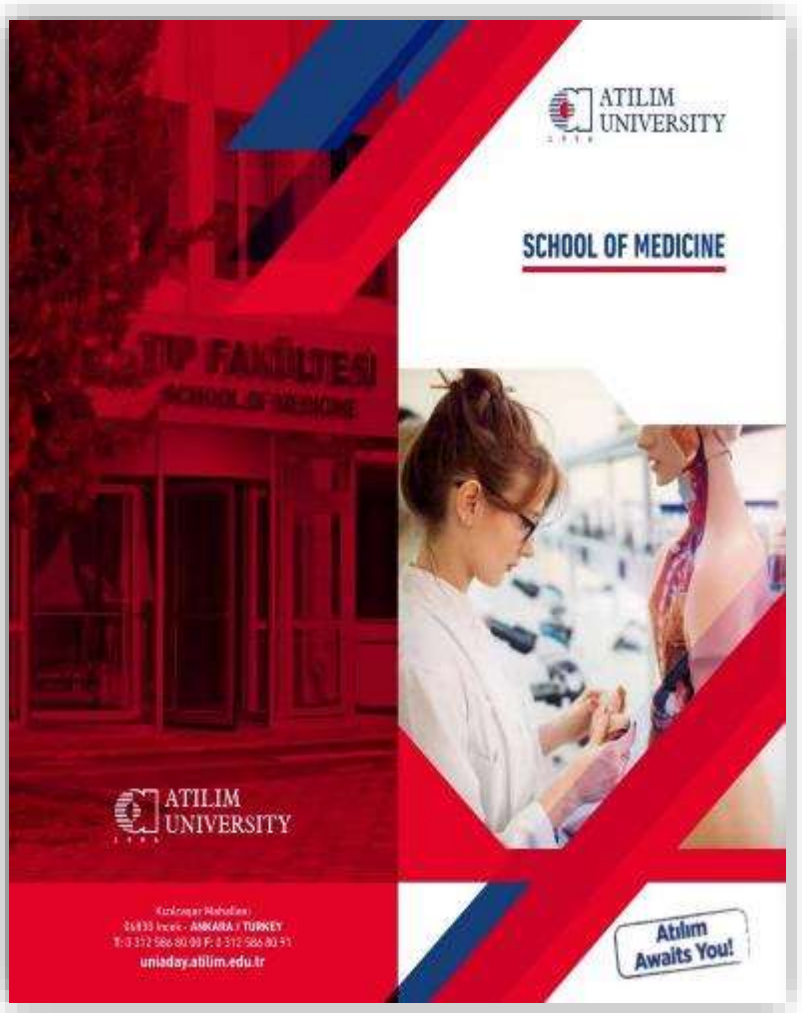

Epidemiologic Research Methods in Medicine

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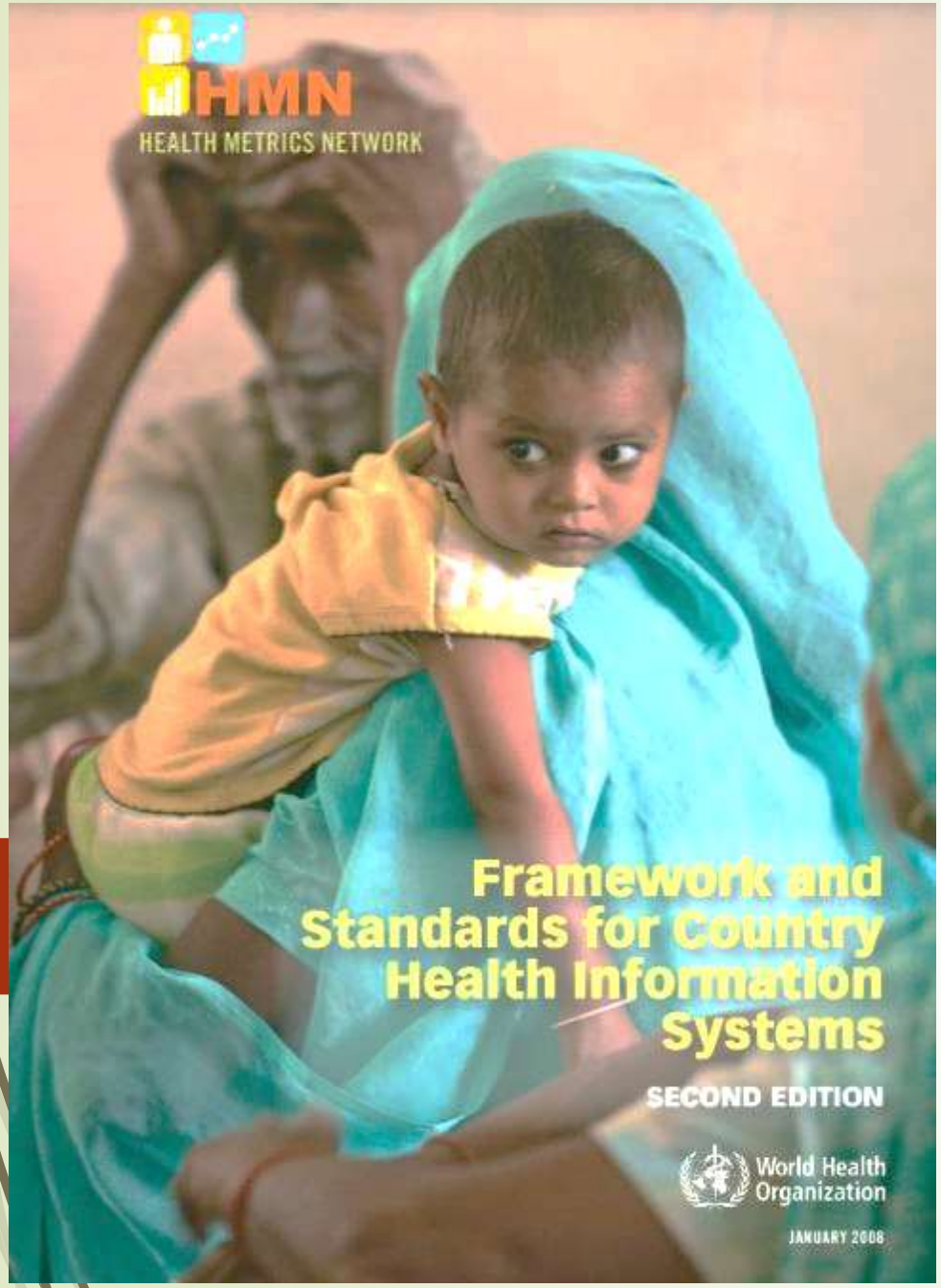
Definition of Epidemiology :

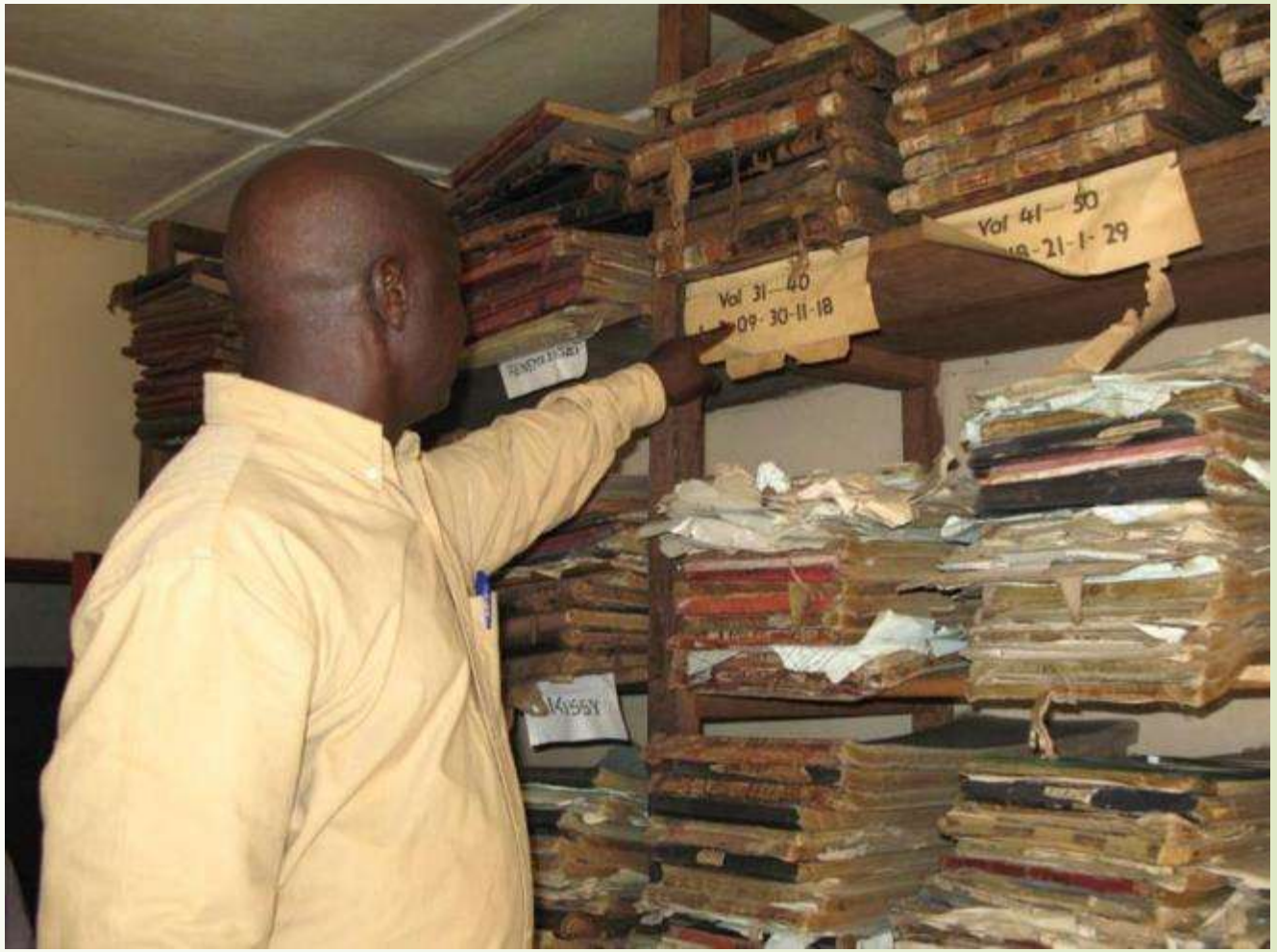
Many definitions have been proposed, but the following definition captures the underlying principles and public health spirit of Epidemiology:

*Epidemiology is the **study** of the **distribution**and **determinants** of **health-related states or events** in **specified populations**, and the **application** of this study to the control of health problems.*

Phase 1 lecture, 2020 - 2021 academic year, spring semester

09th June 2021, Ankara - TURKIYE


HMN
HEALTH METRICS NETWORK
Framework and Standards for Country Health Information Systems
SECOND EDITION
World Health Organization
JANUARY 2008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Epidemiology

Epidemiology is a scientific discipline with sound methods of scientific inquiry at its foundation.

Epidemiology is data-driven and relies on a systematic and unbiased approach to the collection, analysis, and interpretation of data. ***Basic epidemiologic methods*** tend to rely on careful observation and use of valid comparison groups to assess whether what was observed, such as the number of cases of disease in a particular area during a particular time period or the frequency of an exposure among persons with disease, differs from what might be expected.

However, ***Epidemiology*** also draws on methods from other scientific fields, including Biostatistics and Informatics, with biologic, economic, social, and behavioral sciences.

Epidemiology

In fact, **Epidemiology** is often described as the basic science of **Public Health**, and for good reason.

First, **Epidemiology** is a quantitative discipline that relies on a working knowledge of probability, statistics, and sound research methods.

Second, epidemiology is a method of causal reasoning based on developing and testing hypotheses grounded in such scientific fields as biology, behavioral sciences, physics, and ergonomics to explain health-related behaviors, states, and events.

However, **Epidemiology** is not just a research activity but an integral component of Public Health, providing the foundation for directing practical and appropriate Public Health action based on this science and ***causal reasoning***.

