Variation in Mortality From Heart Disease

—*Race, Sex, and Socioeconomic Status*—

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ONE of the more important reasons for obtaining knowledge of the distribution of a disease in a population is that such knowledge provides a means by which hypotheses concerning pathogenesis can be evaluated. If a hypothesis does not adequately account for at least a majority of the epidemiological features of a disease, it will have to be modified in whole or in part.

The distribution of coronary disease in various socioeconomic groups of the population is particularly pertinent to several etiological hypotheses that have been advanced. From official studies of occupational mortality, Logan has reported the relative mortality risks from coronary disease in England and Wales for five social classes (*1–3*). He has observed that among men the highest social class has consistently had (both in 1930–32 and 1950) the highest mortality from coronary disease and that the mortality risk decreases with a decrease in social status. For married women the social class variation has not been as large nor as consistent. In 1930–32 the pattern for married women was similar to that observed among men, but in 1950 little variation by social class was noted in those aged 20–64. For married women 65 years of age and over the social class pattern of proportionate mortality ratios was similar to that observed among men, although it must be realized that proportionate mortality ratios are difficult to interpret. These distributions may be considered as being consistent with the hypothesis proposed by Keys that excessive fat consumption is an important etiological factor in coronary disease (*4*). It is also consistent with the observation made by Morris and his associates that physical inactivity increases the risk of coronary disease (*5*).

Logan has also reported the results of an analysis of mortality from other forms of myocardial degeneration in England and Wales (*1–3*). The social class distribution for this category is exactly opposite to that observed for mortality from coronary disease; that is, the mortality risk is highest in the lowest social class and it decreases with an increase in social status. This observation suggests that the social class differences with regard to coronary disease mortality might be the result of variation in diagnostic practices in the various social classes. It is conceivable that the greater availability of medical care may have increased the number of diagnoses of coronary disease in the upper income groups.

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In view of the difficulties of diagnosis for the various forms of heart disease, it occurred to me that a combination of the deaths from coronary disease and other myocardial degeneration might be about the same for all social groups. In an attempt to study this particular question, I have made an analysis of the mortality from heart disease in Baltimore, Md., for the 3-year period 1949 through 1951. This report presents the results of that analysis. In addition to data on coronary disease and myocardial degeneration, data on hypertension and other forms of heart disease are included.

Method of Study

During the period 1949 through 1951, 14,504 deaths certified as due to heart disease were recorded in Baltimore. Of these, 3,016, or about 21 percent, occurred in the nonwhite population. The distribution of deaths for five categories of heart disease by race and sex are presented in table 1.

To estimate the socioeconomic status for each heart disease death, information concerning characteristics of census tracts in Baltimore published by the United States Bureau of the Census was used. The census tract comprises a neighborhood of between 3,000 and 6,000 persons who are relatively homogenous with regard to such characteristics as median monthly rental, occupational status, and extent of home ownership.

The census tracts in Baltimore were ranked according to the median monthly rental as determined in the 1950 census and then assembled into fifths so that about 20 percent of the city's population of about 950,000 fell into each fifth. The median monthly rental was considered a valid index of relative socioeconomic status because of its high correlation with the other indexes, such as family income, years of school completed, and occupation. The lowest socioeconomic fifth was designated 1; the next fifth, 2; and so on. Each heart disease death was assigned to a socioeconomic fifth on the basis of its allocation to a given census tract from the street address on the death certificate.

One possible limitation to this method of socioeconomic classification, particularly with regard to nonwhite persons, should be noted. Because the method is based on average characteristics of an area rather than actual characteristics of an individual, nonwhites, for example, may be classified in a socioeconomic group higher than their socioeconomic circumstances warrant when they are located in a census tract that is predominantly white. The same difficulty is present with regard to the white population but probably to a lesser extent. However, census-tract classification provides an inexpensive and readily available method for studying the socioeconomic distribution of mortality from a disease.

