



Epidemiology – Basic Principles

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Epidemiology – definition

Epidemiology defined: 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 (*John Last, 1988*).



TABLE 1—Three Eras in the Evolution of Modern Epidemiology

Era	Paradigm	Analytic Approach	Preventive Approach
Sanitary statistics (first half of 19th century)	Miasma: poisoning by foul emanations from soil, air, and water	Demonstrate clustering of morbidity and mortality	Drainage, sewage, sanitation
Infectious disease epidemiology (late 19th century through first half of 20th century)	Germ theory: single agents relate one to one to specific diseases	Laboratory isolation and culture from disease sites, experimental transmission, and reproduction of lesions	Interrupt transmission (vaccines, isolation of the affected through quarantine and fever hospitals, and ultimately antibiotics)
Chronic disease epidemiology (latter half of 20th century)	Black box: exposure related to outcome without necessity for intervening factors or pathogenesis	Risk ratio of exposure to outcome at individual level in populations	Control risk factors by modifying lifestyle (diet, exercise, etc.) or agent (guns, food, etc.) or environment (pollution, passive smoking, etc.)



Historical background

Hippocrates (Kos, 460 BC – Larissa, 377 BC)

“... ancient Greek physician who lived during Greece’s Classical period and is traditionally regarded as the Father of modern Medicine ...”



The monument of Hippocrates in Larissa, Greece

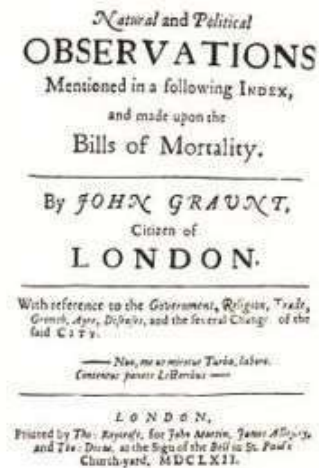


Hippocrates' views on the causes of diseases.



John Graunt (1620-1674)

"... was one of the first demographers, and perhaps the first epidemiologist, though by profession he was a haberdasher ..."



James Lind (1716-1794)

"... By conducting one of the first ever clinical trials, he developed the theory that citrus fruits cured scurvy ..."



William Farr (1807-1883)

“... was a British epidemiologist, regarded as one of the founders of medical statistics ...”



John Snow (1813-1858)

“... was an English physician and a leader in the development of anaesthesia and medical hygiene ...”



He is considered one of the founders of modern epidemiology.

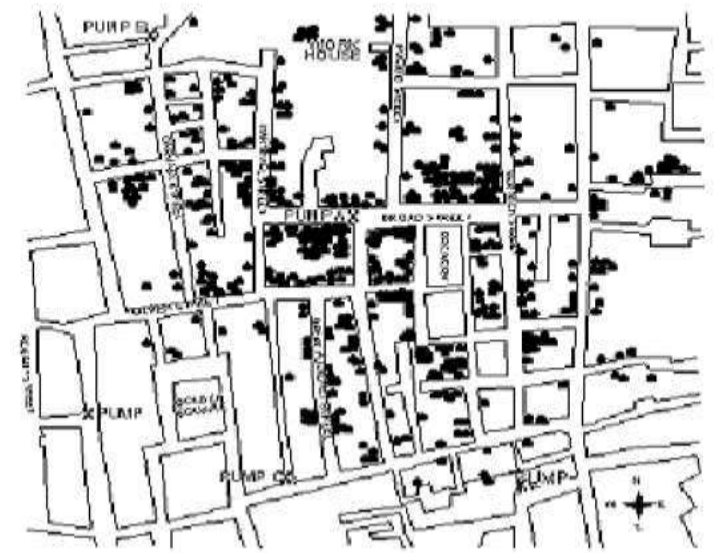


John Snow - Cholera outbreak in Soho, London (1854)

At the time, it was assumed that cholera was airborne. However, Snow did not accept this 'miasma' (bad air) theory, arguing that in fact entered the body through the mouth. He published his ideas in an essay 'On the Mode of Communication of Cholera' in 1849. A few years later, Snow was able to prove his theory in dramatic circumstances. In August 1854, a cholera outbreak occurred in Soho. After careful investigation, including plotting cases of cholera on a map of the area, Snow was able to identify a water pump in Broad (now Broadwick) Street as the source of the disease. He had the handle of the pump removed, and cases of cholera immediately began to diminish. However, Snow's 'germ' theory of disease was not widely accepted until the 1860s.

(http://www.bbc.co.uk/history/historic_figures/snow_john.shtml)

Figure 1.1
Distribution of cholera cases in the Golden Square area
of London, August-September 1854



Epidemiology – key words

Epidemiology is the research discipline concerned with the distribution and determinants of disease in population.

- Distribution of disease
- Determinants of disease
- Population

} *key words*



Health Outcomes

Health Outcomes (The Five D's)

Death	A universal health outcome, the timeliness of the event being the issue.
Disease	A combination of symptoms, physical signs, and laboratory test results.
Disability	The functional status of patients in terms of ability to live independently and go about their daily lives at home, work, or recreation.
Discomfort	Uncomfortable symptoms, such as pain, nausea, vertigo, tinnitus, or fatigue.
Dissatisfaction	Emotional and mental states, such as agitation, sadness, or anger.

