Measurements in Epidemiology

Measurement in Epidemiology

1. Measurement of Morbidity
2. Measurement of Mortality
3. Measurement of Disability
4. Measurement of Natality

5. **Measurement of the presence and absence or distribution of the characteristic or attributes of the disease.**
6. **Measurement of medical needs, health care facility, utilization of Health services.**

7.Measurementsof environmental factors on disease causation

8. Measurements of demographic data

Tools of measurement

The basic tools of measurement in epidemiology;

1. Rate

2. Ratio

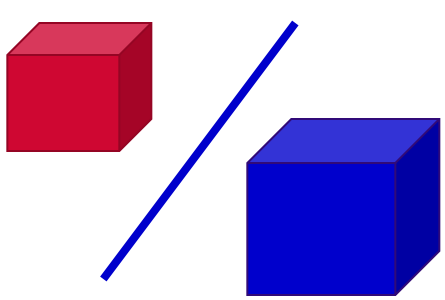
3. Proportion

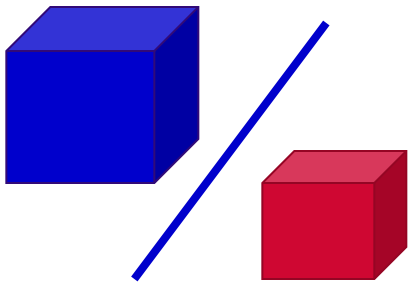
Ratio

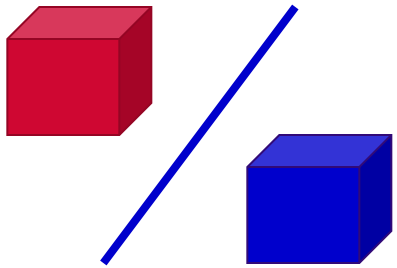
- a numerical expression of a relation in size between 2 random quantities.
- numerator is not a component of denominator.
- Calculated result may be equal to 1 or <1 or >1

Eg. Ratio between x and y ,

Male and female ratio





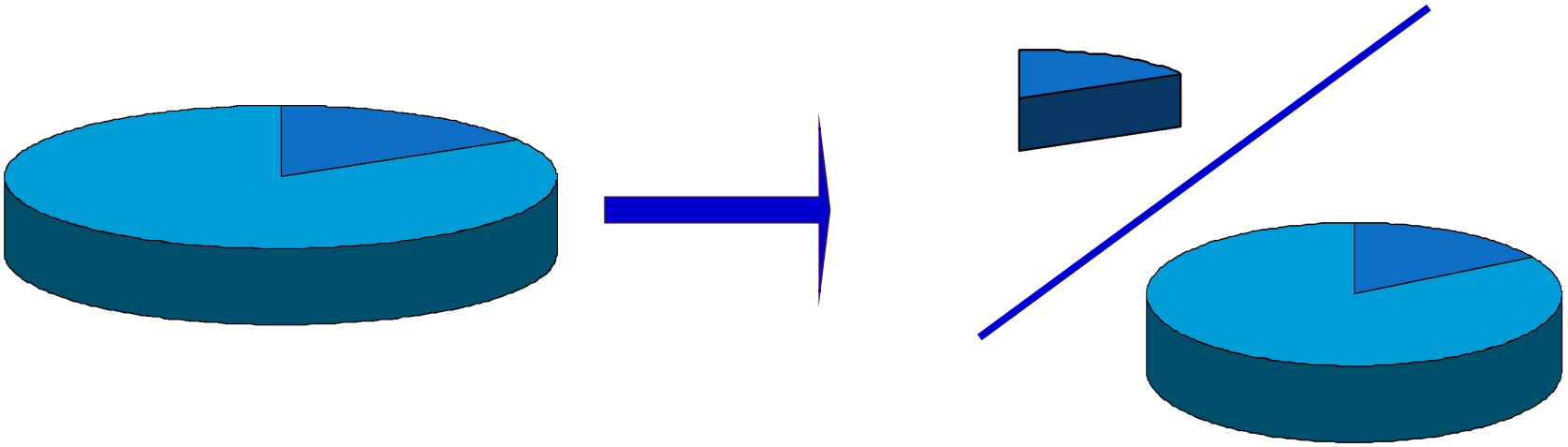


Proportion

- is a special form of ratio
- indicate the relation in magnitude of a part as a whole
- numerator is always part of denominator.
- Can never take values <0 or >1

Proportion of children with scabies

$$= \frac{\text{no. of children with scabies at a certain time}}{\text{total no.of children in village at the same time}} \times 100$$



- **Both ratio and proportion are dimentionless.**
- **They have no unit of measurement.**
- **The units of both numerator and denominator are canceled out.**

Rate

- measure occurrence of some particular event
- (development of disease or occurrence of death)
- in a population during a given time period
- Rate is the risk of developing the condition.

$$\text{Death rate} = \frac{\text{no. of death in one year}}{\text{mid-year population}} \times 1000$$

