Lab: Rate Adjustment ("Standardization")

Background: The Atherosclerosis Risk in Communities (ARIC) study monitored a large open population of 315,000 individuals for cardiovascular disease, as well as following a cohort of 16,000 persons selected from this population. Below are data from this study. This lab will help you gain experience evaluating crude and standardized rates. It will also help you gain experience exploring differences in the evaluation of opened and closed population rates.

A. *Coronary Heart Disease Mortality Rates in the Open Population*

1. Population growth and age-redistribution. Generally, the population grew at an annual rate of 3% in all age groups. However, in 1992 there was a large migration of older people into the study area, resulting in a 6% growth rate in the oldest age decade for that year.

Use these data to calculate the crude CHD mortality rates for each of the three years, 1990, 1991, and 1992 in women.

CHD mortality in ARIC communities, women, 1990-1992

	1990		1991		1992	
Age	Pop'n	Deaths	Projected pop.	Deaths	Projected Pop.	Deaths
35-44	14,108	2	14,531	4	14,967	0
45-54	7,777	5	8,010	3	8,250	1
55-64	6,027	17	6,208	25	6,394	25
65-74	4,929	19	5,077	25	5,382	13
Total	32,841	43	33,826	57	34,993	39

2. Crude comparisons?

(a) Can these crude rates be compared without some age-adjustment? Explain your response.

(b) The terms "exposure" and "disease" are used to refer to the explanatory ("independent") variable and response ("dependent") variable in epidemiologic studies, respectively. In this analysis, what is the "exposure variable"? What is the "disease variable" in this analysis?

(c) All variables other than the "exposure" and "disease" are "potential confounders." Confounding variables must be considered for the proper interpretation of epidemiologic data. What potential confounder is being addressed in this analysis?

3. Age-specific rates. Because the age distribution is changing over time, the comparison of event rates can be improved by computing age-adjusted rates. The **first step** in making this adjustment is to calculate age-specific rates for each time period. The age-specific rates for 1990 are computed in the table below. Calculate the age-specific rates for 1991 and 1992 and fill-in the table with this information.

1990 Data

Age	Pop'n	Deaths	rate per 1000
35-44	14,108	2	0.14
45-54	7,777	5	0.64
55-64	6,027	17	2.82
65-74	4,929	19	3.85

Calculate the age-specific rates for 1991 and put them in this table:

1991 Data

Age	Pop'n	Deaths	rate per 1000
35-44	14,531	4	
45-54	8,010	3	
55-64	6,208	25	
65-74	5,077	25	

Calculate the age-specific rates for 1992 and put them in this table:

1992 Data

Age	Pop'n	Deaths	rate per 1000
35-44	14,967	0	
45-54	8,250	1	
55-64	6,394	25	
65-74	5,382	13	

4. Age-adjusted rates. The relative age distribution in the US population for the year 2000 can be used as weights for a direct age-adjustment. These are provided here.

Reference Age Distribution
U. S. for the year 2000

Age group	Weight (w_i)
35-44	0.361
45-54	0.299
55-64	0.194
65-74	0.146

We are going to compute age-adjusted mortality rates for each year of data using this *reference* age distribution.

Let us use version 2 of the direct adjustment formula for calculating that age-adjusted rates. This version of the formula is algebraically equivalent to the formula in the text, but permits a clearer application of *weighted averages*. It is also a little easier to use. The formula is:

$$aR = \sum w_i r_i$$

where w_i is the stratum weight provided by the reference population and r_i is the stratum-specific rate in the study population. This formula says "*add up* the *products* weight × rate for each stratum." This merely rebalances the stratum-specific rates in the study population to that of the reference age distribution.

The horizontal expansion of the formula for four strata is $aR = \sum w_i r_i = w_1 \cdot r_1 + w_2 \cdot r_2 + w_3 \cdot r_3 + w_4 \cdot r_4$. However, it is more efficient to work vertically with the data in columns. As an illustrative example, here's calculation for the year **1990**.

Age group	Weight (w)	Rate 1990	$w_i \times r_i$
35-44	0.361	0.14	0.05054
45-54	0.299	0.65	0.19435
55-64	0.194	2.82	0.54708
65-74	0.146	3.85	0.56210
		$aR =$	$\sum w_i r_i = 1.35$

The adjusted rate is shown as the sum of fourth column. Thus, the aR for 1990 is 1.35.

Comment: If you prefer the horizontal expansion of the formula: $aR = \sum w_i r_i = (0.361)(0.14) + (0.299)(0.65) + (0.194)(2.82) + (0.146)(3.85) = 1.35$.

Calculate the adjusted rate for the year **1991**. Here's a table shell that facilitates calculations. (You may ignore the shell if you wish.)

Age group	Weight	Rate 1991	$w_i \times r_i$
35-44	0.361		
45-54	0.299		
55-64	0.194		
65-74	0.146		

Now calculate the adjusted rate for the year **1992**.

Age group	Weight	Rate 1992	$w_i \times r_i$
35-44	0.361		
45-54	0.299		
55-64	0.194		
65-74	0.146		

Comment on the trends in the age-adjusted rates seen in the data.

B. CHD Rates in a Cohort Selected from the Population

A cohort of 16,000 individuals 45– 64-years of age were selected from the population in 1987 and were followed until 1992.

1. What happens to the age distribution of the cohort as we follow it over time? How will this influence annual mortality rates?

2. From follow-up of the cohort from 1987 (baseline) to 1992, the CHD mortality rates were:

CHD mortality for women in the ARIC cohort by age at baseline

Age at baseline	Deaths per 1,000 person years
45-54	1.2
55-64	3.1

Are these age-specific rates directly comparable to the age-specific rates reported earlier in this lab? Why or why not?