Session 2: Epidemiological Measures of Disease.
Part 4: Mortality Measures
Learning Objectives

• In epidemiologic studies
  • Identify and calculate commonly used measures of mortality
Measures of Mortality

- **Mortality rate** = incidence of death in a population
- Number of deaths occurring in a specified population in a given time period
- You can only die once – so the numerator can only be incident cases
- You are at risk of dying all your life!

- When is a mortality rate a good surrogate for an incidence rate of disease?
  - When survival is low
Examples of mortality rates

• Crude mortality: total death rate in an entire population (generally per 100,000 person-years)

• Cause-specific mortality rate: rate at which deaths occur for a specific cause
  • # of deaths from specific cause/total population for a given year

• Age-specific mortality
  • # deaths for age group/total population in age group for a given year
Possible Reasons for Changes in Mortality Trends of Disease

• **Artifactual**
  • Error in the numerator due to:
    • Changes in the recognition of disease
    • Changes in rules and procedures for classification of causes of death
    • Changes in accuracy of reporting age at death
  • Error in the denominator due to:
    • Enumeration of the population
Possible Reasons for Changes in Mortality Trends of Disease (cont.)

• **Real**
  • Changes in age distribution of the population
  • Changes in survivorship due to treatment
  • Changes in incidence of disease resulting from genetic factors, environmental factors or prevention (e.g. vaccination)
Proportionate Mortality Ratio

- Useful for identifying leading causes of death
- Gives the relative importance of a specific cause of death in relation to all deaths

\[
PMR = \frac{\text{# of deaths from given cause in specified time period}}{\text{Total deaths in same time period}} \times 100\%
\]
Leading Causes of Death

• PMR
  • Lives that can be saved
  • Magnitude depends on deaths from other causes (e.g. unintentional injuries among children vs. elderly)

<table>
<thead>
<tr>
<th>Age</th>
<th>Death Rate/100,000 All causes</th>
<th>Death Rate/100,000 Accidents</th>
<th>PMR for accidents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>70</td>
<td>28.2</td>
<td>40.0</td>
</tr>
<tr>
<td>65-74</td>
<td>3190</td>
<td>65.5</td>
<td>2.1</td>
</tr>
</tbody>
</table>
Case Fatality (Rate)

• Refers to proportion of fatal cases among those who have the disease
• Provides an index of the deadliness of a particular disease within a specific population

\[
CFR = \frac{\text{# of deaths due to disease } X}{\text{Number of cases of disease } X} \times 100
\]
Comparing Mortality Rates and CFRs

• Example: Rabies
  • Deaths from human rabies is rate in the US

• Cause-specific mortality rate would be low
  • Small numerator (# deaths due to rabies)
  • Total population denominator

• Case fatality would be high
  • Because once symptomatic, death is almost certain
  • Numerator (# deaths due to rabies) almost the same as denominator (# cases of rabies)
What is the question?

• Cause-specific Mortality Rate
  • What is the risk of death from disease X for this population?

• Case Fatality
  • What proportion of cases of disease X are fatal?

• PMR
  • What proportion of all deaths is attributable to disease X?
Question 1

• In the year 2000, City A had a population of 200,000. 200 existing cases of colon cancer were reported, 80 of which were diagnosed in 2000. 50 deaths were attributed to colon cancer.

• What measure would we use to estimate the need for resources devoted to colon cancer treatment?

  Prevalence = 200/200,000 = 0.001x100,000 = 100 per 100,000
Question 2

• In the year 2000, City A had a population of 200,000. 200 existing cases of colon cancer were reported, 80 of which were diagnosed in 2000. 50 deaths were attributed to colon cancer.

• What measure would we use to estimate the average risk of colon cancer?

  Incidence $80/200,000 = 0.0004 \times 100,000 = 40$ per 100,000
Question 3

• In the year 2000, City A had a population of 200,000. 200 existing cases of colon cancer were reported, 80 of which were diagnosed in 2000. 50 deaths were attributed to colon cancer.