- usually expressed per1,000 or 10,000 or 100,0000 to avoid fraction

Categories of rate

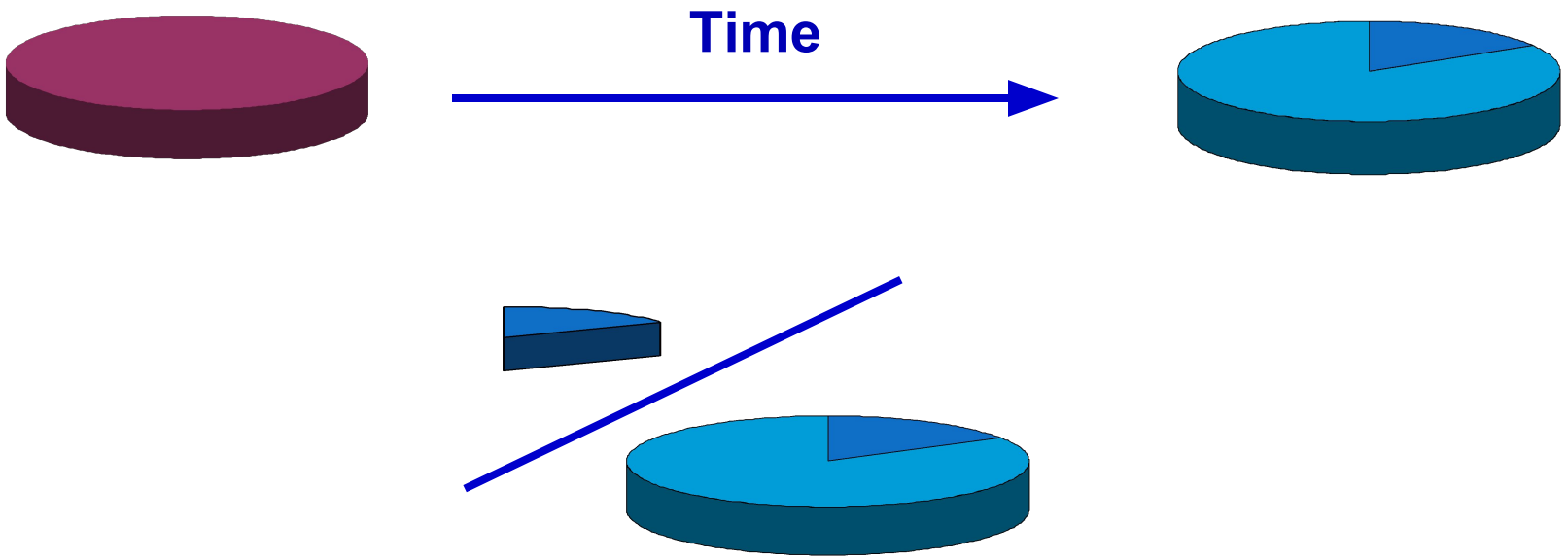
-CDR, CBR

-Standardized rate (direct, indirect)

-Specific rates

three important aspects

- persons in the denominator must reflect the population from which the cases in the numerator arose.
- persons in the denominator must be "at risk" for the event
- counts in the numerator and denominator should cover the same time period.


Time

For instance,annual death rate is a measure of risk of dying in a given year among the peopole in a defined area.

Rate is express in it's specific units.

The denominator used for rate is not population observed,but rather, Mid year population (average population size which would encompass the entire one year period)- Average person year of observation.

The concept inherent in rate estimation is the time dimension within which disease or death occurs.

Rates

- how fast the disease is occurring in a population

Proportion

- what fractions of the population is affected

Uses of Rates, Ratios and Proportions

Condition	Ratios	Proportions	Rates
Morbidity (Disease)	Risk ratio (Relative risk) Rate ratio Odds ratio	Attributable proportion Point prevalence	Incidence rate Attack rate Secondary attack rate Person-time rate Period prevalence
Mortality (Death)	Death-to-case ratio Maternal mortality rate Proportionate mortality ratio Postneonatal mortality rate	Proportionate mortality Case-fatality rate	Crude mortality rate Cause-specific mortality rate Age-specific mortality rate Sex-specific mortality rate Race-specific mortality rate Age-adjusted mortality rate Neonatal mortality rate Infant mortality rate Years of potential life lost rate
Natality (Birth)		Low birth weight ratio	Crude birth rate Crude fertility rate Crude rate of natural increase

Measure of disease occurrence/
Measure of disease frequency/
Measure of Morbidity

1. Prevalence -Period prevalence
   -Point prevalence
2. Incidence -Incidence density
   or incidence rate
   - Cumulative incidence

- **Prevalence**
  - measures the proportion of population that is in the diseased state at a specific time.
- **Incidence**
  - measure the rate of flow from the disease free state to the diseased state.

Prevalence

Definition : Prevalence is the proportion of the population that has the disease at a certain point in time.

$$P = \frac{\text{Number of people having the disease at a specific time}}{\text{Number of individuals in the population at that point in time}}$$

- **Proportion ,Dimensionless**
- **Can never take values less than 0 or greater than 1.**
- **Useful in assessing the disease burden of a community and in projecting demands for medical services.**

Prevalence

1. Point prevalence
2. Period prevalence

Point prevalence :

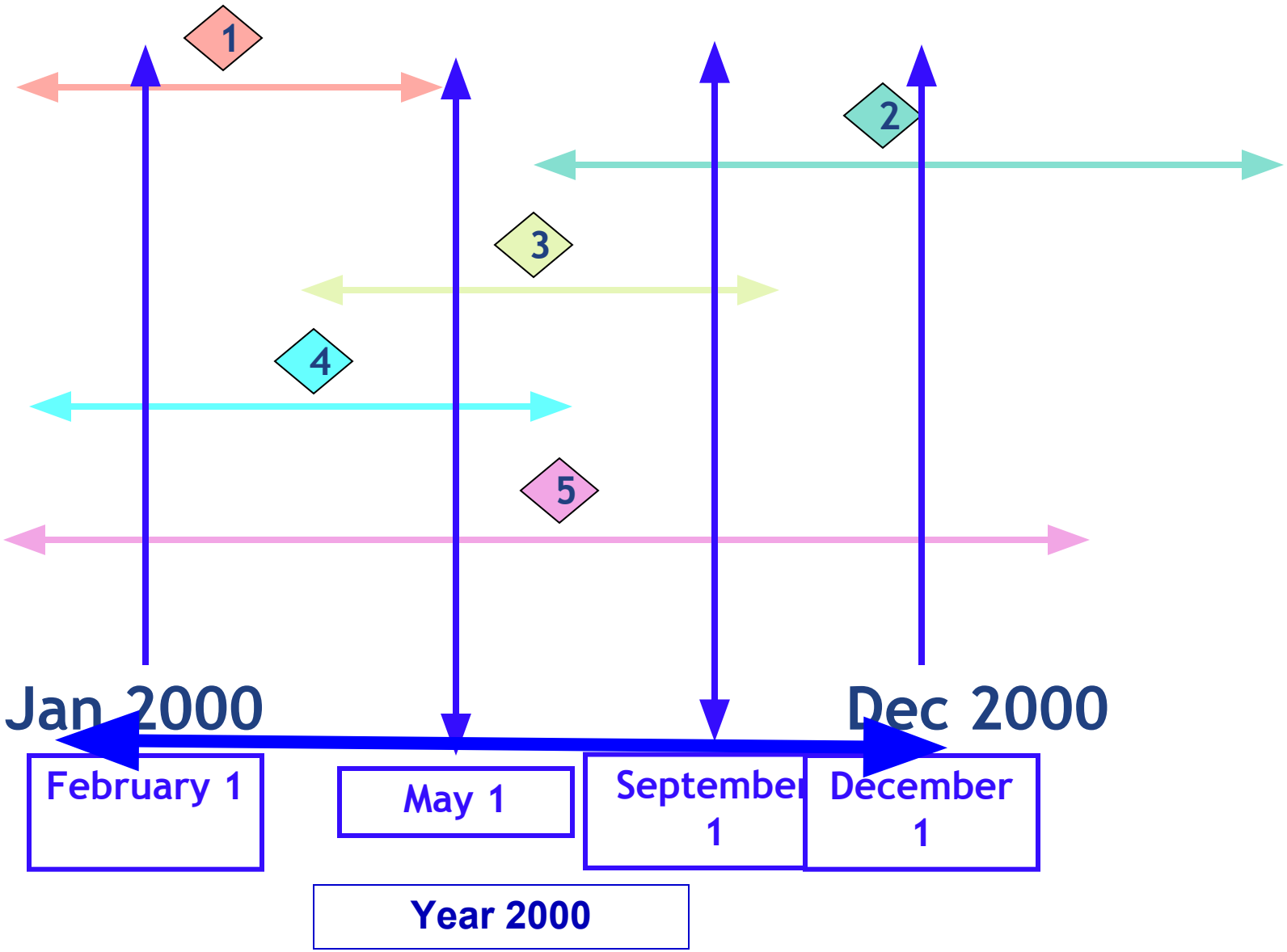
- **Prevalence of the disease at a point in time.**

