Epidemiologic Measures of Disease Burden and Distribution: Part IV Mortality Measures

OUHSC College of Medicine

Foundations of Biostatistics and Epidemiology

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In this 4-part series, we will discuss epidemiologic measures of disease burden and distribution.

In this final module, I present information related to epidemiologic measures that are commonly used to summarize mortality.

Learning Objectives

- In epidemiologic studies,
  - Identify and calculate commonly used measures of mortality

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After completing this module, you will be able to identify, calculate and interpret 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

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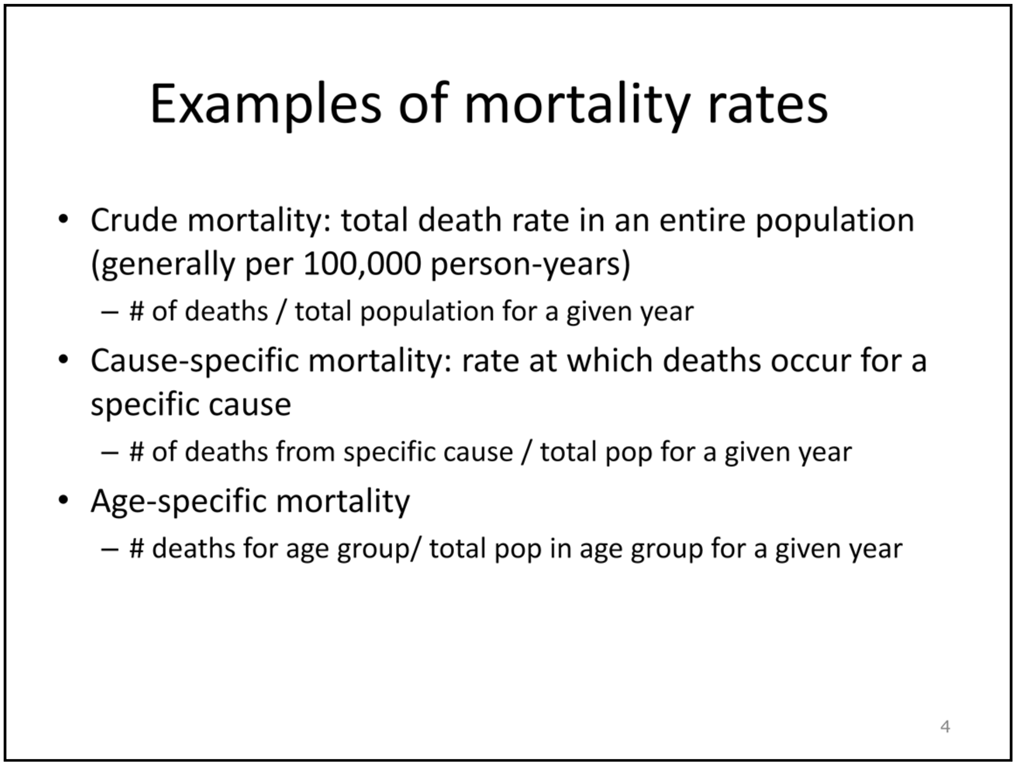
The mortality rate is defined as the incidence of death in a population and is calculated as the number of deaths occurring in a specific population in a given time period. The numerator and denominator are straightforward; the numerator reflects the number of deaths while the denominator reflects the number at risk of dying.

Mortality rates are commonly used as surrogates for incidence data because the data are more readily available, for example through death registries or vital statistics databases.

When is a mortality rate a good surrogate for an incidence rate of disease?

When survival is low.

Note that the mortality rate is not good surrogate for incidence of diseases that are non-fatal or fatal only after a long duration of disease.



Examples of mortality rates include the following:

The crude mortality reflects the total death rate in an entire population (generally per 100,000 person-years) and is calculated as the # of deaths / total population for a given year.

The cause-specific mortality is the rate at which deaths occur for a specific cause and is calculated as the # of deaths from specific cause / total pop for a given year.

The age-specific mortality is calculated as the # deaths for age group/ total pop 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

When we study changes in mortality rates over time, we need to keep in mind that those changes may be real or may be artifactual.

Artifactual changes can arise if there is an error in the numerator due to changes in the detection or diagnosis of disease or if there are changes in rules and procedures for classification of causes of death. There may also be changes in the accuracy of reporting age at death. All of these sources of change may result in changes in the mortality rate over time where the change in the rate is a due to an artifactual reason and not due to an actual change in the mortality rate.

