

Apparently real geographic variations in mortality from coronary heart disease occur in the United States. Further study of the populations with high death rates and those with low death rates may provide new clues concerning the factors responsible for this disease.

Geographic Patterns in Deaths From Coronary Heart Disease

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CONDITIONS for 1950 are more favorable to a study of deaths from coronary heart disease in the United States than for any prior period.

A complete population enumeration, which is important for the computation of death rates, is available for that year. Moreover, the sixth revision of the International Lists of Diseases and Causes of Death, which became effective in 1949, provided a single category (420) under which deaths from coronary arteriosclerosis were to be counted. Also, under the sixth revision of the International Lists, the Manual of Joint Causes of Death was abandoned, and the physician signing the medical certificate of death was given the responsibility for designating the underlying cause of death, the cause used in primary statistical tabulations. (There are a few exceptions to this general rule, but they are favorable to the counting of coronary

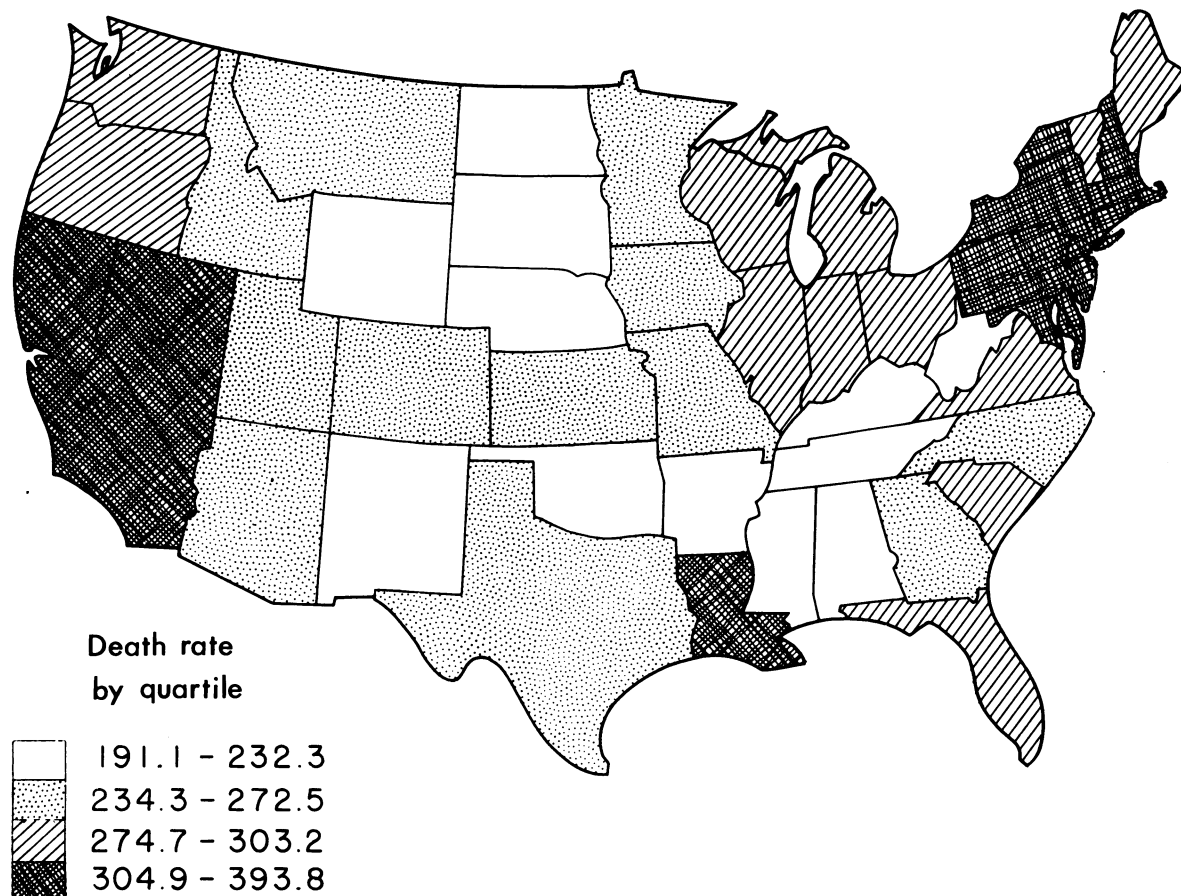
heart disease in primary tabulations.) According to the joint cause manual, if a death certificate carried the diagnoses of nephritis and acute coronary thrombosis, for example, it was counted as a death from nephritis. Under the sixth revision, if the attending physician states that the underlying cause of death is acute coronary thrombosis (coronary heart disease), the death is counted as a coronary heart disease death. (The term "coronary heart disease" as used here is synonymous with the International List term "arteriosclerotic heart disease.")