(how much of a particular disease is present in a population at a single point in time)

- **point may be a day, several days or even a few weeks**

Period prevalence:

- How much of a particular disease is present in a population during a certain period (over a longer period may be a week, month , year ,decade etc.)
- every person represented by the numerator had the disease at some time during the period specified.


1
2
3
4
5
Jan 2000
Dec 2000
February 1
May 1
September 1
December 1
Year 2000

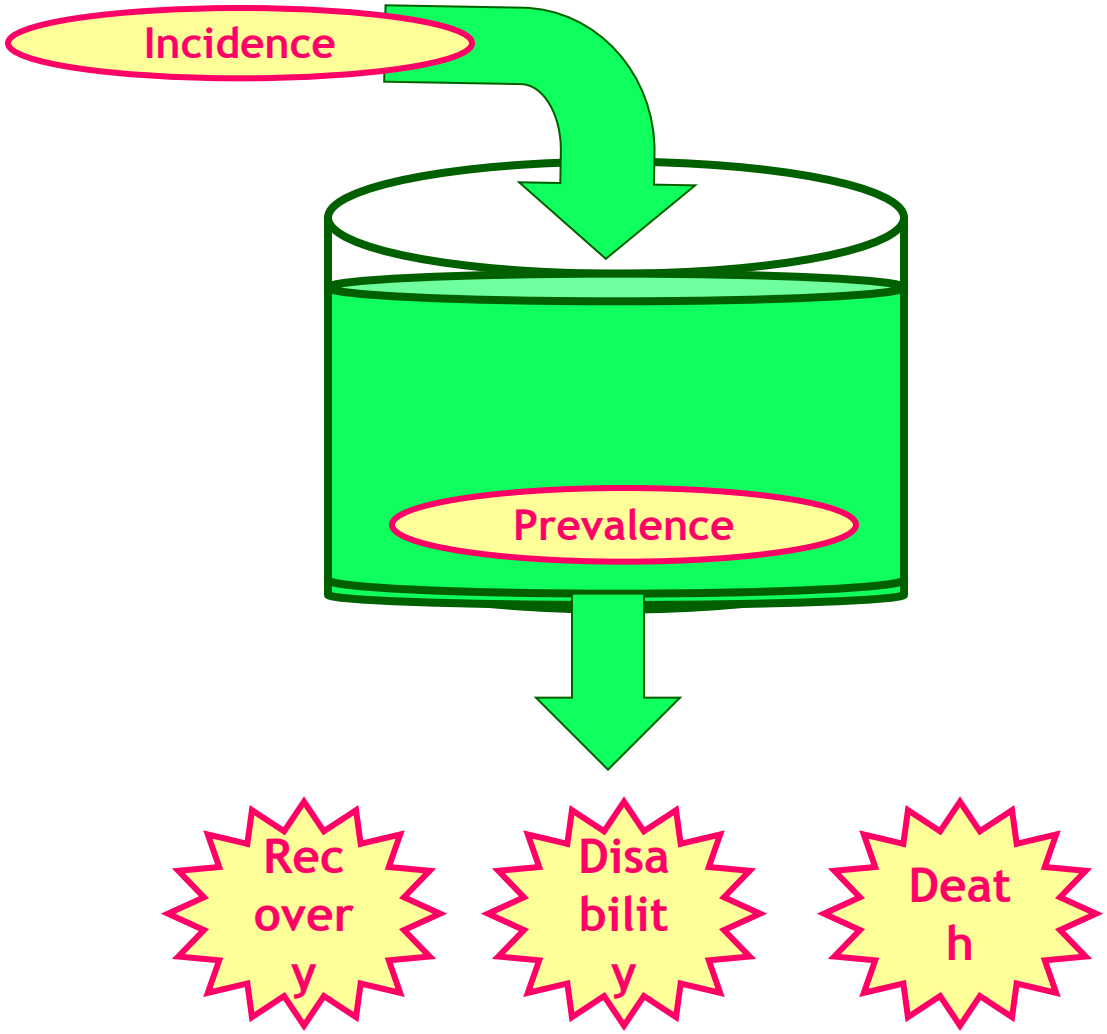
Several factors can influence prevalence.

- The severity of the illness.
- The duration of illness.
- The number of new cases.