Artifactual sources may also reflect the error in the denominator due to errors in the enumeration of the population

(e.g., changes in the census methods).

Possible Reasons for Changes in Mortality Trends of Disease

- 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 (i.e. vaccination)

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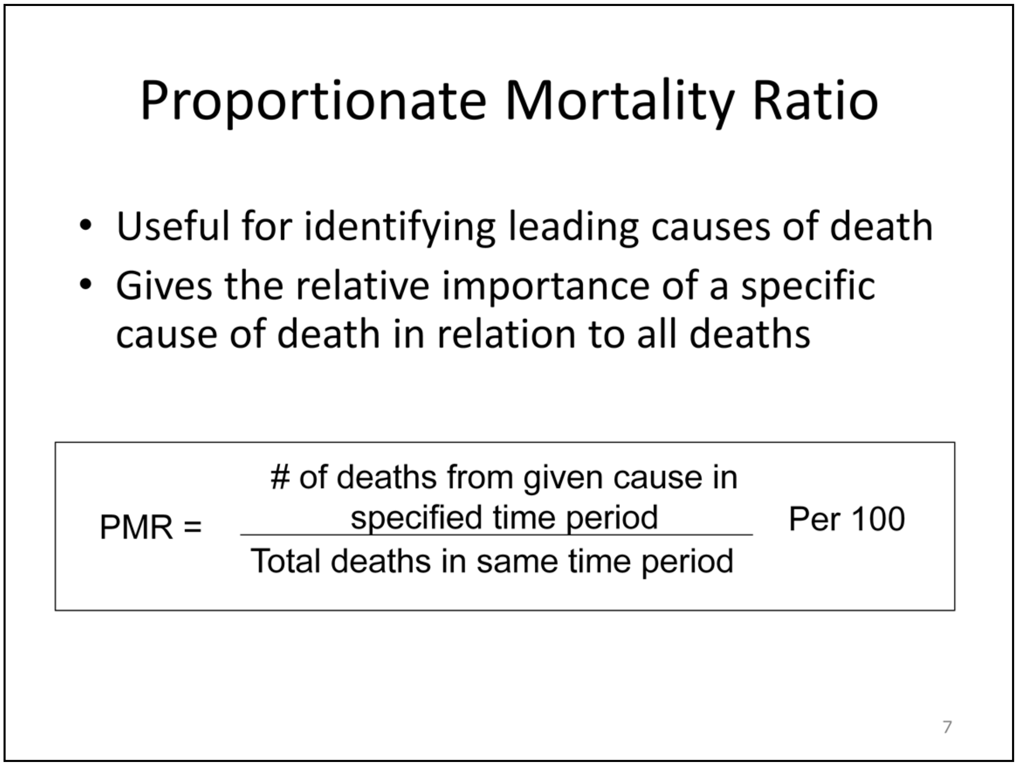
Real changes in mortality trends may arise doe to changes in age distribution of the population; changes in survivorship due to treatment; or changes in incidence of disease resulting from genetic factors, environmental factors or prevention (i.e. vaccination) to name a few causes.



Now, let's consider some additional measures of mortality.

First, let's consider the proportionate mortality ratio. This is calculated as the number of deaths from a given cause in a specific time period divided by the total number of deaths in the same time period.

This is useful for identify leading cases of death and provides a measure of the relative importance of a specific cause of death in relation to all deaths.

Keep in mind that **PMR is not a rate** so it is not a measure of risk of dying because the denominator is 'total deaths' not 'total person time at risk'.

The PMR only indicates the relative importance of a specific cause of disease within a particular population.

The PMR should be used with caution when comparing populations because different populations may have different rates of total mortality (so the denominator is different).

Leading Causes of Death

- PMR
  - lives that can be saved
  - magnitude depends on deaths from other causes
    - ex: unintentional injuries among children vs. among elderly (source: NCHS 1975)

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

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PMR permits an estimation of the lives that could be saved by eradication of a given cause of death.

However, PMRs can be misleading because the magnitude depends on death from other causes besides the condition being evaluated.

In this example, we show that the proportion of deaths due to accidents is greater for young children than for the elderly.

(Of all deaths occurring in this age group, accidents account for 40%); however, the death rates from accidents are actually higher among the elderly.

The reason for the discrepancy in ranking is that the total number of deaths (denominator for PMR) is higher in the elderly.

