Measuring the health of a population

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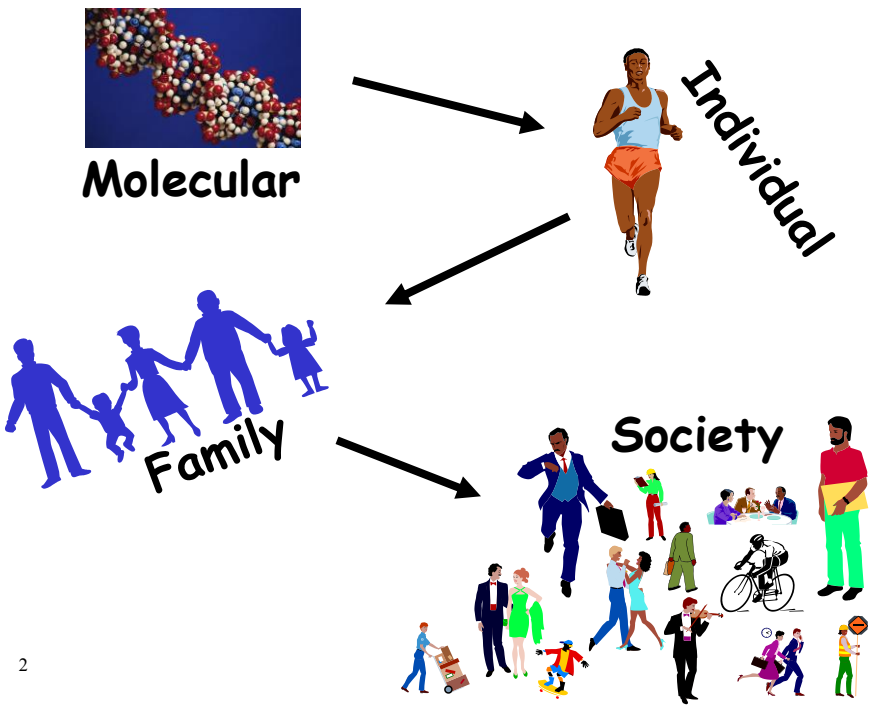

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"When we measure, we know better"

- Center for Disease Control (CDC), Atlanta, Georgia,USA

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"Not everything that can be counted counts, and not everything that counts can be counted"

- Albert Einstein

Key messages

- The measure of health and disease is fundamental to the practice of epidemiology.
- A variety of measures are used to characterize the overall health of populations.
- Population health status is not fully measured in many parts of the world, and this lack of information poses a major challenge for epidemiologists

Health

- **Health is defined as "a state of complete physical, mental & social wellbeing, and not merely an absence of disease or infirmity"**
- **This statement has been amplified to include the ability to lead a "socially and economically productive life"**
- **Measurement have been framed in terms of illness (or lack of health), consequences of ill- health (morbidity, mortality) & economic, occupation & domestic factors that promote ill health**

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National Health Indicators

- **Health indicators:** are used to measure health status of the community.
- They are defined as parameters that can measure changes in the level of health.
- In fact, they are indirect parameters or variables that assess state of the health of the community. Indicators can be:

1.Rates

2.Ratios

3.Proportion (in a specific place and time).

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Uses of Health Indicators

- **Measurement of the health of the community.**
- **Compare health status of one community with another whether in the same continent or globally.**
- **Assessment of health care needs.**
- **Proper allocation of human and non-human resources according to the needs.**
- **Monitoring and evaluation of health services, activities, and programs.**
- **Compare health status of different areas or groups of people over time.**

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Characteristics of Indicators

1. **Valid: They should actually measure what they are supposed to measure, e.g. use of case fatality rate to measure severity of a disease.**
2. **Reliable: give similar results when the measure is used for the same person in different times with similar circumstances.**
3. **Objective: does not depend on subjective feelings of the persons, but depends on defined standards.**
4. **Sensitive: they should be sensitive to the changes in the measured condition .**

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Characteristics of Indicators

5. **Specific: only reflects the changes in the measured condition.**
6. **Feasible: they should have the ability to obtain data needed.**
7. **Relevant: they should contribute to the understanding of the phenomenon of interest.**

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Health Indicator

WHO defines Indicators as "variables which measure change"

- A health indicator is a variable that provides a single numeric measurement of an aspect of health within a population for a special period of time, normally a year.

