

Mortality from Heart Disease in Puerto Rico as Shown by Vital Statistics¹

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INTRODUCTION

AN OLD INTEREST in the study of mortality from heart disease in Puerto Rico sent me to the following sources for information: (a) vital statistics records; (b) statistics kept by hospitals and clinics; (c) autopsy records, and (d) local physicians, for a general consensus of opinion regarding such mortality. This paper, however, deals only with the first part of my investigation, that is, with the vital statistics relative to mortality from heart disease in Puerto Rico.

Everyone knows that vital statistics are liable to serious errors due to:

(a) Indifference with which physicians at times fill out a death certificate when they have no thorough knowledge either of the illness itself or of the cause of death;

(b) Difficulty in getting physicians to use an international classification when informing the causes of death;

(c) The desire of every physician to use his own terminology;

(d) The habit of informing more than one nosological condition as the direct cause of death;

(e) The effect that fads in diagnosis exercise upon death certificates. Prior to 1908 all cardiac conditions were diagnosed as valvular; afterwards they were known as functional and, at the present time, are spoken of as structural—perhaps too drastically so—since this last terminology does not give a functional diagnosis the importance it deserves. Such variance of thought is naturally reflected in mortality statistics.

(f) The ability to interpret vital statistics correctly. Few persons, other than those professionals qualified for the work, can understand mortality statistics when tabulated according to the International List which classifies the causes of death. During the year 1922–1929, all cardiac deaths in the United States were tabulated under Titles 87 to 90 of the International List, published in 1920.

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Those deaths occurring from 1930–1936 were placed under Titles 90 to 95 of the 1929 list. In Puerto Rico the Department of Health includes under the words, "Death from Heart Disease," all forms of heart disease, including angina pectoris and coronary conditions. In the United States, angina pectoris did not fall within the above-named sections during certain years, yet during others it did.

(g) The methods followed in tabulation, whereby the officer in charge generally has to work in accordance with a certain number of essentially arbitrary rules;

(h) Nonability to compare specifically all data relating to the changes that the Standard of Diagnosis has undergone during the years;

(i) Differences in the Standard of Diagnosis in different localities of the same country.

Obstacles in the field of vital statistics are of such a nature that, in spite of the extreme exactness and care which must accompany all pathological work, it still remains difficult to determine at times which has been, from a philosophical viewpoint, the exact cause of death. This is a fact that all pathologists admit. Nothing better substantiates the above assertion than the example cited by Pearl:²

"A woman has cancer of the breast, is operated upon in the hope of curing this disease, develops a postoperative pneumonia, and dies. Now, if the woman had not had cancer and had therefore not been operated on for its relief, this train of circumstances would not have got under way. This way of looking at the matter plainly suggests that the cancer is fundamentally the cause of this death. But, on the other hand, if she had not been operated on, even though she still had the cancer, she would not have died when she did, but at some later time. This view rather tends to make the operation the cause of death, at least, at the particular time and place at which it occurred. Again, suppose she had been operated on, and had not developed the postoperative pneumonia. Then she might have been permanently cured of the cancer (some are) and lived to a ripe old age. This view of the case truly makes the pneumonia the cause of death. Which of the three things—cancer, operation, or pneumonia—is to be charged as the primary cause of death plainly depends upon the point of view or, put in another way, upon what definitions or rules are set up as to what shall be called the cause of death."

2. R. Pearl, *Medical Biometry and Statistics* (Philadelphia: W. C. Saunders & Co., 1940).

The development of vital statistics in Puerto Rico centers around the organization and growth of the Bureau of Vital Statistics, whose functioning is so closely related to that of the Department of Health of Puerto Rico. We therefore consider it advisable to give at this point a brief resumé of the development of the Department of Health in relation to this special field of vital statistics.

Immediately preceding the change of sovereignty in Puerto Rico, there existed on the Island a Superior Board of Health composed of eight members chosen from high official rank. Absolute authority in matters of public health, however, was vested only in the Captain General of the Island. In addition to this Board, there were local Boards of Health exercising more limited powers, with subcommittees to handle matters of pharmacy. These last, however, had no intervention in the collection of statistical data. Autonomous rule on the Island, which was to establish a definite line between civil and military jurisdictions, was so short-lived that government officials were never able to develop specific plans regarding the health and sanitation of the people.

