

INTERNATIONAL RESEARCH ON MORTALITY<sup>1</sup>Ruth R. Puffer<sup>2</sup> and G. Wynne Griffith,<sup>3</sup> Pan American Health Organization

The marked decline in death rates during this century in the United States as well as in other countries of the Americas has been due principally to the measures taken for the prevention of communicable diseases, and the decline has been much greater for mortality in infancy and childhood than in adult life. Although the decreases in the deaths due to malaria and to tuberculosis have also affected the death rates in adult life, further reduction in death rates in the United States, as in other countries, requires greater understanding of the causation of mortality in adults, especially that due to cardiovascular diseases and cancer. The slowing down in the decline in mortality in the last decade in the United States (1) and in other countries indicates the need for a continuing analysis of these problems.

The fact that death rates from diseases of the heart, particularly coronary heart disease, were much higher in the United States than in many other countries of the world was the initial observation (2) that led the Pan American Health Organization to undertake the Inter-American Investigation of Mortality. It was thought that clues to the causative factor or factors could be obtained if the wide differences in the observed mortality were verified, that is, if the differences were shown not to be due to variations in medical practice, in terminology, and in the classification of the underlying causes. Thus, this Investigation was designed to study mortality in adult life in the 60-year age span from 15 to 74 years with particular attention to cardiovascular diseases and cancer. In this collaborative research project, which involved the intensive study of deaths in 12 widely separated cities (two English-speaking, two Portuguese-speaking, and eight Spanish-speaking), great care has been taken to obtain complete data to ensure the

uniform assignment of the underlying cause of death. The results of this large-scale study of 43,298 deaths are now being analyzed and will be published in full later this year.

A previous publication (3) has described the events which led to this Investigation in the period 1957 to 1961, the planning conferences held in 1961 and 1962, the selection of the 12 participating cities and the principal collaborators in these cities, and the method of data collection to assemble all available clinical, laboratory, and autopsy findings on approximately 2,000 deaths per year for two years in each city. The field work was carried out from 1962 to 1964 and all records were received for processing and analysis in 1965. The underlying cause of death has been classified, in accordance with international procedures, with the assistance of two outstanding medical referees: Dr. Percy Stocks, formerly of the General Register Office of England and Wales and former Director of the WHO Center for International Classification of Diseases; and Dr. Dario Curiel, former Director of the Latin American Center for Classification of Diseases in Venezuela.

The results have revealed remarkable differences in mortality in adult life. Much more information on causes of death is available from hospital and autopsy reports than is provided on official death certificates. In several cities death rates for preventable diseases and conditions in early adult life are excessive. The Investigation indicates that it is time for statisticians to take a new look at mortality statistics and to introduce needed changes so that mortality statistics will again become (as in the past) an important research tool.

At this time some of the results are presented in order to show the nature of the ma-

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terial, the need for prevention, and possible directions for further research. Data for five of the cities are used--San Francisco in the United States; Bristol in England; Guatemala City in Central America; Caracas, Venezuela, in northern South America; and Santiago, Chile, at the other end of the continent. The principal collaborators in these cities are as follows:

Dr. Ellis D. Sox, Director of Public Health, City and County of San Francisco, California

Professor R. C. Wofinden, Medical Officer of Health, City and County of Bristol, and Professor of Public Health, University of Bristol School of Medicine, England

Dr. J. Romeo de León, Jr., Medical Officer, Epidemiology Branch, Division of Public Health, Institute of Nutrition of Central America and Panama (INCAP), Guatemala City, Guatemala

Dr. Carlos L. González, Technical Adviser, Ministry of Health and Social Welfare, and Professor of Preventive Medicine, Vargas Medical School, Central University of Venezuela, Caracas

Dr. Adela Legarreta, Professor of Biostatistics, School of Public Health, University of Chile, Santiago

#### Death Rates by Age for Cities and Corresponding Countries

Differences in the age-specific death rates for the five cities in the 60-year age span are clearly evident, the death rates in the three 10-year age groups from 15-44 years being two or three times higher in one city than in another (Table 1 and Figure 1). The death rate of San Francisco is twice as high as the rate of Bristol in the age group 35-44 years, and about 50 per cent higher for age groups 25-34 years and 45-54 years.