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Health Indicators measure:

- 1) Health policy and economy: political statements and systems ; expenditure on health and health insurance, ..etc
- 2) Health through life: Birth and death, marriage and fertility, education and housing, …etc
- 3) Morbidity and mortality: incidence and prevalence, attack and fatality, Mortality and disability, …etc
- 4)Health services coverage: health manpower, health centers, hospitals, ..etc

Factors influencing health Indicators

- Health is multidimensional
- Each dimension is influenced by numerous factors
- Economic, occupational, cultural, educational, social

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Health Indicators

- **Mortality indicators**
- **Morbidity indicators**
- **Disability rates**
- **Nutritional status indicators**
- **Health care delivery indicators**
- **Utilization rates**
- **Indicators of social and mental health**
- **Environmental indicators**
- **Socio-economic indicators**
- **Health policy indicators**
- **Indicators of quality of life**
- **Other indicators**

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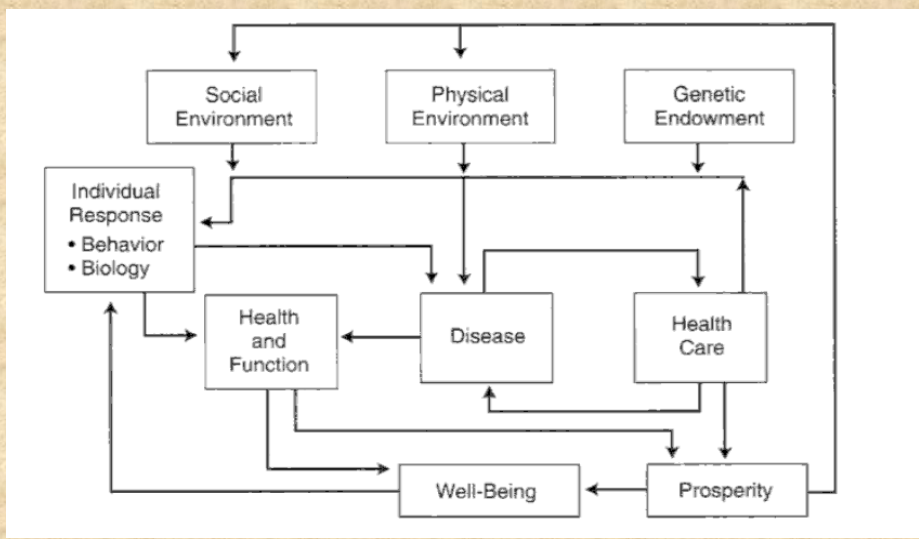
Measuring Health



- Practical definitions of health and disease are needed in epidemiology, which concentrates on aspects of health that are easily measurable and amenable to improvement

Demography

Age structure

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The importance of age structure

The age structure has a special role in Demography

The main reason: the strong relationships between age structure and demographic processes

On the other side, the age structure of a population is determined by these same demographic processes

Finally, broad societal processes that may be determinants of demographic change (and therefore age structure) may themselves be affected by the age structure of the population

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Age-sex Pyramids

A simple graphic tool describing the age-sex structure of a given population at a specific point it time

It is in practice a kind of (double) histogram (one for each sex) representing the population size for each age (and sex) group shifted 90^0 in a way that the lowest age groups are at the basis of the graph and each sex looks into the opposite direction (usually females right and males left)

The X axe represents the size of the age group and the Y axe its age (or year of birth)

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The pyramid shape

Age structure is the result of the fertility, mortality and at times also migration patterns the specific population went through during the last decades

Since these patterns many times leave a unique stamp on the pyramid shape, the age-pyramid may serve as a "story teller" of the demographic history of the specific population

Age structure indicators: Proportions at different ages and specifically children (0-14), old people (65+) and those at working ages (15-64)