When the Americans first set up a military government in Puerto Rico, Order No. 91 of June 29, 1898 was promulgated, establishing a new Superior Board of Health composed of six civilians and officers with specific duties but with limited powers. A subsequent Order No. 102 of July 18, 1899 extended the duties of this Board to cover all matters directly affecting public health. On May 1, 1900, a civil government was established in Puerto Rico, and this same Board of Health was incorporated into the newly organized Insular Department of the Interior. In the year 1902 the Insular Legislature created the post of Director of Public Health and, with this post, a new Superior Board of Health. A later law, approved on May 1, 1904, established a so-called "consolidated Department" that handled all matters relating to health, charities, and reform, and started the compilation of mortality statistics in Puerto Rico.

Some years after, the Foraker Bill provided for the creation of a Consulting Board of Health, with special powers to undertake epidemiological surveys, to collate mortality statistics, and so forth. On March 9, 1911, a Public Bill was approved for Puerto Rico and later, in order to reorganize all sanitary services in the Island, it was amended on March 14, 1912. This law made possible the integration of all health matters into one public health organization similar to the ones operating in the United States. Five years later the Jones Act, approved by Congress on March 2, 1917, created the post of

Commissioner of Health in charge of all affairs pertaining to public health, sanitation, and charity. Finally, by virtue of a special law, the year 1931 saw the establishment of a Bureau of Vital Statistics.

In spite of their limitations, vital statistics have a universally recognized value that is attested to by the large appropriations assigned for such work, by the numerous personnel employed in the departments given over to it by every nation of the world, and by the tremendous amount of literature published on the subject.

STATISTICAL DATA

In order to study this subject of mortality from heart disease, the following tables and graphs have been prepared from information obtained in the Bureau of Vital Statistics of the Insular Department of Health.

Table 1 presents the general mortality from some of the most important disease conditions during the period 1915 to 1941, inclusive, and shows the relative place in order of importance that heart disease holds as a cause of death. This same table also demonstrates the tendency of the death rate from heart disease to increase.

Table 2 summarizes mortality from heart disease by sex, color, and age for the ten year period 1932-1941, inclusive, and makes evident the following facts:

(a) In general, mortality rates are higher among nonwhites than among whites for all age groups of both males and females.

(b) In both whites and nonwhites, mortality is higher among males than among females. However, if we consider mortality rates by age groups for both sexes, we find that, from a statistical viewpoint, these are significantly higher in both white and nonwhite females in the "under 35 years of age" group. From then on mortality is higher in the male groups.

(c) Mortality rates increase with advancing age in both color and both sex groups.

Graph I shows the course of the mortality rate in Puerto Rico during the years 1915 to 1942, inclusive. Section A of this graph (1915-1924, inclusive) shows a decreasing trend in such death rates. On the other hand, Section B (1925-1941, inclusive) shows an increasing trend. Section C (1932-1941, inclusive) shows an increasing trend but with a less pronounced slope.

To get a more accurate idea of the magnitude of these trends, corresponding to each one of these three periods, a straight line has

been fitted by the method of least squares to each group of observations. The result is the following:

(a) Straight line equation corresponding to observations between the years 1915 to 1924, inclusive: y equals $91.7 - 2.3x$.

(b) Straight line equation corresponding to observations between the years 1924 to 1932, inclusive: y equals $79.4 + 3.41x$.

(c) Straight line equation corresponding to observations between the years 1932 to 1941, inclusive: y equals $105.6 + 1.74x$.

During the period 1915 to 1924, inclusive, the equation demonstrates that mortality rates from heart disease were declining at an average of 2.3 deaths per 100,000 population per year. From 1924 to 1932, inclusive, however, the equation shows a reverse trend and a mortality rate that increased throughout the period at an average rate of 3.41 deaths per 100,000 population per year. Although the trend continued in the same direction from 1932 to 1941, inclusive, the magnitude of the average increase in mortality for this period was reduced to 1.74 deaths per 100,000 population per year. Due to the fact that the Bureau of Vital Statistics was organized during the year 1931, we shall limit the analysis of mortality rates to the period comprised between the years 1932 to 1941, inclusive, as these years offer more reliable information than the preceding ones.