- P =I *D
- I = Incidence
- D = Duration of illness

The magnitude of the disease prevalence depends on Incidence and duration of the disease.

P = I*D



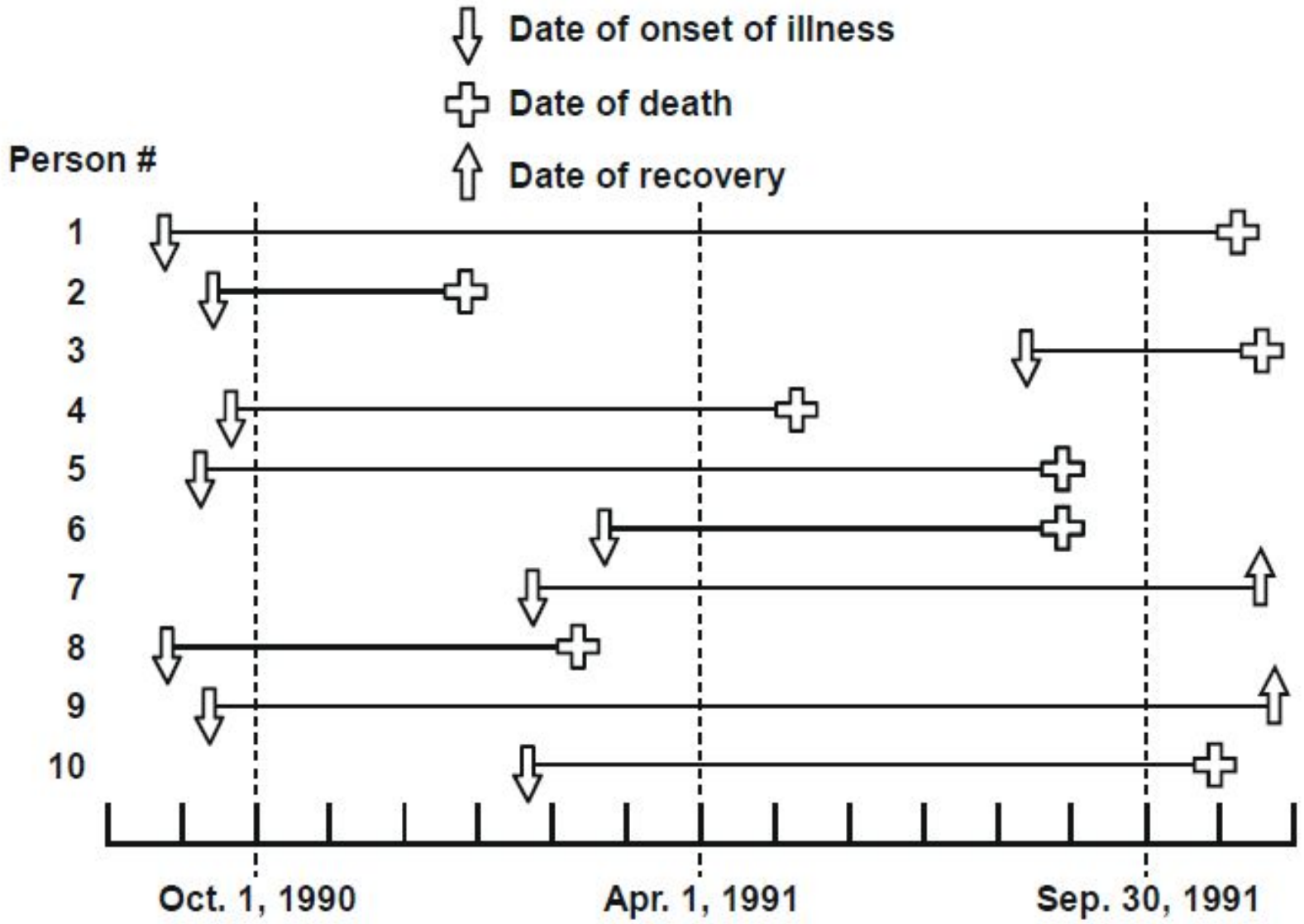
Increased by

- Longer duration of illness.
- Prolongation of life of patients without cure.
- Increase in new cases.
- In- migration of cases/ Susceptible.
- Out migration of healthy people.
- Improved in diagnostic facility.(Better reporting)

Decreased by :

- Shorter duration of illness.
- High case fatality rate from cases.
- Decrease in new cases.(Incidence)
- In-migration of healthy people.
- Out- migration of patients.
- Improved cure rate of cases.
- High prevalence,Low incidence-Diabetes.
- Low prevalence,High incidence-Common cold

Ten episodes of an illness in a population of 20



Incidence

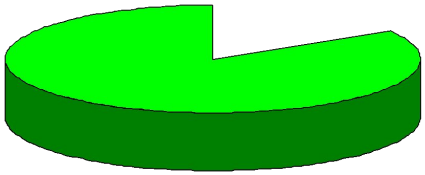
Incident cases are newly occurring cases.

Cumulative incidence : is the proportion of individuals in disease free state at the beginning of the period that move to the disease state during the period.

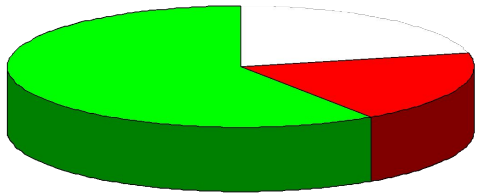
♦ $$CI = \frac{\text{Numbers of individuals who get the disease during a certain period}}{\text{Numbers of individuals in the population at the beginning of the period}}$$