• What measure would we use to estimate the death rate for colon cancer?

  Cause-specific mortality rate = 50/200,000 = 0.00025 x 100,000 = 25 per 100,000
Question 4

• In the year 2000, City A had a population of 200,000. 200 existing cases of colon cancer were reported, 80 of which were diagnosed in 2000. 50 deaths were attributed to colon cancer.

• What measure would we use to estimate the proportion of colon cancers that are fatal?

Case fatality rate = 50/200 = 0.25 x 100 = 25%
Infant Mortality

- Defined as deaths under 1 year
Neonate Mortality

• Neonatal death – death during the first 28 days (0-27 days)

\[
\text{Neonatal Mortality Rate (NMR)} = \frac{\text{No. of neonatal deaths (0 –27 days)}}{\text{No. of live births}} \times 1000
\]

• Indicator of newborn care
  • Prenatal
  • Intrapartum
  • Neonatal care
Under-five Mortality

• A child dying between birth and five years of age
Maternal Mortality

\[
\text{Maternal Mortality} = \frac{\text{No. of deaths related to childbirth}}{\text{No. of live births}} \times 100,000
\]

- Denominator = only live births
  - Ideally would be all pregnancies
  - Registration more complete for live births than for miscarriages/fetal deaths
Other “Rates”

• Crude birth rate:
  • Number of live births per average population
  • Not quite a rate nor a proportion – more a ratio

• Fertility rates:
  • Rate of live births per population of women of child-bearing age
  • Not quite a rate – not all women are ‘at risk’ of pregnancy
  • Not time ‘at risk’
Life expectancy

• Aka LONGEVITY

Average number of years that a group of infants would live if the group was to experience throughout life the age-specific death rates present in the year of birth
Life Expectancy

• Has increased throughout the world
• US 70.8 years in 1970 to 78.7 years in 2010
• Improved life expectancy due to:
  • Transition from infectious to chronic diseases
  • Improved perinatal care
  • Advances in medicine and healthcare
  • Access to healthcare
Life expectancy

• Factors which reduce life expectancy
  • Reduced survival of children and young adults
    • Childhood mortality (infant, neonatal mortality)
    • Higher death rates among young adults due to diseases including CVD, diabetes, cancer, homicide, suicide, and unintentional injuries
Standardization

- Crude measures
  - Summary measures for total population

- Specific measures
  - Measures for population subgroups
  - Restricts the numerator and denominator to specific subgroups (age, sex, race)

- Adjusted measures
  - Summary measures for total population statistically transformed to remove the effect of differences in population composition (such as age)
  - Allows fair comparisons
Standardization

• Why standardize (adjust)?

Example: Incidence densities in two hypothetical populations stratified by age

<table>
<thead>
<tr>
<th>Age</th>
<th>Population A</th>
<th></th>
<th>Population B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases</td>
<td>Person-years</td>
<td>ID</td>
<td>Cases</td>
<td>Person-years</td>
</tr>
<tr>
<td>0-34</td>
<td>99</td>
<td>99,000</td>
<td>1</td>
<td>1,000</td>
</tr>
<tr>
<td>35+</td>
<td>10</td>
<td>1,000</td>
<td>990</td>
<td>99,000</td>
</tr>
<tr>
<td>All</td>
<td>109</td>
<td>100,000</td>
<td>991</td>
<td>100,000</td>
</tr>
</tbody>
</table>

• Primarily to compensate for differential age distributions among comparison populations
  • E.g. to remove the influence of age when comparing rates between two populations
Standardization

• Advantages
  • Difference in adjusted factor between populations is removed
  • Permits unbiased comparison relative to adjusted factor

• Disadvantages
  • Artificial rate
  • Absolute magnitude depends on standard population chosen
  • Does not represent the actual risk of death or disease
Summary

• Variety of mortality measures
• Numerator: number of deaths
• Denominator:
  • Key component of mortality measures
  • Driven by question of interest