Figure 2 was prepared in order to illustrate the possible similarity between these death rates of cities and those of the corresponding countries as a whole, and to point out any equally wide variation in the rates in those countries. For the national rates, the figure includes the data for two additional age groups, under 15 years and 75 years and over. The data for the cities have been confined to the 60 years for which accurate death rates for residents were

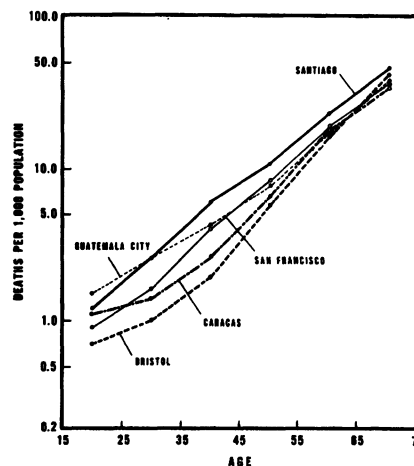
Table 1

Annual Death Rates per 1,000 Population for 10-Year Age Groups, 15-74 Years, in Five Cities, Inter-American Investigation of Mortality, 1962-1964

Age group	Bris- tol, England	Caracas, Vene- zuela	Guatema- la City, Guatema- la	San Fran- cisco, U. S. A.	San- tiago, Chile
15-74 years					
Crude	8.9	4.1	5.4	10.5	7.7
Age-adjusted	4.6	5.0	5.8	5.5	7.3
15-24 years	0.7	1.1	1.5	0.9	1.2
25-34 years	1.0	1.4	2.6	1.6	2.6
35-44 years	1.9	2.6	4.2	4.0	6.0
45-54 years	5.7	6.7	7.8	8.3	10.6
55-64 years	16.2	18.3	16.7	18.8	23.2
65-74 years	41.7	34.6	37.1	35.7	45.0

Figure 1

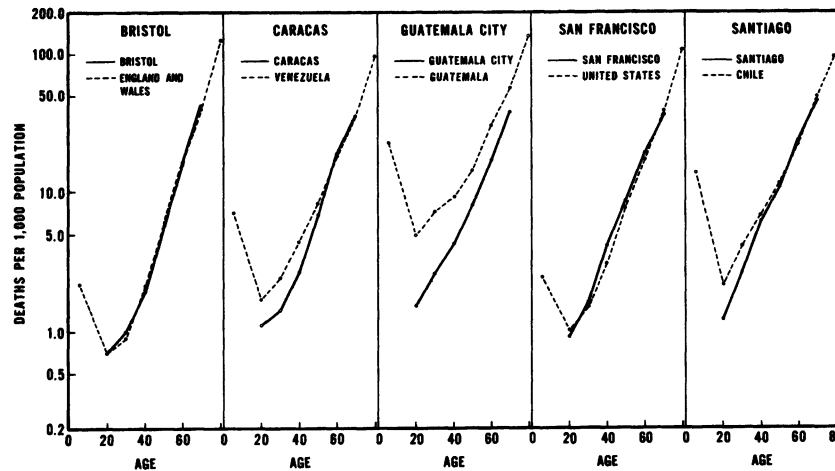
Annual Deaths per 1,000 Population for Adults 15-74 Years of Age, in Five Cities, Inter-American Investigation of Mortality, 1962-1964



obtained in the Investigation.

As was pointed out by the principal collaborator in Bristol, the death rate in that city is practically the same as for England and Wales as a whole, and has been so for many years. In Venezuela the situation is entirely different, the rate for the country being much higher than in the capital city, especially for the age period 15-54 years. Since the regis-

Figure 2  
Annual Deaths per 1,000 Population for Adults 15-74 Years of Age in Five Cities, and for All Ages in Corresponding Countries, Inter-American Investigation of Mortality, 1962-1964



tration of deaths in rural areas is known to be incomplete, the urban-rural differences are probably even greater. In Guatemala City likewise the death rates for the city are well below those for the country as a whole, while in Chile the death rates for the country also exceeded those in Santiago in the three 10-year age groups from 15-44 years. Many factors probably contribute to the lower death rates in the capital cities in these Latin American countries--such as, for example, the concentration of health and medical facilities in cities.