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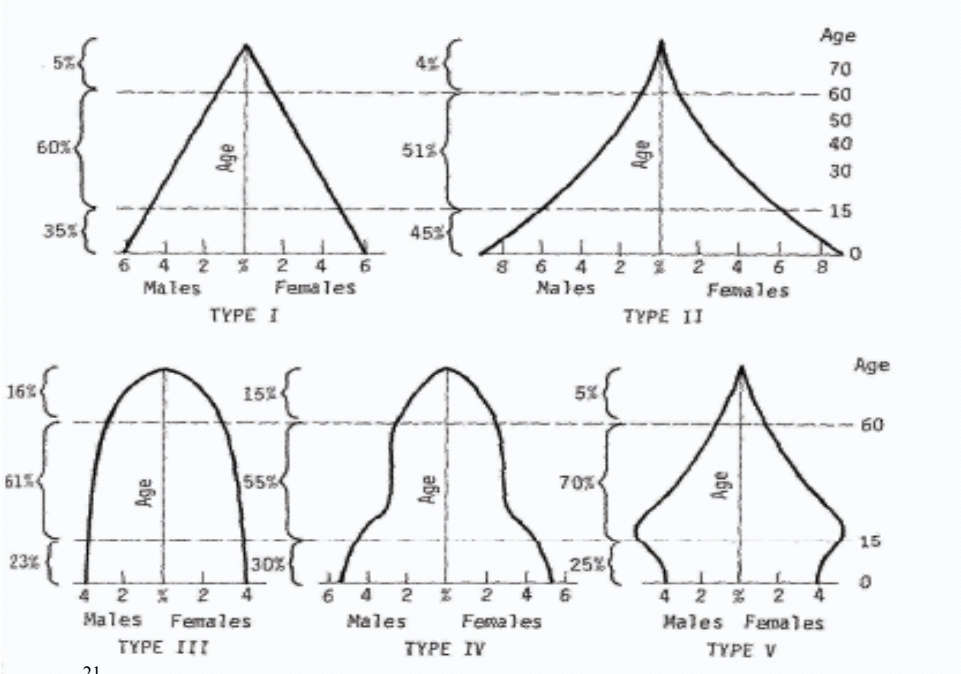

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FIGURE 8-1. A typology of population pyramids. (Source: Hartley, 1972:35.)

Other age structure indicators

Besides the proportions at different ages two additional common indicators are:

Sex ratio by age

The age dependency ratio

Sex ratio: usually men to women (x100) – beginning with a slight advantage for men (106) diminishes continuously arriving at high ages to very low levels (50 men to 100 women)

Dependency ratio: a simple indicator connecting between age structure and economic issues

Population Growth Rate

- **Population Growth Rate**: Growth of the population size in one year expressed in percent.
- **Total Fertility Rate**: The number of children that would be born per women if she were to live to the end of the childbearing years and bear children at each age in accordance with the prevailing age-specific fertility rates.

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Life Expectancy

- $LE_{age\ X}$ = average number of years a person aged x will live, if subject to the mortality rates contained in the life table (i.e. if the age-specific death rates for a given year prevailed for the rest of that person's life)

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"In the long run, we are all dead"
- John Maynard Keynes

- Good indicator of socioeconomic development
- Positive health indicator of long time survival

- Is there an upper limit to life expectancy?
- **Compression of mortality**: An increasing of concentration of deaths at older ages
- **Compression of morbidity**: An increasing of illness and disability in the latter years of life with fewer years of disabled life before death among the elderly
- Are health gains matching or exceeding gains in survival?

If there is no compression of mortality and no postponement of morbidity, then increasing life expectancy will result in growing numbers of ill and disabled elderly, creating increasing burdens on the health care system and society

Measures of Mortality

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Measures of Mortality

- Crude Death Rates
- Age-Specific Death Rates
- Life Table Estimates
  - –Life expectancy
  - –Survivorship (by age)
- Cause-Specific Death Rates
- Special Indicators
  - –Infant and maternal mortality rates

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Indicators

- Midyear population is an approximation of the average population exposed to risk
- Total person-years lived is a better denominator if available