For comparison with the Baltimore data, some of the data for England and Wales reported by Logan will be presented. In the British reports on social distribution, classification is based on occupational groups. According to the 1951 census, 3.3 percent of the male population aged 15 years and over falls into social class I (professional); 15.0 percent in class II (intermediate between I and III); 52.7 percent in class III (skilled); 16.2 percent in class

Table 1. Number of deaths from various types of heart disease, by race and sex, Baltimore, 1949–51

Type of heart disease [1]	White		Nonwhite		Total
	Male	Female	Male	Female	
Arteriosclerotic heart disease, including coronary disease (420)	3, 296	1, 987	389	236	5, 908
Other myocardial degeneration (422)	1, 194	1, 252	357	308	3, 111
Hypertensive disease with mention of heart disease (440–443)	999	1, 418	542	682	3, 641
Hypertensive disease without mention of heart disease (444–447)	74	84	62	65	285
All other types	592	595	196	176	1, 559
Total	6, 155	5, 336	1, 546	1, 467	14, 504

[1] Numbers in parentheses are category numbers of the International Statistical Classification of Diseases Injuries, and Causes of Death, sixth revision of the International Lists, 1948.

IV (semiskilled); and 12.8 percent in class V (unskilled) (*2*, *3*). Thus, the English social classes I and II are roughly comparable to the Baltimore socioeconomic fifth 5; social class III, to socioeconomic fifths 3 and 4; social class IV, to socioeconomic fifth 2; and social class V, to socioeconomic fifth 1. By presenting this information, I do not intend to imply that the two classifications are completely comparable; it merely gives some idea of their comparability with regard to the percentage of population in each class.

In making comparisons between sexes, races, and socioeconomic groups, differences in the age composition of the population in these groups must be taken into account. This can be done readily by the method of age adjustment commonly employed in routine vital statistics practice. For this study, the standard population used for age adjustment was the total population of Baltimore in 1950. The data presented for each sex, racial, and socioeconomic group are average annual age-adjusted death rates and are therefore directly comparable.

In the British reports, an indirect method of age adjustment resulting in an index termed the standardized mortality ratio was used. Since this method differs from the one used to describe the Baltimore experience, the results cannot be directly compared in absolute terms. However, comparisons can be made between the social classes within each of the two geographic areas, and it is with such comparisons that we are concerned. The interested reader is referred to the text on medical statistics by Bradford Hill, where these methods of age adjustment are discussed (*6*).

Arteriosclerotic Heart Disease

The International List category designated arteriosclerotic heart disease includes three subcategories: arteriosclerotic heart disease, coronary artery disease, and angina pectoris. All heart disease deaths in which coronary artery disease is mentioned are placed in this category, but, admittedly, deaths not due to coronary disease are also included. This category was used as representing deaths from coronary disease in the analysis of mortality in England and Wales in 1949 and 1950. It would appear reasonable to assume that if there are significant racial, sex, or socioeconomic variations in mortality from coronary disease, it would be possible to detect them by an analysis of this category of deaths, unless, of course, the distributions of each subcategory are in opposite directions.

Table 2. Average annual age-adjusted death rates per 10,000 population for arteriosclerotic heart disease (including coronary disease)[1] by race, sex, and socioeconomic status, Baltimore, 1949–51

Socioeconomic fifth	White		Nonwhite	
	Male	Female	Male	Female
1 (lowest)	29. 2	15. 9	20. 7	11. 4
2	34. 6	14. 7	14. 4	7. 4
3	33. 0	12. 1	15. 2	9. 6
4	29. 9	14. 0	[2] 17. 5	[2] 14. 8
5 (highest)	32. 3	13. 0	[2] 24. 8	[2] 9. 0

[1] International List No. 420.
[2] Based on population of less than 1,000.

The results of the analysis of mortality from arteriosclerotic heart disease in Baltimore are presented in table 2. It is to be noted that males have markedly higher death rates than females, in both racial groups and in all socioeconomic groups. But perhaps of more interest is the fact that there is no particular pattern of variation in mortality for the different socioeconomic groups; the differences between socioeconomic groups may well be due to chance variation.