Before continuing, it would be wise to find out whether the mortality trend during the period to be studied is of such magnitude that it can be considered statistically significant. For this purpose, we calculated the Standard Error of the slope of the straight line fitted to our observations by Van Uven's formula, which reads as follows:³

$$b^2 \text{ equals } \frac{S v_k^2 - \frac{(S u_k v_k)^2}{S u_k^2}}{(n - 2) S u_k^2}$$

and where n equals the number of observed points to be filled; u_k equals $x_k - \bar{x}$; v_k equals $y_k - \bar{y}$; \bar{x} equals the mean of all the x ; \bar{y} equals the mean of all the y ; b equals the Standard Error of b in y equals $a + bx$; S denotes the summation over all n values, and k takes the successive values from 1 to n . The Standard Error, as calculated by this formula, is ± 0.743 deaths per 100,000 population per year. As the slope of the trend is 1.74, the same is more than twice its Standard Error and can thus be considered statistically as slightly significant.

3. R. Pearl, *op. cit.*

Table 3 gives the data relative to the age factor for the period 1932 to 1941, inclusive. Graph II was made from this table and demonstrates that, though general mortality from heart disease has been significantly increasing during this period, the evolution of the same, when analyzed by age groups, suggests a slightly decreasing trend in all except the age group 65-74 years, in which a slight increasing trend lacking statistical significance can be observed. (It should be observed that in Table 4 this is the population group that shows the greatest relative increase from 1930 to 1940.) The straight line equations calculated for these age groups by the same procedure of least squares are the following:

Under 35 years:	y equals $14.8 - 0.15x$
35-44 years:	y equals $88.4 - 1.4x$
45-54 years:	y equals $224.0 - 2.4x$
55-64 years:	y equals $520.8 - 1.2x$
65-74 years:	y equals $1265.3 + 10.9x$
75 years and over:	y equals $3593.6 - 5.5x$

It seems paradoxical that in spite of an apparently decreasing mortality trend, when considered by specific age groups, the general mortality rate from heart disease shows an increasing trend great enough in magnitude to fall outside the ± 20 range of sampling variation. In this respect, however, we call attention to Table 3 which shows the spectacular manner in which mortality increases with age. The data summarized in this table leads one to consider the age factor in its relation to the whole picture we have described.

Table 4 demonstrates conclusively that the average population of Puerto Rico has been gradually growing older. As this aging of the population must forcibly and unfavorably affect the statistics dealing with heart disease, it is absolutely necessary before arriving at any conclusion to determine to what extent the magnitude of the increasing trend of such mortality, as shown by the data collected between the years 1932 and 1941, inclusive, can be attributed to this factor. To solve the problem the rates for age differences have been adjusted.

A theoretical population (Standard Million), having the same age distribution as that shown by the last census in Puerto Rico (April 1, 1940), has been calculated (Table 5). To each corresponding age group of this population we have successively applied the age specific death rates from heart disease as found in Puerto Rico from 1932 to 1941, inclusive (Table 3). The results give the number of

expected deaths from this condition in each age group of this Standard Million population, if it has been subjected to the age specific death rates of each corresponding year from 1932 to 1941, inclusive. Adding up the number of expected deaths corresponding to each age group during each year, the total expected deaths from heart disease in our Standard Million population is obtained. This total expresses the death rates from heart disease, adjusted to age differences. The data relative to this calculation can be seen in Table 6.

Graph III shows the adjusted death rates calculated for the years 1932 to 1941, inclusive, and gives an entirely changed picture. Instead of an increasing trend, this graph gives no impression of a tendency to depart significantly from the horizontal. If we calculate the trend line, corresponding to this theoretical death rate, the following equation is obtained: y equals $123.86 - 0.32x$.