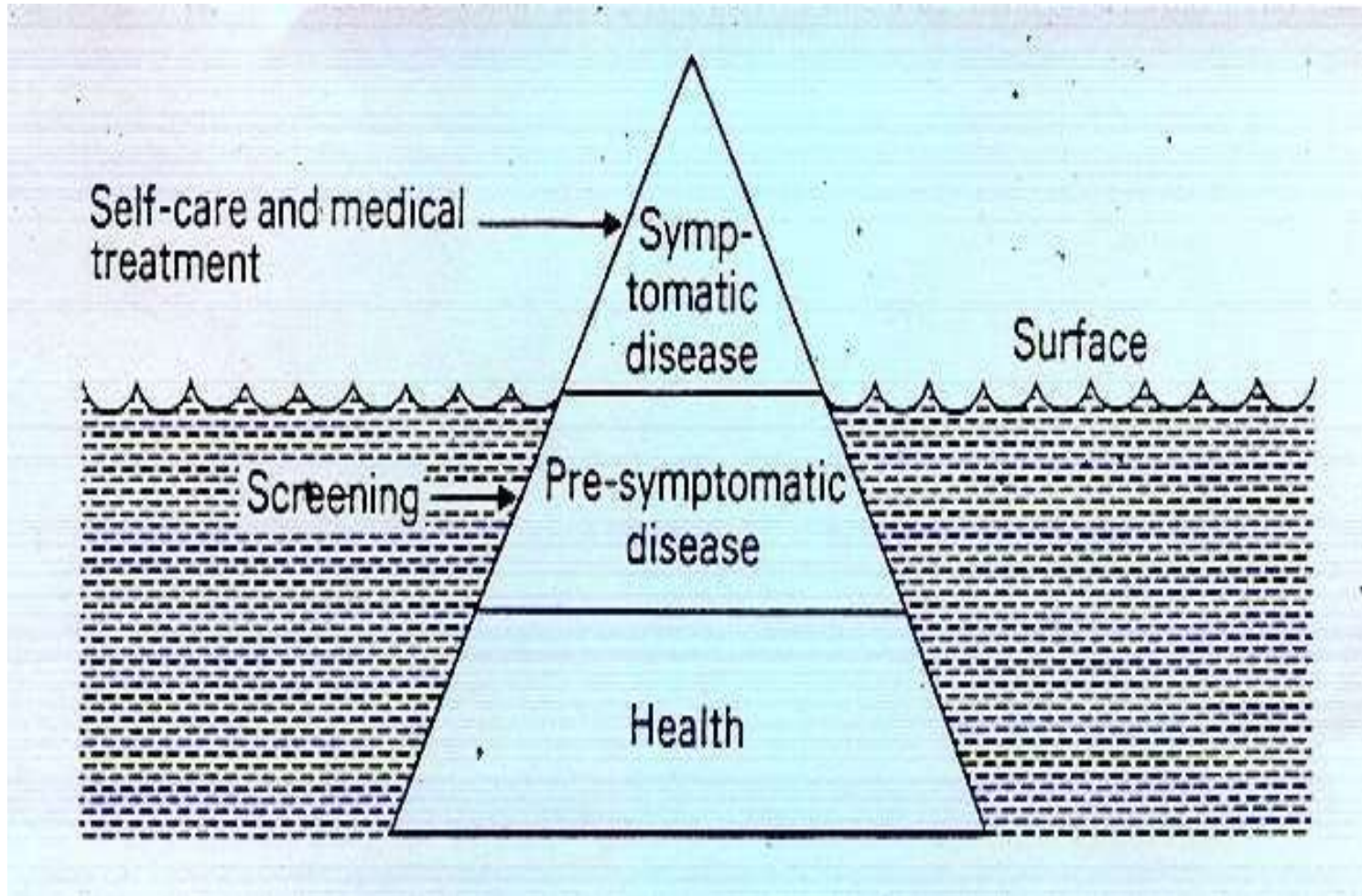


Health Disorders

<i>"Morbus"</i>	<i>"Vitium"</i>
Disease	Impairment
Illness	Disability, Incapacity
Sickness	Handicap