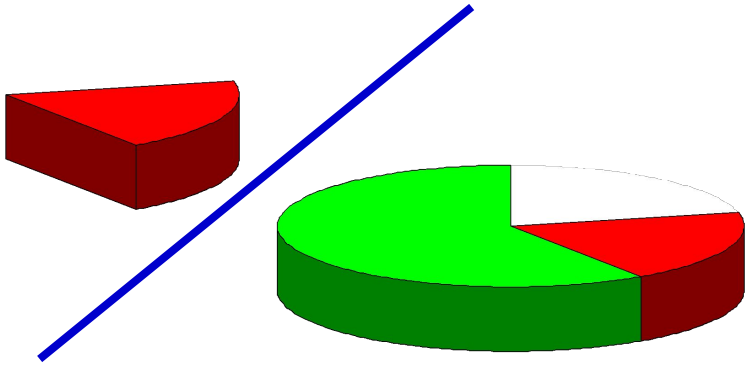
Jan 1, 2008

December 31, 2008



1 Year





Incidence

- **NEW DISEASE OR EVENT**-Involves **TRANSITION** from one state to another
  - Incidence of disease: non-diseased → diseased
  - Incidence of death: alive → dead
  - Incidence of cure: diseased → non-diseased
- Denominator only includes **POPULATION "AT RISK"**
  - Exclude people who already have the disease being measured
  - Exclude people who are immune
    - Vaccination = immunity from measles
    - Male sex = immunity from uterine cancer
- **SPECIFIC AMOUNT OF TIME** that the members of the population are followed until they develop the disease/ event

- Values range of 0 to 1.

- CI is a simpler measure of the occurrence of disease or health status.

What is the cumulative incidence of coronary heart disease over 10 years?

- You conduct a study with 1394 participants whom you follow for 10 years in order to measure the cumulative incidence of CHD in this population.
- At the time of enrollment, 42 participants already had CHD.
- During the 10 year follow-up period, 265 participants were diagnosed with CHD.
- Note: Denominator measures for cumulative incidence typically do not include "prevalent" cases at enrollment and immune individuals

What is the cumulative incidence of coronary heart disease over 10 years?

$$\text{Cumulative Incidence} = \frac{\text{\# NEW cases during time period}}{\text{\# in POPULATION AT RISK at start of time period}}$$

\# NEW cases = 265

\# POPULATION AT RISK = (1394 – 42) = 1352

$$CI = \frac{265}{1352} = 0.196 = 19.6\% \text{ over 10 years}$$

The cumulative incidence of CHD was 19.6% over 10 years of follow-up. Or, the risk of CHD diagnosis was 19.6% over a 10-year period.

Special Types of Cumulative incidence

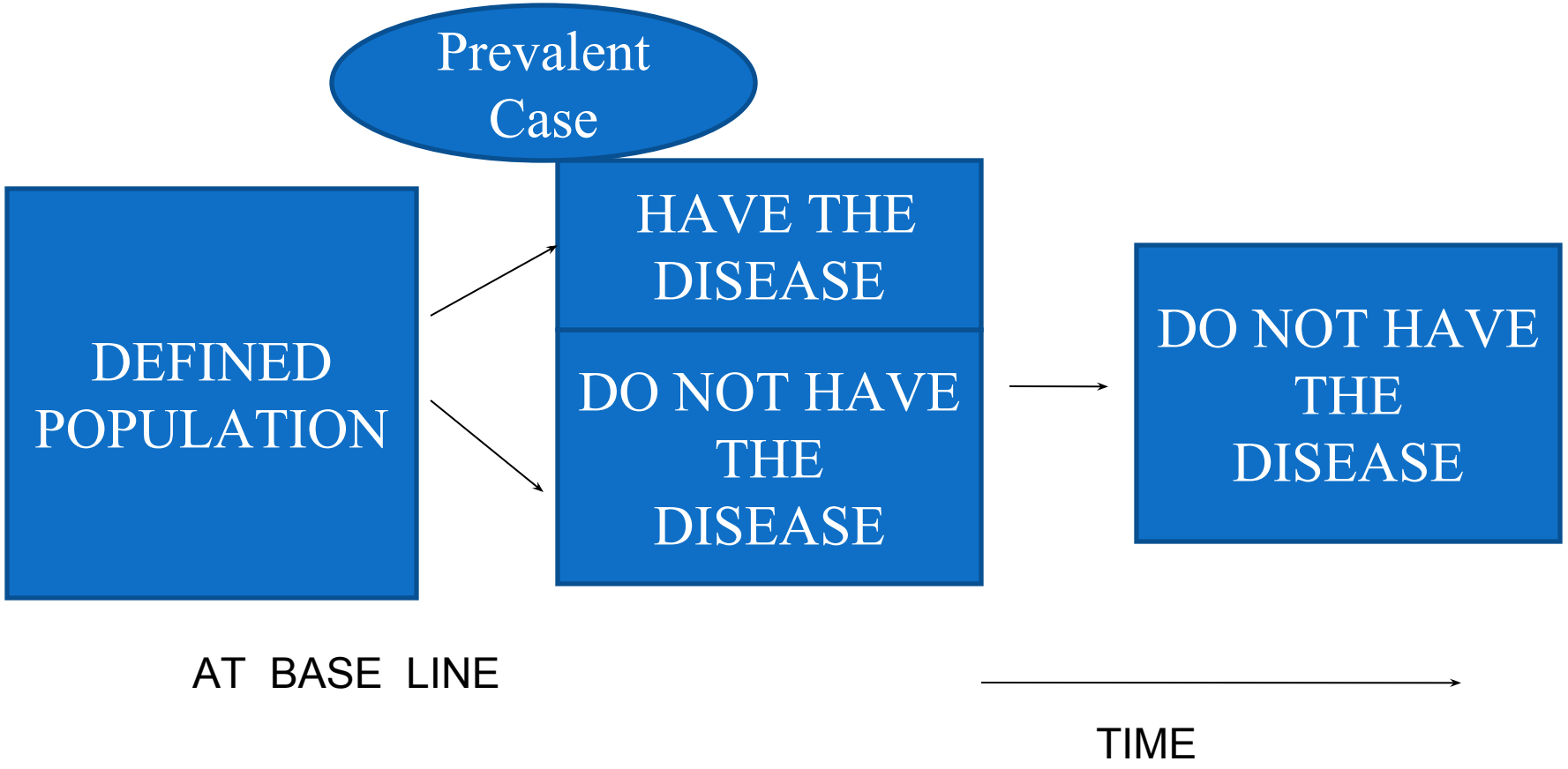
- Attack "rate" Proportion of individuals exposed to an infectious agent who become infected over a certain time period