This equation demonstrates that the trend shows a tendency to decrease slightly. In other words, it is a decreasing instead of an increasing trend, as obtained when computing the original observations mathematically. However, the Standard Error of the slope in this last equation shows that the decreasing trend of the same is statistically insignificant and, therefore, that the same does not depart significantly from the horizontal. In other words, after the age factor has been adjusted, mortality from heart disease in Puerto Rico has not changed significantly in trend within the last ten year period (1932 to 1941, inclusive).

Graph IV was constructed from Table 2 and shows how mortality increases with advancing age in Puerto Rico. Graph V was constructed from Table 7 which shows the deaths and death rates distributed according to residence.

CONCLUSIONS

1. Mortality rates from heart disease in Puerto Rico (as is also the case in other places) increase with age.
2. Mortality rates from this condition are higher in nonwhites than in whites for all age groups and for both sexes.
3. In the age group under 35 years, mortality rates are higher among females than among males. This difference, when treated statistically, is found to be highly significant. From 35 years on, however, the picture reverses and such mortality rates are higher throughout the rest of the life period in the male group.

4. Mortality rates are higher in the urban population than in the rural.

5. The aging of the population in Puerto Rico may explain the increasing trend in mortality rates during the last ten years. By adjusting the mortality rates for age differences during this ten year period, the increasing trend observed, when studying the death rates in the records of the Bureau of Vital Statistics of the Department of Health, is changed to a slightly decreasing trend with no statistical significance.

ACKNOWLEDGMENT

The author is indebted to Mr. José L. Janer, Chief of the Bureau of Vital Statistics of the Department of Health of Puerto Rico, for valuable help in the compilation and analysis of the statistical data presented herein.

Mortality from Heart Disease

TABLE 1
Death Rates per 100,000 Population from Some of the Most Important Disease Conditions
Puerto Rico—1915-1941, Inclusive

Causes of death	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
	Diarrhea and enteritis	416.9	479.1	666.7	482.1	365.5	402.4	393.0	410.2	338.7	317.6	363.7	396.1	405.8
Tuberculosis	173.3	193.5	216.0	211.7	185.4	202.2	202.9	199.1	199.1	203.8	226.2	298.6	251.9	261.3
Bronchitis	116.4	119.0	161.3	134.3	129.9	121.4	130.1	109.1	82.2	79.5	105.3	92.2	78.7	92.4
Pneumonia	117.7	128.2	165.1	236.7	182.2	191.6	214.4	198.0	173.5	158.8	240.6	166.2	162.0	202.4
Nephritis	109.0	133.6	175.9	150.4	135.6	127.5	112.0	115.3	104.7	99.6	134.9	141.7	156.4	167.3
Malaria	93.4	133.3	144.0	120.6	123.4	118.7	96.6	81.5	66.7	85.8	112.3	140.2	139.2	144.2
Heart disease	78.2	86.0	108.9	89.2	76.0	83.6	74.4	76.9	69.0	70.9	84.1	88.5	92.9	101.5
Cancer	28.6	29.6	35.0	27.8	27.4	28.5	27.0	31.0	33.0	33.5	36.7	36.4	39.0	41.2

Causes of Death	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941
	Diarrhea and enteritis	529.9	327.2	338.3	408.2	463.0	362.8	368.6	488.1	477.4	419.1	399.7	416.4
Tuberculosis	302.1	263.2	275.5	297.3	337.2	308.3	368.5	305.3	337.1	274.5	258.4	260.9	242.8
Bronchitis	80.8	57.6	51.9	59.5	56.5	38.9	44.3	35.5	51.8	40.1	38.9	32.4	23.8
Pneumonia	198.0	173.8	199.0	232.5	187.8	146.0	155.5	161.9	187.8	176.0	177.9	169.7	160.0
Nephritis	205.6	138.8	124.5	137.4	149.6	130.8	133.7	125.1	129.5	112.7	108.7	108.7	107.6
Malaria	137.9	121.7	203.7	174.9	200.7	152.8	126.2	141.4	129.5	108.7	89.1	97.0	124.6
Heart disease	132.5	103.0	93.1	107.2	116.2	104.2	97.4	114.0	116.6	119.8	116.2	125.8	117.3
Cancer	39.0	36.1	42.9	43.5	45.9	47.1	50.3	52.0	48.7	51.8	53.8	51.9	54.2