Solving Health Problems

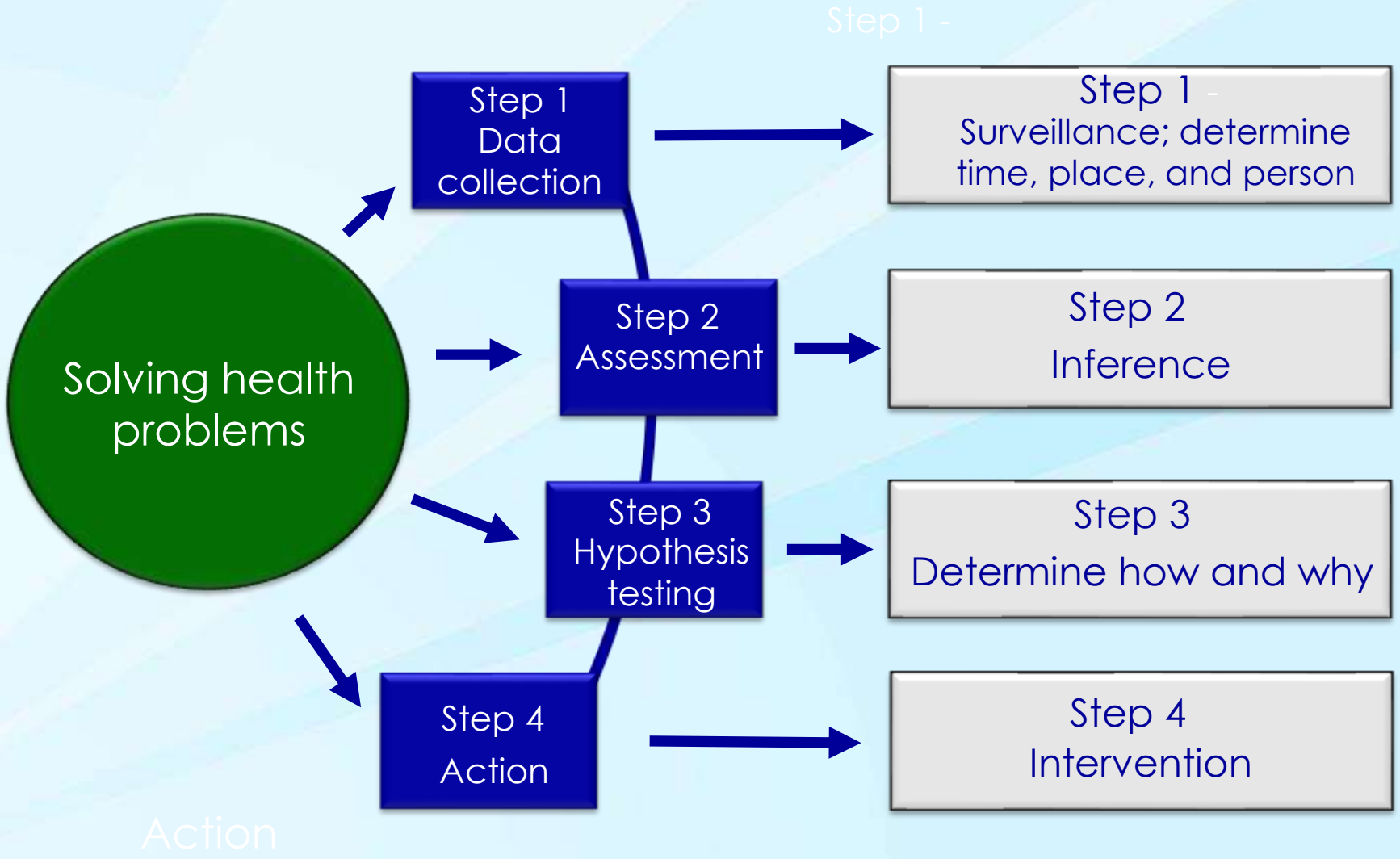
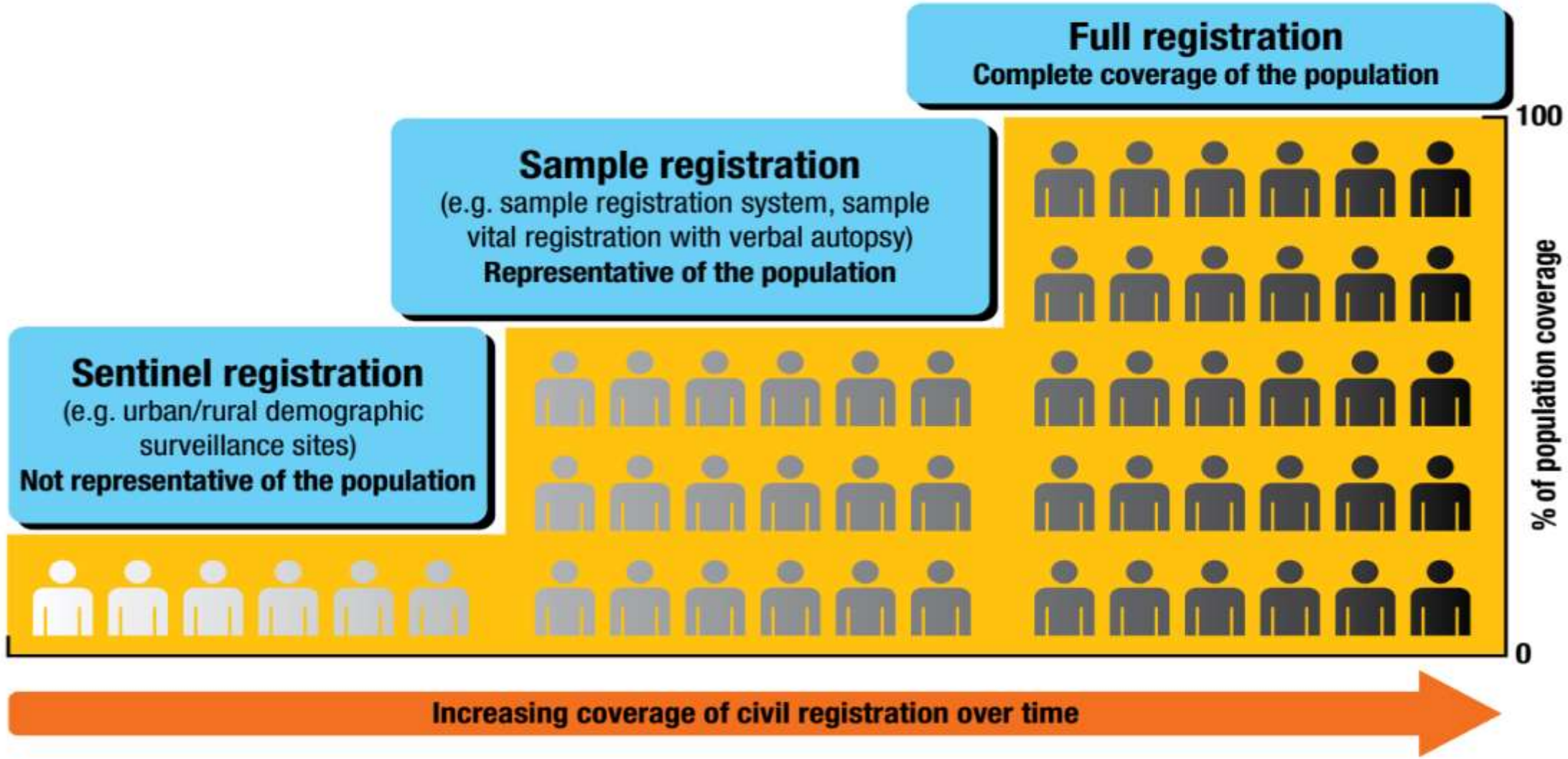


Fig 7. Improving availability of vital statistics

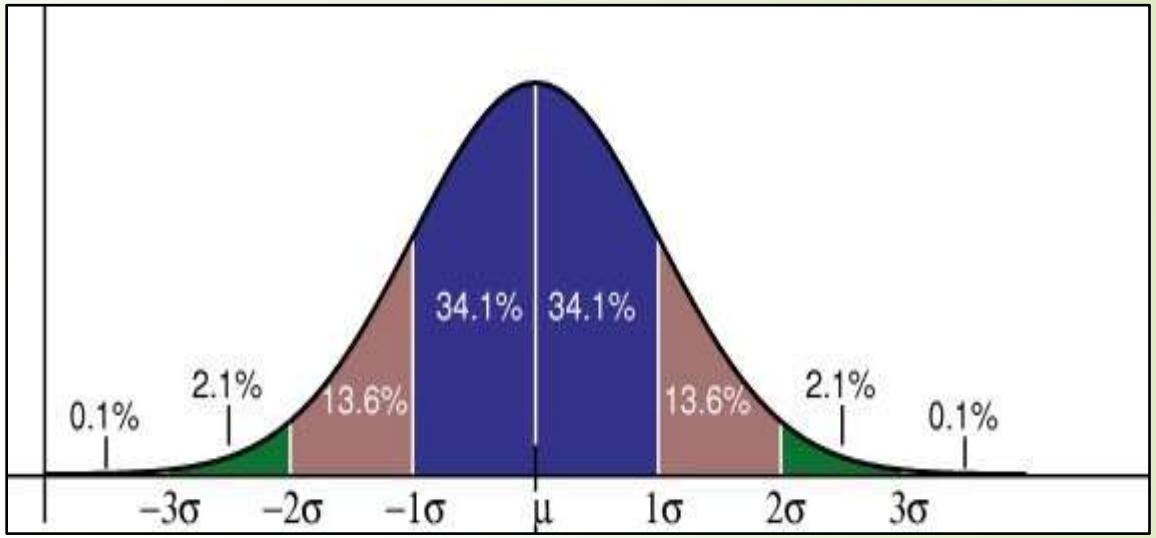


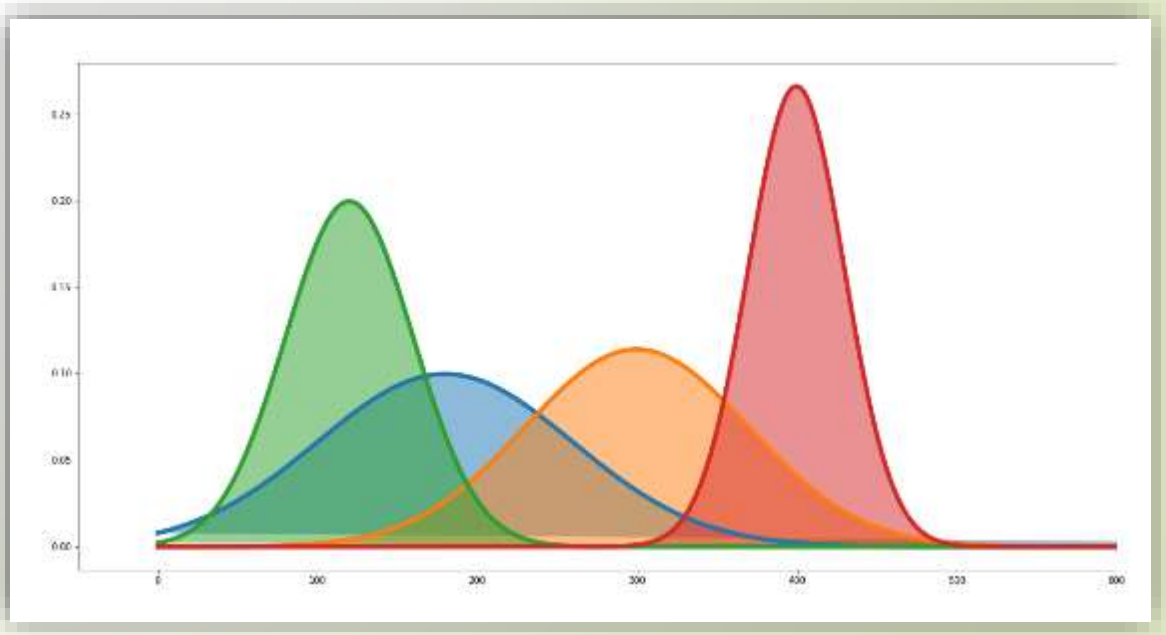
Distribution

Epidemiology is concerned with the **frequency** and **pattern** of health events in a population:

Frequency refers not only to the number of health events such as the number of cases of meningitis or diabetes in a population, but also to the relationship of that number to the size of the population. The resulting rate allows epidemiologists to compare disease occurrence across different populations.

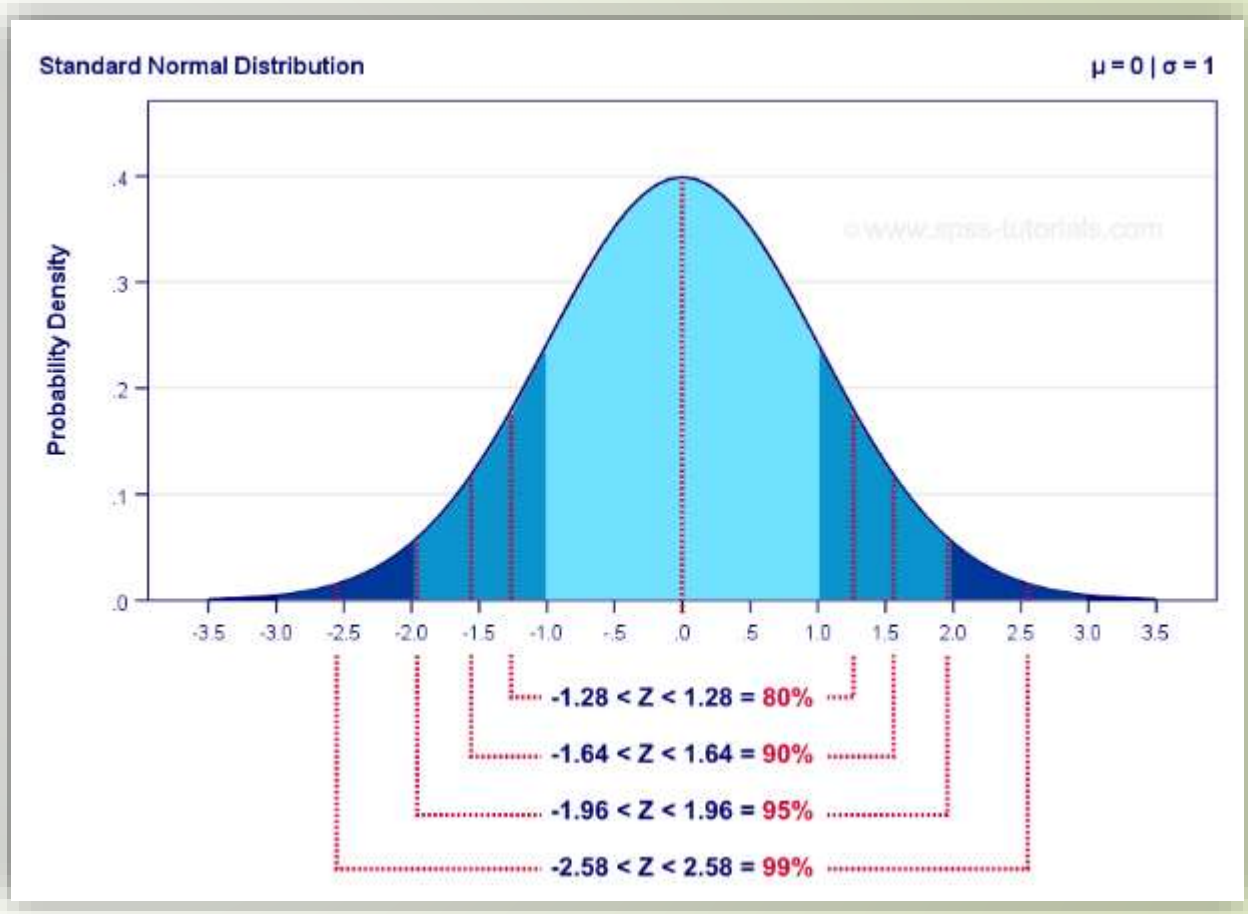
Characterizing health events by time, place, and person are activities of ***descriptive epidemiology***, discussed in detail later in this lesson.