The lack of a socioeconomic pattern in Baltimore is in marked contrast to the findings on

Table 3. Standardized mortality ratios for deaths from coronary heart disease for males and married females aged 20–64 years, by social class, England and Wales, 1950[1]

Social class	Male	Married females
I—Professional	150	92
II—Intermediate between I and III	110	93
III—Skilled workers	104	101
IV—Semiskilled workers	79	100
V—Unskilled workers	89	108

[1] From reference 2.

social class distribution in England and Wales in 1950, which are shown in table 3. In England and Wales, there is an increasing gradient of mortality ratios from the lowest class to the highest among men, and there is a slightly increasing gradient in the reverse direction among married women. Admittedly, the Baltimore and the English data are not strictly comparable. The methods of classifying socioeconomic status differ, and the English data are limited to age groups 20–64 years. (The data for persons aged 65 and over are not presented here because they are expressed as proportionate mortality ratios.) Also, there are differences in the reporting and classification of causes of death: For example, in England the term "arteriosclerotic heart disease" is infrequently used in reporting causes of death. Nonetheless, it seems reasonable to expect that if social class variations in mortality from coronary disease did exist in Baltimore as they appear to exist in England, they should have been evident in the data presented in this report.

Table 4. Average annual age-adjusted death rates per 10,000 population for other myocardial degeneration,[1] by race, sex, and socioeconomic status, Baltimore, 1949–51

Socioeconomic fifth	White		Nonwhite	
	Male	Female	Male	Female
1 (lowest)	20.1	12.8	22.5	16.9
2	13.5	10.9	13.3	14.2
3	12.7	9.4	13.7	12.1
4	9.3	7.2	[2] 11.7	[2] 11.4
5 (highest)	8.4	7.1	[2] 6.2	[2] 4.3

[1] International List No. 422.
[2] Based on population of less than 1,000.

Table 5. Standardized mortality ratios for deaths from myocardial degeneration for males and married females aged 20-64 years, by social class, England and Wales, 1950 [1]

Social class	Male	Married females
I—Professional	67	66
II—Intermediate between I and III	82	67
III—Skilled workers	97	98
IV—Semiskilled workers	98	120
V—Unskilled workers	137	134

[1] From reference 2.

Table 6. Average annual age-adjusted death rates per 10,000 population for hypertension with and without mention of heart disease, by race, sex, and socioeconomic status, Baltimore, 1949–51

Socioeconomic fifth	White		Nonwhite	
	Male	Female	Male	Female
	With mention of heart disease [1]			
1 (lowest)	12.1	13.9	27.6	33.5
2	9.9	12.6	21.8	25.8
3	11.8	12.0	23.9	24.6
4	7.7	9.9	[3] 19.1	[3] 17.7
5 (highest)	9.0	7.7	[3] 22.0	[3] 21.6
	Without mention of heart disease [2]			
1 (lowest)	0.7	0.6	1.9	3.3
2	.8	.9	1.7	1.8
3	.8	.7	2.9	2.2
4	.7	.6	[3] 3.0	[3] 1.3
5 (highest)	.7	.5	[3] 0	[3] 0

[1] International List Nos. 440–443.
[2] International List Nos. 444–447.
[3] Based on population of less than 1,000.

Myocardial Degeneration

The age-adjusted rates for deaths from other myocardial degeneration in Baltimore are presented in table 4. This category, according to the International List, includes such terms as fatty degeneration, myocardial degeneration with arteriosclerosis, cardiovascular degeneration, atheroma of heart or myocardium, and chronic myocarditis.

In general, the rates for white males are higher than the rates for white females, but there is little difference between the sexes for the nonwhite population. In addition, the white and nonwhite male rates are nearly the same. Thus, the nonwhite rates for both sexes are similar to the white male rates, and the white female rates are lower than the rates for the other three groups. This general pattern, which is present for all the socioeconomic groups, differs from that observed for deaths due to arteriosclerotic heart disease. The socio-

economic distribution also differs from that for arteriosclerotic heart disease. There is a decreasing gradient of mortality from the lowest socioeconomic group to the highest, for both races and both sexes.

The social distribution of mortality from myocardial degeneration in England and Wales in 1950 in shown in table 5. For this category of heart disease, the pattern is similar to that for Baltimore. This similarity perhaps increases the significance of the lack of consistency between the two areas with regard to coronary heart disease deaths. It would not seem that differences in the method of classification of social classes or the limitation to a certain age group would produce differences in the patterns of one group of deaths and not in the patterns of another.

Hypertensive Disease

Classified in the International List under hypertensive disease are eight categories. For this report, these have been grouped into (*a*) hypertension with mention of heart disease and (*b*) hypertension without mention of heart disease. The rates for these two groups are presented in table 6. Since there are only a few deaths classified in the second group, no conclusions can be drawn from the data.