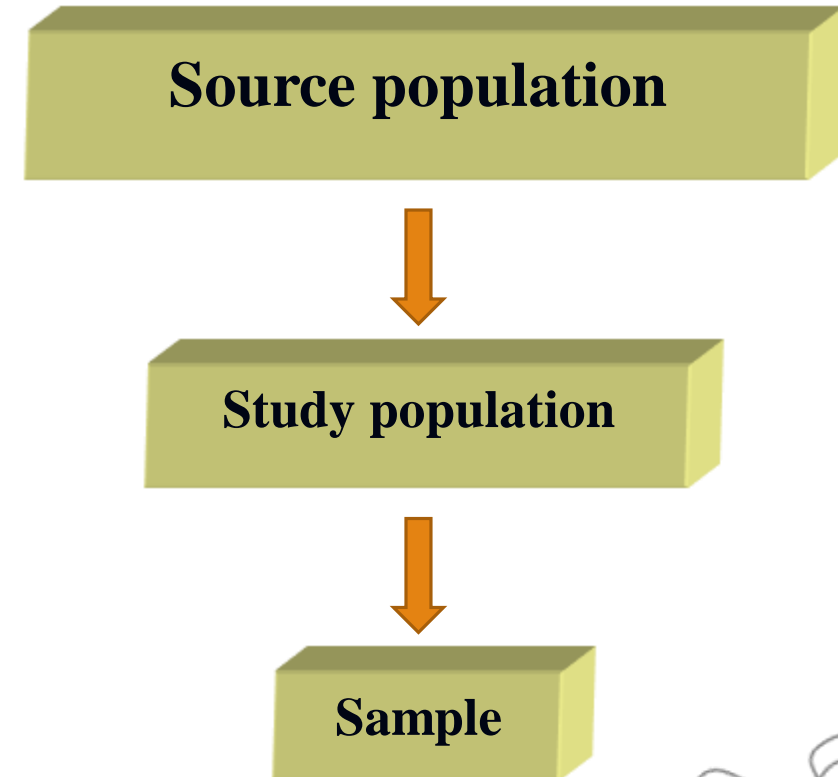
The iceberg of Disease



Population

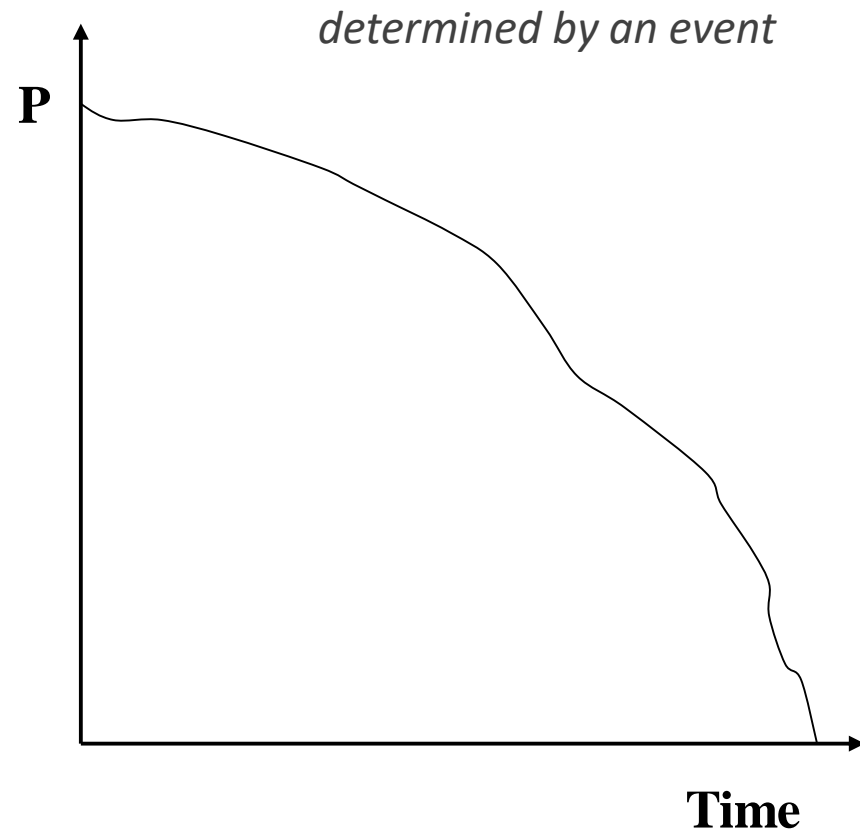
In general, population are large groups of people in a defined setting.

These include relatively unselected people in the community, the usual population for epidemiologic studies of cause; and groups of people selected because of their attendance in a clinic or hospital or because of a characteristic as age, race, or the presence of disease.

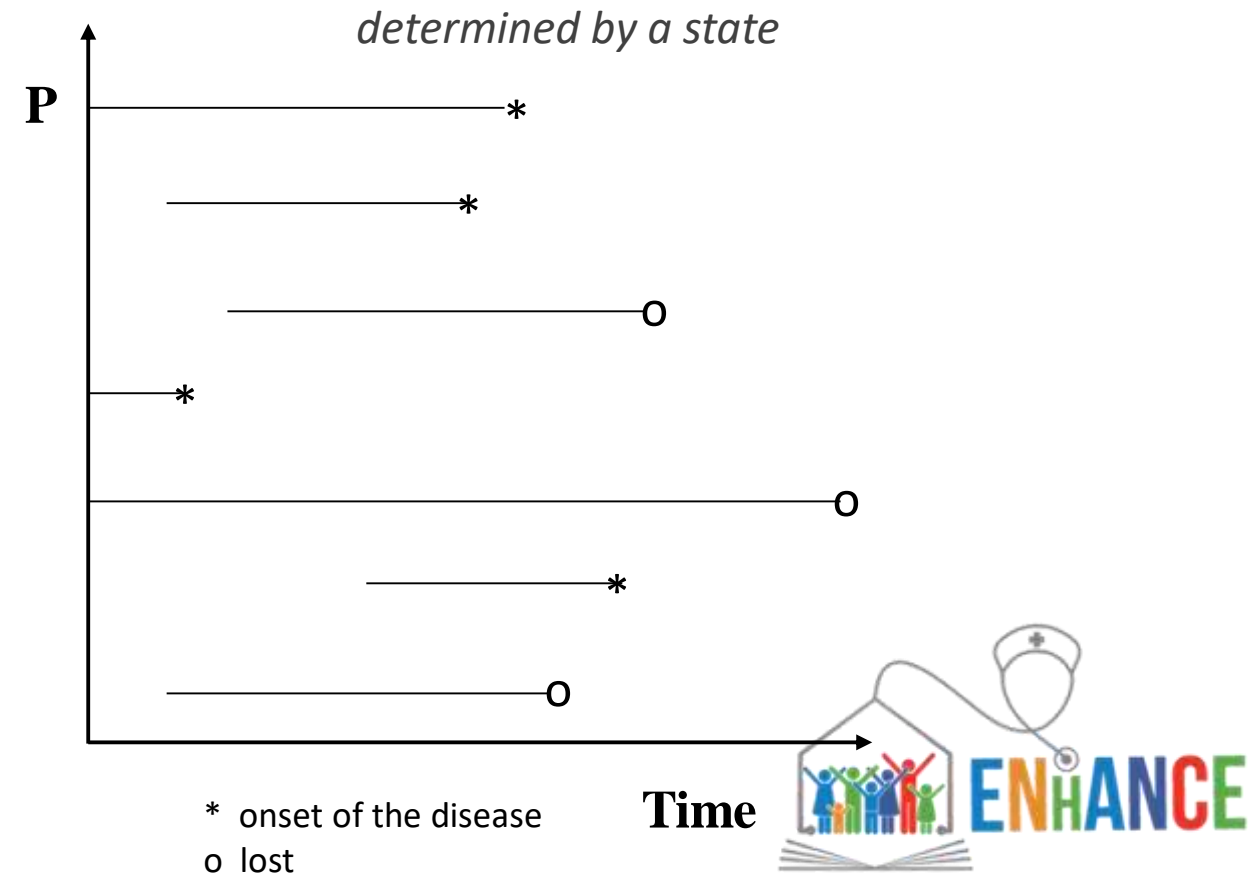


Population

Closed population or Cohort



Open population or Dynamic



Measures of Disease Frequency

1. Incidence or Incidence Rate or Incidence Density
 2. Cumulative Incidence or Incidence Proportion
 3. Prevalence
- Incidence



Incidence (I)

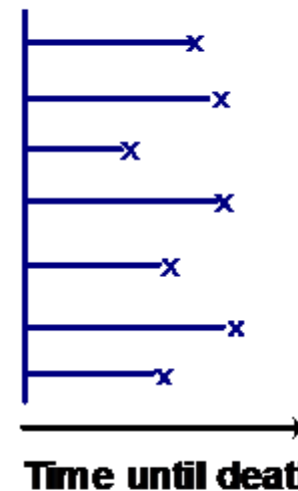
An *Incidence* is the fraction or proportion of a group initially free of the condition that develops it over a given period of time.