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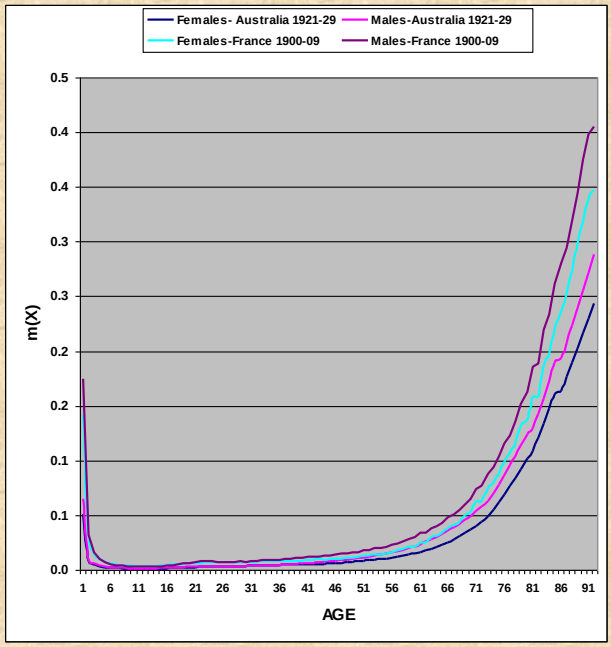
Mortality curves



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Annual Death Rates

- "General" (crude) mortality rate
  - a population group exposed to risk of death
  - a time period
- Crude Mortality Rate = # of deaths occurring in that population during that period of time

$$\text{Annual death rate from all causes} = \frac{\text{Total numbers of death during a specific 12-month time period}}{\text{Number of persons in the total population at middle of the time period}} \times 1{,}000$$

Crude Death Rates

- Does NOT account for differences of age, sex, etc. in any aspect of death
- Info needed:
  - total deaths
  - total population
  - a given period of time

$$\text{CDR} = \frac{\text{Total deaths per year}}{\text{Average total population of that year}} \times 100{,}000$$

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Crude Death Rates
Points to Note

- Risks of death change by age, so CDR is affected by population age structure
- Aging populations can have rising CDRs, even as the health conditions are improving
- LDCs with very young populations will often have lower CDRs than MDCs even though their overall health conditions are poorer
- Therefore mortality comparisons across countries should always use mortality indicators that are adjusted for differences in age composition

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Specific Mortality Rates
Age specific mortality rate

$$\text{Age specific mortality rate} = \frac{\text{Number of deaths of persons age 1–14 in a given year}}{\text{Total persons aged 1–14 in the same period (1 year)}} \times 100{,}000$$

$$\text{Age specific mortality rate} = \frac{\text{Number of deaths of rural elderly age 55+ in a given year}}{\text{Average population of rural elderly in the same period}} \times 100{,}000$$

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Infant Mortality

Number of deaths before one year of age (from a specific cause or all causes) divided by total number of live births (/100,000 live births)

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Specific Death Rates

$$\text{Infant mortality rate} = \frac{\text{Number of child deaths less than 1 year old in one year}}{\text{Number of live births in the same year}} \times 1{,}000$$

$$\text{Infant death rates under one year} = \frac{\text{Number of child deaths less than 1 year old in one year}}{\text{Total population}} \times 100{,}000$$

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Why IMR?

- **Good indicator of overall health status (and healthcare) of a population**
- **Major determinant of LE at birth**
- **Sensitive to changes in socio-economic conditions**
- **availability, utilization &effectiveness of health care, particularly perinatal care.**

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- **The Most Common Causes of Infant Mortality Worldwide**

1. Pneumonia
2. Diarrhea (dehydration)

- **Major Causes of Infant Mortality in developed countries include:**

1. Congenital Malformation
2. Infection
3. Sudden Infant death Syndrome (SIDS)

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Childhood Mortality

- **Infant Mortality: Number of deaths of infants one year of age or younger per 1000 live births.**
- **Perinatal Mortality**: The total number of deaths of the fetus from a gestational age of **28 weeks** to the **seventh day** of life of the newborn.
- **Neonatal Mortality**: Only includes deaths in the first 28 days of life.
- **Post-Neonatal death**: Only includes deaths after 28 days of life but before one year.
- **Child Mortality**: Includes deaths within the first five years after birth.