Geographic Differences

The 1950 death rates for coronary heart disease in the United States present an interesting and thought-provoking geographic pattern, as shown in figure 1 for white males and in figure 2 for white females. The rates for each State and geographic division are given in table 1. These have been age adjusted by the direct method to the age distribution of the total population as enumerated in 1950. Also shown in table 1 are average death rates for the 3-year period 1949-51 for the age group 45-64. The geographic pattern of these rates is essentially the same as the pattern of age-adjusted rates for 1950. Deaths are those coded 420 in ac-

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Figure 1. Age-adjusted death rates for coronary heart disease (420) in white males, 1950.



cordance with the sixth revision of the International Lists, and they have been allocated to place of residence (1).

The death rate for coronary heart disease is roughly twice as high in some States as in others. In New Mexico, Arkansas, and Kentucky, the age-adjusted death rates among white males were 191.1, 201.2, and 211.2, respectively, as compared with death rates in New York, Rhode Island, and the District of Columbia of 393.8, 364.3, and 344.3. For white females the contrast is even greater, with death rates of 83.4, 87.8, and 89.0 in New Mexico, Arizona, and Nebraska, as compared with death rates of 217.4, 176.6, and 175.6 in New York, New Jersey, and Rhode Island. There is a definite tendency for States with similar death rates to cluster.