Distribution

Pattern refers to the occurrence of health-related events by ***time, place, and person***. **Time** patterns may be annual, seasonal, weekly, daily, hourly, weekday versus weekend, or any other breakdown of time that may influence disease or injury occurrence. ***Place*** *patterns include geographic variation, urban/rural differences, and location of work sites or schools.* ***Personal*** *characteristics include demographic factors which may be related to risk of illness, injury, or disability such as age, sex, marital status, and socio-economic status, as well as behavior & environmental exposures.*

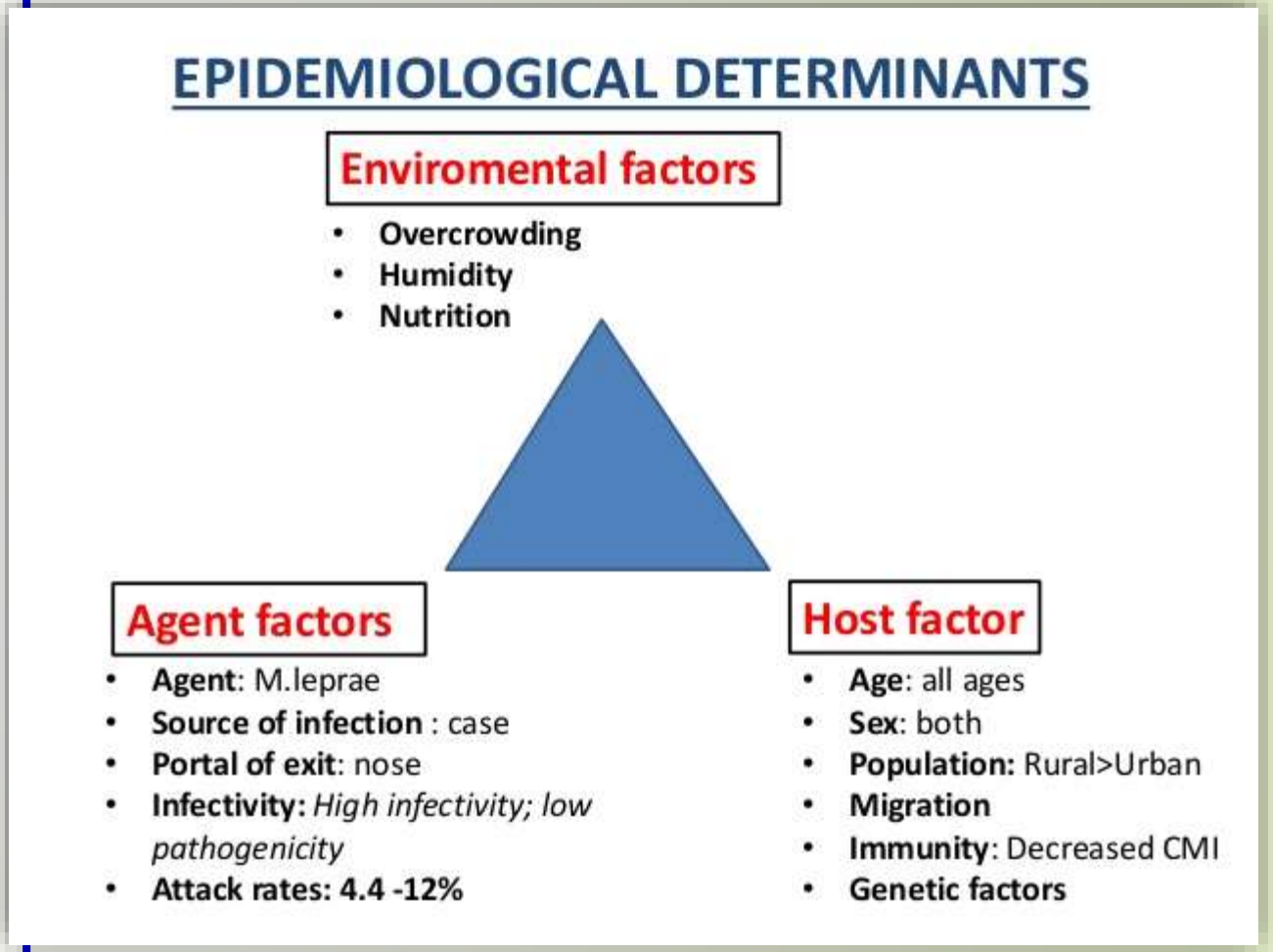


Determinants

Epidemiology is also used to search for **determinants**, which are the causes and other factors that influence the occurrence of disease and other health-related events.

Epidemiologists assume that illness does not occur randomly in a population, but happens only when the right accumulation of risk factors or determinants exists in an individual.

To search for these determinants, Epidemiologists use **Analytic Epidemiology** or epidemiologic studies to provide the "Why" and "How" of such events.

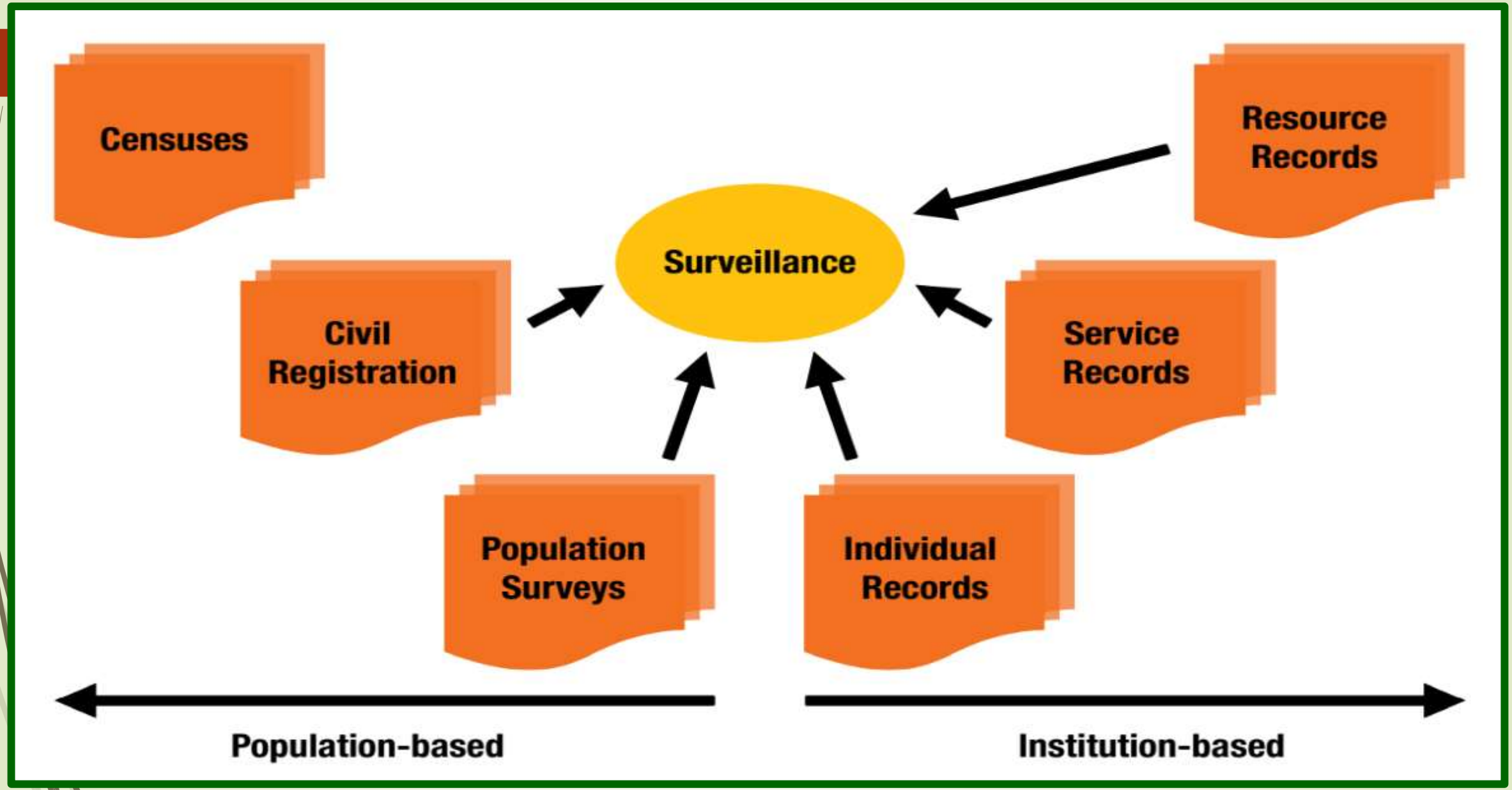


Determinants

They assess whether groups with different rates of disease differ in their demographic characteristics, genetic or immunologic make-up, behaviors, environmental exposures, or other so-called *potential risk factors*. Ideally, the findings provide sufficient evidence to direct prompt and effective public health control and prevention measures.

Determinants of epidemiology:

- Primary determinant:
  - bacteria, viruses, parasites (in case of communicable disease)
  - specific nutrient deficiency (in case of nutritional disorder)
  - vehicles (in case of automobile accidents)
- Secondary determinant:
  - socio economic factors (in case of malnutrition)
  - physical environment (in case of respiratory infection)


Censuses
Resource Records
Surveillance
Civil Registration
Service Records
Population Surveys
Individual Records
Population-based
Institution-based

Box 1.2. Definition of epidemiology[9]

The word "epidemiology" is derived from the Greek words: *epi* "upon", *demos* "people" and *logos* "study".

This broad definition of epidemiology can be further elaborated as follows:

Term	Explanation
Study	includes: surveillance, observation, hypothesis testing, analytic research and experiments.
Distribution	refers to analysis of: times, persons, places and classes of people affected.
Determinants	include factors that influence health: biological, chemical, physical, social, cultural, economic, genetic and behavioural.
Health-related states and events	refer to: diseases, causes of death, behaviours such as use of tobacco, positive health states, reactions to preventive regimes and provision and use of health services.
Specified populations	include those with identifiable characteristics, such as occupational groups.
Application to prevention and control	the aims of public health—to promote, protect, and restore health.

Data management

- Data management – a set of procedures to collect, store, analyse and distribute data.

- Once data are collected, a sound management approach is essential.

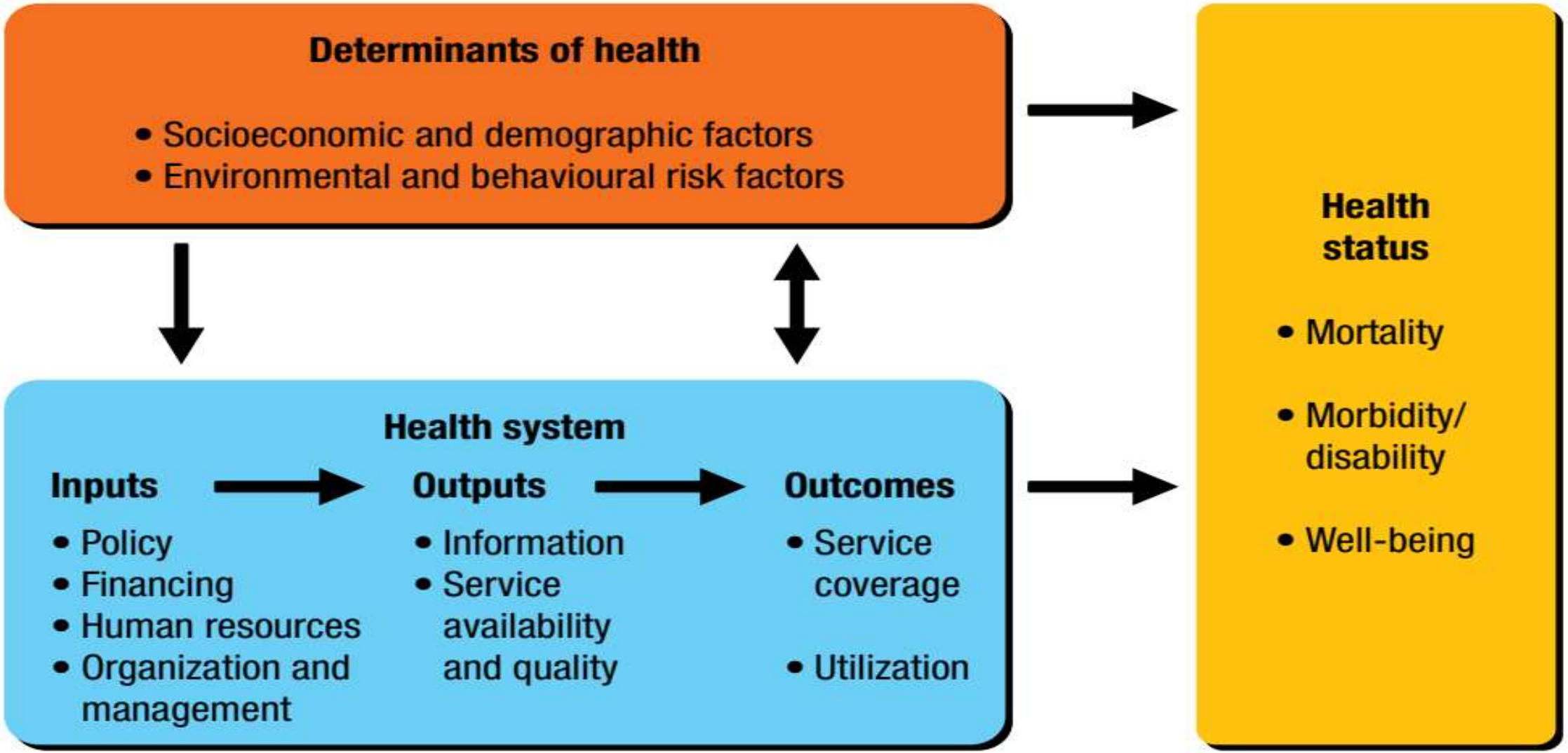
- Firstly, a metadata dictionary is necessary to accurately describe the data elements.

- Next, effective data storage procedures require a well-designed logical structure to permit data retrieval and analysis.

- Data analysis and presentation include calculating indicators and preparing tables and graphs.

- Finally, the data should be made available to all those who can use and act upon them.

Fig 3. Domains of measurement for health information systems



Health-related states or events

- **Epidemiology** was originally focused exclusively on epidemics of communicable diseases but was subsequently expanded to address endemic communicable diseases and non-communicable infectious diseases.
- *By the middle of the 20th Century, additional Epidemiologic methods had been developed and applied to chronic diseases, injuries, birth defects, maternal-child health, occupational health, and environmental health.*

Epidemiology key words:

Health-related states

- Epidemiology is applied to the whole spectrum of health-related events:
  - chronic diseases,
  - environmental problems,
  - behavioral problems,
  - injuries,
  - infectious diseases.

Health-related states or events

- Then **Epidemiologists** began to look at behaviors related to health and well-being, such as amount of exercise and seat belt use.
- *Now, with the recent explosion in **molecular methods**, Epidemiologists can make important strides in examining genetic markers of disease risk.*
- Indeed, the term ***health-related states*** or events may be seen as anything that affects the well-being of a population.
- Nonetheless, many Epidemiologists still use the term "disease" as shorthand for the wide range of ***health-related states*** and events that are studied.

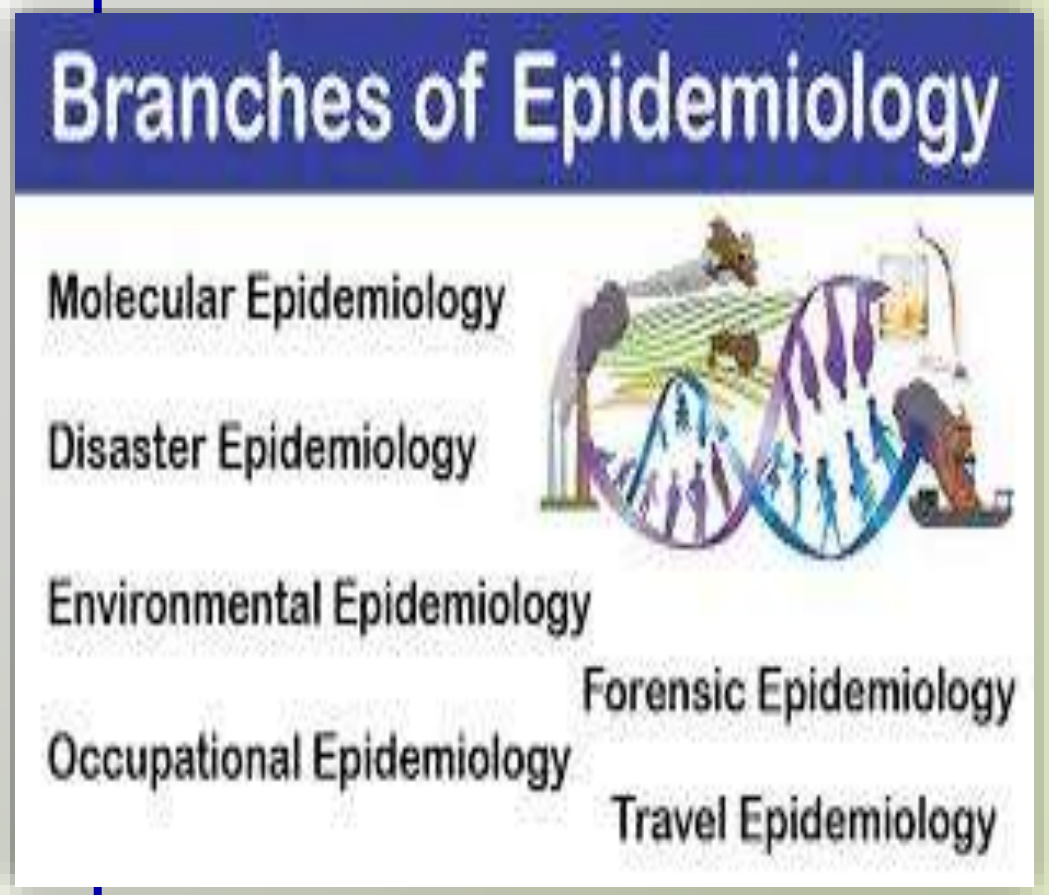
Epidemiology?