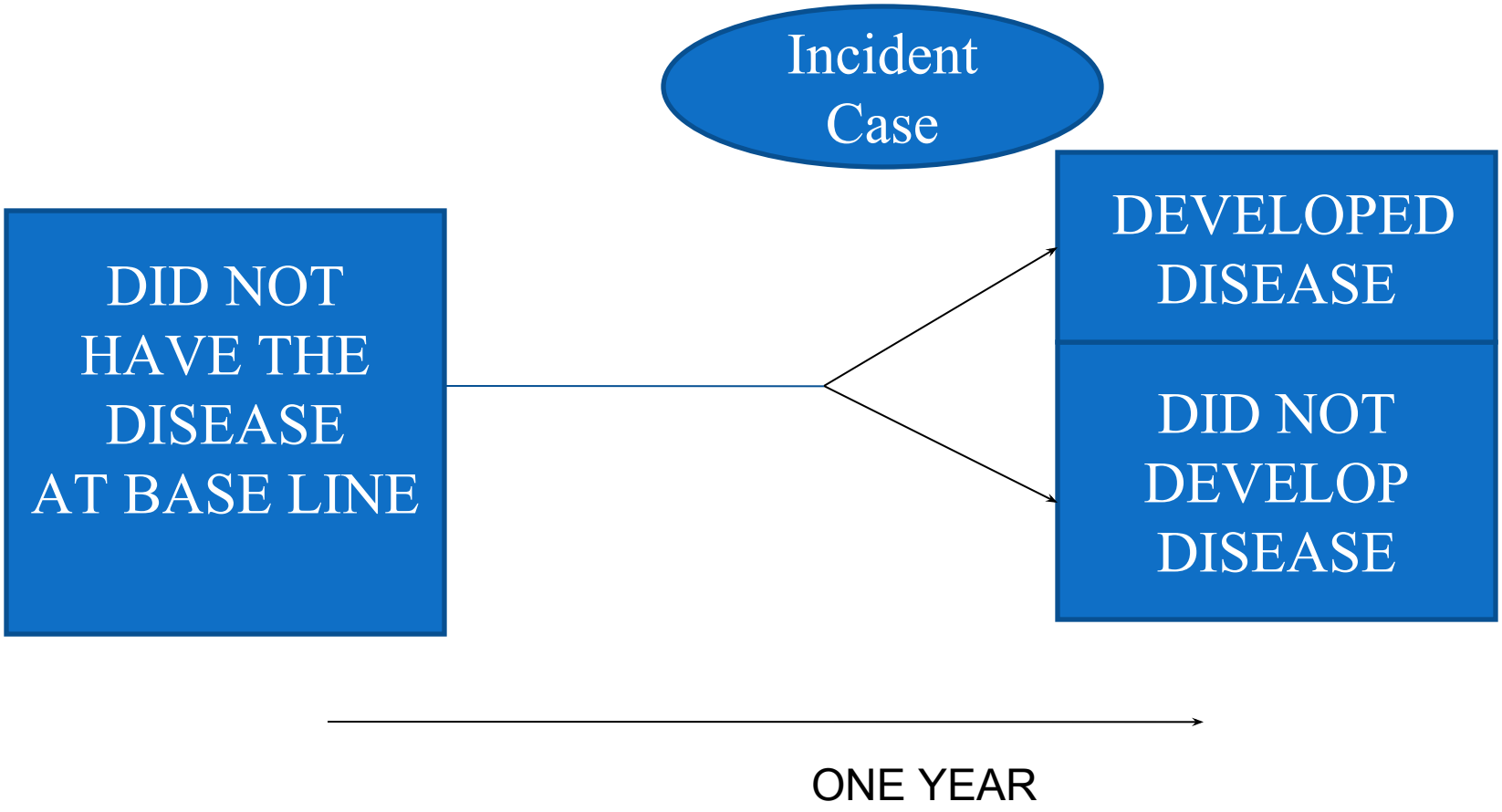
$$\frac{\#\text{ New cases of disease}}{\#\text{ Population at risk at beginning of time period}} \quad \text{during specified time period}$$

- Case fatality "rate" Proportion of individuals with a disease who die of that disease

$$\frac{\#\text{ Deaths due to disease X}}{\#\text{ People with disease X}} \quad \text{during specified time period}$$

Note: The word "rate" is often used incorrectly for cumulative incidence measures


Prevalent Case
DEFINED POPULATION
HAVE THE DISEASE
DO NOT HAVE THE DISEASE
DO NOT HAVE THE DISEASE
AT BASE LINE
TIME


Incident Case
DID NOT HAVE THE DISEASE AT BASE LINE
DEVELOPED DISEASE
DID NOT DEVELOP DISEASE
ONE YEAR

Incidence Rate

-is **defined** as the number of new cases of a disease that occur during a specified period of time in a population at risk for developing disease

Incidence rate(Incidence density)

- $I = \dfrac{\text{Numbers of new cases of a disease occur ring in the population during a period}}{\text{Sum of the length of time of each individual at risk in the population}}$

The sum of the time periods in the denominator is often measured in years and is referred to as person-years. (Person-Time)

Person-time or risk time

- is the time during which that individual is in the study population
- remains free from the disease.
- the sum of the person-times contributed by all members of the population.

So…What is Person-Time?

