Kenya Medical Training College -Port Reitz Campus Department of Clinical Medicine Year Two Semester One Vital Statistics 1st October 2020

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Vital Statistics

- Learning Objective

  To apply the knowledge of vital statistics in calculation of demographic rates, diagnosis and planning of healthcare interventions.

Learning Outcomes

- By the end of this session, you should be able to
  1. Define vital statistics.
  2. Explain the goals of vital statistics.
  3. Explain the uses of vital statistics in healthcare.
  4. Explain the meanings of proportions, rates, ratios, prevalence and incidence.
  5. Apply knowledge of vital statistics in calculation of demographic rates.

Vital Statistics

- Definition:
  1. A branch of statistics focusing on conventionally adapted strategies for studying aspects of the human population such as morbidity, mortality and demography, e.g. the number of births, marriages, and deaths.
  2. Vital statistics is the numerical description of birth, death, abortion, marriage, divorce, adoption and judicial separation.
  - The anthropometric measurements of a woman's bust, waist and hips.

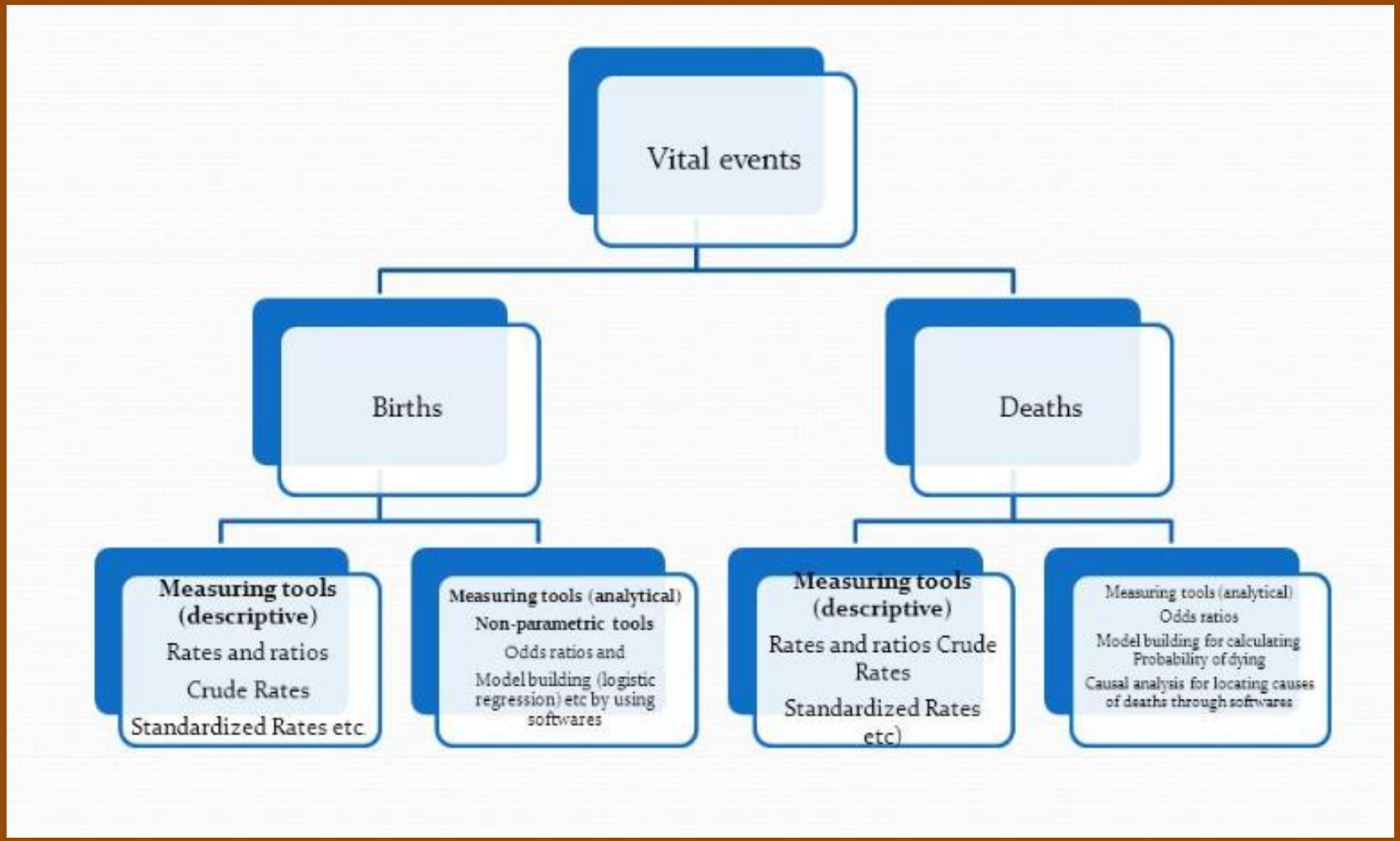
Importance of Vital Statistics

- Importance:
  - Calculation of demographic rates.
- Since its focus is on data for human morbidity, mortality and demography, it is useful for
  1. Knowing health status.
  2. Giving baseline data for diagnosis and planning interventions.
  3. Providing baseline data for developing healthcare programmes.

Vital Statistics

- Synonyms
  1. Life tables
  2. Statistics regarding birth and death
  3. Essential data of life statistics

Vital Statistics



Goals of Vital Statistics

1. To provide reliable, up to date and reasonably complete information for health managers at all levels.
2. To assist planners in studying their current functioning and trends in demands and workloads.
3. To provide at periodic intervals, data that will show the performance of healthcare services.
4. To enable sharing of technical and scientific information by all healthcare providers.

Uses of Vital Statistics in Healthcare

1. To guide on patterns of health and disease in a population or community.
2. Designing and evaluation of healthcare programmes.
3. Comparison of vital experiences of different populations.