"Study of **distribution** and **determinants** of health related state or events & disease in human population"

"Science of rates expressed as probability"

Specified populations

- Although **Epidemiologists** and direct health-care providers (clinicians) are both concerned with occurrence and control of disease, they differ greatly in how they view "the patient." The clinician is concerned about the health of an individual; the **Epidemiologist** is concerned about the collective health of the people in a community or population.
- ***In other words, the clinician's "patient" is the individual; the Epidemiologist's "patient" is the community.***
- Therefore, the clinician and the **Epidemiologist** have different responsibilities when faced with a person with illness.



Specified populations

- For example, when a patient with diarrheal disease presents, both are interested in establishing the correct diagnosis.
- *However, while the clinician usually focuses on treating and caring for the individual, the Epidemiologist focuses on identifying the exposure or source that caused the illness; the number of other persons who may have been similarly exposed; the potential for further spread in the community; and interventions to prevent additional cases or recurrences.*

Who is an epidemiologist?

Any person who researches into occurrence of disease or disability in groups of people is called an epidemiologist.

QUALIFICATIONS OF AN EPIDEMIOLOGIST (SMILLIE):

- Familiar with statistical techniques
- Well grounded in diagnosis of disease
- Thorough with medicine, relating to epidemics
- Good knowledge of bacteriology, immunology and physiology
- Knowledge of principles of preventive medicine

Who is an epidemiologist ?

A professional who strives to study and control the factors that influence the occurrence of disease or health-related conditions and events in specified populations and societies, has an experience in population thinking and epidemiologic methods, and is knowledgeable about public health and causal inference in health

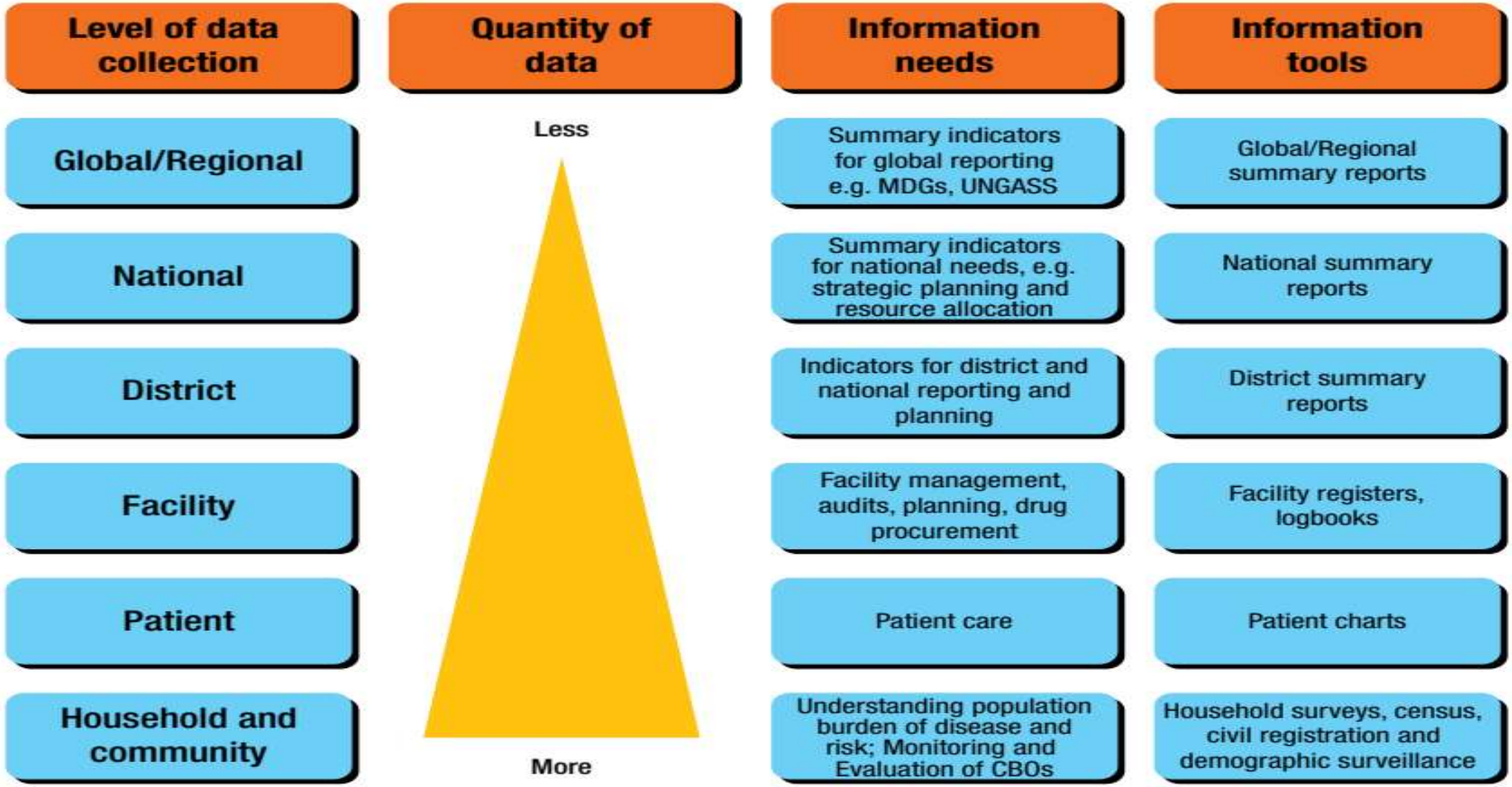
(Porta M, Last J, Greenland S. A Dictionary of Epidemiology, 2008)

Application

- **Epidemiology** is not just “the study of” health in a population; it also involves applying the knowledge gained by the studies to community-based practice.
- *Like the practice of medicine, the practice of epidemiology is both* ***a science and an art.***
- To make the proper diagnosis and prescribe appropriate treatment for a patient, the clinician combines medical (scientific) knowledge with experience, clinical judgment, and understanding of the patient.

Similarly, the epidemiologist uses the scientific methods of descriptive and analytic epidemiology as well as experience, epidemiologic judgment, and understanding of local conditions in “diagnosing” the health of a community and proposing appropriate, practical, and acceptable public ***health interventions*** *to control and prevent disease in the community.*

Fig 2. Information needs and tools at different levels of data collection



Box 1.3. Molecular and genetic epidemiology

Molecular epidemiology measures exposure to specific substances and early biological response, by:

- evaluating host characteristics mediating response to external agents, and
- using biochemical markers of a specific effect to refine disease categories.

Genetic epidemiology deals with the etiology, distribution, and control of disease in groups of relatives, and with inherited causes of disease in populations.

Genetic epidemiological research in family or population studies aims to establish:

- a genetic component to the disorder,
- the relative size of that genetic effect in relation to other sources of variation in disease risk, and
- the responsible gene(s).

Public health genetics include:

- population screening programs,
- organizing and evaluating services for patients with genetic disorders, and
- the impact of genetics on medical practice.

Table 2.2. Differences between incidence and prevalence

	Incidence	Prevalence
Numerator	Number of **new** cases of disease during a specified period of time	Number of **existing** cases of disease at a given point of time
Denominator	Population at risk	Population at risk
Focus	Whether the event is a new case Time of onset of the disease	Presence or absence of a disease Time period is arbitrary; rather a "snapshot" in time
Uses	Expresses the risk of becoming ill The main measure of acute diseases or conditions, but also used for chronic diseases More useful for studies of causation	Estimates the probability of the population being ill at the period of time being studied. Useful in the study of the burden of chronic diseases and implication for health services

Note: If incident cases are not resolved, but continue over time, then they become existing (prevalent) cases. In this sense, prevalence = incidence x duration.

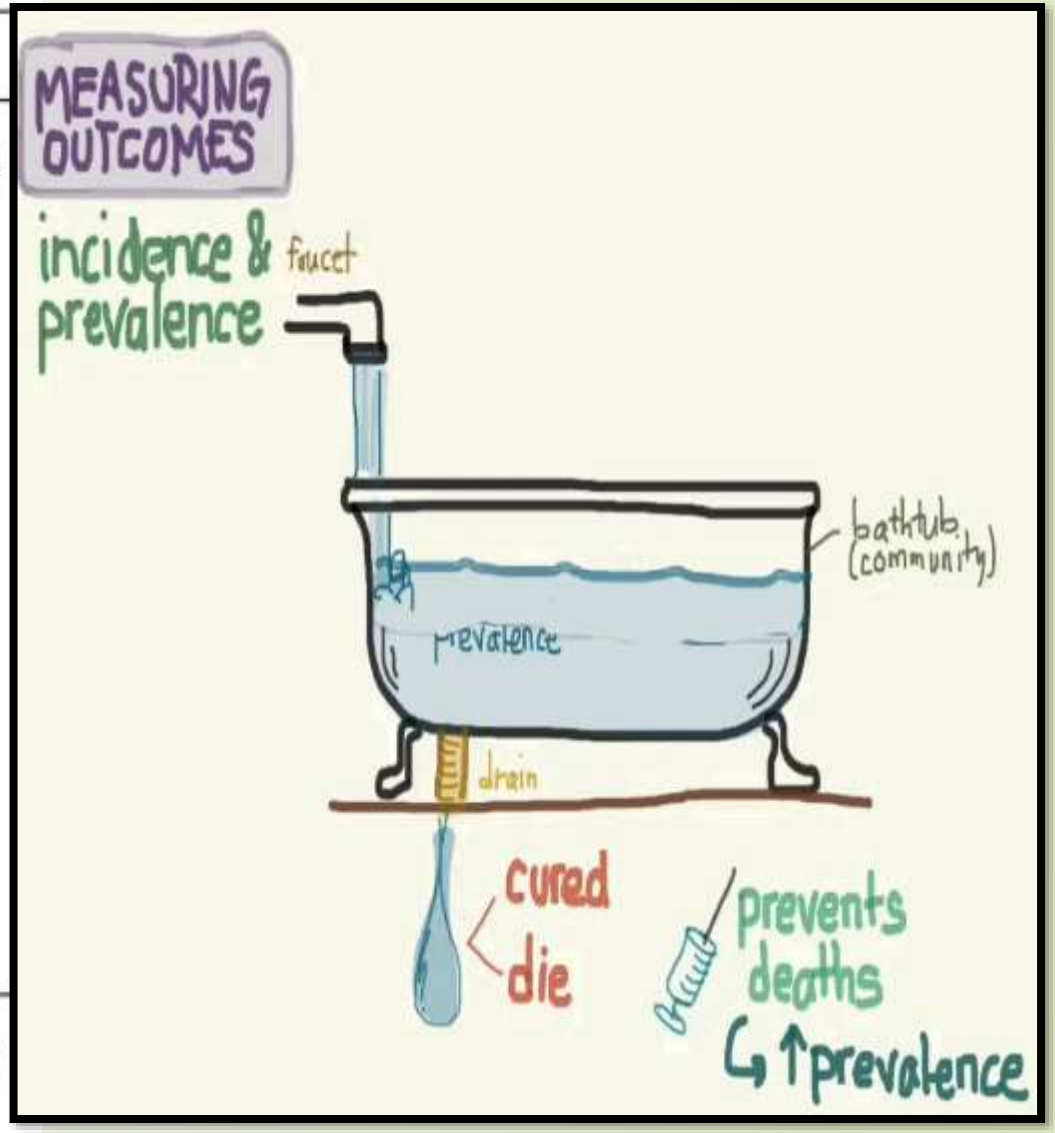
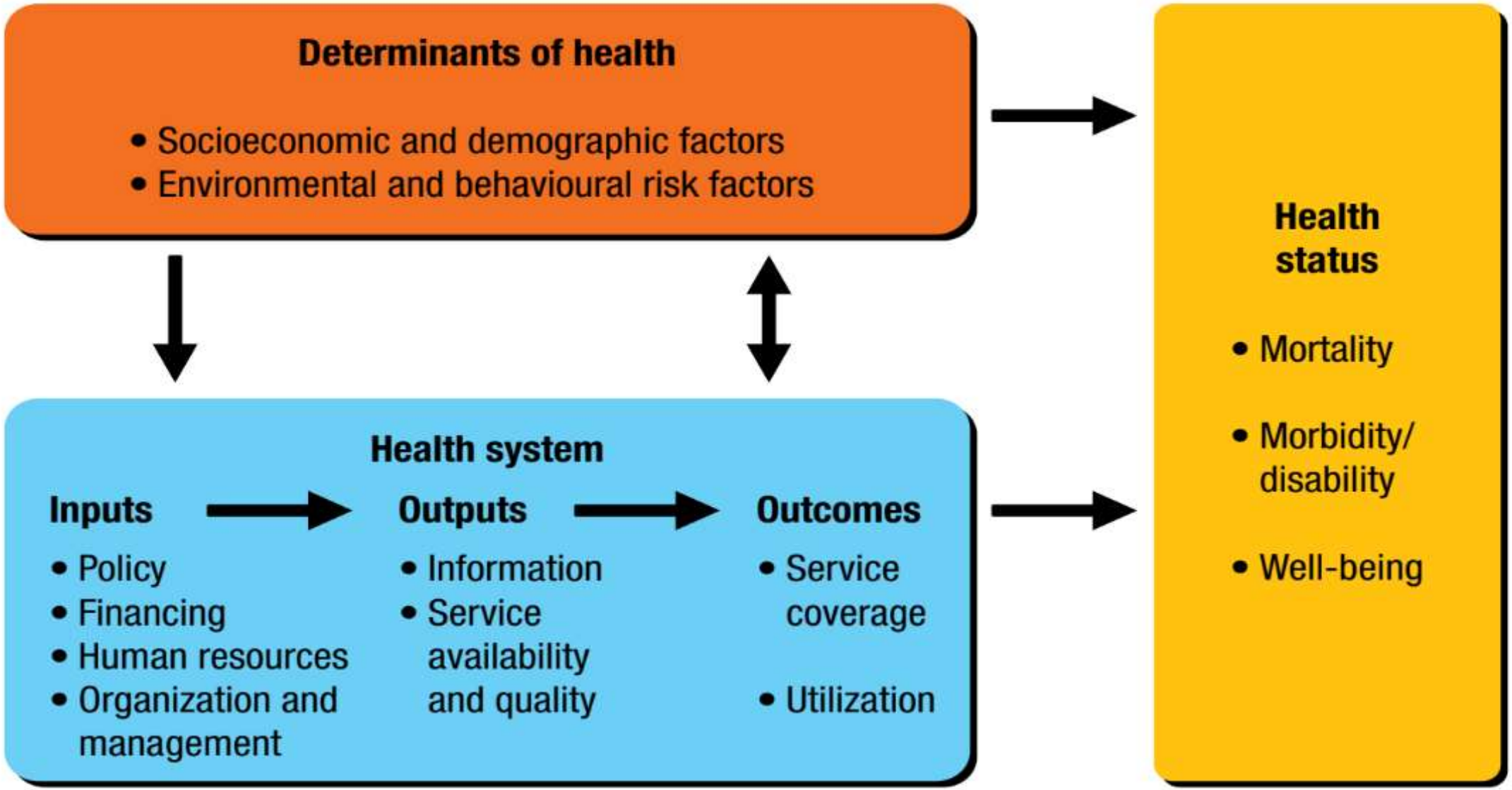
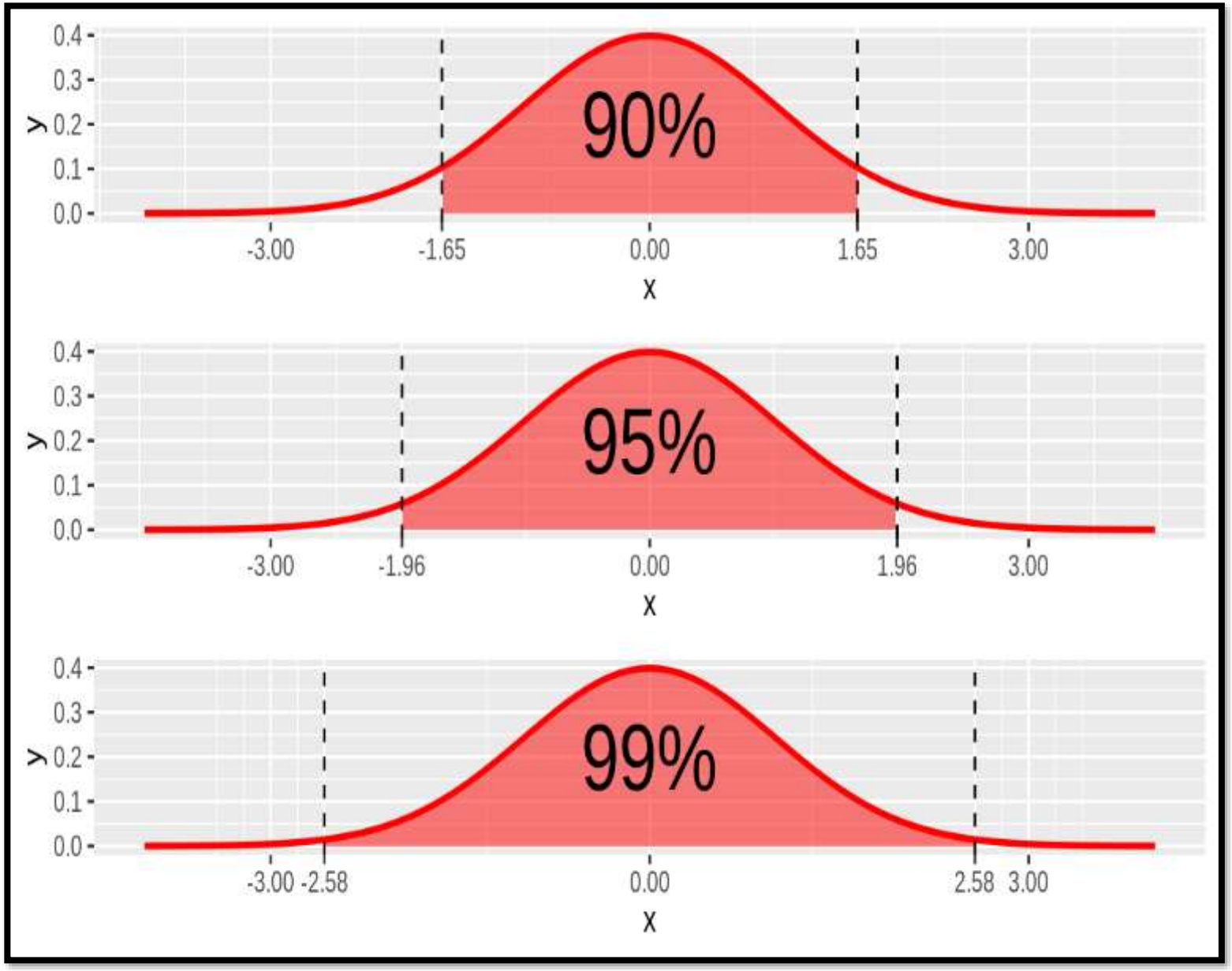


