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Measurements in epidemiology:

Every component of a study e.g. a disease, an exposure, an event, a condition must be defined and measured. These measures are used in assessment of health problems in the community, that will aid in planning and evaluation of the effective health programs for disease control and prevention.

Types of measurements we construct depend upon:

1. the purpose of the measure
2. the nature of the data available to us.

Certain tools are used for this purpose. Such as:

Rates, ratios and proportion.

RATE

$$\text{Rate} = \frac{N}{D} \times K$$

N is numerator =no. of events occurring during a period of time

D is denominator =no. of population at risk of developing that event

K= round no. e.g. 100,1000,10000 …etc according to size of numerator.

Were N is part of D.

e.g. crude death rate in an area=15per 1000 population in 2000 in an area.

RATIO

$$\text{Ratio} = \frac{N}{D}$$

N= no. of persons with an event

D= no. of persons with other event. Were N is not part of D.

e.g.

male to female ratio in a given disease is 3:1

PROPORTION $$\text{Proportion} = \frac{N}{D}$$

N is part of D usually expressed in %.

e.g. proportion of deaths due to ischemic heart disease among all deaths in an area in 2000 is 25%

These tools could be used for diseases or deaths or births or any health related problem.

Population: An aggregation or group of individuals defined by a set of common characteristics.

A. Morbidity:

Morbid means disease. Morbidity is an important part of community health. It gives us idea about disease status in that community.

INCIDENCE: It is the most important measure of morbidity. It is the occurrence of an event or a characteristic over a period of time.

$$\text{Incidence rate} = \frac{\text{No. of new events occurring during a period of time}}{\text{Total population at risk of getting that event}} \times 1000$$

Population should be free of disease at beginning of study.

. A measure of NEW events therefore it's a measure of RISK of disease but must be for a specific time period.

. Everyone in denominator must have the potential to be part of the numerator.

Two main types:

. CUMULATIVE INCIDENCE: incidence calculated using a period of time during which ALL the individuals in the population are at risk for the outcome

. DENSITY INCIDENCE: NO. of new events occurring during a period of time per number of years persons exposed to risk of that event.

Person time denominator is used mostly in occupational medicine .

<u>Uses Of Incidence:</u>

. Describes the rate of diseases occurrence overtime

. Assess patient survival from diseases

. Compare the risk of disease between two or more populations

e.g. a study examined the occurrence of TB in a district. A total of 10000 persons who have no TB were followed for 1year .it was seen that 15 persons developed the disease in that period.

$$\text{Incidence rate of TB in the village} = \frac{\text{The new cases of TB in that year}}{\text{Total persons at risk of having TB}} \times 1000$$

$$\text{The incidence rate} = \frac{15}{10000} \times 1000 = 1.5 \text{ cases of TB per } \frac{1000}{\text{Population in that year}}$$

Note that:

Because incidence rate is a measure of the rate at which healthy people develop a disease during a specific time period, so it is a statement of probability.

Since the incidence rates are affected by any factor that affects the development of a disease, they can be used to detect the etiologic factors.

Time is an integral part of incidence. If it is not mentioned it will be no more than a rate, it will be a proportion. The population at risk should be susceptible and exposed to the disease. The exposed people should not be added to D.

The population at risk should be free of the disease at beginning of time of study.

PREVALENCE:

It is the measure of a burden of a disease in community. It's the presence of an event or characteristic at a point of time in a population.

$$\text{Prevalence rate} = \frac{\text{No. of new and old events occurring at a point of time}}{\text{Total population at risk of getting that event}} \times 1000$$

<u>Uses Of Prevalence:</u>

1. Describes the burden of a disease a community.
2. Define the rate of clinical characteristics in subjects with specified diseases.
3. Estimates the probability of having a disease given the result of a diagnostic test result.

A prevalence rate: is the presence of the disease in the community whether old or new cases in defined population. It's not a measure of risk of disease, and not useful in identifying the cause of disease.

There are two types of prevalence:

1.POINT PREVALENCE: no. of events that are present at a point in time whether an old or new cases. This is the most used form of prevalence.

$$\text{Point Prevalence rate} = \frac{\text{No. of new and old events occurring at a point of time}}{\text{Total population at risk of getting that event}} \times 1000$$

2. PERIOD PREVALENCE: the no. of cases of the disease whether old or new that are present within a period of time (usually a calendar year)