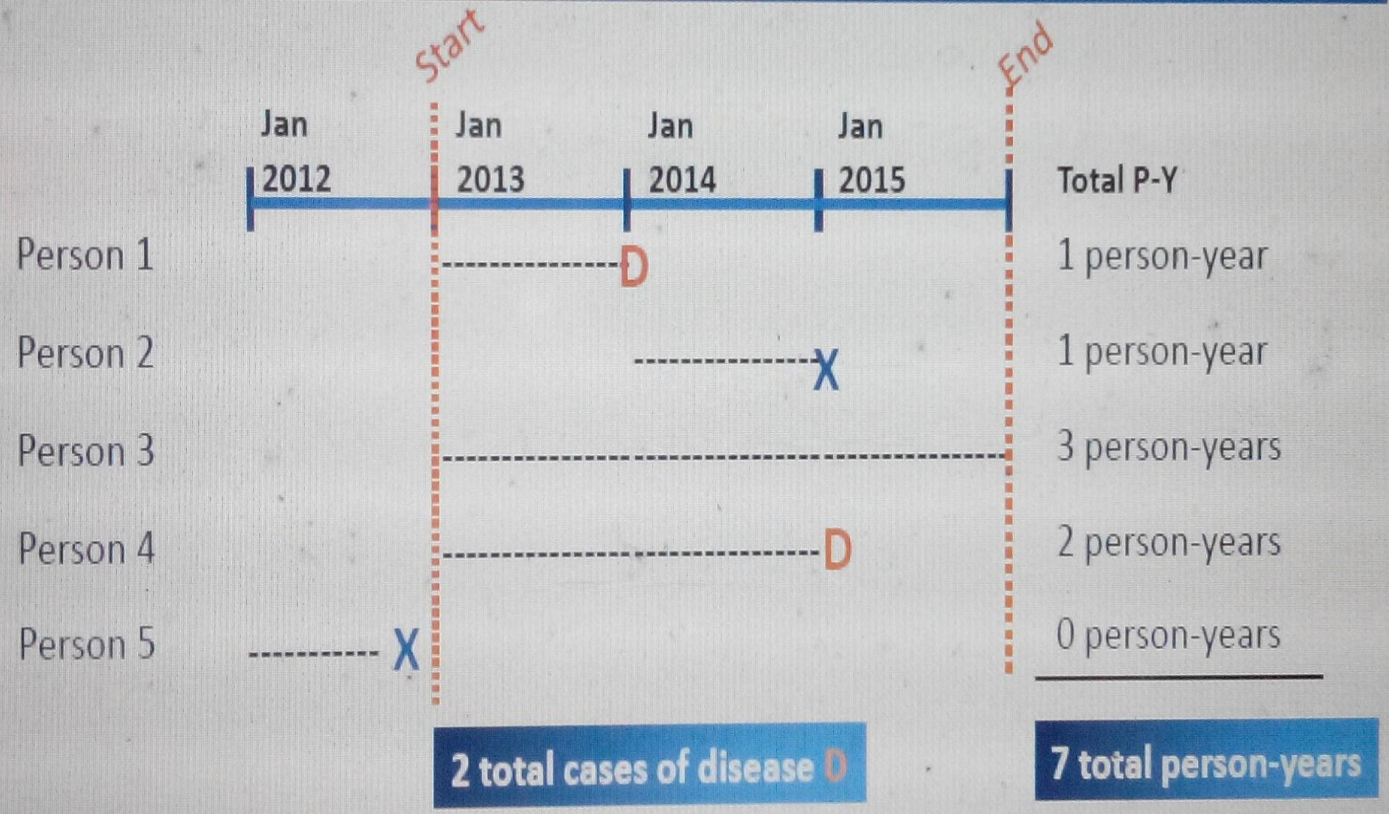
Amount of time each person at risk is under observation

- Accrued only among persons at risk
- Accrued only while being followed (follow-up time)
- Accrual ends when:
  - Person is no longer part of population at risk
    - Develops disease under study
    - Dies
    - Is lost to follow-up (moves away, quits study)
    - No longer meets eligibility criteria (becomes too old)
  - Observation period ends

Each person contributes different amounts of person-time to the denominator

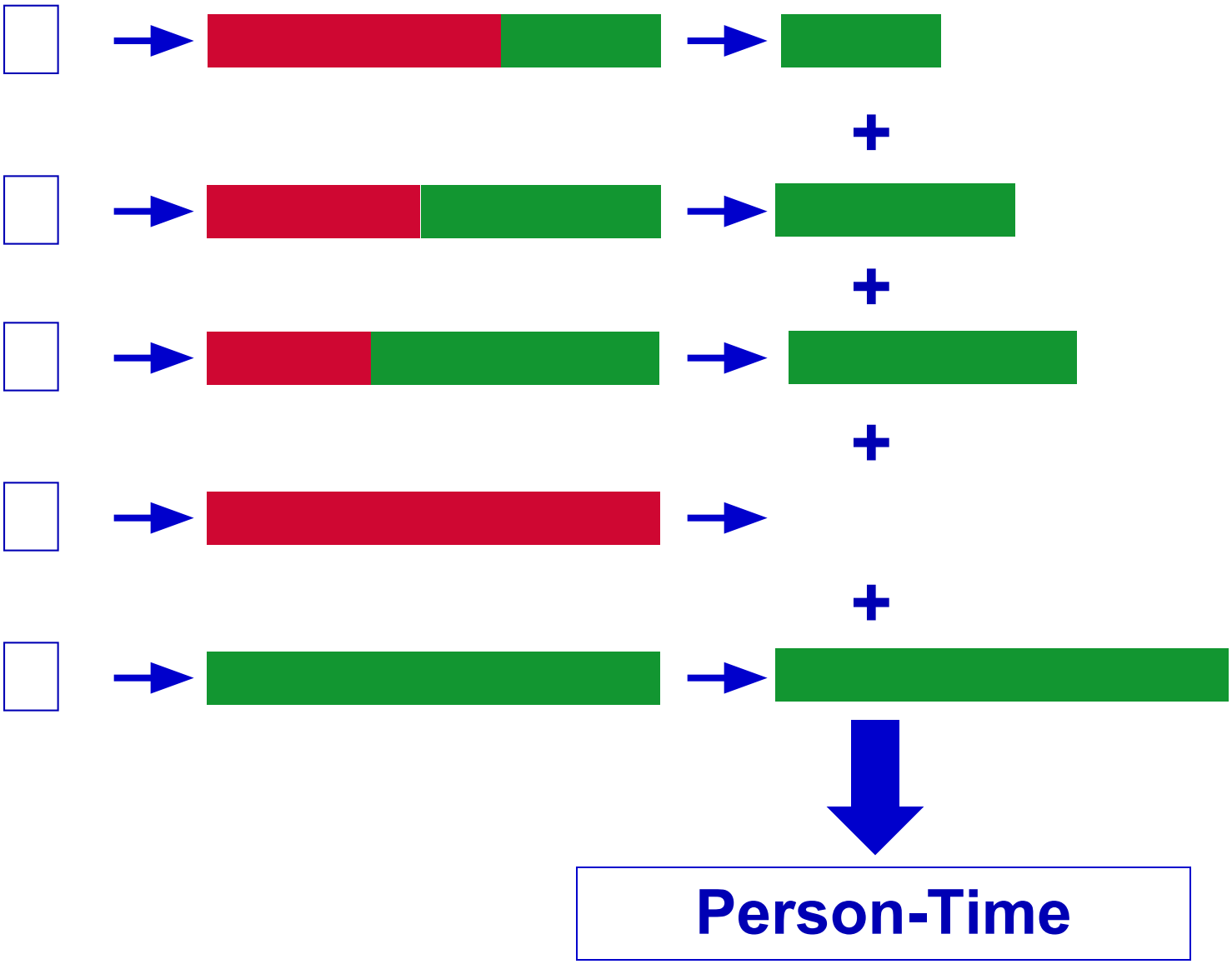
So...What is Person-Time?