Case Fatality

- 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

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

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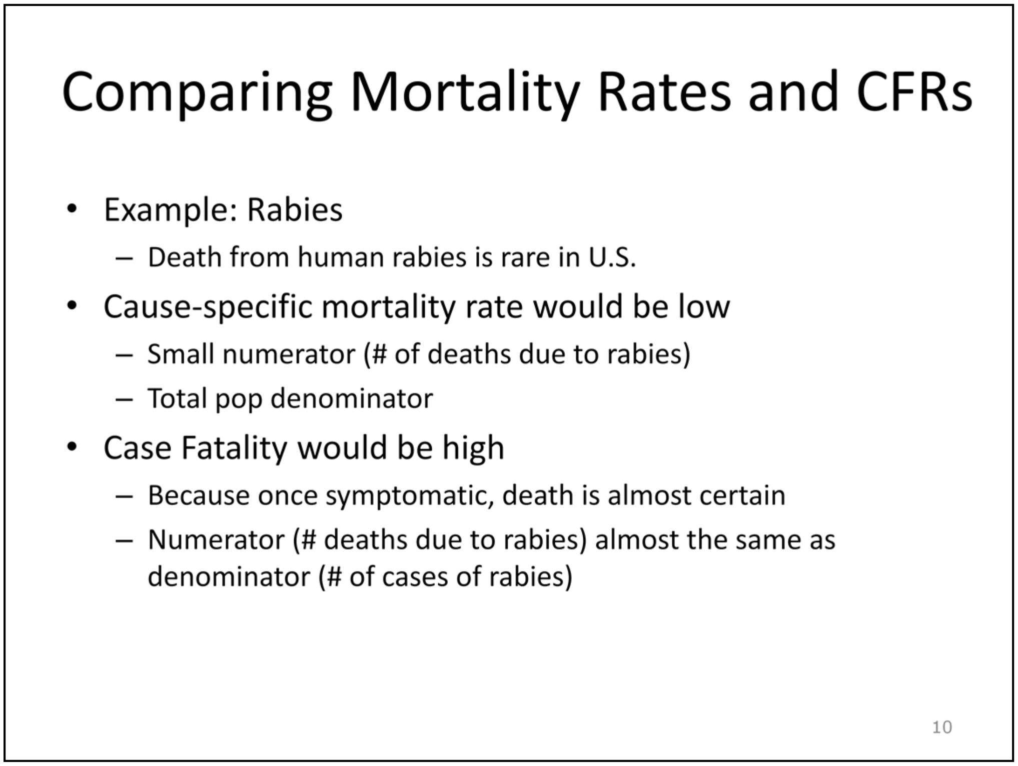
Another useful measure of mortality is the case fatality.

Case fatality is calculated as the number of deaths due to disease X divided by the number of cases of disease X.

The case fatality ratio refers to the proportion of fatal cases among those who have the disease and provides an index of the deadliness of a particular disease within a specific population.



It is helpful to pause and compare cause-specific mortality rates and case fatality ratios.

Consider rabies where deaths due to rabies are rare because post-exposure prophylaxis is highly effective.

For any particular year, the cause-specific mortality rate will be low because the numerator reflects the number of deaths due to rabies and the denominator reflects the total population.

In contrast, the case fatality ratio would be high because once symptomatic, death is almost certain. The numerator, which is the number of deaths due to rabies, is almost the same as the denominator, which is the number of 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?

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When selecting an appropriate measure of mortality, focus on the question of interest.