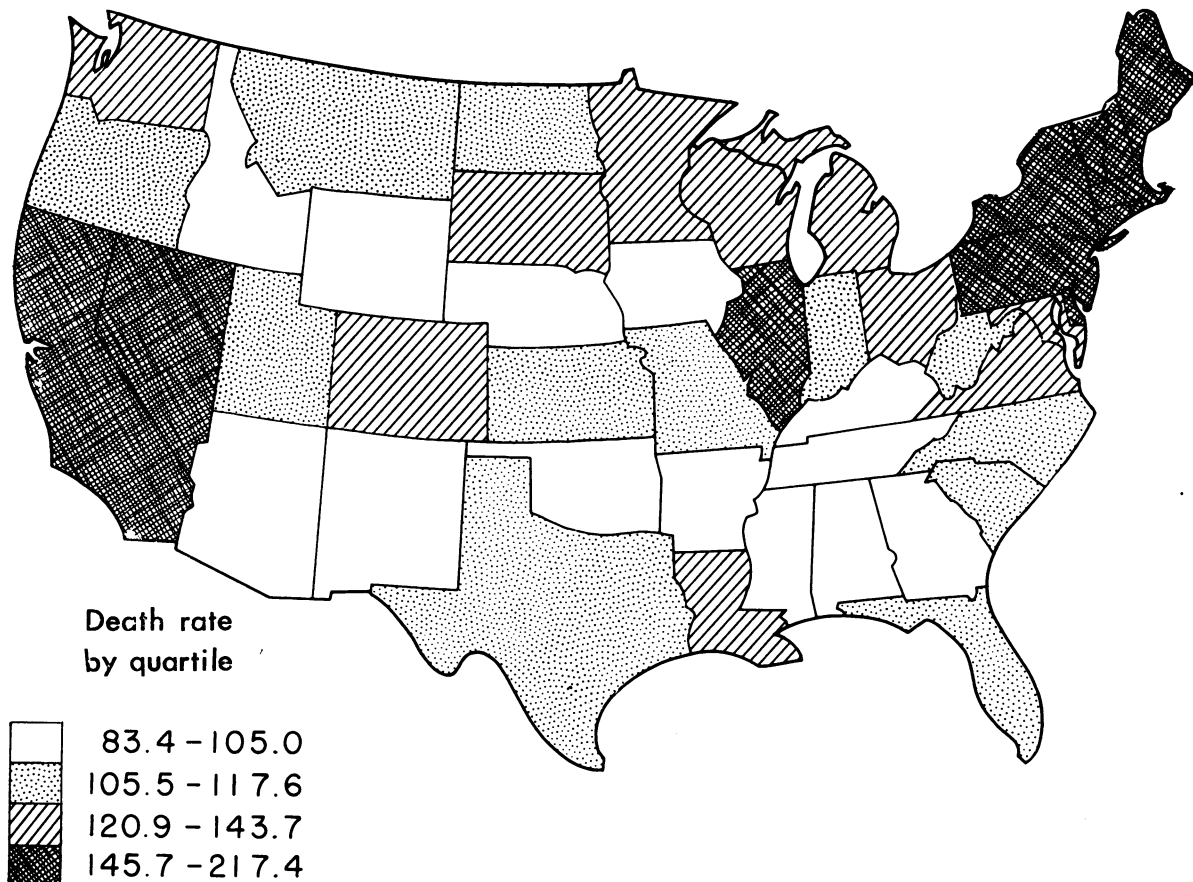
Because coronary heart disease has been recognized as an important clinical entity only since about 1920, it seems possible that dif-

ferences in the observed death rates among States might be due to differences in diagnostic criteria. There are, for example, differences in the amount of medical care available in various sections of the country which may in some way be associated with the likelihood of coronary disease being diagnosed at the time of death. Although the possibility that the observed differences are artificial can be tested only indirectly, the available evidence suggests that the differences in death rates in various parts of the country shown in figures 1 and 2 are real.

Effect on Deaths From All Causes

In the middle and older age groups, coronary heart disease deaths make up a large proportion of the deaths from all causes. As shown in table 2, about a third of all deaths among white males in the age group 45-74 are due to coronary

Figure 2. Age-adjusted death rates for coronary heart disease (420) in white females, 1950.



heart disease. It would be expected, therefore, that if real geographic differences in the death rates from coronary heart disease exist they would be reflected in differences in the death rates for all causes.

Data shown in table 3 for white males indicate that the coronary heart disease death rate does affect the death rate for all causes. Generally, in geographic divisions where the death rate for coronary heart disease is high, the death rate for all causes is high. This relationship is most striking in the age groups 55-64 and 65-74. In the age group 65-74 much of the variation in the death rates for all causes among geographic divisions is, in fact, eliminated when coronary heart disease deaths are excluded.

In the age group 75-84, there appear to be important differences in the diagnostic criteria used in the various geographic regions. This is suggested both by less association between the death rates for coronary heart disease and

the death rates for all causes in this age group as compared with other age groups and by a tendency for death rates for coronary heart disease to be negatively associated with death rates for all causes excluding coronary heart disease. It is probable that some deaths in the age group 75-84 called coronary heart disease in the Middle Atlantic States, for example, are called something else in the East South Central States. Diagnostic differences in the older age groups are to be expected in view of the increasing multiplicity of diseases present at time of death with increasing age, which makes identification of the underlying cause difficult. The numbers of deaths in the older age groups and the probable magnitude of the differences in diagnostic criteria are not sufficiently large, however, to account for an appreciable proportion of the geographic variation in the death rates shown in table 1.