Fig 3. Domains of measurement for health information systems

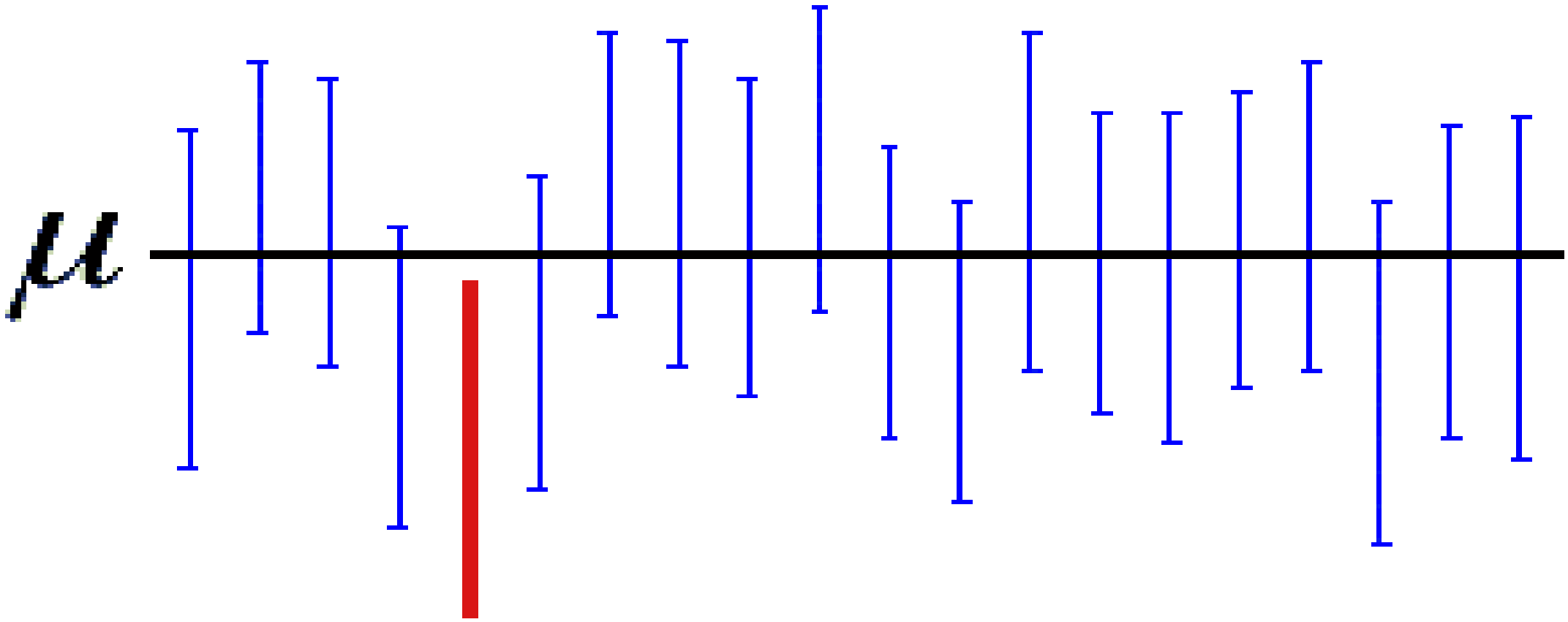


SE & The Confidence Interval



Sometimes, a confidence interval may be computed from theory alone. For instance, means of large, random samples tend to be unbiased and normally distributed. Therefore, the 95 % ***Confidence Interval*** (95 % CI) for any such mean is just m ± 1.96 SE, where m is the observed mean and SE is the ***standard error*** of the mean, as given by the equation below where σ is the population SD *(standard deviation)* for the data and n is the sample size.

$$SE = \frac{SD}{\sqrt{(n)}}$$



A 95% confidence interval indicates that 19 out of 20 samples (95%) from the same population will produce confidence intervals that contain the population parameter.