Mortality from Heart Disease

TABLE 2
Average Annual Deaths and Death Rates from Heart Disease in Puerto Rico
per 100,000 Population Specific for Age, Sex and Color
1932-1941, Inclusive^a

Age	White					
	Male		Female		Total	
	Deaths	Rates	Deaths	Rates	Deaths	Rates
All ages	767	115.4	657	99.2	1,424	107.3
Under 35 years	60	12.0	72	14.2	132	13.1
35-44	54	76.4	45	64.3	99	70.4
45-54	110	229.4	62	148.4	172	191.7
55-64	150	566.0	85	368.5	235	474.1
65-74	181	1,404.6	143	1,123.2	324	1,264.7
75 and over	213	3,387.9	248	3,283.9	461	3,331.2

Age	Non-White					
	Male		Female		Total	
	Deaths	Rates	Deaths	Rates	Deaths	Rates
All ages	298	142.3	262	124.1	560	133.2
Under 35 years	27	16.7	30	18.4	57	17.6
35-44	29	137.8	22	101.7	51	119.5
45-54	44	316.7	31	231.1	75	274.6
55-64	56	762.0	37	525.8	93	646.5
65-74	57	1,641.2	46	1,225.7	103	1,425.4
75 and over	85	4,354.5	94	3,597.4	179	3,921.1

Age	All					
	Male		Female		Total	
	Deaths	Rates	Deaths	Rates	Deaths	Rates
All ages	1,065	121.9	919	105.2	1,984	113.5
Under 35 years	87	13.1	102	15.2	189	14.2
35-44	83	90.5	67	73.1	150	81.8
45-54	154	249.6	93	168.5	247	211.0
55-64	206	646.5	122	405.3	328	512.9
65-74	238	1,425.4	189	1,146.5	427	1,300.1
75 and over	298	3,616.9	342	3,364.5	640	3,477.5

^a Estimated average population by age, sex and color for ten year period 1932-1941.

TABLE 3
Death Rates from Heart Disease by Age Group per 100,000 Population
Puerto Rico 1932-1941, Inclusive

Age in Years	Rates per 100,000 Population of Specific Age Group, 1932-1941										
	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	
All Ages	107.2	116.2	104.2	97.4	114.0	116.6	119.8	116.2	125.8	117.3	
Under 35 years	19.3	14.0	11.9	9.7	15.5	15.3	13.5	13.8	14.4	13.8	
35-44	101.4	87.7	78.5	66.7	87.3	75.8	87.4	77.2	85.3	72.1	
45-54	247.1	242.7	181.8	177.2	230.9	221.4	225.3	181.9	210.0	213.5	
55-64	582.5	552.5	459.3	420.9	498.5	508.2	574.6	533.7	575.3	449.6	
65-74	1,222.2	1,317.0	1,326.5	1,220.8	1,344.3	1,302.6	1,313.7	1,357.6	1,507.2	1,230.0	
75 and over	2,612.3	4,198.3	3,929.0	3,722.9	3,994.2	3,462.0	3,388.7	3,349.0	3,349.0	3,603.1	

TABLE 4
Absolute and Relative Increases and Percentage Distribution by Age Groups
of 1940 Census Population with Respect to the 1930 Census—Puerto Rico

Age Groups in Years	Population				Absolute Increase of 1940 Over 1930	Percentage Increase of 1940 Over 1930
	1930		1940			
	Number	Per- centage	Number	Per- centage		
All ages	1,543,913	100.0	1,869,255	100.0	325,342	21.07
Under 35 years	1,179,802	76.4	1,422,268	76.1	242,466	20.55
35-44	164,904	10.7	187,110	10.0	22,206	13.46
45-54	103,163	6.7	125,993	6.8	22,830	22.13
55-64	56,418	3.6	69,831	3.7	13,413	23.77
65-74	25,828	1.7	41,905	2.3	16,077	62.24
75 and over	13,576	0.9	21,201	1.1	7,625	56.16
Unknown	222	—	947	—	725	—

TABLE 5
A Standard Million from the Actual Living Population of Puerto Rico in 1940

Age Interval	Population Both Sexes Puerto Rico 1940 Census	Population Basis 1,000,000
Under 35 years	1,422,268	761,260
35-44 years	187,110	100,149
45-54	125,993	67,437
55-64	69,831	37,377
65-74	41,905	22,429
75 and over	21,201	11,348
Total	1,868,308 ^a	1,000,000

^a This total does not include 947 persons classified as of "unknown age."