For hypertensive disease with mention of heart disease, the rates for the nonwhites are about twice as high as the rates for the whites. This is true for both sexes and for all socioeconomic groups. The rates for the females are higher than the rates for the males in both racial groups. The higher white female rates are present in all socioeconomic groups except the highest group, where the male rate exceeds the female rate. Among the nonwhites, the female rate is higher than the male rate in the three lower socioeconomic groups, but a suggested reversal occurs in the two upper socioeconomic groups. This change in mortality relative to sex and social class, which occurs in both races, may be of some epidemiological interest and worthy of further investigation.

Table 7. Average annual age-specific death rates per 10,000 population for arteriosclerotic heart disease (including coronary disease),[1] by race, sex, and socioeconomic status, Baltimore, 1949–51

Age group (years)	Male					Female				
	Socioeconomic fifth					Socioeconomic fifth				
	1 (lowest)	2	3	4	5 (highest)	1 (lowest)	2	3	4	5 (highest)
	White									
Under 25	0	0	0	0	0	0	0	0	0	0
25–34	1.0	.8	1.6	.7	.2	.3	.4	.3	0	0
35–44	10.5	13.4	7.6	9.6	9.2	1.3	1.0	1.1	.7	.4
45–54	51.2	38.9	39.7	43.9	36.8	9.7	8.9	7.8	6.4	5.5
55–64	101.9	100.2	112.1	109.7	93.5	42.8	41.4	34.2	27.2	27.0
65–74	151.7	212.8	183.8	114.2	203.5	108.5	85.8	102.2	69.2	100.2
75 and over	190.1	354.6	334.5	332.0	346.9	233.0	243.1	120.7	268.7	219.7
	Nonwhite									
Under 25	2.0	0	0	0	[2] 0	0	0	0	0	[2] 0
25–34	0	0	7.6	[2] 13.1	[2] 0	0	2.6	1.6	[2] 0	[2] 0
35–44	32.3	9.3	16.8	[2] 0	[2] 131.6	10.0	1.5	11.9	[2] 0	[2] 0
45–54	60.4	75.1	71.4	[2] 14.4	[2] 59.5	46.2	35.1	39.0	[2] 47.5	[2] 0
55–64	240.3	169.0	134.8	[2] 105.0	[2] 161.3	136.4	98.0	94.6	[2] 146.3	[2] 155.0
65–74	[2] 335.8	244.1	[2] 293.0	[2] 352.9	[2] 0	[2] 199.6	97.3	146.6	[2] 289.9	[2] 259.7
75 and over	[2] 471.0	[2] 219.2	[2] 260.2	[2] 980.4	[2] 1,500.0	[2] 213.3	[2] 161.3	[2] 282.4	[2] 483.9	[2] 0

[1] International List No. 420.

[2] Based on population of less than 1,000.

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It seems that the lower socioeconomic groups have a higher mortality from hypertensive disease (with mention of heart disease) than the upper groups, and, among females of both races, there is a suggestion of a decreasing gradient from the lowest socioeconomic group to the highest. This pattern can be considered as suggestive only, particularly since it is not clearcut for the males of either race.

Other Results

In view of the differences between the Baltimore and the English experiences with regard to coronary disease deaths, I thought that perhaps the method of age adjustment might be concealing existing differences between social classes. For a better comparison of the mortality in the various social groups, age-specific death rates for three categories of heart disease are presented in tables 7 through 9. Examination of these rates confirms the existence of the patterns noted in the analysis of the age-adjusted rates.

The deaths classified in the remaining heart disease categories in the International List were grouped together, and the age-adjusted rates are presented in table 10. Owing to the heterogeneity of this group, no inferences can be drawn. Unfortunately, no one form of heart disease in this group could be singled out for further study because of the small number of deaths.