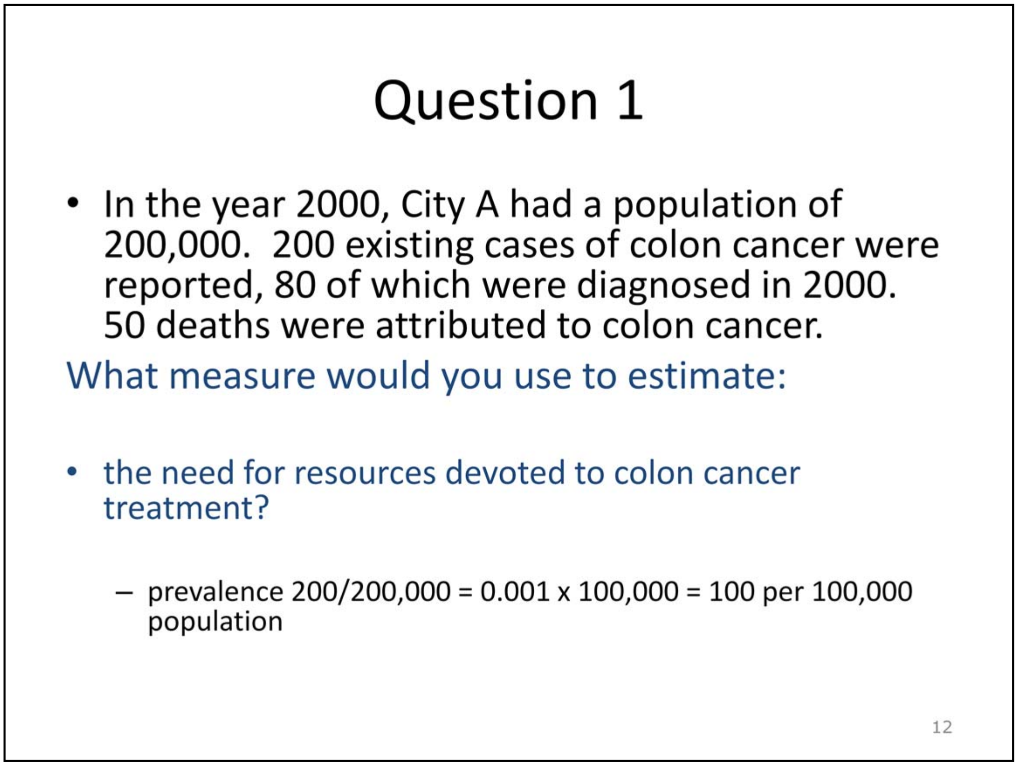
When considering the cause-specific mortality rate, the case fatality ratio, and the proportionate mortality ratio, we see that the numerator is the same in all measures, i.e., the number of deaths.

The difference among the measures lies in the denominator. The denominator value differs depending on the question.

When calculating the mortality rate, the denominator is the total population.

When calculating the case fatality ratio, the denominator is the number of cases of disease.

When calculating the proportionate mortality ratio, the denominator is the number of all deaths.



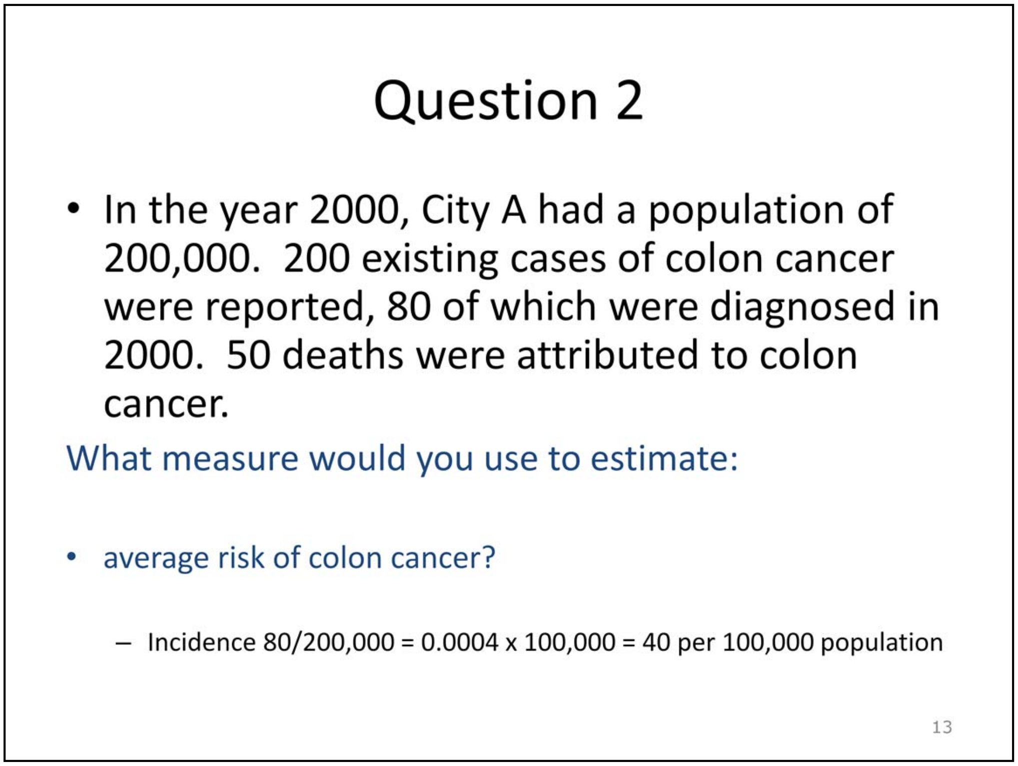
Let's consider a data example and a variety of questions.