4. To predict health risk in populations and make decisions for preventive action.
5. For analysis of trends of healthcare statistics.

Components of Vital Statistics

1. Demography
2. Vital events and health status e.g. morbidity, mortality, disability, quality of life.
3. Environmental health statistics.
4. Communicable and non-communicable diseases.
5. Monitoring and evaluation of healthcare and healthcare resources.
6. Nutrition, Mental and Occupational health.

Measures for Studying Populations

1. Counts of people
   - Rates, proportions, and ratios, e.g. birth rate, death rate, incidence, prevalence, abortion ratio;
2. Distributions of characteristics of people,
   - e.g. mean age, mean education, mean cholesterol level, etc.
3. Characteristics of groups or environment,
   - e.g. obese people, people living with disability (PLWDs), etc.

Proportion

- The total number of events which occur in a data set, usually expressed as a percentage.
- The formula is ***(x/y) x k,***

  Where:

  x is the number of individuals or events in a category,

  y is the total number of events or individuals in the data set,

  k is a constant, in this case 100.

Proportion Cont…

- Example:

  Of the 120 cases of malaria admitted to hospital X last year, 80 were children. The proportion (percentage) of children among cases is (80/120) x 100 or 66.7%.

- With this, the hospital administrator knows that 67% (two-thirds) of malaria hospitalizations occur in the paediatric age group, hence is able to plan accordingly.

Elements of Vital Statistics

- A vital rate has 3 essential elements:
  1. The vital event, e.g. birth, death, etc.
  2. The population at risk of experiencing the vital event of interest.
  3. The time (specified time)
     a) Point in time
     b) Period of time.

Risk

- Risk is the probability or likelihood of experiencing an event.
- If the population at risk is the denominator then, the rate obtained would be a true measure of *risk.*

Risk Cont…

- **Rate ratio** or **relative risk:** Rates for two or more groups are often compared by dividing one by the other (*rate a/rate b*).
- The **rate ratio or relative risk** may be used to identify possible causal risk factors and identify markers that may be useful in targeting services.
- **(Absolute) risk difference:** Rates compared by subtracting one from the other (*rate a minus rate b*).