Incidence is measured by identifying a susceptible group of people (i.e. people free of the disease or the outcome) and examining them periodically over an interval of time so as to discover and count new cases that develop during the interval.

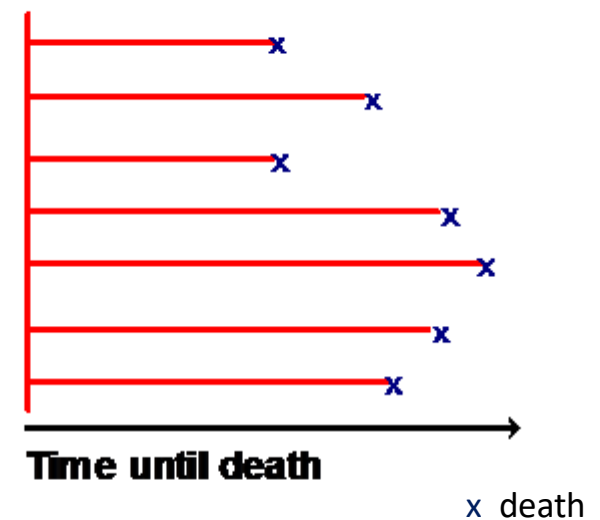
Incidence is measured by first identifying a population free of the event of interest and then following them through time periodic examinations to determine occurrences of the event.

- ✓ *Incidence Density*
- ✓ *Incidence Proportion*

Population A



Population B



**Time differentiates the 2 situations
Incidence time**

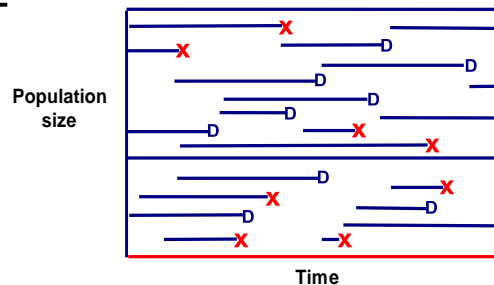


Incidence Density (ID)

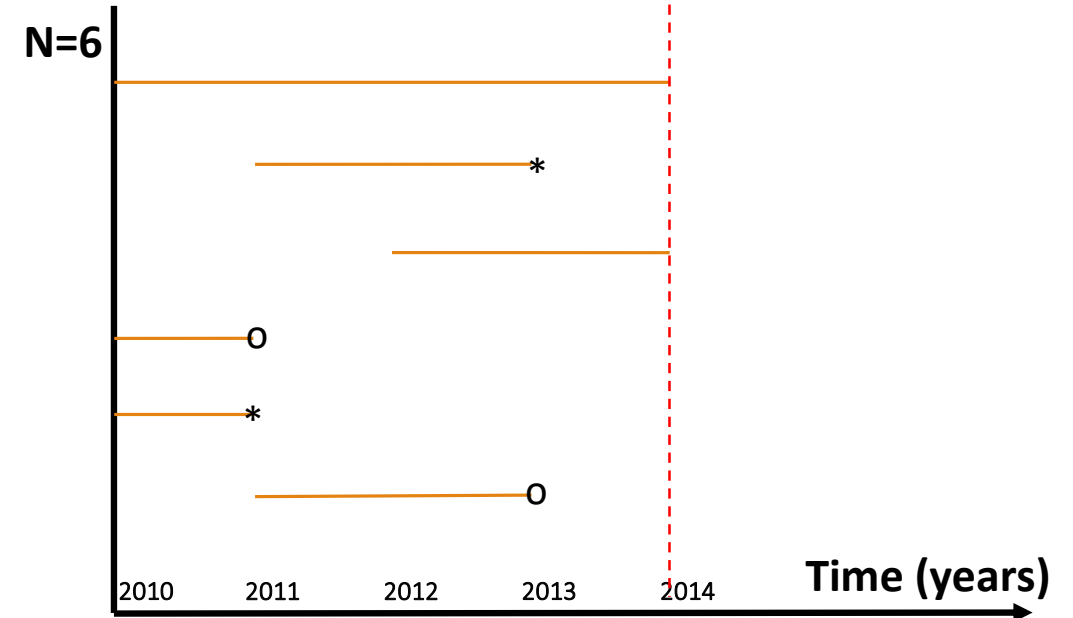
A first approach to *Incidence* is to measure the number of new cases emerging in an ever-changing population, where people are under study and susceptible for varying lengths of time.

An *Incidence* of this type is expressed as the number of new cases per total number of person-years at risk and is called an *Incidence Density*.

$$ID = \frac{\text{No. disease onsets}}{\sum \text{time spent in population persons}}$$