TABLE 6

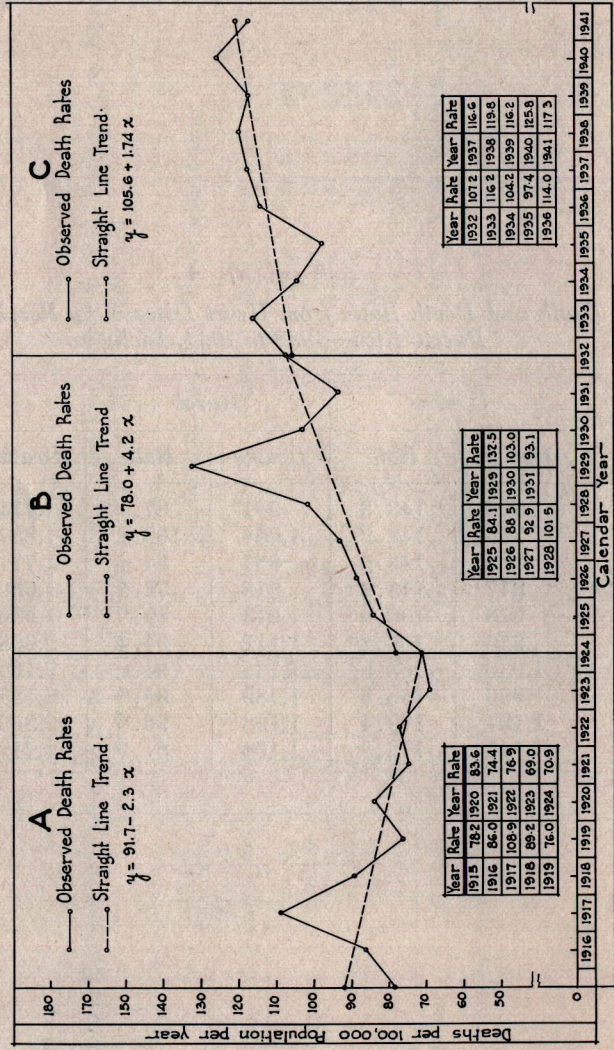
Expected Deaths from Heart Disease in Puerto Rico for the Years 1932 to 1941, Inclusive, on Basis of Actual Population Million of Puerto Rico as Standard

Age in Years	Actual Population Million Puerto Rico	Expected Deaths from Heart Disease by Age Groups									
		1932	1933	1934	1935	1936	1937	1938	1939	1940	1941
Under 35	761,280	146.9	106.6	90.6	73.8	118.0	116.5	102.8	105.1	109.6	105.1
35-44	100,149	101.6	87.8	78.6	66.8	87.4	75.9	87.5	77.3	85.4	72.2
45-54	67,437	166.6	163.7	122.6	119.5	155.7	149.3	151.9	122.7	141.6	144.0
55-64	37,377	217.7	206.5	171.7	157.3	186.3	189.9	214.8	199.5	215.0	168.0
65-74	22,429	274.1	295.4	297.5	273.8	301.5	292.2	294.6	304.6	338.1	276.0
75 and Over	11,348	296.4	476.4	445.9	422.5	453.3	392.9	384.5	380.0	380.0	408.9
Total Deaths	1,000,000	1,203.3	1,336.4	1,206.9	1,109.7	1,302.2	1,216.7	1,236.1	1,189.2	1,269.7	1,174.2
Death Rate per 100,000 Population		120.3	133.6	120.7	111.0	130.2	121.7	123.6	118.9	127.0	117.4