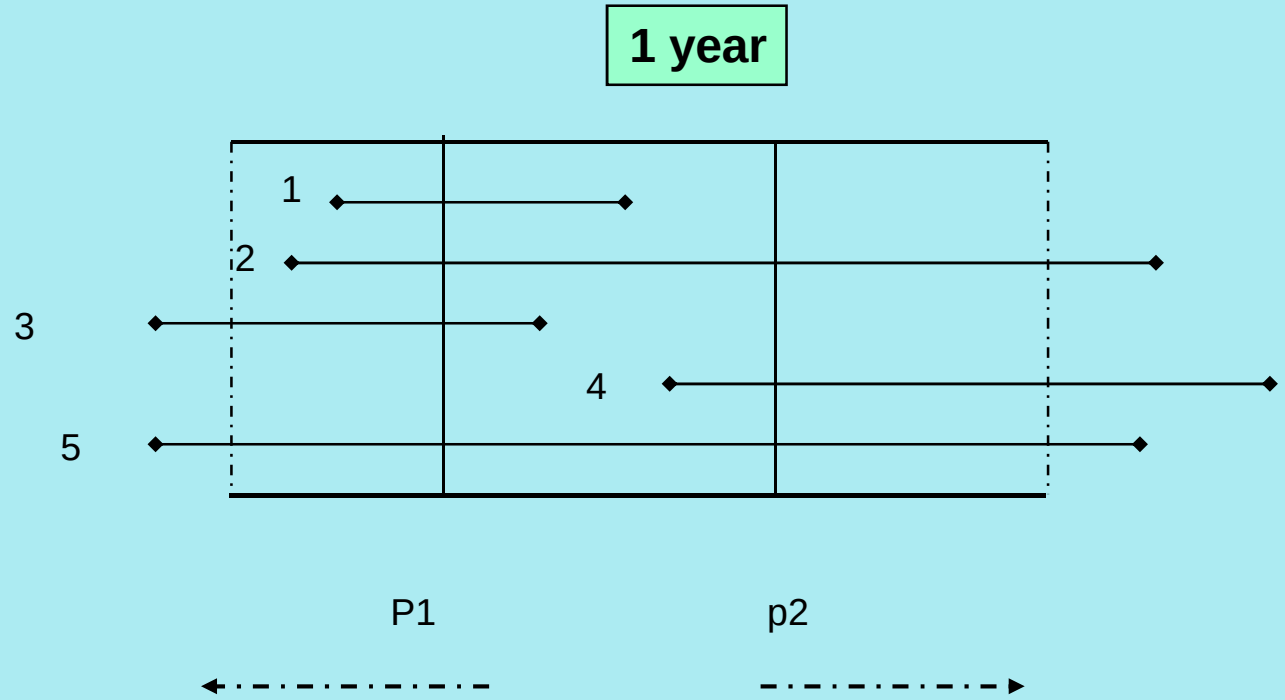
$$\text{Period Prevalence rate} = \frac{\text{No. of new and old events occurring during a period of time}}{\text{Total population at risk of getting that event}} \times 1000$$

This rate sometimes approximates the incidence rate if the course of disease is short.

Note that:

a. prevalence is used primarily to measure the amount of illness in a community. Thus it can be used to determine the health care needs of that community and the resource available for this purposes.

b. prevalence rates are influenced by both the incidence of disease and its duration.



Incidence : cases 1 , 2 & 4

Point prevalence p1 : cases1,2, 3 & 5 , p2 : cases 2 , 4 & 5

Period prevalence : cases 1 , 2 , 3 , 4 & 5

e.g. There were 120 cases of typhoid fever in a small city of 50000 pop at 1st Jan.2002.at the end of this year there were 30 added cases of that disease . At April of that year 60 cases (old and recently diagnosed) . Calculate the point prevalence(at April,2002) and period prevalence for the year 2002.

$$\text{Point Prevalence rate} = \frac{\text{No. of new and old cases of typhoid fever at April}}{\text{Total population at risk of getting that event}} \times 1000$$

$$\text{Point Prevalence rate} = \frac{60}{50000} \times 1000 = \text{1.2 cases of typhoid fever per 1000 pop at April, 2002}$$

$$\text{Period Prevalence rate} = \frac{\text{No. of cases present at the beginning of 2002 + new events occurring during that period of time}}{\text{Total population at risk of getting that disease}} \times 1000$$

$$\text{Period Prevalence rate} = \frac{120+30}{50000} \times 1000 = 2.4$$ cases of typhoid fever per 1000 pop during, 2002