Discussion

Before discussing the inferences that can be derived from the results of this analysis, attention should be directed to some of the limitations of the data. Of prime importance is the question of the accuracy of cause-of-death statements on death certificates. Recently, James, Patton, and Heslin reported an "appreciable degree" of inaccuracy when the causes of death on death certificates were compared with autopsy findings (*7*). The possibility of inaccuracy in cause-of-death statements imposes a serious limitation on what can be inferred from

Table 8. Average annual age-specific death rates per 10,000 population for other myocardial degeneration,[1] by race, sex, and socioeconomic status, Baltimore, 1949–51

Age group (years)	Male					Female				
	Socioeconomic fifth					Socioeconomic fifth				
	1 (lowest)	2	3	4	5 (highest)	1 (lowest)	2	3	4	5 (highest)
	White									
Under 25	0	0	0	0	0	0	0	0	0	0
25–34	0	0	.3	0	0	0	0	0	0	0
35–44	.8	.5	1.4	.5	.2	.4	.5	.4	.5	.6
45–54	10.9	2.9	8.4	1.4	2.4	4.0	2.4	2.5	1.6	1.2
55–64	41.0	31.0	19.4	17.2	8.9	23.1	11.5	11.8	5.1	5.1
65–74	125.4	77.4	77.4	43.3	52.5	56.4	52.5	42.4	34.2	31.0
75 and over	395.6	297.0	264.2	247.1	214.9	337.8	315.7	268.5	220.4	222.4
	Nonwhite									
Under 25	0	1.7	2.7	0	[2] 0	0	1.4	0	0	[2] 0
25–34	0	1.4	0	[2] 13.1	[2] 0	1.4	0	0	[2] 0	[2] 0
35–44	10.2	6.2	6.3	[2] 0	[2] 0	14.9	10.5	4.0	[2] 0	[2] 0
45–54	78.2	48.0	62.5	[2] 57.6	[2] 0	41.1	17.5	47.9	[2] 15.8	[2] 0
55–64	240.3	88.5	99.7	[2] 105.0	[2] 0	160.0	119.2	133.6	[2] 122.0	[2] 0
65–74	[2] 451.2	286.2	[2] 293.0	[2] 235.3	363.6	[2] 354.8	215.4	199.6	[2] 144.9	[2] 129.9
75 and over	[2] 797.1	[2] 438.4	[2] 334.6	[2] 196.0	[2] 0	[2] 453.3	[2] 383.1	[2] 352.9	[2] 645.2	[2] 294.1

[1] International List No. 422. [2] Based on population of less than 1,000.

Table 9. Average annual age-specific death rates per 10,000 population for hypertension with mention of heart disease,[1] by race, sex, and socioeconomic status, Baltimore, 1949–51

Age group (years)	Male					Female				
	Socioeconomic fifth					Socioeconomic fifth				
	1 (lowest)	2	3	4	5 (highest)	1 (lowest)	2	3	4	5 (highest)
	White									
Under 25	0. 1	0	0	0. 1	0	0	0	0	0	0
25–34	. 3	. 4	0	. 2	0	0	. 3	0	. 3	0
35–44	1. 6	1. 9	1. 4	1. 2	. 9	2. 6	4. 3	. 4	1. 4	. 6
45–54	9. 4	7. 4	9. 3	7. 8	6. 2	15. 4	10. 1	10. 2	7. 4	4. 5
55–64	31. 1	32. 6	25. 7	19. 2	22. 2	31. 6	26. 1	34. 8	23. 1	15. 6
65–74	87. 2	62. 9	73. 1	39. 8	61. 4	79. 2	79. 4	66. 6	59. 7	47. 0
75 and over	156. 4	115. 2	188. 3	127. 4	135. 7	220. 0	191. 8	191. 0	167. 5	149. 2
	Nonwhite									
Under 25	0	0	2. 7	0	[2] 0	0	0	0	0	[2] 0
25–34	8. 0	5. 5	0	[2] 0	[2] 0	5. 5	5. 1	8. 1	[2] 11. 3	[2] 0
35–44	35. 7	21. 8	14. 7	[2] 81. 7	[2] 0	51. 4	49. 4	33. 6	[3] 25. 5	[2] 52. 4
45–54	120. 7	68. 9	89. 3	[2] 57. 6	[2] 0	171. 9	135. 9	125. 8	[2] 47. 5	[2] 42. 4
55–64	299. 2	257. 6	193. 4	[2] 210. 0	[2] 80. 7	326. 2	289. 5	239. 3	[2] 219. 5	[2] 0
65–74	[2] 346. 3	370. 4	[2] 512. 8	[2] 117. 7	[2] 727. 3	[2] 510. 0	354. 4	389. 7	[2] 289. 9	[2] 259. 7
75 and over	[2] 760. 9	[2] 493. 2	[2] 632. 0	[2] 588. 2	[2] 1, 000. 0	[2] 693. 3	[2] 362. 9	[2] 470. 6	[2] 322. 6	[2] 1, 764. 7