Density of presence



$$ID = 2/12 = 0.17 \text{ years}^{-1}$$

* onset of the disease
o lost

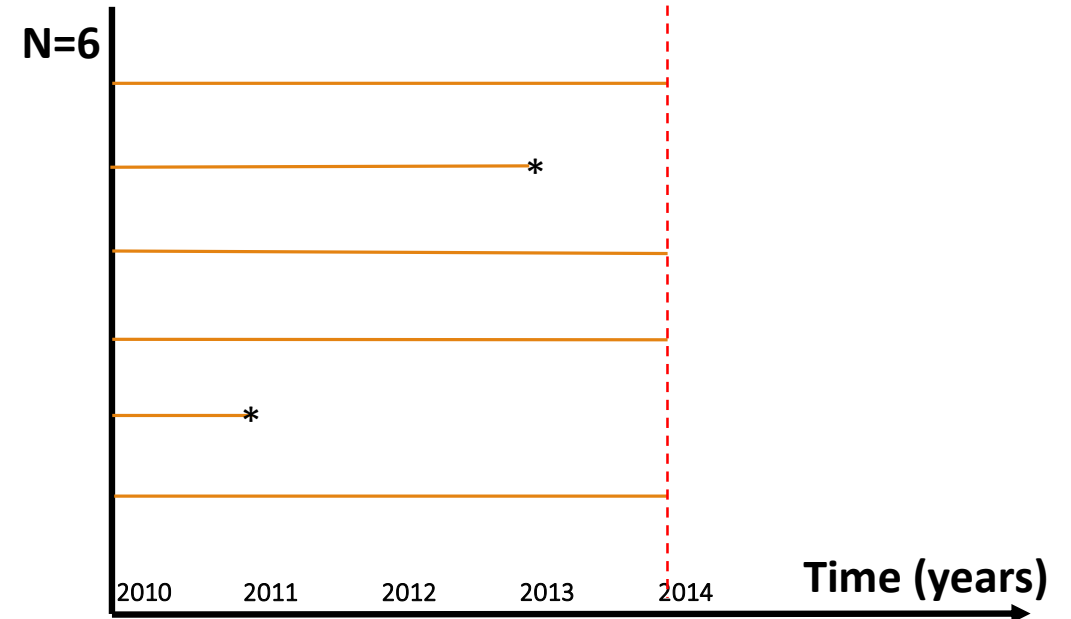


Incidence Proportion (IP)

When considering a given interval of time, we can also express the increase in incident number per unit increase in population size.

If we measure size at the start of the interval and no one enters the population (immigrates) or leaves alive (emigrates) after the start of the interval, such a rate becomes the proportion of people who become cases among those who entered the interval.

We call this quantity the *Incidence Proportion*, which may also be defined as the proportion of a closed population at risk that becomes diseased within a given period of time.



$$IP = 2/6 = 0.33 = 33\% \text{ in 4 years}$$

* onset of the disease



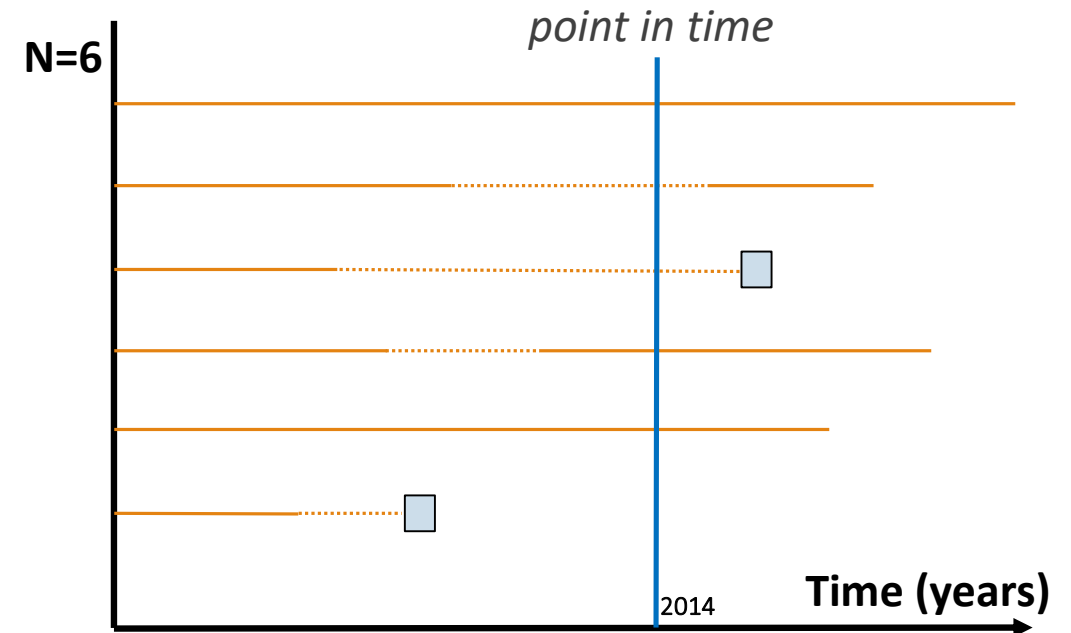
Prevalence (P)

A *Prevalence* is the fraction (proportion) of a group possessing a clinical condition at a given point in time.

Prevalence is measured by surveying a defined population containing people with and without the condition of interest, at a single point in time.

The *Prevalence* of disease is measured by surveying a group of people, some of whom are diseased at that point in time while others are healthy.

The proportion of the group who are diseased constitutes the *Prevalence* of the disease.



$$P = 2/5 = 0.40 = 40\%$$

— nondiseased

... diseased

■ death



Characteristics of Incidence and Prevalence

	Incidence	Prevalence
Numerator	New cases occurring during a period of time among a group initially free of disease	All cases counted on a single survey or examination of a group
Denominator	All susceptible people present at the beginning of the period	All people examined, including cases and noncases
Time	Duration of the period	Single point
How measured	Cohort study	Cross-sectional study

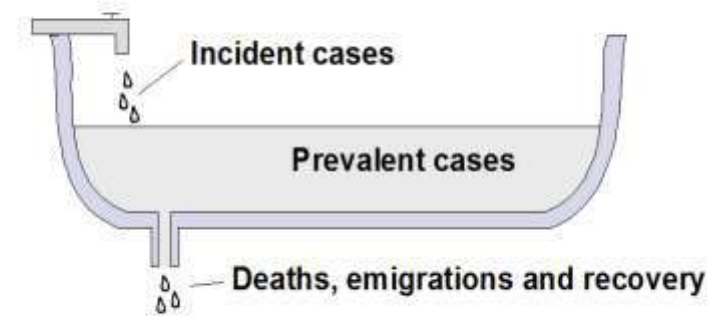


Relationship among Incidence, Prevalence and Duration of Disease

$$\text{Prevalence} \approx \text{Incidence} \times \text{Mean Duration of the Disease}$$

