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

$$\text{PMR} = \frac{\text{\# of deaths from given cause in specified time period}}{\text{Total deaths in same time period}} \quad \text{Per 100}$$

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)

Age	Death Rate/100,000		PMR for accidents (%)
	All causes	Accidents	
1-4	70	28.2	40.0
65-74	3190	65.5	2.1

Case Fatality (Rate)

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

$$\text{CFR} = \frac{\text{\# of deaths due to disease X}}{\text{Number of cases of disease X}} \times 100$$

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 x 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

$$\text{Infant Mortality Rate} = \frac{\text{\# of deaths among infants < 1 year in specified time period}}{\text{\# live births in same time period}} \times 1{,}000$$

Neonate Mortality

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

$$\text{Neonatal Mortality Rate (NMR)} = \frac{\text{No. of neonatal deaths } (0-27 \text{ days})}{\text{No.of live births}} \text{ x } 1000$$

- Indicator of newborn care
  - Prenatal
  - Intrapartum
  - Neonatal care

Under-five Mortality

- A child dying between birth and five years of age

$$\text{Under-5 Mortality Rate} = \frac{\text{No. of under-five deaths (0 days to < 5 years)}}{\text{No.of live births}} \text{ x } 1000$$

Maternal Mortality

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

- 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

	Population A			Population B		
Age	Cases	Person-years	ID	Cases	Person-years	ID
0-34	99	99,000	100	1	1,000	100
35 +	10	1,000	1,000	990	99,000	1,000
All	109	100,000	109	991	100,000	991

- 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