Table 1. Death rates per 100,000 population for coronary heart disease,¹ white males and females, by geographic division and State

Geographic division and State	Age-adjusted rates, 1950 ²				Rates for age group 45-64; 3-year average 1949-51			
	Male		Female		Male		Female	
	Rate	Quartile ³	Rate	Quartile ³	Rate	Quartile ³	Rate	Quartile ³
New England	332.3		167.8		591.7		179.7	
Maine	280.6	3d	145.7	3d	533.4	3d	152.8	4th
New Hampshire	339.6	4th	159.7	4th	590.3	4th	155.2	4th
Vermont	303.2	3d	154.5	4th	559.4	3d	148.1	3d
Massachusetts	337.4	4th	171.0	4th	612.6	4th	188.0	4th
Rhode Island	364.3	4th	175.6	4th	613.4	4th	194.0	4th
Connecticut	339.9	4th	173.4	4th	565.6	3d	176.6	4th
Middle Atlantic	355.6		191.0		619.6		209.9	
New York	393.8	4th	217.4	4th	653.4	4th	223.2	4th
New Jersey	330.1	4th	176.6	4th	588.8	4th	194.3	4th
Pennsylvania	312.7	4th	159.3	4th	580.8	4th	196.7	4th
East North Central	290.5		137.7		535.2		150.8	
Ohio	289.1	3d	137.3	3d	541.3	3d	151.3	3d
Indiana	282.4	3d	117.4	2d	530.8	3d	136.0	3d
Illinois	293.4	3d	146.4	4th	545.2	3d	157.1	4th
Michigan	299.0	3d	135.6	3d	542.8	3d	154.1	4th
Wisconsin	282.5	3d	143.7	3d	488.9	2d	144.3	3d
West North Central	253.2		113.6		452.2		116.3	
Minnesota	272.5	2d	122.3	3d	457.8	2d	125.5	2d
Iowa	266.1	2d	121.3	3d	466.8	2d	119.7	2d
Missouri	246.4	2d	113.2	2d	458.6	2d	123.6	2d
North Dakota	232.3	1st	116.8	2d	374.3	1st	110.1	2d
South Dakota	232.1	1st	120.9	3d	438.2	2d	113.2	2d
Nebraska	221.3	1st	89.0	1st	435.3	1st	90.6	1st
Kansas	255.0	2d	105.6	2d	449.2	2d	102.2	1st
South Atlantic	270.2		118.4		520.1		131.3	
Delaware	330.7	4th	152.1	4th	546.9	3d	176.6	4th
Maryland	304.9	4th	137.9	3d	568.4	4th	146.7	3d
District of Columbia	344.3	4th	137.5	3d	613.1	4th	137.7	3d
Virginia	276.5	3d	122.7	3d	521.5	3d	134.7	3d
West Virginia	229.5	1st	113.2	2d	429.2	1st	137.4	3d
North Carolina	248.2	2d	107.2	2d	473.6	2d	117.7	2d
South Carolina	294.2	3d	108.8	2d	596.4	4th	137.7	3d
Georgia	247.9	2d	102.8	1st	477.2	2d	116.6	2d
Florida	274.7	3d	117.6	2d	569.5	4th	128.4	2d
East South Central	220.0		99.9		398.7		108.3	
Kentucky	211.2	1st	105.0	1st	380.5	1st	107.5	1st
Tennessee	217.4	1st	96.1	1st	385.6	1st	106.1	1st
Alabama	229.3	1st	101.3	1st	422.1	1st	114.5	2d
Mississippi	231.9	1st	92.2	1st	430.9	1st	105.2	1st
West South Central	246.0		106.2		459.5		107.9	
Arkansas	201.2	1st	90.5	1st	388.0	1st	92.7	1st
Louisiana	321.9	4th	138.0	3d	572.4	4th	149.3	3d
Oklahoma	222.3	1st	95.5	1st	436.6	2d	95.8	1st
Texas	247.0	2d	105.5	2d	453.2	2d	104.1	1st
Mountain	247.5		110.4		440.8		112.9	
Montana	250.9	2d	112.1	2d	494.5	3d	129.6	3d
Idaho	246.3	2d	99.4	1st	467.7	2d	106.7	1st
Wyoming	229.6	1st	90.8	1st	433.3	1st	90.4	1st
Colorado	258.5	2d	125.4	3d	446.4	2d	131.3	3d
New Mexico	191.1	1st	83.4	1st	309.0	1st	79.2	1st
Arizona	234.3	2d	87.8	1st	427.1	1st	89.8	1st
Utah	258.2	2d	113.8	2d	434.8	1st	118.5	2d
Nevada	333.4	4th	162.6	4th	569.6	4th	129.3	2d
Pacific	324.4		141.2		594.3		151.1	
Washington	292.8	3d	124.5	3d	539.2	3d	134.6	3d
Oregon	277.6	3d	109.8	2d	511.2	3d	120.6	2d
California	340.2	4th	149.1	4th	620.0	4th	159.0	4th