‘Rate’ as Applied in Vital Statistics

- ‘Rate’ expresses change that takes place within a given time.
- Rates measure the relative frequency of cases in a population *during a specified period of time.*
- Rates may measure incidence (new cases) or prevalence (newly occurring plus pre-existing cases) within a specified period.

‘Rate’ as Applied in Vital Statistics

- The general formula for a ‘Rate”:

$$Rate = \frac{Numerator}{Denominator} \; x \; K$$

Where,

- Numerator is No. of people experiencing the event of interest during a given period.
- Denominator is the No. of people who are exposed to the risk of experiencing the event.
- K is the standardizing factor, e.g. 100 or 1000 or 10000, etc, to eliminate decimals.

Types of Rate

- In Vital Statistics, rates comprise:

1. Crude rates
2. Category-specific rates
3. Adjusted or Standardized rates

Types of Rate

1. Crude rates
   - Rates presented for an entire population, e.g. crude birth rate and crude death rate.
   - Crude rates are summary rates based on the actual number of events in a population over a given time period.
2. Category-specific rates
   - Rates presented for certain categories of the population defined on the basis of particular characteristics, e.g. age, sex, marital status, etc.
3. Adjusted or Standardized rates
   - Rates adjusted for one factor that may influence disease or mortality.

Examples of Rates in Vital Statistics

1. Crude birth rate
2. Crude death rate
3. Infant mortality rate
4. Neonatal mortality rate
5. General fertility rate
6. Maternal mortality
7. Life expectancy

Examples of Crude Death Rates

a) Infant mortality rate
b) Fetal death rate
c) Neonatal mortality rate
d) Postnoenatal mortality rate,
e) Perinatal mortality rate
f) Maternal mortality rate.

Examples of Crude Death Rates

Crude Death Rate = $\frac{\text{Number of deaths within a given period}}{\text{Population size at the middle of that period}}$ x1,000 population

- Crude death rates are used to project population changes.
- It is affected by the number and age composition of women of childbearing age.

Definitions of Rates

- Crude Birth Rate
  - The number of live births per 1000 estimated mid-year population in a given year.
- Crude Death Rate
  - The number of deaths (from all causes) per 1000 estimated mid-year population in one year in a given place.

Definitions of Rates Cont…

- Infant Mortality Rate
  - The ratio of infant deaths registered in a given year to the total number of live births registered in the same year, usually expressed as a rate per 1000 live births.
- Neonatal Mortality Rate
  - The number of neonatal deaths (infant as < 28 days old) in a given year per 1000 live births in that year.

Definitions of Rates Cont…

- Maternal Mortality Rate
  - The death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of pregnancy, from any cause related to or aggravated by pregnancy.
- General Fertility Rate
  - The number of live births per 1000 women in the reproductive age of 15 – 49 years in a given year.

Definitions of Rates Cont…

- Life Expectancy
  - The average number of years a person is expected to live, in the existing conditions of probability of death.

Mortality Rate and Life Expectancy

- In stationary populations, and in cohorts with complete follow-up, the mortality rate is the reciprocal of life expectancy (and vice versa).

