Standardization of rates and ratios - Assignment

1. From the data in the table below, compute for each sex separately (for Rateboro) and for the United States (both sexes) the following measures. Write your answers (rounded to 4 decimal places) in the table; show all work for (c) and (d).

   a. crude death rates

   b. age-specific death rates

   c. directly-standardized death rates for Rateboro males and females (separately) using the U.S. population as a standard.

   d. indirectly standardized death rates as in (c).

Population and Deaths in 1980 in Rateboro
Adults by Age and Sex and U.S. Total
(hypothetical data)

	Rateboro						United States		
	Males			Females			Both Sexes		
Age	Pop.	Deaths	Rate	Pop.	Deaths	Rate	Pop*	Deaths*	Rate
18-34	900	6		800	1		60,000	90	
35-59	800	3		800	5		45,000	270	
60-74	300	15		500	10		20,000	600	
75 +	200	22		500	38		15,000	1500	
Total	2200	46		2600	54		140,000	2460	

(*In thousands. Population and deaths for Rateboro are actual figures.)

Direct standardized rate:

Indirect standardized rate:

2. Based on the results for question 1.:

   a. Do males or females have a more favorable mortality experience in Rateboro? Cite the rates or other figures on which you have based your decision.

   b. How do you account for the similarity in the crude death rates for Rateboro males and females?

   c. Briefly discuss the reasons for and against (i) rate adjustment, and (ii) direct versus indirect methods--in these data.

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* Thanks to Barbara Richardson, Ph.D. for the first version of this question.

d. How would you feel about the conclusion, by an experienced epidemiologist, that "the Rateboro data are generally consistent with the typical finding of a more favorable mortality experience of U.S. females; the anomolous result for the 35-59 year-old group, with the high death rate among females (more than 50% greater than the rate for males) is evidence that the Rateboro environment is more suitable for males in the age range 35-59 than for females."

3. The following extract from "Breast cancer in women after repeated fluoroscopic examinations of the chest" (John D. Boice, Jr., and Richard R. Monson, *J Natl Cancer Inst* 59:823-832, 1977) describes their adjustment procedure:

> "...Expected breast cancer cases were determined with the use of age-calendar year specific incidence rates of Connecticut (refs), a neighboring State whose cancer registry has been in existence since 1935. The years at which a woman was at risk for breast cancer development (i.e., the years after sanitarium admission or fluoroscopy exposure) were computed separately for each 5-year age group, each 5-year period since start of observation, and each quinquennium from 1930 to 1970 through 1974 and for the six month period from January 1975 through June 1975. Multiplication of the age-calendar year specific WY [women-years] at risk by the corresponding Connecticut incidence rates determined the number of expected breast cancers."

a. What method of adjustment is being used, direct or indirect?

b. The following tables show hypothetical data from a follow-up study like that done by Boice and Monson. Why is it not possible to calculate from the information below the number of breast cancer cases expected for the period 1950-1969 with the method used by Boice and Monson (as described above)? (Note: this is a "sticky" question. Do not try to calculate or derive numbers.)

Distribution of Women-Years (WY) among exposed subjects

	Period			
Age	1950-54	1955-59	1960-64	1965-69
30-34	1900	--	--	--
35-39	1800	1700	--	--
40-44	1700	1600	1500	--
45-49	1600	1500	1400	1300

Average breast cancer incidence rates from the Connecticut Cancer Registry (1950-1969), by age (rate per 1000 WY)

Age (years)	Rate
30-34	.2
35-39	.4
40-44	.8
45-49	1.2

c. What advantage does this adjustment procedure have over simple age adjustment?

4. Tuberculosis (TB) has been called the "captain of all men of death" because of its ability to decimate populations. Improvements in the physical conditions of life in the present century, especially nutrition, housing, and the work environment, greatly reduced this scourge even before the advent of effective chemotherapy for the mycobacterium. The discovery of isoniazid and its effectiveness in reducing infectiousness led to the application of public health measures for tracing and treating active cases, thereby effectively controlling TB in the United States and other developed countries. Indeed, U.S. public health policy has set the elimination of TB by the year 2010 as a goal.

   However, TB incidence in U.S. minority populations has never been reduced to the same extent as the overall U.S. incidence, and the ratio of TB risk in nonwhites to whites has grown steadily from about 3 in the mid-1950s to over 5 in the mid-1980s. In 1986, however, the long-term decline in TB was reversed, with an estimated 9,226 cases in 1985-87 beyond those projected from the 1981-84 trend. The 25-44 year age group had the largest 1985-87 increase, made up of a 17% increase among non-Hispanic blacks and 27% among Hispanics. The HIV epidemic has been implicated in the upswing in tuberculosis; poverty, homeless, and immigration of persons from higher TB areas may also have a role. [Source: Reider HL, Cauthen GM, et al. Tuberculosis in the United States. *JAMA* 1989 (July 21); 262(3):385-389.]

   In this question, you are asked to interpret data from three North Carolina counties. The following tables show the number of TB cases during the period January 1, 1986 to December 31, 1990, the mean population during that time period, and the corresponding U.S. TB rates.

Cases of tuberculosis in three N.C. counties during January 1, 1986 - December 31, 1990

County	White males	White females	Nonwhite males	Nonwhite females
Johnston	11	8	43	13
Orange	5	3	3	4
Wilson	6	10	51	27

Source: NC TB Control Branch

Mean population sizes of three N.C. counties during January 1, 1986 - December 31, 1990

County	White males	White females	Nonwhite males	Nonwhite females
Johnston	31,721	33,955	6,910	8,078
Orange	34,542	37,649	7,510	8,753
Wilson	19,844	22,259	10,692	12,788

Source: (Log Into North Carolina [LINC] database)

Mean annual incidence of tuberculosis,
United States, January 1, 1986 to December 31, 1990

	White males	White females	Nonwhite males	Nonwhite females
Cases per 100,000	7.4	3.6	39.2	19.8

Source: Centers of Disease Control, *Tuberculosis in the United States*

Your interpretation should compare the counties to each other and to the U.S. Is there a greater-than-expected TB incidence in any of the counties? Is an increase confined to particular race-sex-groups?

Suggestions:

a. Compute the race-sex-specific TB rates for each county and overall.

b. Compute an SMR comparing each county to the national TB rates.

5. .This question is optional. If you like it, do it; if you don't like it, forget it! Show that:

   a. if age-specific rates for group A are all equal and age-specific rates for group B are all equal (but not equal to those in group A, i.e., $r_{ai} = r_a$ and $r_{bi} = r_b$ for all i), then:

$$\frac{\text{Directly standardized rate for A}}{\text{Directly standardized rate for B}} = \frac{\text{Crude rate for A}}{\text{Crude rate for B}}$$

   Under what conditions will this ratio equal the ratio of indirect standardized rates?

   c. if age-specific rates in groups A and B are not all equal, but for each stratum

$$\frac{r_{ai}}{r_{bi}} = K \qquad \text{[Where K is the same for all strata]}$$

   then SMR (for A using B as the standard) = K

   d. If the proportional age distributions in two populations are identical, then direct adjustment, indirect adjustment, and crude rates are all comparable between the two populations.

6. (Optional) Solve problem #1 using a computer spreadsheet.