¹ International List No. 420.

² Direct method using total United States population in 1950; adjusted in 10-year age groups, under 5, 5-15 . . . 85 and over.

³ Twelve States are in each quartile; the District of Columbia was assigned to the quartile in which it naturally fell.

Table 2. Number of deaths from all causes and from coronary heart disease and percentage due to coronary heart disease, white males and females, by age group, 1950

Age group (years)	Deaths from all causes	Deaths from coronary heart disease	Percentage due to coronary heart disease
<i>Males</i>			
15-24	14, 769	103	0. 7
25-34	19, 323	943	4. 9
35-44	36, 293	7, 389	20. 4
45-54	77, 150	25, 317	32. 8
55-64	142, 419	50, 238	35. 3
65-74	181, 770	60, 087	33. 1
75-84	147, 984	41, 876	28. 3
85 and over	48, 249	11, 213	23. 2
<i>Females</i>			
15-24	7, 024	72	1. 0
25-34	12, 235	278	2. 3
35-44	22, 915	1, 283	5. 6
45-54	42, 994	5, 244	12. 2
55-64	79, 803	16, 497	20. 7
65-74	130, 712	33, 813	25. 9
75-84	141, 519	35, 066	24. 8
85 and over	61, 785	13, 448	21. 8

For white females the association between death rates for coronary heart disease and death rates for all causes is similar to that for white males; that is, in geographic divisions where the death rate for coronary heart disease is high, the death rate for all causes is high.

Table 4 shows a refinement of the data in table 3 for white males in the age group 55-64. Excluding deaths due to violence from deaths for all causes does not alter the association shown in table 3. The death rates for two disease categories (list Nos. 421-422 and 330-334) that might be confused with coronary heart disease either tend to be positively associated with the death rate for coronary heart disease or show no association at all. These data strongly support those shown in table 3 in favor of real and fairly large geographic differences in the death rate for coronary heart disease. Similar data for the other age groups likewise support this conclusion. Nevertheless, it is recognized that the differences may, to some extent, be influenced by differences in diagnostic criteria.

Table 3. Death rates per 1,000 population for coronary heart disease, all causes, and all causes excluding coronary heart disease, white males in selected age groups by geographic division, 1950