$$\text{Life expectancy} = \frac{1}{\text{Mortality Rate}}$$

- Example: For a mortality rate of 0.0267 per year,

$$\text{Life expectancy} = \frac{1}{.0267/\text{year}} = 37.5 \text{ years}$$

‘Rate’ as Applied in Vital Statistics

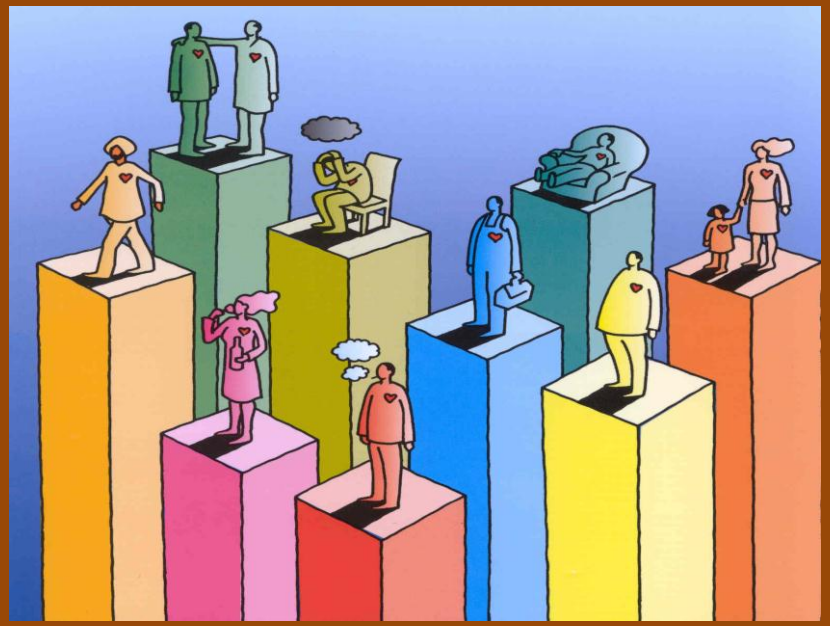
- “Rates” are composed of numerators and denominators
- **Numerator** ⇒ case count
  - **Incidence count** ⇒ onsets
  - **Prevalence count** ⇒ old + new cases
- ***Denominator*** ⇒ reflection of population size.

Measurement of Morbidity

- Morbidity pertains to sickness, disease or disability within specific populations.
- Measurements of morbidity describe the frequency of illness within a population.
- The most commonly used measures of morbidity (disease occurrence) are:
  a) Prevalence
  b) Incidence:
     i. Incidence proportion
     ii. Incidence rate

Measurement of Morbidity

- Prevalence.
- Incidence proportion (risk)
- Incidence rate (density)



Prevalence

- Prevalence measures the frequency of all existing or current cases of disease in a population at a specific time or during a specific period of time.
- Example
  - To determine the prevalence of hysterectomies:
  - 1000 women are recruited.
  - Ascertain: 100 with hysterectomies

$$\text{Prevalence} = \frac{\text{No. of cases}}{\text{No. of people}} = \frac{100\ \cancel{\text{people}}}{1000\ \cancel{\text{people}}} = 0.10 = 10\%$$

Prevalence Cont…

- There are two types of prevalence:
  a) Point prevalence
  b) Period prevalence.
- Point Prevalence
  - Measures the frequency of cases of disease or condition at a given instant in time.

Point Prevalence

- Example: In January of 2020, there were 350 malnourished children in a community with an estimated population of 800,000 children.

$$Point\ Prevalence = \frac{No.\ of\ Existing\ Cases\ at\ a\ Specific\ Point\ in\ Time}{The\ Total\ Population}\ x\ K$$

$$Point\ Prevalence = \frac{350}{800000}\ x\ 10000$$

= 4.4 cases per 10,000 children.

- If not multiplied by K, it would be 0.000044.

Period Prevalence

- Period prevalence measures the frequency of cases of a disease or condition in a specific period of time.

$$Period\ Prevalence = \frac{No.\ of\ Existing\ Cases\ During\ a\ Specific\ Time\ Period}{The\ Average\ or\ Mid-Point\ Population\ Size} \times K$$

Period Prevalence

- Example:
  - In a mass screening of 15000 women, 55 were diagnosed with disease X. During the next 2 years, another 25 of the examined women developed the disease X .

$$Period\ Prevalence = \frac{55 + 25}{15000}\ x\ K$$

$$Period\ Prevalence = \frac{80}{15000}\ x\ 1000$$

= 5.3 per 1000 women within two years.

Incidence

- Incidence measures the development or occurrence of new cases of a disease in a population during a specific period, i.e. the frequency of new cases in the population at risk during a specific period of time.

$$Incidence\ Rate = \frac{No.\ of\ New\ Cases\ Within\ a\ Specific\ Period}{The\ Total\ Population\ at\ Risk} \times K$$

- Incidence rate is the occurrence of new cases of a disease within a defined population at risk during a specified period of time.