Example of How Person-Time is Accrued



D = disease of interest

X = death


Person-Time

- The incidence rate is not a proportion like prevalence
- numerator is the number of cases
- denominator is the number of person-time units.

5. Ten factory workers were followed for 90 days to assess the development of asthmatic-like symptoms after acute exposure to toluene as the result of an industrial accident. Workers contributed to follow-up until they developed symptoms or for 90 days if they did not develop symptoms. There were no losses to follow-up. Consider this table of data obtained from the exposed factory workers:

Subject	Follow-up (Days)	Status at End of FUP	
A	90	No symptoms	
B	10	Symptoms	1
C	90	No symptoms	
D	90	No symptoms	
E	30	Symptoms	1
F	60	Symptoms	1
G	90	No symptoms	
H	90	No symptoms	
I	15	Symptoms	1
J	25	Symptoms	1

5 cases

What is the **90-day cumulative incidence** of asthmatic-like symptoms?

CI = # new cases/total population at risk

= 5 cases / 10 people = 0.50 = 50% during the 90 day study period

6. Ten factory workers were followed for 90 days to assess the development of asthmatic-like symptoms after acute exposure to toluene as the result of an industrial accident. Workers contributed to follow-up until they developed symptoms or for 90 days if they did not develop symptoms. There were no losses to follow-up. Consider this table of data obtained from the exposed factory workers:

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E	30	Symptoms	1
F	60	Symptoms	1
G	90	No symptoms	
H	90	No symptoms	
I	15	Symptoms	1
J	25	Symptoms	1
	590 person-days		5 cases

What is the **incidence rate** of asthmatic-like symptoms in these workers?

IR = # new cases/total person-time at risk

= 5 cases / 590 person-days = 0.0085/day = 85 cases/10,000 person-days

7. Ten factory workers were followed for 90 days to assess the development of asthmatic-like symptoms after acute exposure to toluene as the result of an industrial accident. Workers contributed to follow-up until they developed symptoms or for 90 days if they did not develop symptoms. There were no losses to follow-up. Consider this table of data obtained from the exposed factory workers:

Subject	Follow-up (Days)	Status at End of FUP	
A	90	No symptoms	
B	✓ 10	Symptoms	1
C	90	No symptoms	
D	90	No symptoms	
E	X [illegible]	[illegible]	
F	X [illegible]	[illegible]	
G	90	No symptoms	
H	90	No symptoms	
I	✓ 15	Symptoms	1
J	✓ 25	Symptoms	1

3 cases

Assuming that the observation of all subjects began on the same calendar date and that symptoms didn't resolve, what was the **prevalence** of symptoms on day 28?

P = # existing cases/total population

= 3 cases / 10 people = 0.30 = 30% on day 28

Person-Time Calculation for Prostate Cancer

8. A population of 100 healthy men was followed for the development of prostate cancer. 20 men developed prostate cancer after being followed for 5 years. Another 10 men were followed for 1 year and then were lost to follow up. The remaining 70 men were followed for 10 years and never developed prostate cancer. Calculate the number of person-years of observation accrued by this population

- (20 x 5 years) + (10 x 1 year) + (70 x 10 years) =

  100 + 10 + 700 = 810 person years

Summary: Putting It All Together

	Prevalence $\frac{\text{Existing cases}}{\text{Total population}}$	Cumulative incidence $\frac{\text{New cases}}{\text{Population at risk}}$	Incidence rate $\frac{\text{New cases}}{\text{Person-time at risk}}$
Type	Proportion	Proportion	Rate
Units	None	None	1/time
Range	0-1	0-1	0-∞
Numerator	Existing cases	New cases	New cases
Denominator	Total population	Pop'n at risk	Person-time at risk
Specify time?	Yes (using words)	Yes (using words)	Yes (in denominator)
Population	Fixed or Dynamic	Fixed with few exits	Fixed or Dynamic
Uses	Disease burden, when incidence difficult to obtain	Causes of disease, impact of interventions	Causes of disease , impact of interventions

$P \approx IR * D$

Measure of Association

Absolute comparison

1. Risk difference (Attributable risk)
2. Attributable fraction(exposed)
3. Population attributable risk
4. Population attributable fraction

Relative comparison

1. Relative risk

Relative comparison

Relative risk : is the ratio of the risk of occurrence of disease among exposed people to that among the unexposed.

Better indicator of the strength of association.

		OUTCOME		TOTAL
		+	-	
EXPOSURE	+	a	b	a+b
	-	c	d	c+d
TOTAL		a+c	b+d	G.T

RELATIVE RISK = Comparison of risk outcomes

RISK RATIO = Ratio of risk outcomes

$$RR = \frac{\text{“Incidence rate” of outcome among exposure cohort}}{\text{“Incidence rate” of outcome among non-exposure cohort}}$$

$$RR = \frac{a/a+b}{c/c+d} = \frac{Ie}{Ine}$$

Attributable risk

$$AR = I_{exp} - I_{unexp}$$

Attributable fraction

$$AFe = \frac{I_{exp} - I_{unexp}}{I_{exp}}$$

Population attributable risk

$$AFP = I_P - I_{unexp}$$

Population attributable fraction

$$AFP = \frac{I_P - I_{unexp}}{I_P}$$

END OF LECTURE