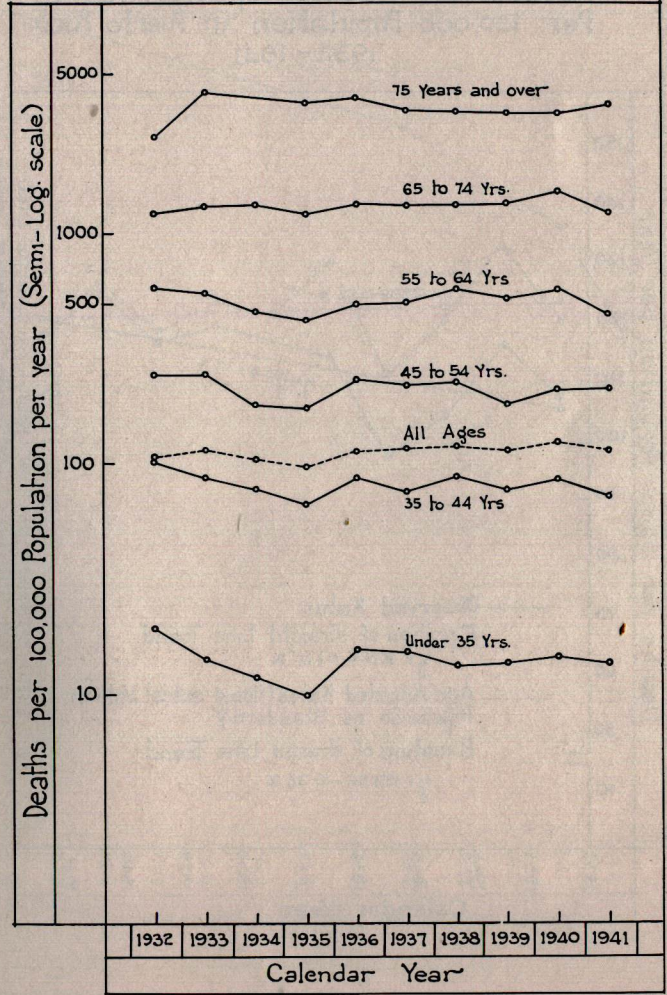
TABLE 7
Death and Death Rates from Heart Disease, by Residence
Puerto Rico—1932 to 1941, Inclusive

Calendar Year	Urban		Rural		Total	
	Deaths	Rate	Deaths	Rate	Deaths	Rate
1932	773	148.3	941	87.1	1,714	107.2
1933	793	148.2	1,094	100.2	1,887	116.2
1934	786	143.2	931	84.4	1,717	104.2
1935	817	145.2	813	72.9	1,630	97.4
1936	923	160.0	1,013	89.9	1,936	114.0
1937	956	160.2	1,112	94.4	2,068	116.6
1938	1,030	168.8	1,135	94.6	2,163	119.8
1939	996	153.3	1,139	95.9	2,135	116.2
1940	1,187	179.4	1,168	96.6	2,355	125.8
1941	1,140	173.3	1,102	87.9	2,242	117.3

Graph I
Death Rates From Heart Diseases Per 100,000 Population
Puerto Rico: 1915-1941