Fig 12. Health information system

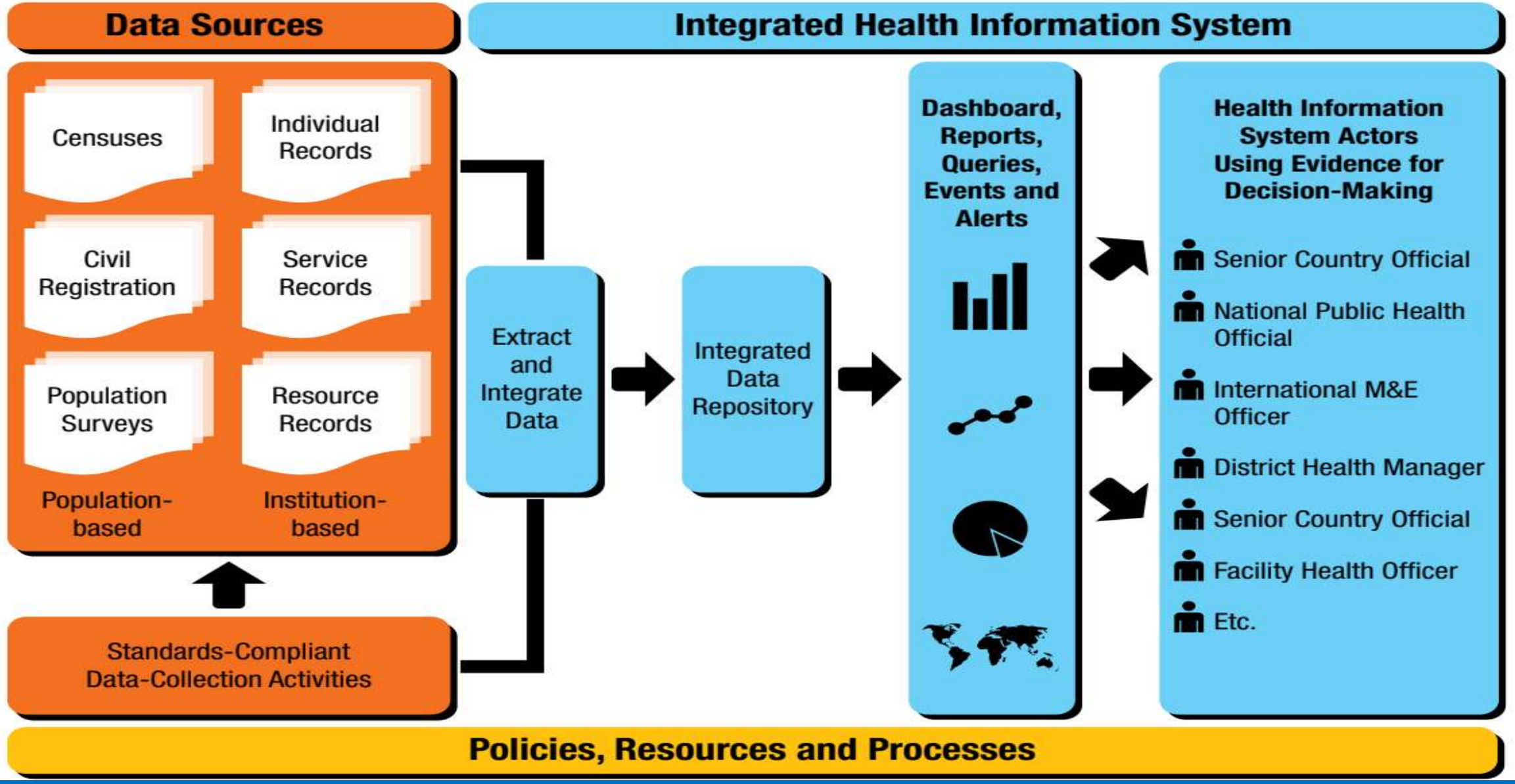
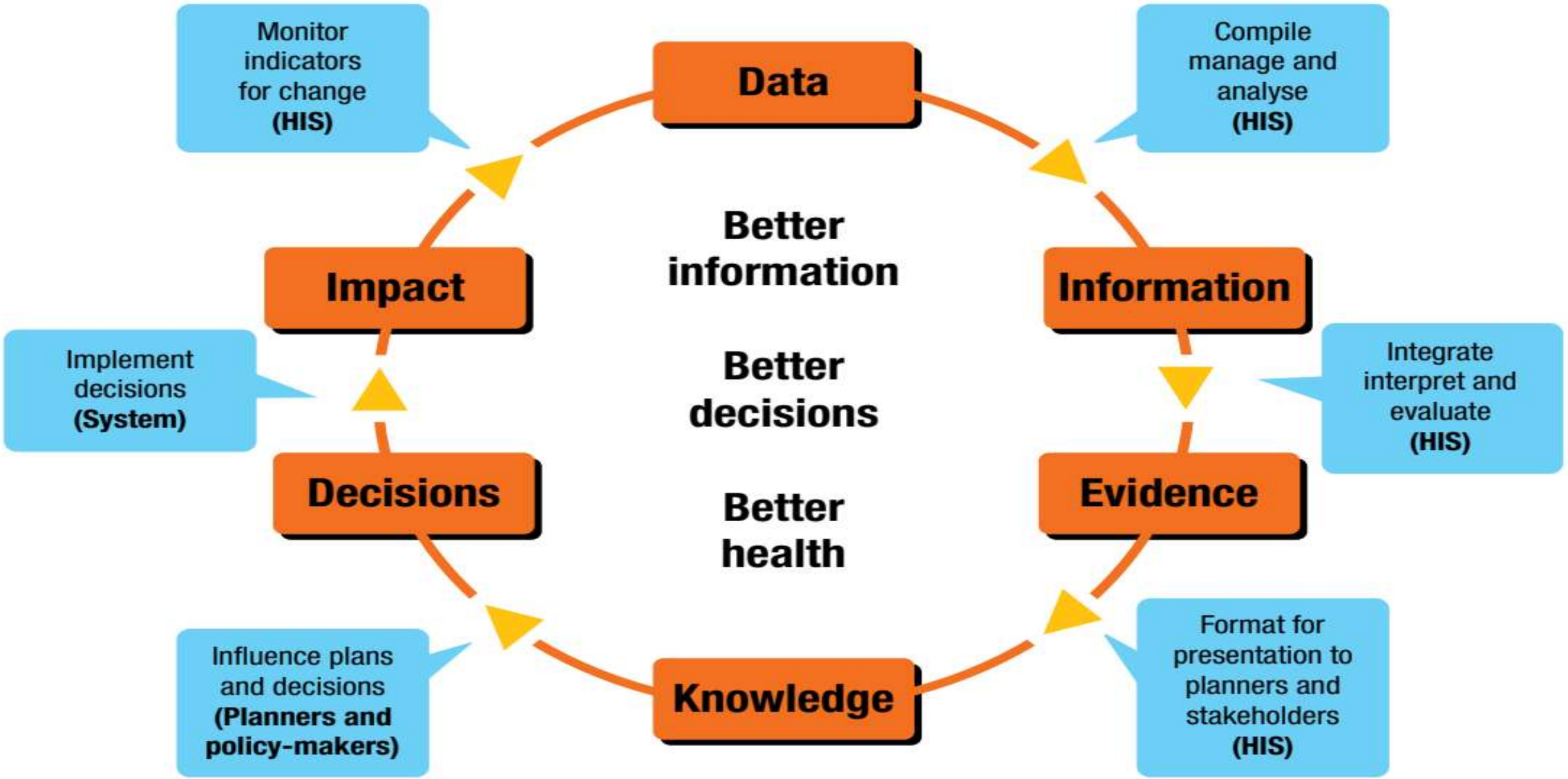
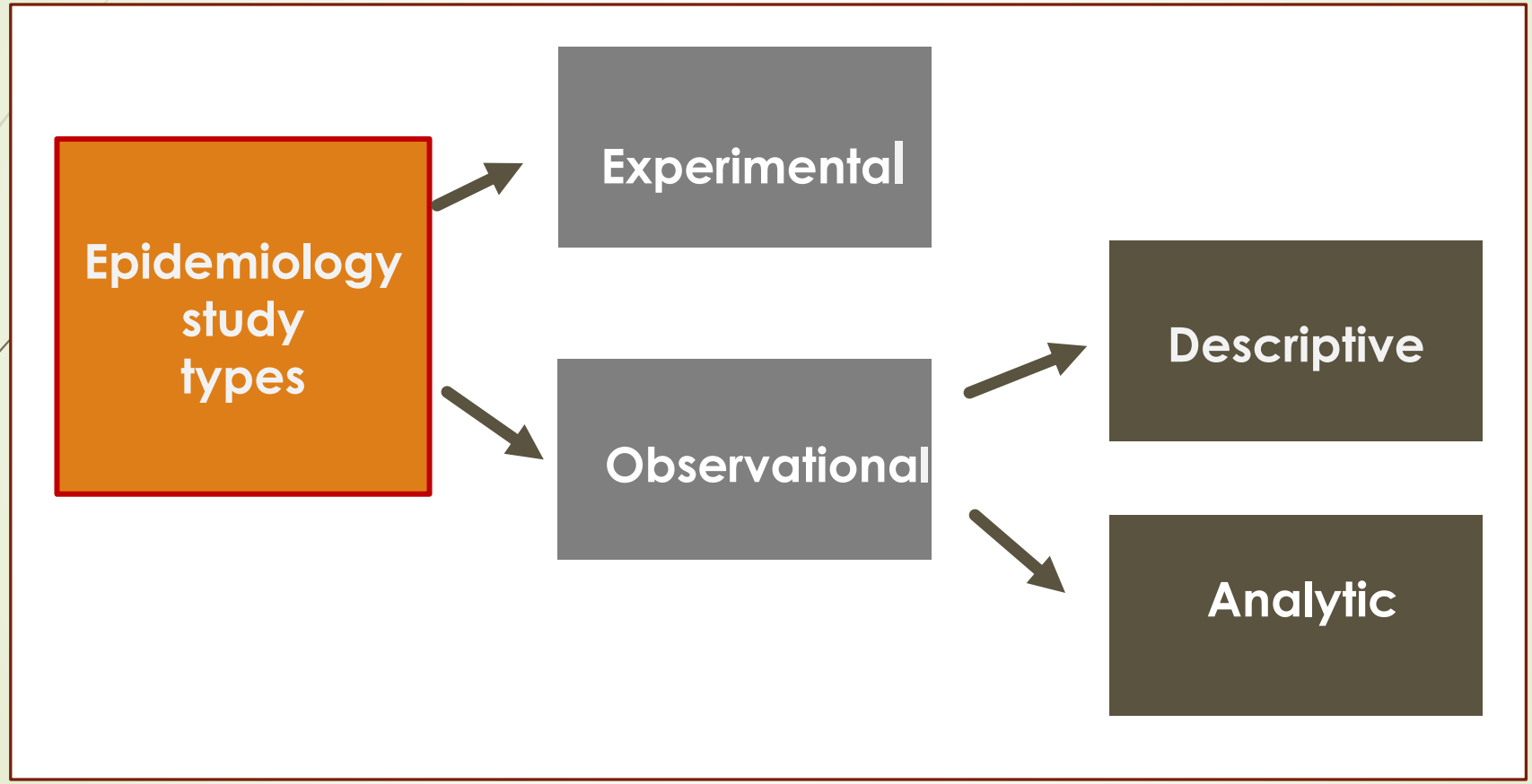
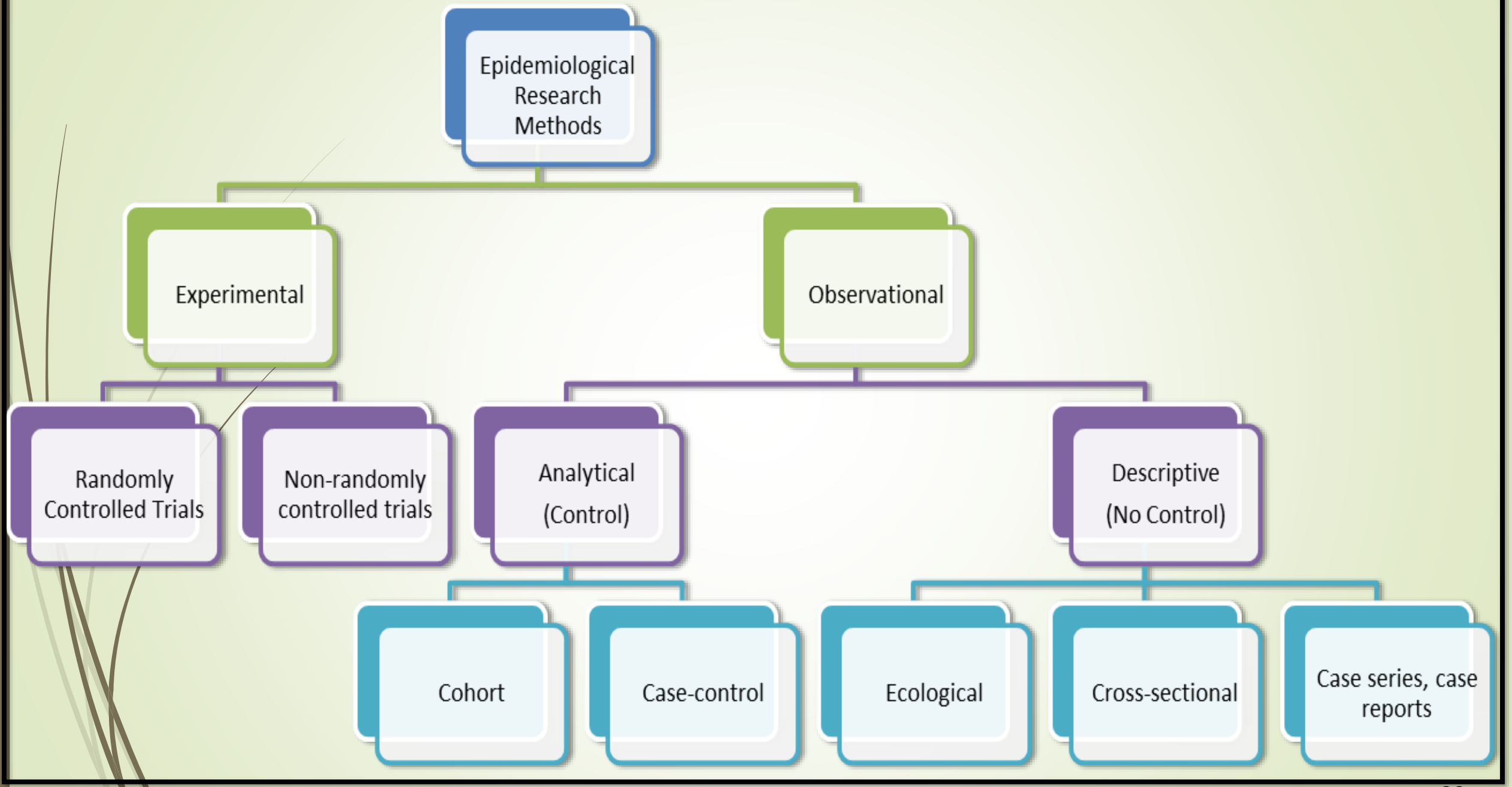


Fig 13. Transforming data into information and evidence



Epidemiology Study Types




Epidemiological Research Methods
Experimental
Observational
Randomly Controlled Trials
Non-randomly controlled trials
Analytical (Control)
Descriptive (No Control)
Cohort
Case-control
Ecological
Cross-sectional
Case series, case reports

Descriptive and Analytic Epidemiology

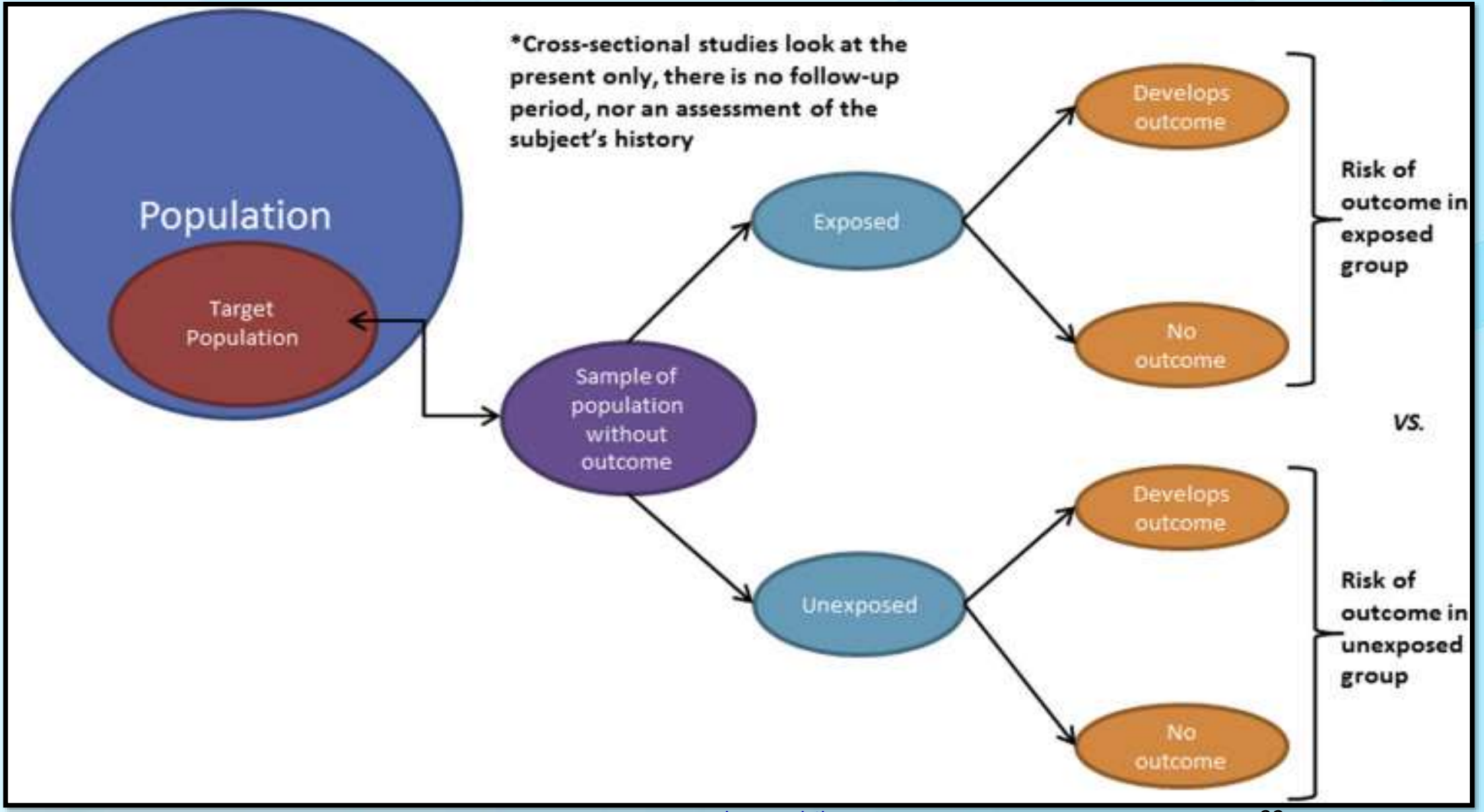
Descriptive epidemiology	Analytic epidemiology
When was the population affected?	How was the population affected?
Where was the population affected?	Why was the population affected?
Who was affected?	

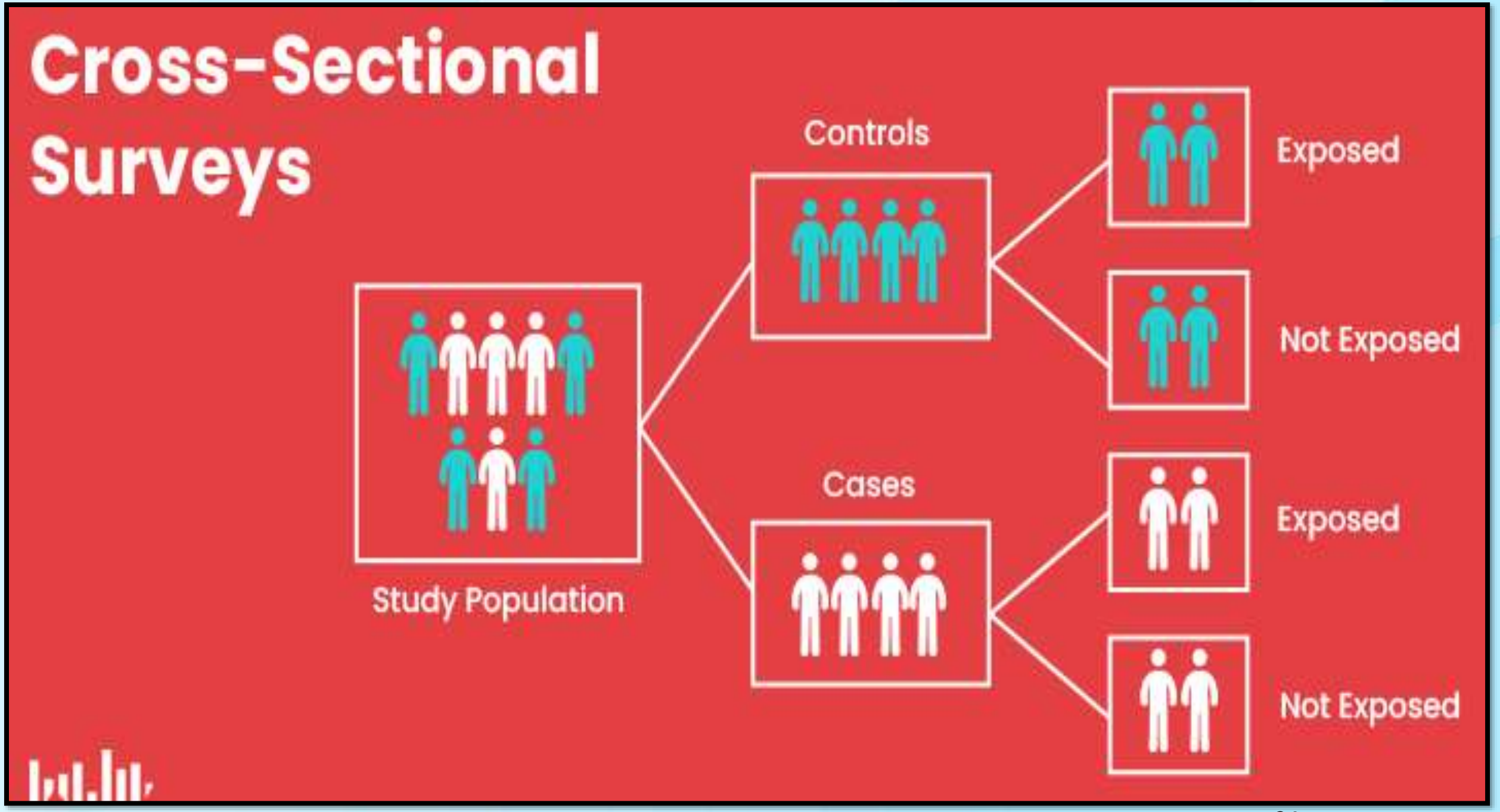
Study Design : Cross-Sectional Study

Subjects are selected because they are members of a certain population subset at a certain time

