______ mortality rates is a key application in maternal health.
2. Air pollution is linked to ______ diseases.
3. Epidemiology helps quantify the prevalence of ______ disorders.
4. Climate change increases the risk of ______-borne diseases.
5. Why is epidemiology important in addressing emerging global health issues?

Series Summary – Series 5: Applications of Epidemiology in Disease, Injury, and Health Problems

In this Series, we explored how epidemiology is applied across diverse health domains:

- **Communicable diseases**: Epidemiology guides surveillance, outbreak investigation, and control measures such as vaccination, isolation, and contact tracing. Case examples included malaria, tuberculosis, and HIV.
- **Non-communicable diseases (NCDs)**: Epidemiology identifies risk factors for chronic diseases like cancer, cardiovascular disease, and diabetes. It also informs lifestyle interventions and screening programs.
- **Injury epidemiology**: Epidemiology helps uncover risk factors for road traffic injuries, occupational hazards, and violence, while shaping prevention strategies such as safety laws, protective equipment, and community programs.
- **Other health problems**: Applications extend to maternal and child health, environmental and occupational exposures, mental health, and emerging global challenges like climate change and pandemics.

By completing this Series, learners should now be able to apply epidemiologic principles to communicable and non-communicable diseases, injuries, and broader health problems, critically evaluating interventions and understanding their role in shaping public health policy and practice.

Glossary of Terms – Series 5: Applications of Epidemiology in Disease, Injury, and Health Problems

- **Surveillance**: Continuous, systematic collection, analysis, and interpretation of health data to detect changes in disease patterns.
- **Outbreak investigation**: Rapid epidemiologic response to unusual increases in cases, involving case definition, data collection, and control measures.
- **Vaccination**: Preventive measure that protects susceptible individuals from infection.
- **Isolation and quarantine**: Strategies to limit spread from infected or exposed individuals.
- **Contact tracing**: Identifying and monitoring people exposed to cases to prevent further transmission.
- **Chronic disease epidemiology**: Study of patterns and determinants of long-term diseases such as cancer, cardiovascular disease, and diabetes.

- **Lifestyle risk factors**: Behaviors such as smoking, poor diet, and physical inactivity that increase risk of non-communicable diseases.
- **Screening programs**: Systematic testing to detect disease early, e.g., Pap smears, mammography, blood pressure checks.
- **Road traffic injuries**: Injuries resulting from vehicle crashes, influenced by risk factors like speeding and alcohol use.
- **Occupational injuries**: Injuries occurring in the workplace due to hazards such as machinery, chemicals, or repetitive strain.
- **Violence and intentional injuries**: Injuries caused by interpersonal violence, often linked to poverty, substance abuse, and social inequality.
- **Maternal mortality**: Death of a woman during pregnancy, childbirth, or within 42 days of termination of pregnancy.
- **Child health indicators**: Measures such as growth monitoring and immunization coverage used to assess child health.
- **Environmental health risks**: Hazards such as air pollution, chemical exposure, and noise that affect health.
- **Mental health epidemiology**: Study of prevalence, determinants, and interventions for mental health disorders like depression and anxiety.
- **Emerging global health issues**: New or evolving challenges such as climate change impacts and pandemics requiring epidemiologic response.

Concept Check Questions – Series 5: Applications of Epidemiology in Disease, Injury, and Health Problems

Objective questions (linked to SLOs 5.1–5.4)

1. Continuous, systematic collection and analysis of health data is called ______.
2. Identifying and monitoring people exposed to cases is called ______.
3. Epidemiology links hypertension and cholesterol to ______ disease.
4. Lack of ______ is a major risk factor for road traffic injuries.
5. Air pollution is linked to ______ diseases.

Short-answer questions (linked to SLOs 5.1–5.4)

6. What is the purpose of outbreak investigation in communicable disease epidemiology?

7. Name two lifestyle risk factors for non-communicable diseases.

8. Give one example of a screening program and the disease it targets.

9. List two occupational hazards that epidemiology helps identify.

10. Provide one example of how epidemiology is applied in maternal and child health.

Long-answer questions (linked to SLOs 5.1–5.4)

11. Discuss the role of epidemiology in controlling communicable diseases, using malaria or tuberculosis as an example.

12. Explain how lifestyle and behavioral risk factors contribute to non-communicable diseases, and how epidemiology informs prevention strategies.

