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N442 Population and Global Health

Rate Calculation Work Sheet

Rate: is a measure of the frequency of a health event in "a defined population, usually in a specified period of time." (Porta, 2009, p 207) It is a ratio of one number to another, but it is not a proportion (percentage), because the denominator is a function of both the population size and the dimension of time, whereas the numerator is the number of events (Stanhope & Lancaster, 2016, p262)

Three categories:
Crude: Rates computed for a population as a whole
Specific: Rates calculated for subgroups of a population
Adjusted: Rates calculated to compare populations with different distributions of a factor known to affect the health condition of interest.

Two types of rates are especially important in epidemiology. These are morbidity (illness) and mortality (death) rates. There are several specialized rates in each of these two broad categories.

Some examples of these specialized **mortality (death) rates** are:

1. **Crude death rate:** the proportion of the population that has died from **any** cause irrespective of age.
   Example: $\frac{\text{\# of deaths in Illinois}}{\text{Total estimated mid-year Population of Illinois}} \times 100{,}000$ = crude death rate

2. **Age-specific rate:** the number of deaths among persons of a **given age group**.
   Example: $\frac{\text{\# of deaths of persons 18-30 years old in Illinois}}{\text{\# total estimated mid-year Population of Illinois}} \times 100{,}000$ = Age specific death rate

3. **Cause-specific rate:** the number of deaths from a **specific cause**
   Example: Cancer $\frac{\text{\# of deaths for cancer from Illinois}}{\text{\#Total Population}} \times 100{,}000$ = rate
4. **Case-fatality rate:** number of deaths from a specific cause within a given period.
   $\frac{\text{\# of deaths from breast cancer in Illinois}}{\text{Among all individuals diagnosed with the disease over a certain period of time}} \times 100{,}000$ = rate

Note: Case fatality rate typically is used as a measure of disease severity and is often used for prognosis (predicting disease course or outcome), where comparatively high rates are indicative of relatively poor outcomes.

Vital Statistics

5. **Birth rate** $\frac{\text{\# of live births}}{\text{\#Total population}} \times 1{,}000$ = birth rate
6. **Infant mortality rate-** -number of infant deaths **under 1 year of age** in a year. The rate formula uses live births as the denominator.
   $\frac{\text{\# of infant deaths < 1 year in state}}{\text{\# live births}} \times 1{,}000$ = infant mortality rate state

7. **Neonatal mortality rate-** -number of infant deaths **under 28 days** in a year.
   The rate formula uses live births as the denominator

$$\frac{\text{\# of neonatal deaths under 28 days in the state}}{\text{\# live births}} \times 1{,}000$$

Three of the specialized **morbidity (disease) rates**:

1. **Point Prevalence rate --** measure of **existing** disease in a population at a **specific point in time**

Example: Rubella $\frac{\text{\# of cases of a disease from a specific cause for one month for the state}}{\text{Population at the same specified point in time}} \times 100{,}000 = \text{rate}$

2. **Period Prevalance Rate** – measure of **existing** disease in a population **over a period of time**

Example: Varicella $\frac{\text{\# of cases of a disease from a specific cause for one year for the state}}{\text{Total population of state that year}} \times 100{,}000 = \text{rate}$

3. **Incidence rate** -- the number of **new** cases developing in a population **at risk** during a specified time.

Example: HIV $\frac{\text{\# of new cases of disease over a specific period of time}}{\text{\# of persons at risk of disease over that specific period of time}} \times 100{,}000 = \text{rate}$

All rates are calculated using a **scaling factor** (multiplier) which is usually between 1,000 to 100,000 to avoid small fractions. This multiplier represents the population base and can vary for different purposes. The results are expressed as the number of deaths per 100,000 persons, or the number of cases or number of new cases of disease per 100,000, With vital statistics they are usually figured per 1,000 population. This is different than a percentage which doesn't give an idea of the actual population base i.e. a rate of illness is 13% in one city and 25% in another but doesn't give an idea of what that might mean in terms of numbers.

The **numerators** in the rate problems represent the persons of interest. For example, in a crude death the numerator is the total number of persons who died within the defined period (usually during the past year). It is necessary to know the persons of interest that the rate requires.

The **denominators** in the rate problems can represent the total population of interest. **It is necessary to know which population figure the rate requires.**

Types of specialized **Incidence Rates**:

1. Incidence Density - a person-day reflects one person at risk for 1 day, and a person-year represents one person at risk for 1 year.
   Example: Incidence Density = $\frac{\text{New cases occurring during the study period}}{\text{Person-time units accumulated by subjects during the study period}} \times \text{Base multiple of 10}$

2. Attributable Risk – the difference between the incidence rates in an exposed group of people and an unexposed group of people
   Example: Attributable Risk = Incidence rate in the exposed – The incidence rate in the nonexposed

3. Relative Risk Ratio - a ratio of the incidence rate in the exposed group and the incidence rate in the nonexposed group.
   Example: Relative Risk = $\frac{\text{Incidence rate in the exposed group}}{\text{Incidence rate in the nonexposed group}}$

**A relative risk of 1.0 indicates that the risk is equal for both groups, and conversely, a relative risk greater than 1.0 indicates that the risk is greater in the exposed group. A relative risk less than 1.0 indicates that the risk is less in the exposed group.

Rates to Determine Validity and Reliability

1. Sensitivity: the ability of a test to identify correctly people who have the health problem under study

   Example: Sensitivity = $\frac{\text{true positive results}}{\text{(true positive results + false negatives)}}$

2. Specificity: the ability of a test to correctly identify people who do not have the health problem

   Example: Specificity = $\frac{\text{true negative results}}{\text{(true negative results + false positives)}}$

Calculate the following rates using the information provided. Use the scaling factor of 100,000 for all of the problems.