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Specific Death Rates

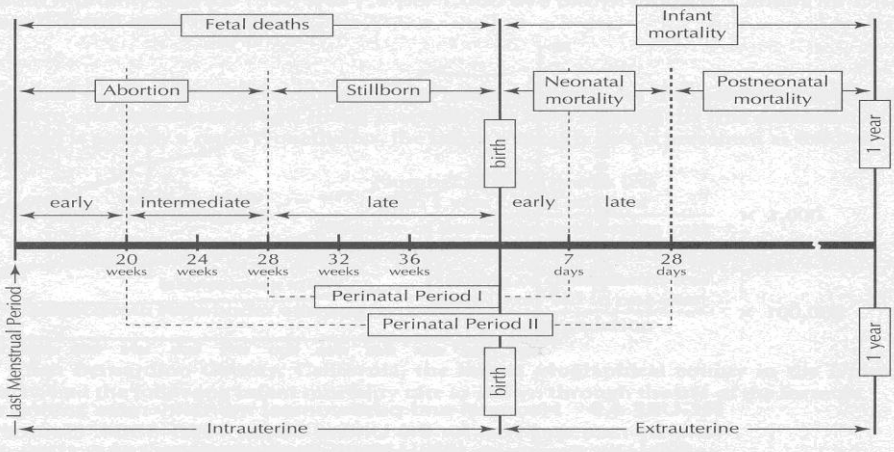

FIGURE 4.10 Chart of early life mortality measures.

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Child Mortality Rate (Under- Five Mortality Rate)

- **The annual number of children dying between birth and exactly five years of age, expressed per 1000 live births.**
- **Correlates with inadequate MCH services, malnutrition, low immunization coverage and environmental factors**
- **Other indicators are Perinatal mortality rate, Neonatal mortality rate, Stillbirth rate, etc.**
- **Correlates with inadequate antenatal care and perinatal care.**

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Causes of Child Mortality

- According to **UNICEF** most child mortality result from one of the following causes or a combination of:

1. Acute Respiratory Infection (ARI)
2. Diarrhea
3. Malaria
4. Measles
5. Malnutrition
6. Perinatal Disorders

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Maternal Mortality Rate

- **Number of maternal deaths per year per 100000 women aged 15-49 years. (Reproductive Age of women is 15-49 years).**
- **Accounts for the greatest number of deaths among women of reproductive age in developing countries.**

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Maternal Mortality Rate

$$= \frac{\text{\# of Maternal Deaths}}{\text{\# of women ages 14-49}} \times 100{,}000$$

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Maternal Mortality

- According to WHO "A maternal death is defined as the death of a women while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes".

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Major Causes of Maternal Mortality

- According to WHO Report (2005) Major Causes of Maternal Death are:

1. Severe bleeding/hemorrhage (25%)
2. Infections (13%)
3. Unsafe abortions (13%)
4. Eclampsia (12%)
5. Obstructed labor (8%)
6. Other direct causes (8%)
7. Indirect causes (20%), such as malaria, anemia, HIV/AIDS, CVD complicate pregnancy or are aggravated by it.

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Maternal Mortality Ratio (MMR)

- Number of deaths of women from pregnancy- related causes per 100000 live births.
- The MMR is used as a measure of the quality of a health care system.
- Measures the risk of death among pregnant and recently delivered women.

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Maternal Mortality Ratio

$$= \frac{\#\ of\ Maternal\ Deaths}{\#\ of\ live\ births} \times 100{,}000$$

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Case fatality

- Case fatality is a measure of disease severity and is defined as the proportion of cases with a specified disease or condition who die within a specified time. It is usually expressed as a percentage.

$$\text{Case fatality}(\%) = \frac{\text{Number of deaths from diagnosed cases in a given period}}{\text{Number of diagnosed cases of the disease in the same period}} \times 100$$

Measures of Morbidity

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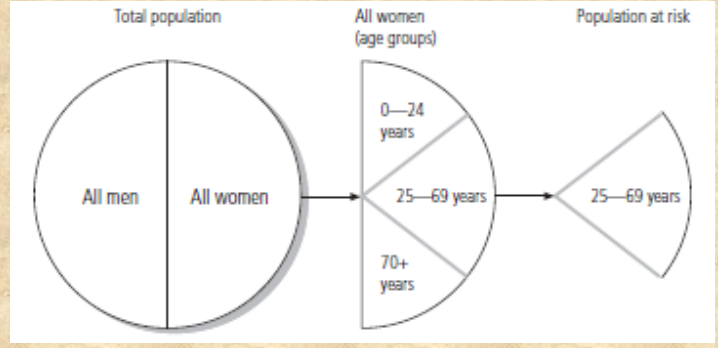
Population at risk

- An important factor in calculating measures of disease frequency is the correct estimate of the numbers of people under study.
- Ideally these numbers should only include people who are potentially susceptible to the diseases being studied. For instance, men should not be included when calculating the frequency of cervical cancer.