13. Analyse the importance of injury epidemiology in shaping public health interventions, with examples from road traffic or occupational injuries.

14. Evaluate the contributions of epidemiology to mental health, including measurement of prevalence and assessment of interventions.

15. Assess the role of epidemiology in addressing emerging global health issues such as climate change and pandemics.

Answers to Pilot Questions – Series 5: Applications of Epidemiology in Disease, Injury, and Health Problems

Pilot questions 5.1 (Communicable diseases)

1. Surveillance
2. To identify the source, mode of transmission, and implement control measures
3. Contact tracing
4. Vaccination
5. Distribution of insecticide-treated nets

Pilot questions 5.2 (Non-communicable diseases)

1. Cardiovascular
2. Smoking
3. Obesity/diabetes
4. Cervical
5. Because they detect disease early and guide prevention strategies

Pilot questions 5.3 (Injury epidemiology)

1. Seat belts (or helmets)
2. Road safety laws or seat belt campaigns

3. Prevention
4. Violence/intentional
5. Because it identifies risk factors and informs prevention strategies

Pilot questions 5.4 (Other health problems)

1. Maternal
2. Respiratory
3. Mental health
4. Vector
5. Because it provides evidence for preparedness, response, and policy decisions

References and Attributions – Series 5: Applications of Epidemiology in Disease, Injury, and Health Problems

General references

- Course content adapted from *EHS 202: Fundamentals of Epidemiology (2 Units)*, focusing on applied epidemiology.
- Explanations of concepts are based on standard epidemiology literature and open educational resources (OERs).

Figures

- *Figure 5.1: Surveillance cycle* – AI-generated using the prompt "Generate a diagram showing the surveillance cycle: data collection, analysis, dissemination, and action."
- *Figure 5.2: Chronic diseases and risk factors* – AI-generated using the prompt "Generate a diagram linking chronic diseases (cancer, cardiovascular disease, diabetes) to risk factors."
- *Figure 5.3: Road traffic injury prevention* – AI-generated using the prompt "Generate a diagram linking risk factors (speeding, alcohol, lack of seat belts/helmets) to interventions (laws, campaigns, helmet promotion)."
- *Figure 5.4: Maternal and child health indicators* – AI-generated using the prompt "Generate a diagram showing maternal mortality, child growth, and immunization coverage as indicators."
- *Figure 5.5: Emerging global health issues* – AI-generated using the prompt "Generate a diagram showing climate change, pandemics, and preparedness strategies as global health issues."

Boxes

- *Box 5.1: Control measures in communicable diseases* – AI-generated using the prompt “Create a text box listing vaccination, isolation/quarantine, and contact tracing with brief definitions.”
- *Box 5.2: Lifestyle risk factors for NCDs* – AI-generated using the prompt “Create a text box listing smoking, diet, and physical inactivity as risk factors for NCDs.”
- *Box 5.3: Occupational injury epidemiology* – AI-generated using the prompt “Create a text box listing occupational hazards and prevention strategies.”
- *Box 5.4: Environmental and occupational health risks* – AI-generated using the prompt “Create a text box listing air pollution, chemical exposure, and noise as health risks.”

Tables

- *Table 5.1: Applications of epidemiology in communicable diseases* – AI-generated using the prompt “Generate a table linking malaria, tuberculosis, and HIV to specific epidemiologic applications.”
- *Table 5.2: Screening programs in NCD epidemiology* – AI-generated using the prompt “Generate a table linking screening programs (Pap smear, mammography, blood pressure check, glucose monitoring) to specific diseases.”
- *Table 5.3: Applications of epidemiology in injury prevention* – AI-generated using the prompt “Generate a table linking road traffic, occupational, and violence injuries to epidemiologic applications.”
- *Table 5.4: Mental health epidemiology* – AI-generated using the prompt “Generate a table linking depression, anxiety, and substance use disorders to epidemiologic applications.”