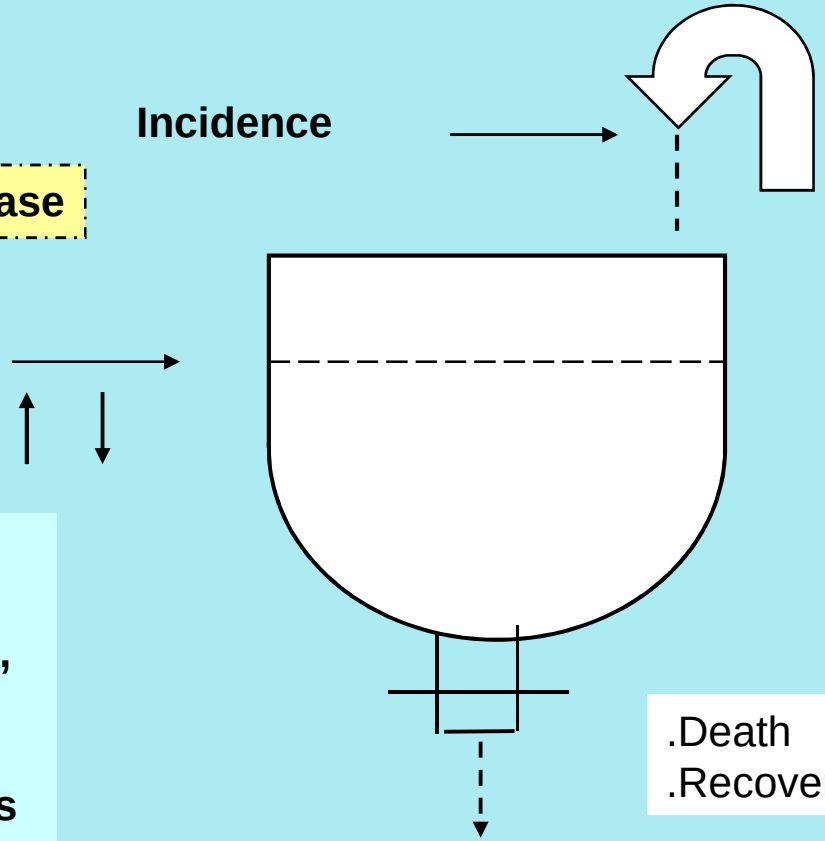
. The prevalence reflects the status of disease in the population, and estimates the probability that an individual will be ill at a point in time.

. The incidence estimates the risk that an individual will develop the disease during a specified period of time.

The relation between the incidence and prevalence:

Diseases with acute course which will end either in death or recovery of patientse.g. (pneumonia, measles). Such cases don't accumulate in the community, and don't contribute much to prevalence. While chronic diseases such as diabetes mellitus and hypertension, have impact on the prevalence , as these patient are included in every disease survey. In stable diseases :

Prevalence = incidence x duration of disease



If the incidence of disease in the community, its fatality and recovery rate, are relatively stable, the prevalence is affected by duration of disease. Prolonged duration of disease, increases the prevalence rate and vice virsa.

“Attack Rate":

The proportion of susceptible individuals exposed to a specific risk factor in a disease outbreak that become cases.

For an infectious risk factor, the attack rate is the number of secondary cases occurring within the accepted incubation period divided by the number of susceptible individuals in a closed group exposed to the primary (index) case.

$$\text{Attack rate} = \frac{\text{No. persons getting the disease during a specific time}}{\text{Total population at risk of getting the disease}} \times 100$$

B. Mortality rates:

Mortality rates are of many types:

1. Crude death rates:

They are summary measures. Calculated by dividing total no. of an event among a population (of all ages of both sexes and of all causes) by total no. of the population during a specific period of time.

. They represent the actual experience of the population.
. Provide data useful for public health planning and administration.
. Widely used for comparison purposes.
. Easy to calculate.
.Use midyear because popn changes and this approximates the average pop.

This rate is very useful in giving a general picture of mortality and not the accurate estimation because of the effect of age, sex and other confounding factors on the mortality. So observed differences may be due to the differences in population structure.

Often this is reduced to measure rate in a particular popn but must reduce / restrict both numerator & denominator – this is a specific rate (like age specific or disease specific) which is:

2.Category specific rates:

They are calculated among categories of the pop. defined on the basis of particular characteristics (e.g. age, sex, race….etc).

. Category specific rates are unconfounded by that factor .

. Provide the most detailed and accurate information about the pattern of the disease in the pop. But the comparison is difficult because of large no. & rates.

e.g.

$$\text{Cause specific mortality rate} = \frac{\text{No. of deaths due to specific cause during a period of time}}{\text{Total population at risk}} \times 1000$$

$$\text{Infant mortality rate} = \frac{\text{No. of deaths among infants during a period of time}}{\text{Total live births}} \times 1000$$

. Neonatal mortality rate, postneonatal mortality rate, perinatal mortality rate… etc

3.Adjusted(standardized) rates:

It is a statistically constructed single summary rate for each pop that takes in consideration any differences in the structure of pop with respect to certain variables. So the remaining differences cannot be attributed to the effect of that variable. Standardization could be:

a. Direct standardization:

The multiplication of the category specific rate in each pop by the weights taken from standardized pop.