[1] International List Nos. 440–443. [2] Based on population of less than 1,000.

the analysis of mortality data. But analysis of death certificate information is a readily available, inexpensive means of studying distributions of certain diseases, and it is generally considered a satisfactory method of uncovering areas for further investigation. Another limitation, as already pointed out, results from the use of census tracts as a means of socioeconomic classification.

The initial interest in this analysis was to determine whether the social pattern of coronary disease mortality observed in England and Wales might be due to differences in diagnostic practices in the various social classes. It seemed that this might be inferred if a similar pattern were observed in Baltimore and if a combination of the deaths from coronary disease and other myocardial degeneration should result in a disappearance of the social differential. But the distribution of coronary disease deaths was not found to be like the English pattern. If the two categories were combined, the highest socioeconomic fifth would have the lowest rates, and there would be an increase in the mortality risk with a decrease in socioeconomic status. On the other hand, a reviewer of this paper has shown that when the English data for these two categories are combined, the highest social class still has the highest rates, although the difference between social classes is diminished.

Table 10. Average annual age-adjusted death rates per 10,000 population for all other forms of heart disease, by race, sex, and socioeconomic status, Baltimore, 1949–51

Socioeconomic fifth	White		Nonwhite	
	Male	Female	Male	Female
1 (lowest)	7. 0	5. 5	14. 3	7. 2
2	6. 7	5. 5	12. 3	6. 7
3	6. 3	4. 2	13. 8	6. 6
4	4. 6	3. 8	[1] 15. 6	[1] 4. 8
5 (highest)	4. 9	4. 0	[1] 8. 5	[1] 12. 7

[1] Based on population of less than 1,000.

To explain the discrepancies between the Baltimore and English experiences, one is tempted to postulate the existence of possible biological differences. For example, from the viewpoint of a dietary hypothesis of coronary heart disease, it is conceivable that there may be differences in dietary habits among the social classes in England that do not exist in Baltimore. But before hypothesizing this type of explanation, it would be necessary to eliminate the possible influence of nonbiological differences, such as methods of social classification and of death certification and diagnostic practices.

The present analysis also raises the question as to whether the pattern observed in England and Wales can be used as a test of the consistency of any particular etiological hypothesis of coronary disease with the social distribution of mortality from this disease. If the social distributions were found to be similar in many geographic areas, the confidence with which these distributions could be used as an index of the validity of an etiological hypothesis would be increased. The apparent existence of dissimilar distributions in Baltimore and in England and Wales suggests the need for further investigation of social variations in heart disease mortality.

Summary

From information on certified deaths in Baltimore during the period 1949 through 1951, mortality from various types of heart disease was analyzed by race, sex, and socioeconomic status.

Mortality rates for arteriosclerotic heart disease (including coronary artery disease) were observed to be higher among males than among females and higher in the white population than in the nonwhite. No significant differences were noted in the rates for five socioeconomic groups. This latter observation is in contrast to the social distribution found in England and Wales, where the risk of dying from coronary disease is highest in the upper social classes.

Mortality rates for myocardial degeneration were higher among white males than among white females. Among the nonwhites, no essential differences were noted between the sexes. The rates for the nonwhites were somewhat higher than those for the whites. For both sexes and both races, the highest rates were noted in the lowest socioeconomic group, with a gradual decrease in rates with an increase in socioeconomic status. This social distribution is similar to that observed in England and Wales.

Mortality rates for hypertensive disease were higher in the nonwhite population than in the white. The lowest socioeconomic group had the highest rates, and there tended to be a decrease in rates with an increase in socioeconomic status, although the pattern was not regular. The female rates were higher than the male rates in the lower socioeconomic groups, whereas the reverse was true in the upper groups; this was observed for both races.

The use of death certificate information for analysis of mortality and the use of census tracts for socioeconomic classification both impose certain limitations on the data derived. Nonetheless, the apparent existence of differences in the social distribution of coronary disease deaths in two geographic areas indicates a need for further study of the subject.

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