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 you use to estimate the need for resources devoted to colon cancer treatment?

The measure of interest is prevalence.

Prevalence is calculated as the number of colon cancer cases divided by the population.

200/200,000 = 0.001 x 100,000 = 100 per 100,000 population



In this same data example, what measure would you use to estimate the average risk of colon cancer?

The cumulative incidence rate is the measure of interest.

Incidence is calculated as the number of new cases diagnosed in 2000 divided by the number at risk for developing colon cancer. As an approximation, we can use the total population because subtracting the number of existing cases (120) won't have a notable impact on the estimate. The calculation is 80/200,000 = 0.0004 x 100,000 = 40 per 100,000 population

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 you use to estimate:

- death rate for colon cancer?
  - Cause-specific mortality rate = 50 / 200,000 = 0.00025 x 100,000 = 25 per 100,000 population

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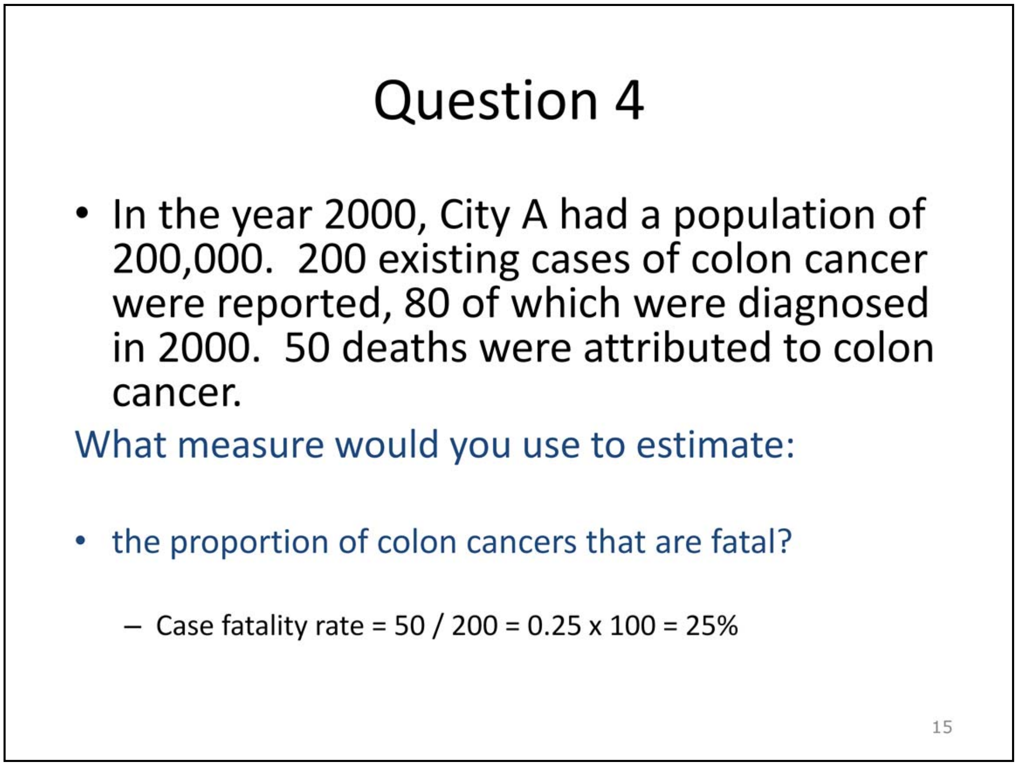
In this same data scenario, what measure would you use to estimate the death rate for colon cancer?

The measure of interest is the cause-specific mortality rate.

The cause-specific mortality rate is calculated as the number of deaths due to colon cancer divided by the population size = 50 / 200,000 = 0.00025 x 100,000 = 25 per 100,000 population



In this same data scenario, what measure would you use to estimate the proportion of colon cancers that are fatal?

The measure of interest is the case fatality ratio.

The case fatality ratio is calculated as the number of deaths due to colon cancer divided by the number of colon cancer cases = 50 / 200 = 0.25 x 100 = 25%

Summary

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

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There are a variety of measures that can be used to summarize morality information.

Keep in mind that while the numerator term is straightforward, the number of deaths, the denominator will influence the inference that can be drawn.

The specific mortality measure is dictated by the question of interest.