Prerequisite:

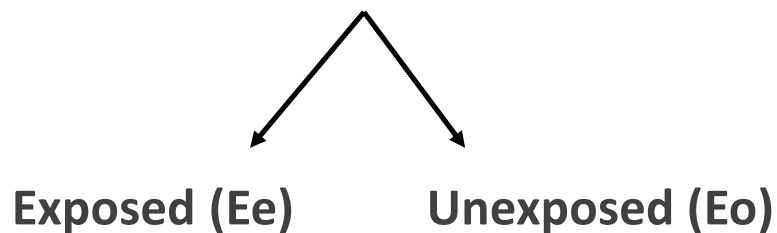
The population is steady-state and the incidence and mean duration of the disease remain approximately or exactly constant.



Determinant / Risk Factor

Characteristic that is associated with an increased risk of becoming diseased.

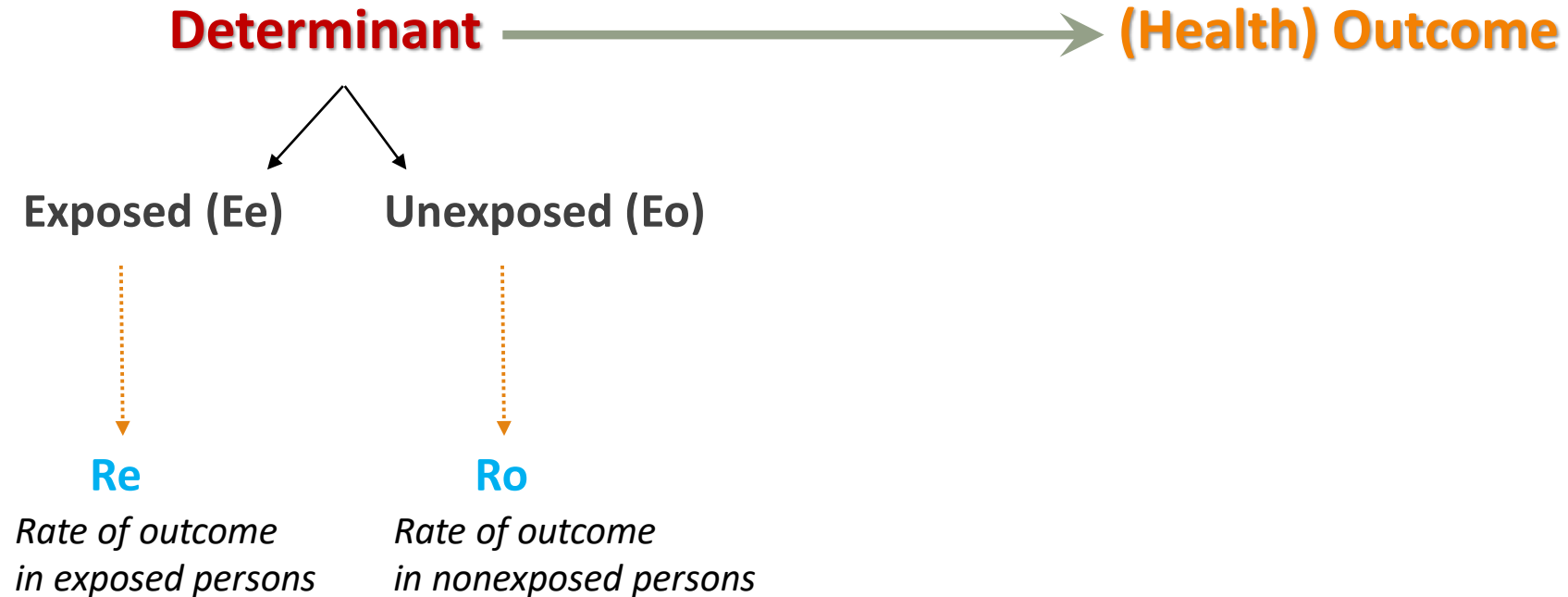
- **Genetic** (e.g. age, gender)
- **Behavioral** (e.g. smoking, drinking)
- **Environmental, physical or social** (e.g. toxins, loss of a spouse)



- DETERMINANT (OF OCCURRENCE)
- EXPOSURE
- INDEPENDENT VARIABLE
- RISK INDICATOR
- STUDY FACTOR
- RISK FACTOR
- CAUSAL RISK INDICATOR
- PUTATIVELY CAUSAL FACTOR
- PREDICTOR FACTOR
- CHARACTERISTIC