Incidence

- For the mass screening of 15000 women,

$$Incidence\ Rate = \frac{25}{15000 - 55}\ x\ K$$

- Example:
  - In a population with an estimated mid-year population of 50,000 people, 200 new cases of TB were reported in 2017. Calculate the IR.

$$Incidence\ Rate = \frac{200}{50{,}000}\ x\ 1000$$

IR = 4 cases per 1000 population year.

Incidence Proportion (IP)

- Can be calculated only in cohorts.
- A cohort is a closed population (Latin *cohors* which was the basic tactical unit of a Roman legion) made up of members sharing some common characteristics or traits.

$$\text{IP} = \frac{\text{No. of onsets over time}}{\text{No. at risk at beginning of study}}$$

- Synonyms of Incidence Proportion
  - Risk, Cumulative Incidence, Attack Rate
- Interpretation: average risk.

The Attack Rate

- The attack rate is the incidence rate, expressed as a percentage.
- It describes the incidence of disease when the population at risk is exposed for a short period, e.g. food poisoning outbreak.

- Attack rate = $\frac{\text{Number of people affected}}{\text{Number of people exposed}} \times 100$

The Attack Rate

- Example 1
  - During an outbreak of food poisoning, 250 of the 1000 students were affected.

  Number of students affected = 250

  Number of students exposed to food poisoning = 1000.

$$Attack\ Rate = \frac{250}{1000}\ x\ 100 \quad = 25\%$$

The Attack Rate

- Example 2

  Objective: To estimate the risk of uterine cancer.

  I. A cohort of 1000 women recruited.

  II. 100 had hysterectomies, leaving 900 at risk.

  III. The ‘at risk’ individuals followed for 10 years.

  IV. 10 onsets of uterine cancer observed.

$$IP = \frac{\text{No. of onsets}}{\text{No. at risk}} = \frac{10 \cancel{\text{women}}}{900 \cancel{\text{women}}} = 0.0111$$

- 10 year average risk is 0.11 or 1.1%

The Attack Rate

- The attack rate only differs from the incidence rate if there is a large proportion of persons in the population who are not at risk e.g. children who have been successfully vaccinated against measles may be considered not to be at risk of measles infection.
- Attack rate is often used instead of incidence during a disease outbreak in a narrowly defined population over a short period of time (Bonita *et. al.*, 2006).

The Incidence Rate (IR)

- $$\text{Incidence Rate (IR)} = \frac{\text{Number of onsets}}{\text{Sum of person-time at risk}}$$
- Synonyms:
  - Incidence density; Person-time rate.
- Interpretation A:
  - "Speed" at which events occur.
- Interpretation B:
  - When disease is rare: rate per person-year ≈ one-year risk.
- Calculated differently in closed and open populations.

The Incidence Rate (IR)

- Example

  Objective: To estimate the risk of uterine cancer.

  I. A cohort of 1000 women recruited.

  II. 100 had hysterectomies, leaving 900 at risk.

  III. The 'at risk' individuals followed for 10 years.

  IV. 10 onsets of uterine cancer observed.

$$IR = \frac{\text{No. of onsets}}{\text{Person - time}} = \frac{10 \text{ ~~women~~}}{900 \text{ ~~women~~} \times 10 \text{ years}} = \frac{10}{9000 \text{ years}}$$

$$= \frac{.00111}{\text{year}}$$

- Rate is 0.00111per year or 11.1 per 10,000 years.

Relationship Between I, P and Ď

- For a stable disease, P = I x Ď

  Where,

  P is Prevalence,

  I is Incidence rate

  Ď is Average rate of disease

- For Chronic or endemic disease: P = I x Ď
- Acute disease may not be able to raise many new cases hence, incidence study is preferred.

Uses of the Measures

- Prevalence Measures
  1. Used for determining the extent of the health problem, hence valuable for rational planning of healthcare services.
  2. Useful for monitoring programmes for control of chronic or endemic diseases.
- Incidence measures
  1. determine an individual's risk of acquiring a disease in a population.
  2. Also determine the aetiology of the disease.