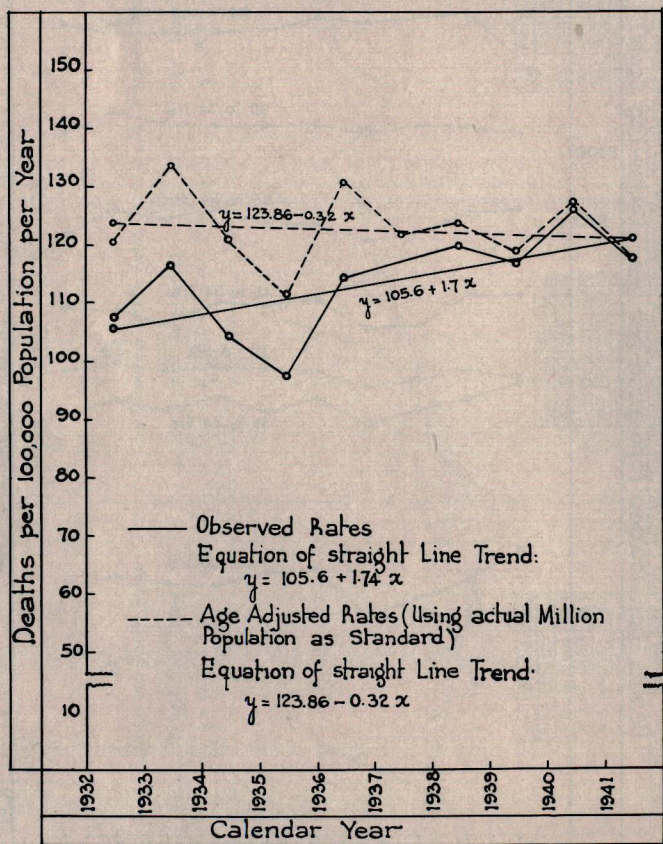


Graph II
Death Rates From Heart Disease per 100,000
Population of Specific Age Group in Puerto Rico.
1932 to 1941



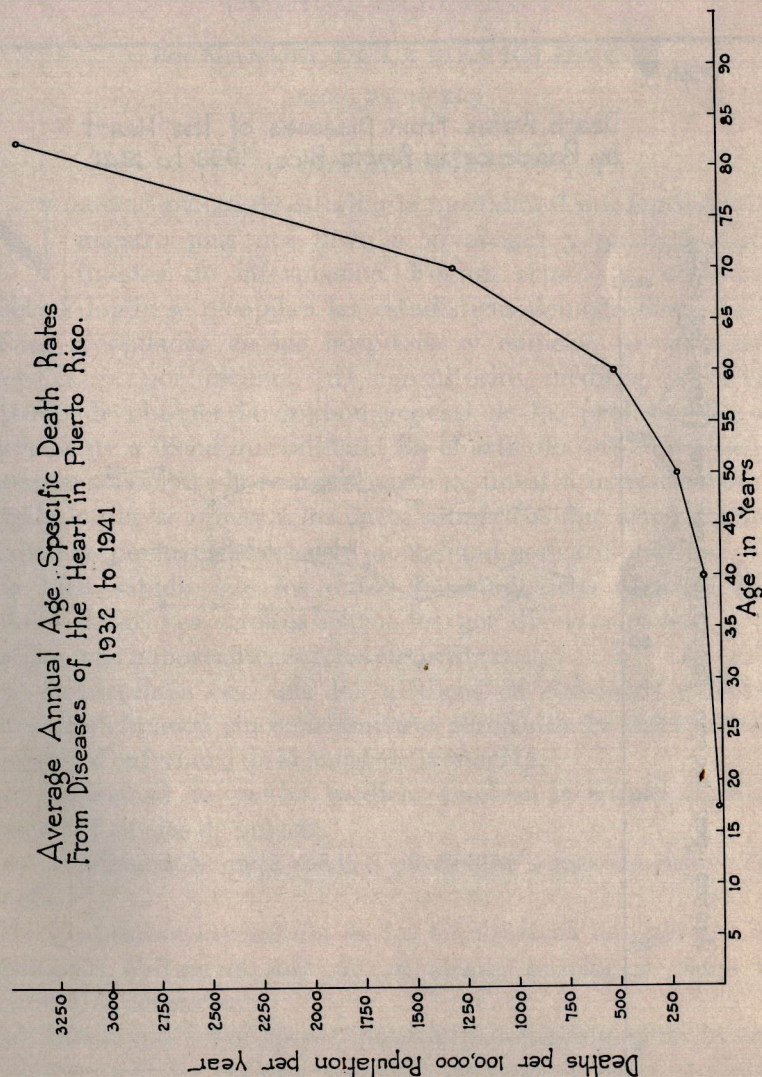
Graph III

Observed and Age Adjusted Death Rates From Diseases of The Heart Per 100,000 Population in Puerto Rico. 1932 - 1941



Graph IV

Average Annual Age-Specific Death Rates From Diseases of the Heart in Puerto Rico. 1932 to 1941



Graph V

Death Rates From Diseases of the Heart
by Residence, in Puerto Rico, 1932 to 1941.