Geographic division ¹ and age group	Coro-nary heart disease (420)	All causes	All causes exclud-ing coro-nary heart disease	Geographic division ¹ and age group	Coro-nary heart disease (420)	All causes	All causes exclud-ing coro-nary heart disease
<i>Age group 45-54</i>				<i>Age group 65-74</i>			
Middle Atlantic	3. 7	10. 6	6. 9	Middle Atlantic	19. 6	54. 0	34. 4
Pacific	3. 5	10. 5	7. 0	New England	18. 2	50. 6	32. 4
New England	3. 5	9. 9	6. 4	Pacific	17. 5	48. 2	30. 7
East North Central	3. 2	9. 8	6. 6	East North Central	15. 7	49. 1	33. 4
South Atlantic	3. 2	10. 2	7. 0	South Atlantic	14. 3	47. 8	33. 5
West South Central	2. 9	9. 1	6. 2	West North Central	13. 8	44. 1	30. 3
West North Central	2. 7	8. 2	5. 5	Mountain	13. 7	45. 5	31. 8
Mountain	2. 5	9. 6	7. 1	West South Central	13. 4	43. 4	30. 0
East South Central	2. 5	9. 1	6. 6	East South Central	11. 6	44. 6	33. 0
<i>Age group 55-64</i>				<i>Age group 75-84</i>			
Middle Atlantic	9. 4	25. 5	16. 1	Middle Atlantic	37. 1	111. 4	74. 3
Pacific	9. 1	23. 4	14. 3	New England	34. 0	101. 7	67. 7
New England	8. 9	23. 5	14. 6	Pacific	32. 2	101. 1	68. 9
South Atlantic	8. 0	23. 6	15. 6	East North Central	29. 2	108. 2	79. 0
East North Central	7. 9	23. 3	15. 4	West North Central	27. 0	103. 7	76. 7
West South Central	6. 9	20. 9	14. 0	Mountain	26. 3	99. 5	73. 2
West North Central	6. 8	19. 4	12. 6	South Atlantic	25. 2	103. 9	78. 7
Mountain	6. 4	20. 9	14. 5	West South Central	23. 8	96. 4	72. 6
East South Central	6. 2	20. 6	14. 4	East South Central	21. 2	105. 9	84. 7

¹ Geographic divisions arrayed in order of magnitude of death rates per 100,000 population for coronary heart disease.

Table 4. Death rates per 1,000 population for all causes (excluding violence), arteriosclerotic and degenerative heart disease, and strokes, white males aged 55-64, by geographic division, 1950

Geographic division ¹	All causes excluding violence	Arteriosclerotic and degenerative heart disease and strokes				
		Total	Arteriosclerotic and degenerative heart disease			Strokes, list Nos. 330-334
			Total	List No. 420	List Nos. 421-422	
Middle Atlantic.....	24.1	12.3	10.6	9.4	1.2	1.7
New England.....	22.2	11.4	9.6	8.9	.7	1.8
South Atlantic.....	22.1	11.2	8.9	8.0	.9	2.3
East North Central.....	21.7	11.0	9.1	7.9	1.2	1.9
Pacific.....	21.5	11.5	9.8	9.1	.7	1.7
West South Central.....	19.4	9.3	7.5	6.9	.6	1.8
East South Central.....	19.1	9.2	7.0	6.2	.8	2.2
Mountain.....	18.9	8.7	7.2	6.4	.8	1.5
West North Central.....	17.9	9.1	7.4	6.8	.6	1.7

¹ Geographic divisions arrayed in order of magnitude of death rate per 100,000 population for all causes excluding violence.

Possible Causes

It is productive to speculate as to possible causes for the apparently real geographic differences in mortality from coronary heart disease. One point of particular interest is the fact that whatever the causes are they appear to affect males and females in about the same manner. (There are, however, possibly meaningful differences in the ratio of white male to white female death rates; the ratio ranges from 1.8 in New York and 1.9 in New Jersey and South Dakota to 2.9 in South Carolina and Arizona.)

The most patent explanation for the geographic pattern seems to lie in an association between urbanization and mortality from coronary heart disease. It will be noted that areas of relatively high mortality in figures 1 and 2 tend to be highly urbanized. In support of this theory, Gover and Pennell reported that for 1940 the age-adjusted white death rates for diseases of the coronary arteries and of the myocardium were only about two-thirds as high in rural areas as in urban areas (2).