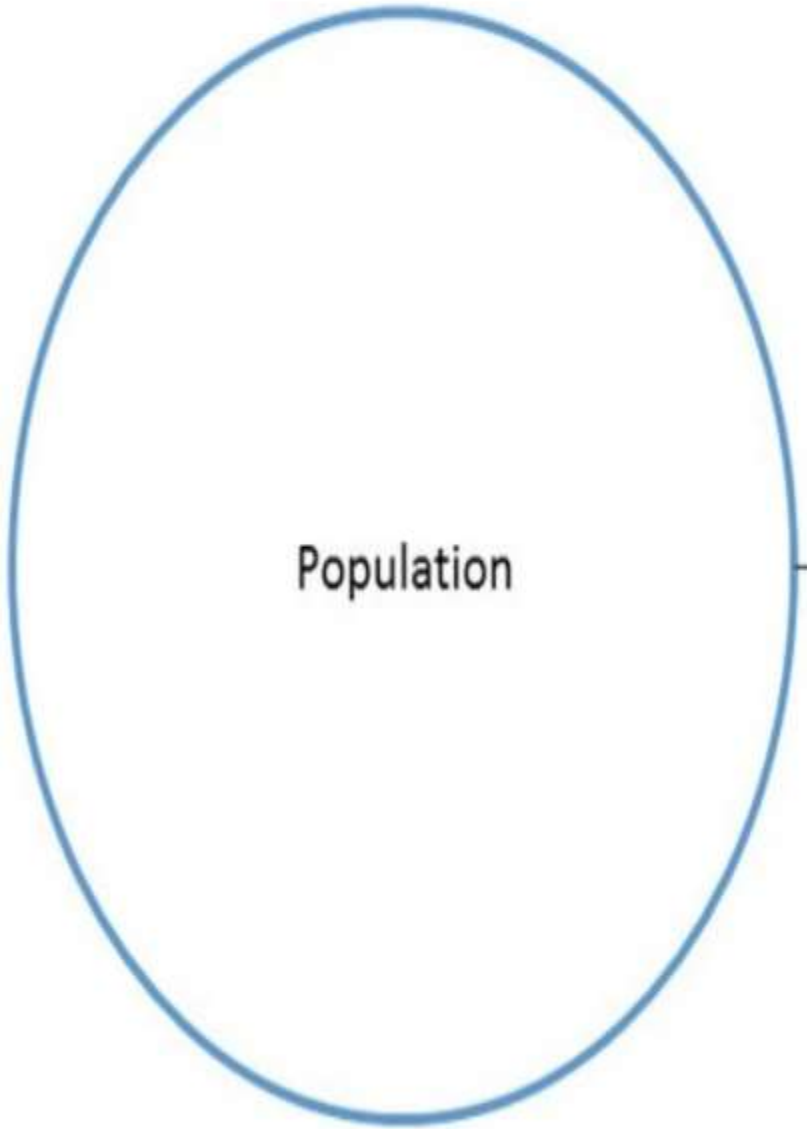
Study Design Type : Case-Control Study

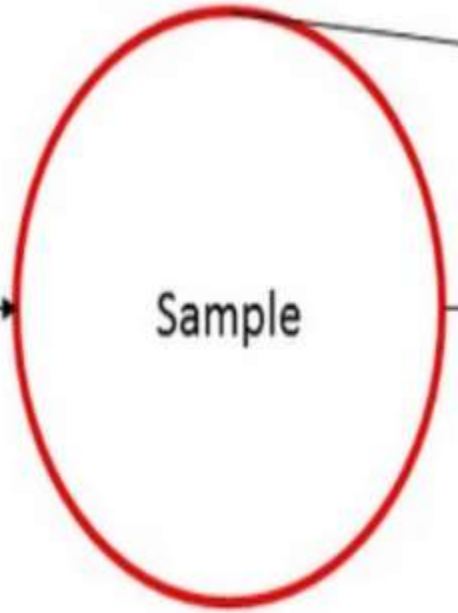
Subjects identified as having a disease or condition are compared with subjects without the same disease or condition.


*Cross-sectional studies look at the present only, there is no follow-up period, nor an assessment of the subject's history
Population
Target Population
Sample of population without outcome
Exposed
Unexposed
Develops outcome
No outcome
Develops outcome
No outcome
Risk of outcome in exposed group
VS.
Risk of outcome in unexposed group


Cross-Sectional Surveys
Controls
Exposed
Not Exposed
Cases
Exposed
Not Exposed
Study Population

$$\text{Odds} = \frac{\text{Probability of event}}{\text{Probability of non-event}}$$





	Outcome	No outcome
Exposure	A	B
Not exposed	C	D

Odds ratio

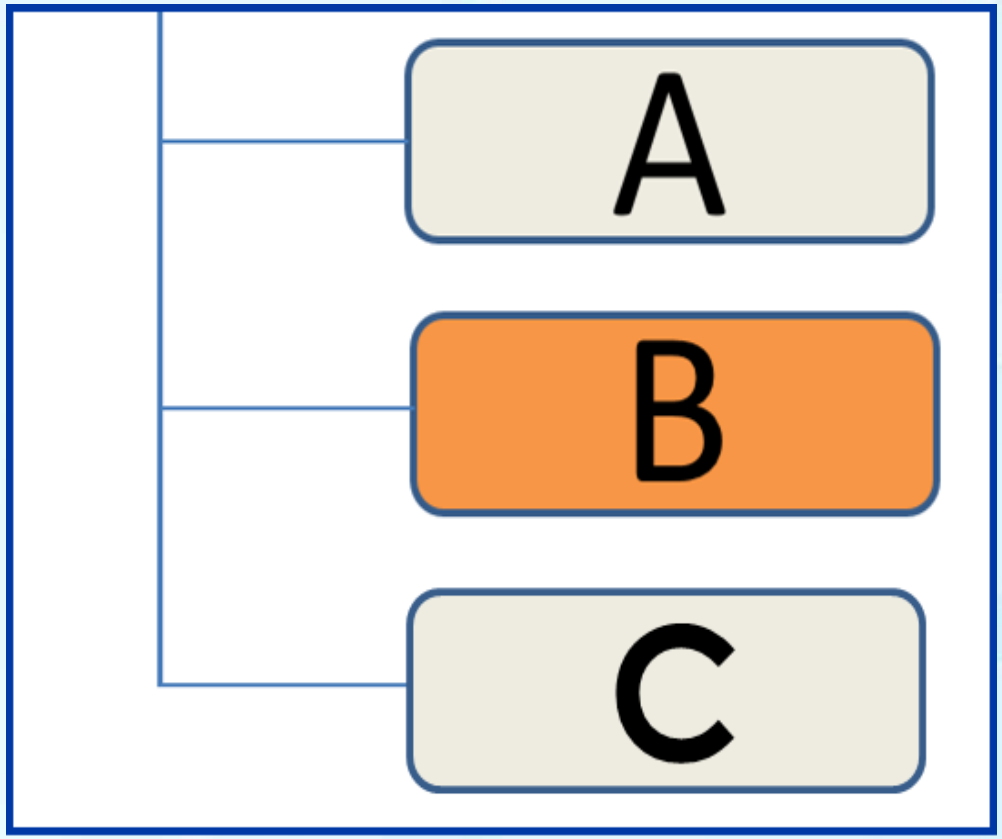
	Disease CASES	No disease CONTROLS
Exposed	a	b
unexposed	c	d

$$\text{Odds of exposure in cases} = \frac{\#\text{ cases with exposure}}{\#\text{ cases without exposure}} = \frac{a}{c}$$

$$\text{Odds of exposure in controls} = \frac{\#\text{ controls with exposure}}{\#\text{ controls without exposure}} = \frac{b}{d}$$

$$\frac{\text{Odds of exposure in cases}}{\text{odds of exposure in controls}} = \frac{a/c}{b/d} = \frac{ad}{bc} = OR$$

Study Design : Cohort Study



Subjects are categorized on the basis of their exposure to one or more risk factors.

Framework of cohort study

What is Relative Risk?

- **Relative Risk (RR):** A ratio of the probability of the event (outcome variable) occurring in the exposed (risk factor) group to the probability of the outcome occurring in a non-exposed (no risk factor) group.

$$RR = \frac{\text{incidence rate in exposed group}}{\text{incidence rate in unexposed group}}$$

$$RR = \frac{\left(\frac{a}{a+b}\right)}{\left(\frac{c}{c+d}\right)}$$

	EXPOSED	NON EXPOSED	TOTAL
DISEASE	40 (A)	20 (B)	60
NO DISEASE	30 (C)	40 (D)	70
TOTAL	70	60	

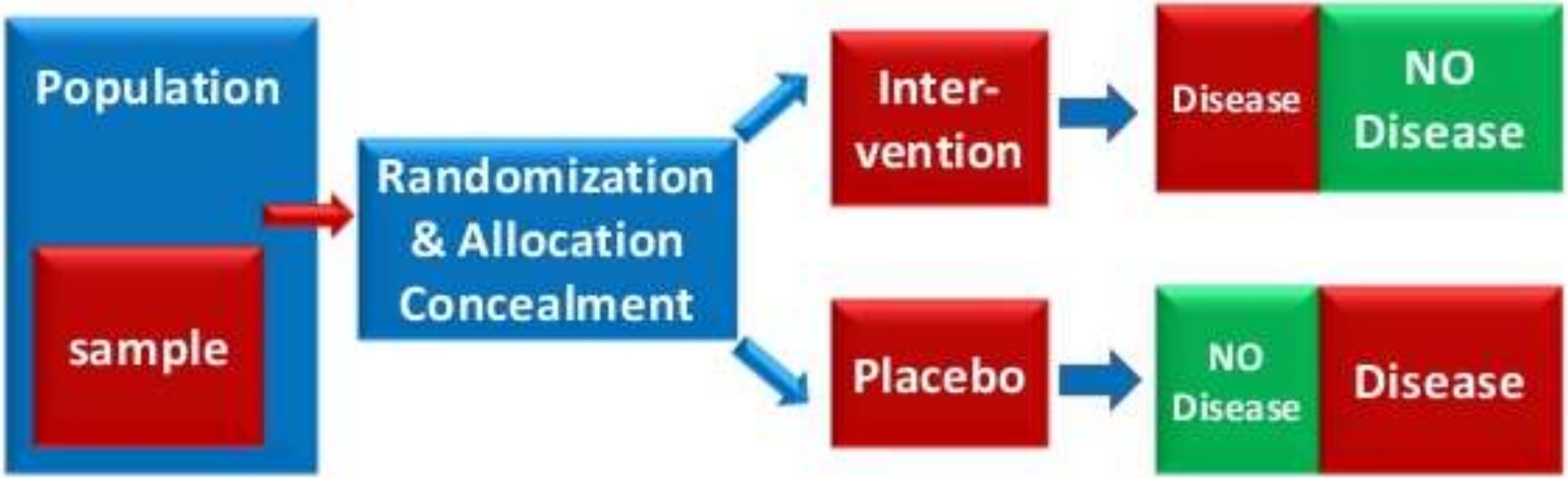
Relative Risk = (A/A+C)/(B/B+D)

Odds Ratio = (A/B)/(C/D) or AD/BC

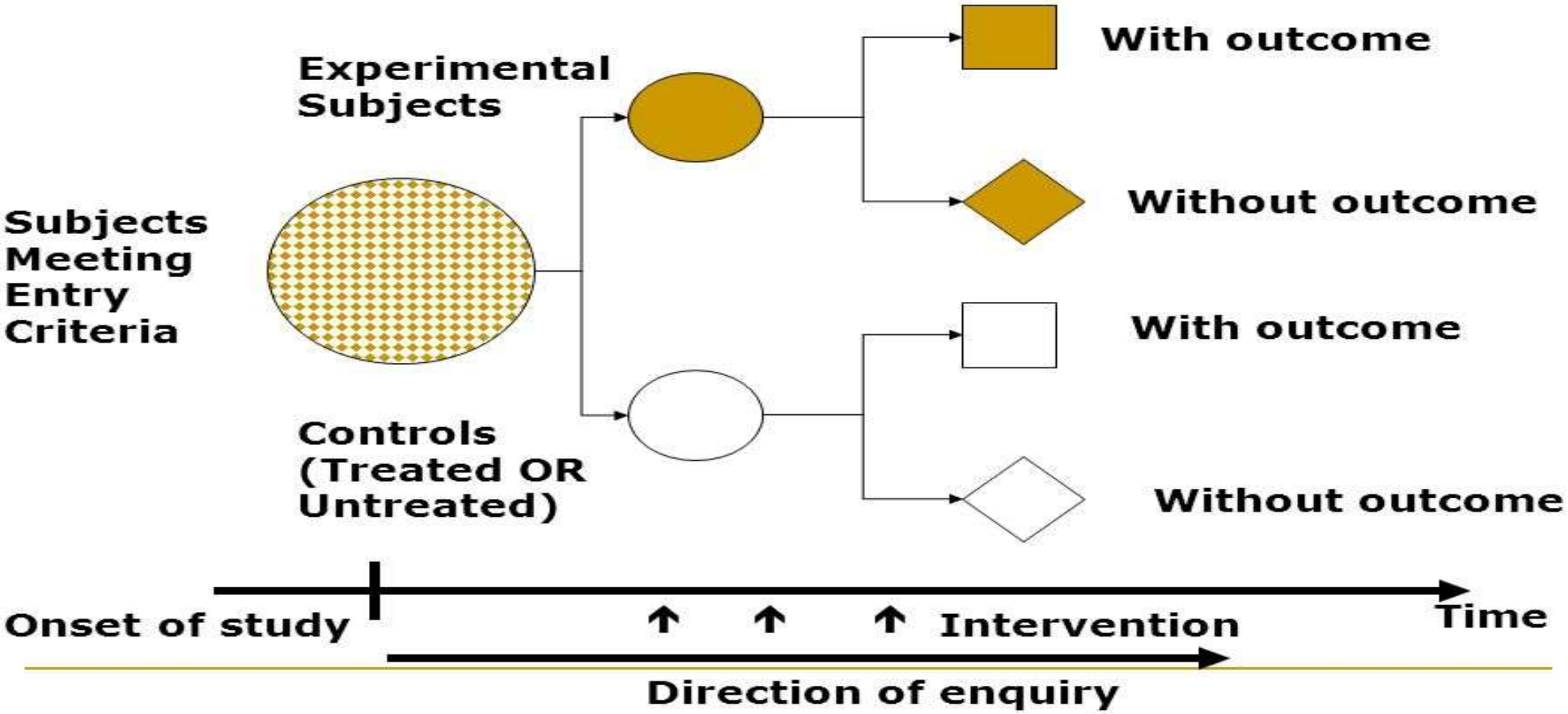
The Framingham Heart Study

- **The Framingham Heart Study** is a long-term, ongoing cardiovascular study on residents of the town of Framingham, Massachusetts.
- The study began in **1948** with 5,209 adult subjects from Framingham, and is now on its 3rd generation of participants.
- Prior to it almost nothing was known about the «**Epidemiology** of hypertensive or arteriosclerotic cardiovascular disease."
- Much of the now-common knowledge concerning heart disease, such as the effects of diet, exercise, and common medications such as aspirin, is based on this ***longitudinal study***.
- It is a project of the **National Heart, Lung, and Blood Institute**, in collaboration with *(since 1971)* Boston University.
- Various health professionals from the hospitals and universities of Greater Boston staff the project.