Prevalence and Incidence

- Example
  - In January, 3 new cases of trachoma were detected in a village. There were already 10 people in the village who had the disease, but two successfully completed a course of therapy during the month and were considered cured. The population of the village was 2600.
  - The incidence rate is

    (3/2600) x 1000 or 1.2 per 1000 or 0.1%
  - The period prevalence rate is

    (3+10)/2600) x 1000 or 5 per 1000 or 0.5%
  - The point prevalence rate as at 31 January is

    (3+10-2)/2600) x 1000 or 4.2 per 1000 or 0.4%.

Relationship Between Prevalence and Incidence

- When disease is rare and population is stationery:
  - Prevalence =Incidence Rate x Average Duration
- Example:
  - Incidence rate = 0.01/year
  - Average duration of illness = 2 years
  - Prevalence = 0.01/year x 2 years = 0.02 or 2%

Relationship Between Prevalence and Incidence

- The relationship between incidence and prevalence varies among diseases.
- There may be low incidence and high prevalence e.g. diabetes.
- Or a high incidence and a low prevalence, e.g. common cold.
- Colds occur more frequently than diabetes but last only a short time, whereas diabetes is life-long.

Prevalence and Incidence: Relationship

	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 in time.
Denominator	Population at risk	Population at risk
Focus	Whether the event is a new case. Time of the 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 disease or conditions, but also used for chronic diseases. More useful for studies of causation.	Estimate the probability of the population being ill at the period of time being studied. Estimate 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.

Ratio

- A ratio is an expression of the relative frequency of the occurrence of some event compared with some other event.
- Example, the ratio of cases among males to cases among females.
- Perinatal Mortality Ratio

$$= \frac{\text{Number of late fetal deaths after 28 weeks or more gestation plus infant deaths within 7 days of birth}}{\text{Number of live births}} \times 1{,}000 \text{ live births}$$

Measure of Mortality

- Mortality is clearly an index of the severity of a disease from both clinical and public health standpoints.
- Mortality can also be used as an index of the risk of disease.
- Mortality rate is a good reflection of the incidence rate under two conditions:
  1. When the case fatality is high (e.g. in untreated rabies)
  2. When the duration is short.

Measure of Mortality Cont…

- Under these conditions, mortality is a measure of incidence and thus a measure of the risk of the disease.
- Example, cancer of the pancreas: death generally occurs within a few months of diagnosis, and long-term survival is rare.
- Thus, unfortunately, mortality from pancreatic cancer is a good surrogate for incidence of the disease.

Maternal Mortality Rate

- =Number of deaths assigned to causes related to childbirth / Number of live births x 100,000 live births during one year

- Infant Mortality Rate
  - Measures the risk of dying during the first year of life among infants born alive.

= Number of infant deaths among infants aged 0-365 days during the year / Number of live births during the year x 1,000 live births

Annual Mortality Rate

- Annual mortality rate for lung cancer =

$$\frac{\text{Number of deaths from lung cancer}}{\text{Population size at mid-year}} \times 1{,}000$$

Case Fatality Rate

- The percentage of people who die within a certain time after diagnosis with a certain disease.
- In case fatality rate, the denominator is limited to those who already have the disease.
- This is contrary to mortality rate, where the denominator represents the entire population at risk of dying from the disease.
- The numerator of case fatality rate is restricted to deaths from the disease.

Case Fatality Rate

- Case-Fatality Rate

$$= \frac{\text{No. of individuals dying during a specified period of time after disease onset or diagnosis}}{\text{No. of individuals with the specific disease}} \times 100$$

Summary

- Vital statistics is the essential data of life statistics for numerical description of vital events and human demographics.
- In vital statistics, rates measure the relative frequency of cases in a population *during a specified period of time.*
- Incidence measures new cases of a disease; prevalence measures newly occurring plus pre-existing cases within a specified period.

References

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