1. The total death in County Z last year was 6,092. The population of County Z last year was 524,263. What was the crude death rate?

   $\frac{6,092}{524,263} \times 100,000 = 1,162.0122$ | 1,162.0 per 100,000

2. There were 4,953 deaths from neoplasms in City B during the past year. The year end population was 3,495,678. What was the specific cancer death rate for last year?

   $\frac{4,953}{3,495,678} \times 100,000 = 141.689252$ / 141.7 per 100,000

3. The population of the US in 2000 was 281,421,906. The number of deaths from heart disease in the US in 2000 was 710,760. The total number of deaths in the US in 2000 was 2,403,351.

   a Calculate the percentage (%) of heart disease deaths for the US in 2000.

   $\frac{710,760}{2,403,351} \times 100 = 29.5737077$ / 29.6 %

   b Calculate the rate of heart disease deaths in the US in 2000 for the US.

   $\frac{710,760}{281,421,906} \times 100,000 = 252.560296$ | 252.6 per 100000

4. In Illinois in 2000, the population was 12,419,293. The number of Salmonella cases in 2000 was 1,502 in Illinois. Calculate the incidence rate for Salmonella for Illinois in 2000.

$$\frac{\text{\# of new cases}}{\text{\# at risk}} = \frac{1,502}{12,419,293} \times 100,000 = 12.0940862$$ | 12.1 per 100,000 people

5. There were 45,238 neonatal deaths out of 5,672,000 live births in City F. Calculate the neonatal mortality (death) rate.

$$\frac{45,238}{5,672,000} \times 1,000 = 7.97566996$$ | 8 per 1,000 births

6. The population in Sangamon county in 2000 was 188,951

a The number of live births in Sangamon County in 2000 was 2,646. Figure the Live Birth rate for Sangamon country for 2000.

$$\frac{2,646}{188,951} \times 1,000 = 14.0036306$$ | 14 per 1,000 births

b The number of infant deaths in Sangamon County in 2000 was 18. Figure the infant mortality rate for Sangamon country for 2000.

$$\frac{18}{2,646} \times 1,000 = 6.80272109$$ | 6.8 per 1000 births

7. A city has a population of 250,000. Of these, 10,000 have disease X, which is incurable. There are 1,000 new cases and 400 deaths each year from this disease. There are 2,500 deaths per year from all causes. What is the prevalence rate based on a multiplier 100,000.

$$\frac{11,000}{250,000} \times 100,000 = 4,400$$ per 100,000 people

	Quintile of CRP Level				
	1	2	3	4	5
	0.49 mg/dL	>0.49-1.08 mg/dL	>1.08-2.09 mg/dL	>2.09-4.19 mg/dL	>4.19 mg/dL
Relative Risk	1.0	1.8	2.3	3.2	4.5
Number of women	6000	6000	6000	6000	6000

8. Based on the relative risk data above, one can conclude:
   a There is no risk of heart attack/stroke for women with CRP levels in the first quintile.
   b Decreasing CRP level appears to increase the risk of heart attack/stroke.
   (c) Increasing CRP level appears to increase the risk of heart attack/stroke.
   d There appears to be no association between CRP levels and heart attack/stroke.

9. In 2020, the population of Illinois is 12.63 million. Total cases of COVID-19 is 900,370. Using 100,000 as a multiplier, what is the period prevalence rate?

$\frac{900,370}{12\ 630\ 000} \times 100,000 = 7128.82027$ / 7,128.8 per 100,000

10. In 2020, the population of Illinois is 12.63 million. The total deaths from COVID-19 is 128,000. Using 100,000 as a multiplier, what is the cause-specific mortality rate?

$\frac{128\ 000}{12\ 630\ 000} \times 100,000 = 1,013.46002$ / 1,013.4 per 100,000

EPIDEMIOLOGY EXERCISES
INFANT MORTALITY, CHICAGO COMMUNITY AREAS

TABLE 1

			DEATHS UNDER ONE YEAR	
	COMMUNITY AREA	# of LIVE BIRTHS	#	RATE PER 1000 BIRTHS
01.	Rogers Park	1,054	13	12.3
02.	West Ridge	966	5	5.2
03.	Uptown	1,340	26	19.4
04.	Lincoln Square	760	13	17.1
05.	North Center	610	7	11.5
27.	East Garfield Park	763	19	24.9
28.	Near West Park	1,338	34	25.4
36.	Oakland	295	8	27.1
39.	Grand Boulevard	1,209	24	19.9
40.	Washington Park	735	17	23.1
68.	Englewood	1,303	27	20.7
73.	Washington Heights	507	17	33.5
	CHICAGO	55,216	914	16.6
	UNITED STATES	--	--	12.5

A. Fill in the blank columns in Table 1 using the formula to calculate infant mortality rate. A hand or desk calculator speeds calculations but is not essential.

B. Compare the infant mortality rate you calculated for Lincoln Square with that of East Garfield Park. Are they the same or different?

They have different infant mortality rate. East Garfield Park has a higher infant mortality rate of 24.9 per 1000 births than Lincoln Square infant mortality rate of 17.1 per 1000 births

C. What general trends, if any, are apparent from these data?

Washington height have the highest infant mortality since they only have 507 live births and ~~only~~ 17 death.

Those area who have less than 1000 live birth have more higher infant mortality than areas that have higher live birth

D. Compare the infant mortality rate of the City of Chicago with that of the United States. Are the rates the same of different? What factors may account, between Chicago and the United States, affect these rates? Chicago infant mortality rate is higher than United States since Chicago is just a ~~small~~ part of United States the rate can be higher since the live birth in the Chicago is only a portion of live birth in the U.S.

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