Etiological Occurrence Function



Re vs Ro

Measures of
Association

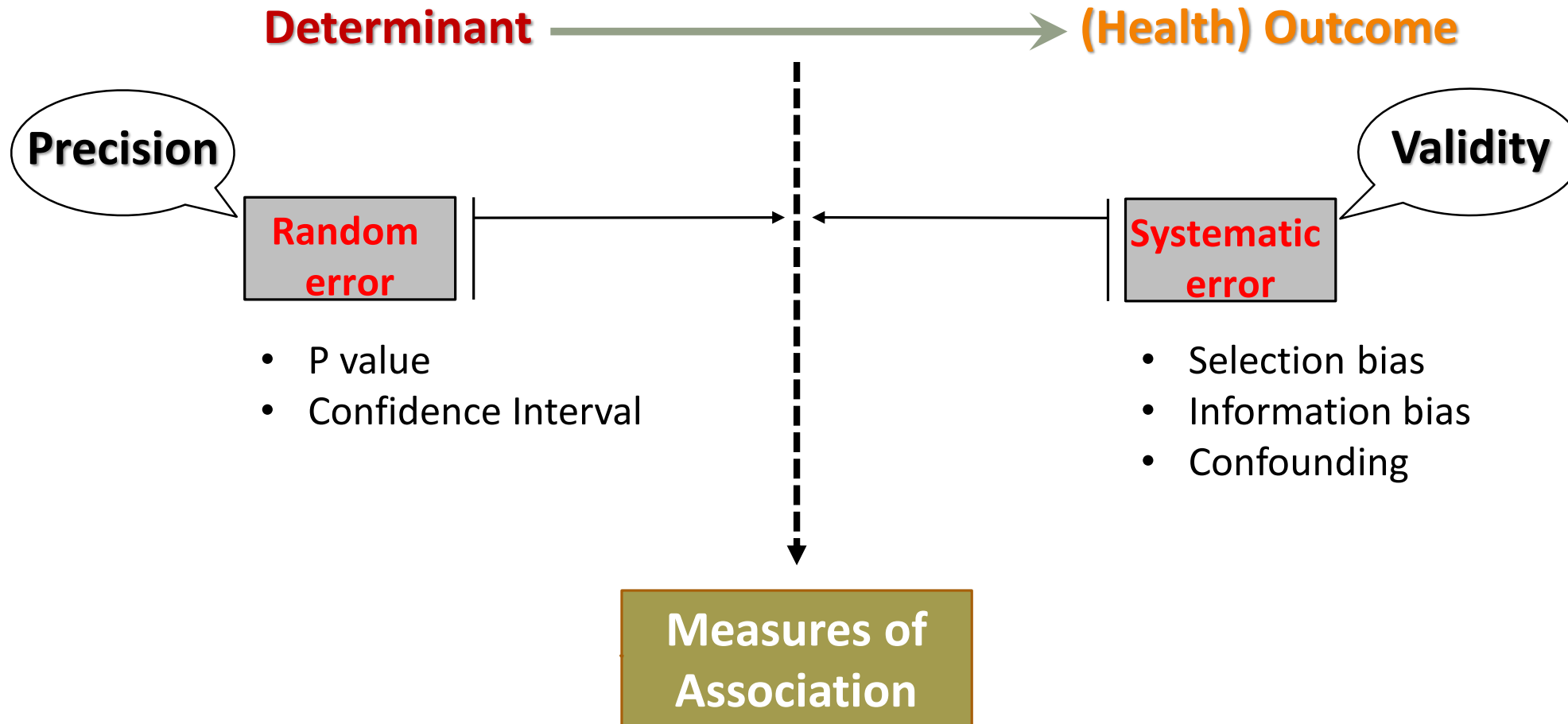


Measures of Association

1. **Relative Risk** [$RR = Re/Ro$]
2. **Attributable Risk** [$AR = Re - Ro$]
3. **Relative Excess Risk** [$RER = (Re - Ro)/Ro = RR - 1$]
4. **Attributable Fraction in exposed or Attributable Proportion or Attributable Risk Percent or Etiologic Fraction** [$AF_e = (Re - Ro)/Re = (RR - 1)/RR$]
5. **Attributable Fraction in population or Population Attributable Risk Percent**
[$AF_p = AF_e \times f$]
6. **Odds Ratio** [$OR = \text{Odds exposure in Cases} / \text{Odds exposure in Controls}$]



Accuracy of Association



Types of Epidemiologic Studies

Research Designs

**Experimental Studies or
Interventional Studies or
Randomized Controlled Trials**

Non-Experimental Studies

**Quasi Experimental Studies or
Non-Randomized Controlled Trials**

**Meta-Experimental Studies or
Observational Studies**



Experimental Studies or Interventional Studies or Randomized Controlled Trials

Randomized Studies of Therapeutic Intervention or Clinical Trials

Randomized Studies of Preventive Intervention

- **Field Trials**
- **Community Intervention Trials**



Meta-Experimental Studies or Observational Studies

Cohort Studies or Follow-up Studies or Prospective Studies

Case-Control Studies or Retrospective Studies

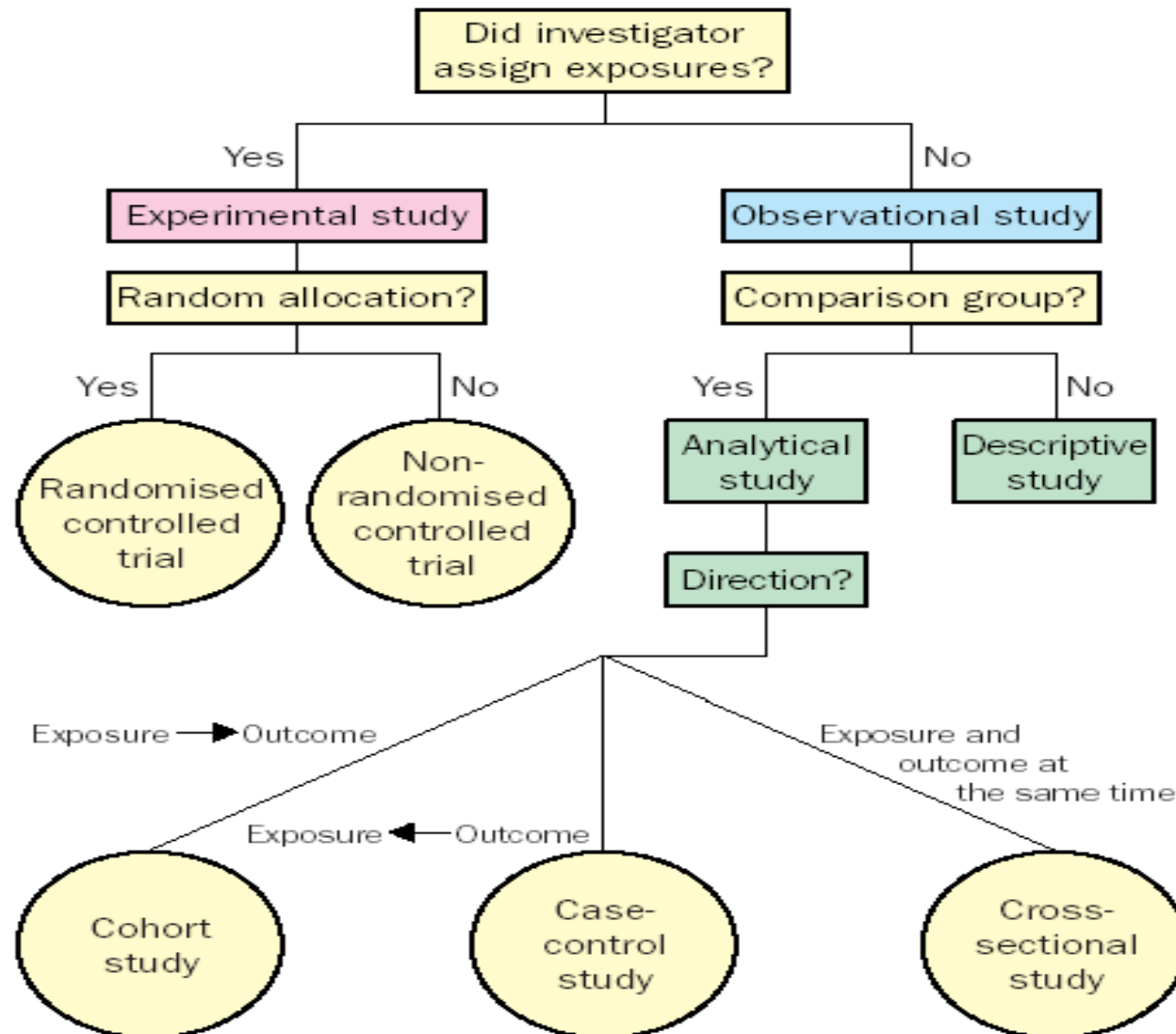
Cross-Sectional Studies and Longitudinal Studies