RCT Study Design

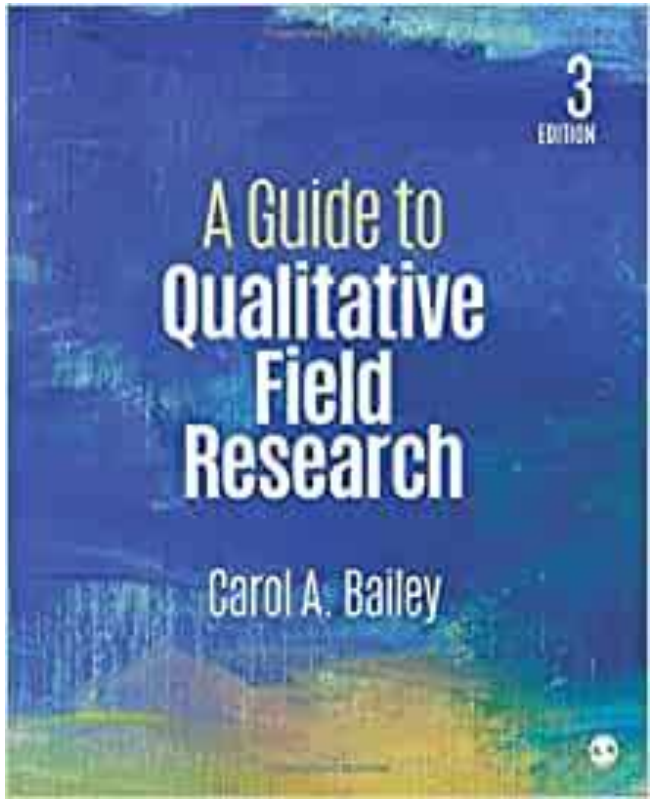


Randomised Controlled Clinical Trial



Qualitative Field Research-1

- **Definition :**
  - A disciplined inquiry examining the personal meanings of individuals' experiences and actions in the context of their social environment.
  - **Qualitative field research** involves data collection aimed at understanding persons in their own environments. Rather than generating numerical data supporting or refusing clear cut hypotheses; qualitative field research aims to produce accurate descriptions based on ***face - to - face knowledge of individuals and social groups in their natural settings, habitats, worksites, farms, schools, barrack..***

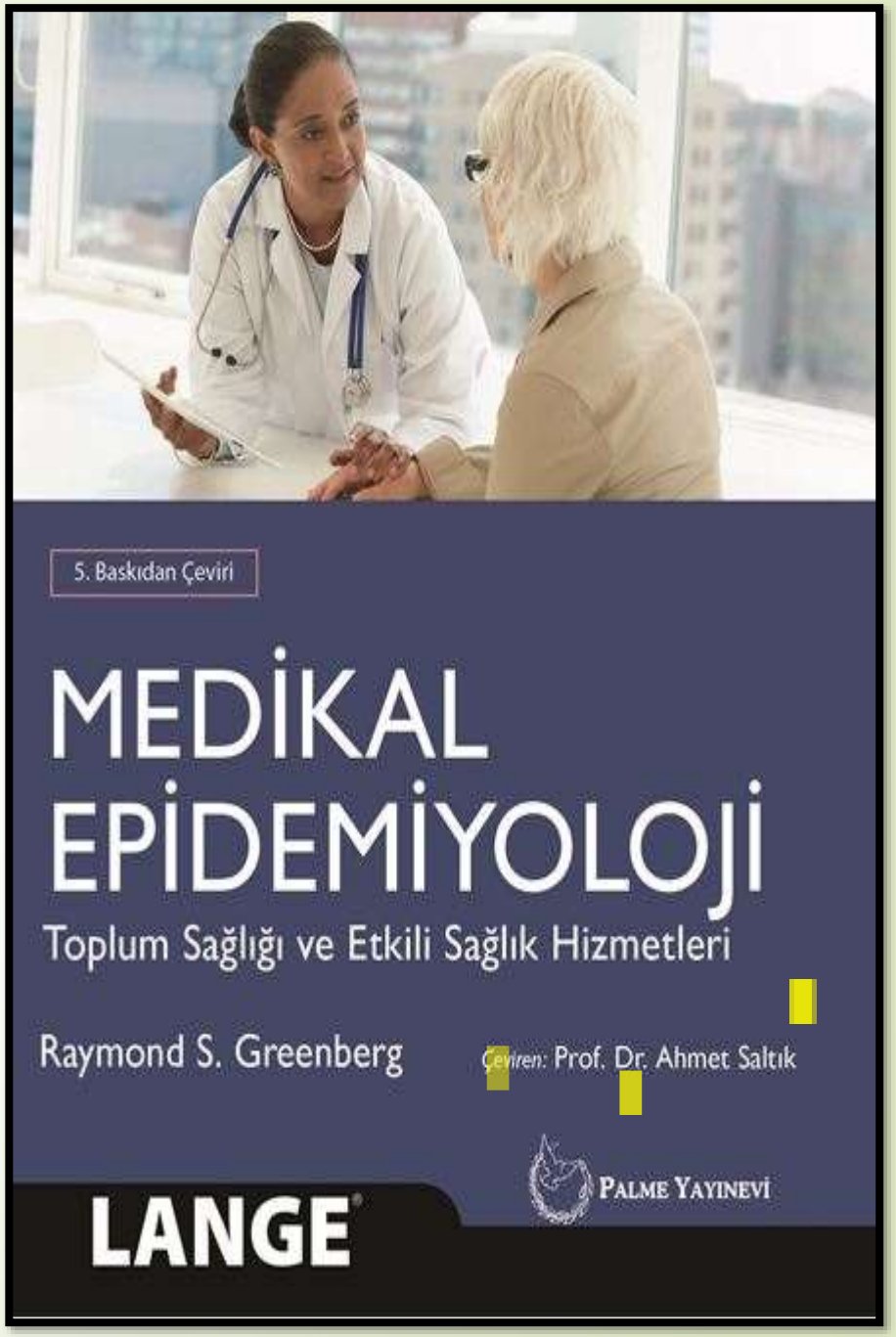


Qualitative Field Research-2

- ***Qualitative;*** because of the nature of the data collected, detailed descriptions recorded by the investigator.
- ***Field research;*** because the investigation is carried out in the usual environment where the phenomenon occurs.
- ***Disciplined;*** because the inquiry is guided by **methodological principles** for *problem definition, data collection and Epidemiological analysis, and* **theory formulation** *to understand the life.*

Summary

Epidemiology is the study *(scientific, systematic, data-driven)* of the distribution *(frequency, pattern)* and determinants *(causes, risk factors)* of health-related states and events *(not just diseases)* in specified populations *(patient is community, individuals viewed collectively)*, and the application of *(since Epidemiology is a discipline within public health)* this study to the control of health problems.

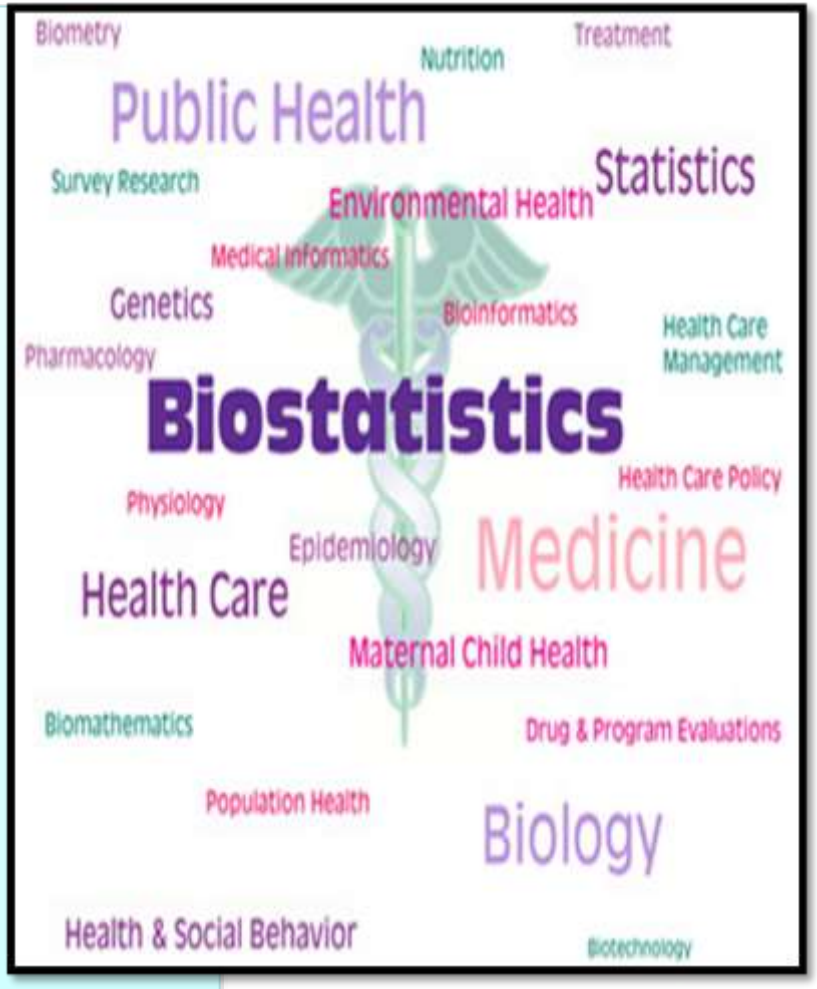


During this course, you've learned to

- define Epidemiology and key concepts
- describe basic terminology and concepts of Epidemiology
- identify types of data sources
- identify basic methods of data collection and interpretation
- describe a public health problem in terms of time, place, and person
- identify the types of Epidemiologic research; Odd's ratio, relative risk, confidence interval..

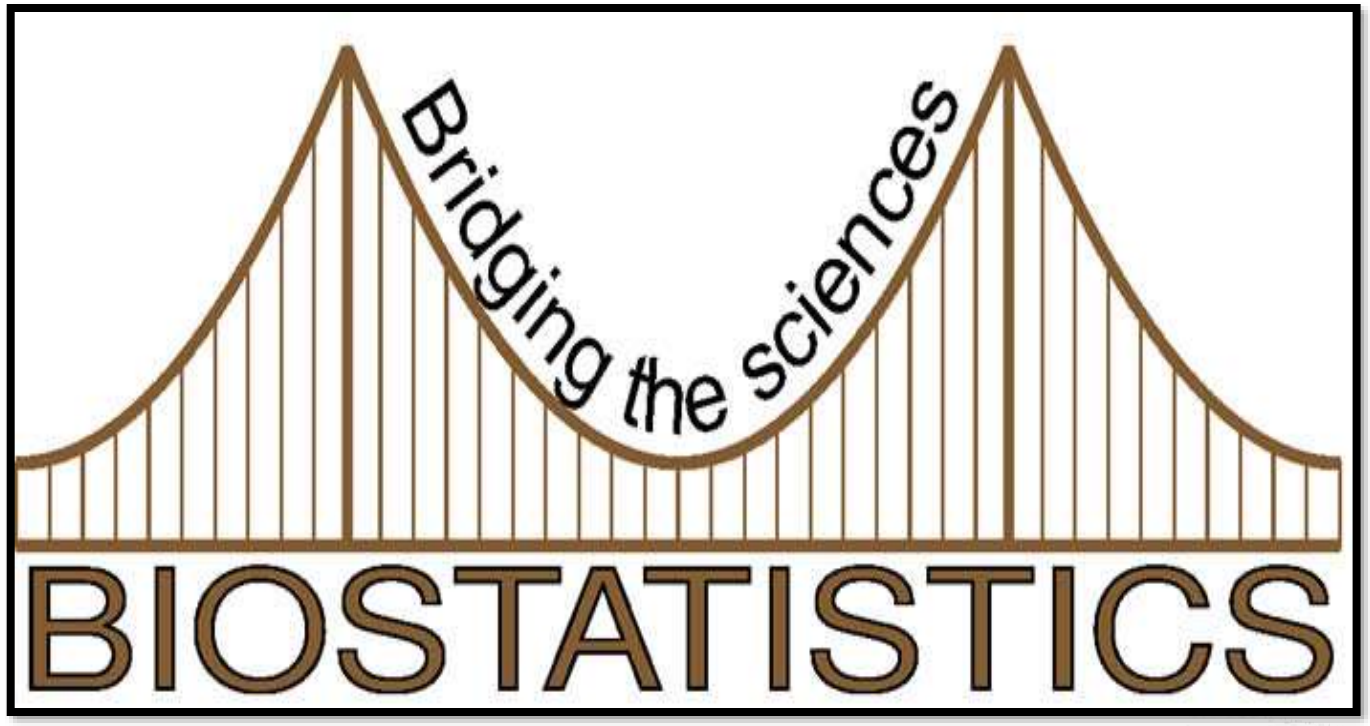
The Mysterious of the numbers…

- 1 x 8 + 1 = 9
  12 x 8 + 2 = 98
  123 x 8 + 3 = 987
  1234 x 8 + 4 = 9876
  12345 x 8 + 5 = 98765
  123456 x 8 + 6 = 987654
  1234567 x 8 + 7 = 9876543
  12345678 x 8 + 8 = 98765432
  123456789 x 8 + 9 = 987654321



In Santiago, Chile, Alejandra Landabur enters information from death certificates into a database. She records 100 forms daily.

PHOTO: WHO/ALIOSHA MARQUEZ



Thanks for cooperation..