At this time, mortality tabulations which would permit an adjustment of the 1950 mortality rates for coronary heart disease for urbanization are not available. However, a comparison of the 1940 rates for diseases of the coro-

nary arteries and of the myocardium for urban and rural areas and for rural areas alone with the 1950 rates for coronary heart disease for each of the nine geographic divisions throws some light on the question. This comparison, shown in table 5, indicates that the same geographic pattern persists in rural areas as in the United States as a whole. (The same conclusion is reached if only diseases of the coronary arteries, list Nos. 94a and 94b, are used.) Although there were defects in the identification of coronary heart disease under the fifth revision of the International Lists, which was in effect in 1940, they probably do not invalidate the comparison. It would seem unlikely, therefore, that an adjustment of the 1950 data for urbanization would change greatly the geographic pattern shown in figures 1 and 2.

Most of the current theories which might explain geographic differences in coronary disease fall into two categories—genetic and cultural. With regard to the latter, many possibilities have been suggested, including such things as diet, exercise, and stress. All of these may play a part. There may also be hereditary factors which are manifested by differences in the physical characteristics of populations in various parts of the country (as well as in various parts of the world) and which are in some way re-

Table 5. Age-adjusted rates¹ per 1,000 population for coronary heart disease, 1950, and for diseases of the coronary arteries and myocardium, 1940, white males and females, by geographic division

Geographic division ²	Coronary heart disease (420), 1950	Diseases of the coronary arteries and myocardium (94a,b, 93a,b,d,e), 1940	
		All areas	Rural areas only
<i>Males</i>			
Middle Atlantic.....	3.6	3.6	3.1
New England.....	3.3	3.2	2.6
Pacific.....	3.2	3.1	2.6
East North Central.....	2.9	2.7	2.2
South Atlantic.....	2.7	2.4	1.8
West North Central.....	2.5	2.1	1.6
Mountain.....	2.5	2.2	1.7
West South Central.....	2.5	2.0	1.3
East South Central.....	2.2	1.8	1.2
<i>Females</i>			
Middle Atlantic.....	1.9	2.4	2.3
New England.....	1.7	2.2	1.8
Pacific.....	1.4	1.7	1.6
East North Central.....	1.4	1.9	1.6
South Atlantic.....	1.2	1.5	1.2
West North Central.....	1.1	1.3	1.1
Mountain.....	1.1	1.4	1.2
West South Central.....	1.1	1.2	.9
East South Central.....	1.0	1.2	.9

¹ Direct method, using 1950 population as standard for coronary heart disease, and 1940 population as standard for diseases of the coronary arteries and myocardium.

² Geographic divisions arrayed in order of the magnitude of the death rate per 100,000 population for coronary heart disease in 1950.

responsible for differences in mortality from coronary heart disease. These theories might be investigated very profitably by studying intensively populations in those areas of the United States experiencing high death rates from coronary heart disease and populations in those areas experiencing low death rates from coronary heart disease.

Summary

For 1950, the age-adjusted death rates for coronary heart disease for white males and white females were roughly twice as high in some States as in others.

The geographic differences are probably not due to differences in standards of diagnosis. However, studies to verify this would be desirable. In those age groups in which coronary heart disease is an important cause of death, the geographic differences in the coronary heart disease death rates are reflected in the death rates for all causes. Moreover, the death rates for two disease categories that might be used in lieu of coronary heart disease show no tendency to be negatively associated with the death rates for coronary heart disease.

The geographic differences do not seem to be due, to any large extent, to differences in urbanization in various parts of the country since they persist if rural areas are examined separately.

Whatever the factors responsible, they appear to affect males and females in about the same manner.

Some of the current theories as to the importance of various factors in the etiology of coronary heart disease might be investigated profitably by studying the populations in the areas of the United States with low and high death rates for this disease.

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