Ecological Studies

Proportional Mortality Studies



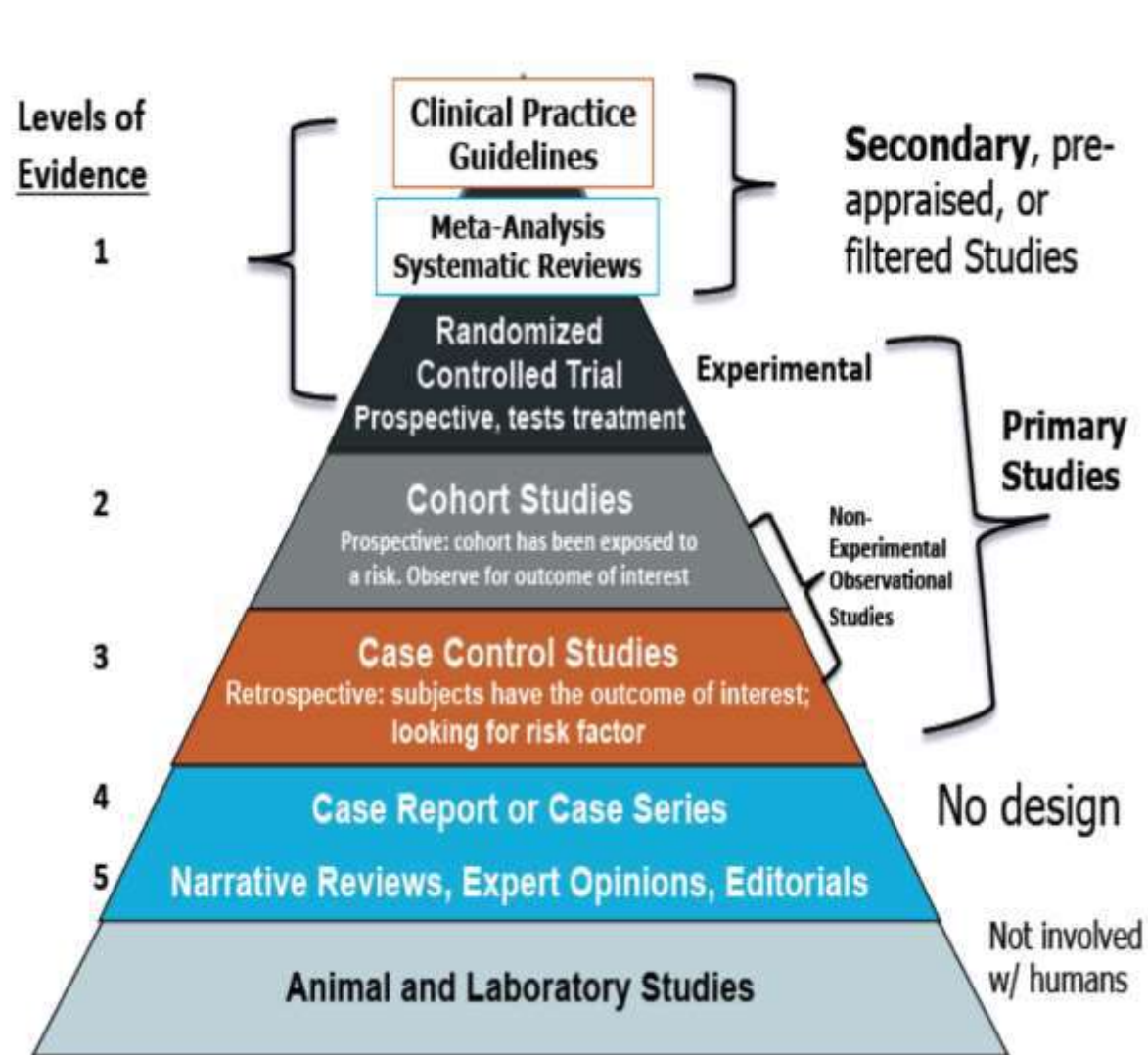
Algorithm for classification of types of clinical research



Source:
THE LANCET 2002, 359(5): 57- 61



Hierarchy of Research Designs



Weight of Evidence

strong



weak



Bibliography

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- ❖ Fletcher R.H., Fletcher S.W., Wagner E.H. (1988): Clinical Epidemiology. The Essentials. Williams and Wilkins, Baltimore.