Direct Standardization ;

- Define the standard population.
- Multiply the age-sex specific death rate of the population under study by number of individuals in the equivalent age-sex stratum of the standard population=number of expected deaths that would occur in the standard population for age and sex stratum.
- Add the expected number of deaths in the standard population at all age-sex strata

$$\text{Standardized death rate} = \frac{\text{Total no. of expected deaths}}{\text{Total standard pop.}} \times 1000$$

Example of direct age adjustment; When mortality in the United States and in Mexico was compared for 1995 to 1997, the crude mortality rate for all ages in the United States was 8.7 per 1,000 population and in Mexico only 4.7 per 1,000 population. But for each age group, the age-specific mortality rate was higher in Mexico than in the United States (aside from the over 65 group in which the rates were similar).

In order to eliminate the possibility that the differences in mortality between the United States and Mexico could have been due to differences in the age structure of the two populations, we need to control for age. Therefore, we select a standard population and apply both the age-specific mortality rates from the United States and from Mexico to the same standard population. As seen in Table 4-12

TABLE 4-12 -- An Example of Direct Age Adjustment: Comparison of Age-adjusted Mortality Rates in Mexico and in the United States, 1995–1997

Age Group (yr)	Standard Population	Age-specific Mexico Mortality Rates per 100,000	Expected Numbers of Deaths Using Mexico Rates	Age-specific United States Mortality Rates per 100,000	Expected Numbers of Deaths Using United States Rates
All ages	100,000				
<1	2,400	1,693.2	41	737.8	18
1–4	9,600	112.5	11	38.5	4
5–14	19,000	36.2	7	21.7	4
15–24	17,000	102.9	17	90.3	15
25–44	26,000	209.6	55	176.4	46
45–64	19,000	841.1	160	702.3	133
65+	7,000	4,967.4	348	5,062.6	354
Total numbers of deaths expected in the standard population			639		574
Age-adjusted rates:			$\text{Mexico} = \frac{639}{100{,}000} = \frac{6.39}{1{,}000}$		$\text{United States} = \frac{574}{100{,}000} = \frac{5.74}{1{,}000}$

Indirect standardization

- Define the standard specific rates.
- For each age group stratum multiply the standard rates X equivalent age- sex stratum of index population=expected number of deaths in the index population under standard death rate .
- Add the expected number of deaths in the index population in all age-sex strata**.**
- The ratio of the total number of deaths actually observed to the total number of deaths expected, if the population of interest had the mortality experience of the known population, is then calculated. This ratio is called the standardized mortality ratio (SMR).

Example of indirect age adjustment; in a population of 534,533 white male miners, 436 deaths from tuberculosis occurred in 1950. Is this mortality experience from tuberculosis greater than, less than, or about the same as that expected in white men of the same ages in the general population?

TABLE 4-13 -- Computation of a Standardized Mortality Ratio (SMR) for Tuberculosis, All Forms (TBC), for White Miners Ages 20 to 59 Years, United States, 1950

Age (yr)	Estimated Population for White Miners (1)	Death Rate (per 100,000) for TBC in Males in the General Population (2)	Expected Deaths from TBC in White Miners if They Had the Same Risk as the General Population (3) = (1) × (2)	Observed Deaths from TBC in White Miners (4)
20–24	74,598	12.26	9.14	10
25–29	85,077	16.12	13.71	20
30–34	80,845	21.54	17.41	22
35–44	148,870	33.96	50.55	98
45–54	102,649	56.82	58.32	174
55–59	42,494	75.23	31.96	112
Totals	534,533		181.09	436

$$\text{SMR} = \frac{\text{Observed deaths for an occupation – cause – race group}}{\text{Expected deaths for an occupation – cause – race group}} \times 100$$

$$\text{SMR (for 20–59-yr-olds)} = \frac{436}{181.09} \times 100 = 241$$

4.Case fatality rate:

$$\text{Case fatality rate} = \frac{\text{No. Of deaths due to a disease during a period of time}}{\text{Total no. of cases of that disease}} \times 100$$

. Denominator limited to those already having disease NOT whole popn
. It is % of people diagnosed with the disease dying in a certain time after diagnosis
. It is a measure of disease severity.
. Can measure effectiveness of a new treatment

5.Proportional mortality:

$$\text{Proportional mortality} = \frac{\text{No. of deaths from a specific disease in a given year}}{\text{Total no.of deaths in that year}} \times 100$$

. It is NOT a rate, it is proportion expressed in %
.Tells nothing about risk (to tell risk use mortality rate)