Population at risk in a study of carcinoma of the cervix



Prevalence

- **Number of persons who have a particular disease/condition (existing cases) at a given point in time per 10^n population**
- **Snapshot of an existing health situation**
- **Includes all known cases of a disease that have not (yet) resulted in death, cure (or remission)**

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The proportion of a population-at-risk affected by a "disease" at a specific point in time

Prevalence rate (P) is calculated as:

$$\frac{\text{\# of people with the disease at a specific time}}{\text{\# of people in the population at-risk at the specified time}} \times 10^n$$

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Point Prevalence

- Calendar time (ex. Oct 10, 2007)
- Babies born between Jan 1 – Dec 31, 2006
  - Of 20,000 born, 60 had symptoms of malformation
- Infants who enter a study when they show up at the clinic and are examined only once

Point Prevalence

Proportion of individuals in a specified population at-risk who have a disease/condition of interest at a given point in time

Period Prevalence

- **Proportion of individuals in a specified population at-risk who have a disease/condition of interest over a specified period of time**
- **Examples: annual prevalence rate, lifetime prevalence rate**

- **Point Prevalence** rate = $\frac{\text{\# persons with the condition}}{\text{total number of persons}}$ **at a point in time**
- **Period Prevalence** rate = $\frac{\text{\# persons with condition}}{\text{total number of persons}}$ **in a specified period of time**

Asthma question

Interview question:

Do you currently have asthma?

Type of measure:

- **Point prevalence?** ✓
- **Period prevalence?**
- **Lifetime prevalence?**

Asthma question

Interview question:

Have you had asthma in the last 10 years?

Type of measure:

- **Point prevalence?**
- **Period prevalence?** ✓
- **Lifetime prevalence?**

Asthma question

Interview question:

Have you ever had asthma?

Type of measure:

- **Point prevalence?**
- **Period prevalence?**
- **Lifetime prevalence?** ✓

Factors influencing observed prevalence rate

- Longer duration of the disease
- Prolongation of life without cure
- Increase in new cases (incidence / risk)
- Out-migration of non-diseased people
- In-migration of susceptible/diseased people
- Improved diagnostics &/or reporting

Factors influencing observed prevalence rate

- Shorter duration of the disease
- Increased case-fatality rate
- Decrease in new cases (incidence / risk)
- In-migration of "healthy" people
- Out-migration of diseased people
- Improved cure rate

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Incidence

An incidence measure takes into account the number of individuals in a population that become ill and the time period experienced by members of the population during which these events (disease) occur

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Incidence

Members of the population who are not susceptible to the disease (not at risk) are excluded from the denominator when calculating disease frequencies

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Incidence

$$\frac{\text{number of NEW cases of disease occurring in a population during a specified period of time}}{\text{number of persons AT RISK of developing the disease during that period of time}}$$

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Morbidity Indicators

1. **Notification rates is calculated from the reporting to public authorities of certain diseases . yellow fever , poliomyelitis, cholera, plague**

   •They provide information regarding geographic clustering of infections, quality of reporting system

2. **Attendance rates at health centers.**
3. **Admission, Readmission and discharge rates.**
4. **Duration of stay in hospital – reflects the virulence and resistance developed by the etiological factor**
5. **Absence from work or school: reflects economical loss to the community**
7. **Hospital data constitute a basic and primary source of information about diseases prevalent in the community.**

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Socio-economic indicators

- **These do not directly measure health but are important in interpreting health indicators**
  - **Level of unemployment**
  - **Illiteracy rate**
  - **Poverty**
  - **Population**
  - **Total Fertility Rate (TFR)**
  - **Family size**
  - **Population increase rate**
  - **Contraceptive use**

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Health Policy Indicators

- **The single most important indicator of political commitment is allocation of adequate resources**

- **The relevant indicators are:**
  - **Proportion of GDP spent on health services-**
  - **Proportion of GDP spent on health related activities like water supply and sanitation & housing and nutrition**
  - **Proportion of total health resources devoted primary health care**

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Indicators of Quality of Life

- **Human Development Index**
  - **Life expectancy at birth**
  - **Literacy rate**
  - **Income- GDP per capita income**

- **The result is placed on the 0 to 1 scale**

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