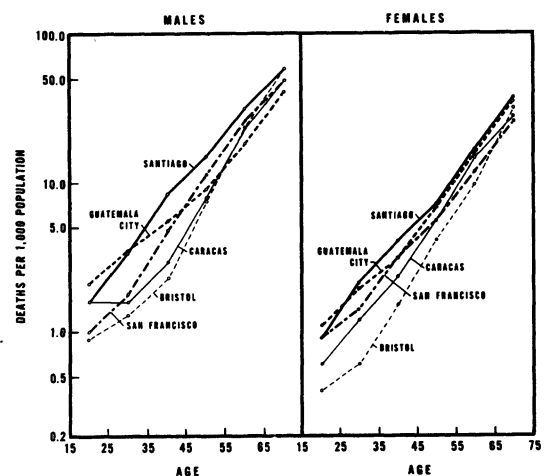
In San Francisco mortality appears to follow a different pattern, the death rates in that city being definitely in excess of those in the United States for the age span 35 to 64 years.

The data presented in these two figures give a clear indication of wide variations in death rates in the 30-year age span 15-44 years in these five cities and between the capital cities and Latin American countries as a whole. Indeed, mortality in rural areas in Latin America may be many times--six to eight--higher than the lowest of the rates found in one of these five cities. The excessive mortality, not only in certain capital cities, but even more so outside them is a challenge to all concerned with the health of the population. Also the differences between mortality in cities and that in the corresponding countries certainly indicate the need for analysis of resident data by causes in urban and rural areas, as a basis

for measuring health problems in Latin American countries as well as in the United States.

Death rates by sex also show marked variations, the mortality of males being consistently higher than that of females in the same age groups in the same city (Figure 3 and Table 2). The age-adjusted death rate\* of males

Figure 3  
Annual Deaths per 1,000 Population for Males and Females 15-74 Years of Age in Five Cities, Inter-American Investigation of Mortality, 1962-1964



\* Death rates have been adjusted by the direct method to a standard population, the composite population of the cities included in the Investigation.

Table 2

Annual Death Rates per 1,000 Population, by Sex, for 10-Year Age Groups, 15-74 Years, in Five Cities, Inter-American Investigation of Mortality, 1962-1964

Age group	Male					Female				
	Bristol	Caracas	Guatemala City	San Francisco	Santiago	Bristol	Caracas	Guatemala City	San Francisco	Santiago
15-74 Years										
Crude	11.1	4.5	6.4	13.8	10.0	6.9	3.6	4.6	7.5	5.8
Age-adjusted	6.3	6.3	7.0	7.2	9.8	3.2	4.0	4.9	4.0	5.4
15-24 years	0.9	1.6	2.2	1.0	1.6	0.4	0.6	1.1	0.9	0.9
25-34 years	1.3	1.6	3.5	1.8	3.3	0.6	1.2	1.9	1.4	2.1
35-44 years	2.3	2.9	5.5	4.8	8.4	1.5	2.3	3.1	3.3	4.0
45-54 years	7.3	7.9	9.1	11.3	15.0	4.1	5.5	6.8	5.6	7.0
55-64 years	23.8	23.1	18.6	26.1	31.9	9.6	14.6	15.3	11.8	16.6
65-74 years	58.0	47.7	40.8	47.5	57.3	31.4	27.6	34.6	25.7	37.1

for the 60-year age span in Bristol (6.3 per per 1,000 population) was nearly twice the rate of females (3.2). In San Francisco the corresponding age-adjusted rates were higher for both males and females, namely, 7.2 and 4.0 per 1,000 population. For the other three cities, they were as follows: Caracas, male 6.3, female 4.0; Guatemala City, male 7.0, female 4.9; Santiago, male 9.8, female 5.4.

The data from these five cities were of good quality: of the 18,869 deaths studied, 51.2 per cent had occurred in hospitals, autopsies had been performed on 44.2 per cent, and 62.7 per cent of the deceased had been hospitalized during their last year of life.

#### Important Causes of Death in Forty-Year Age Span

In these populations mortality in young adult life shows much more variation than in the older age groups. An analysis of the causes of death is therefore presented for the 40-year age span 15-54 years with division into two 20-year age groups, 15-34 years and 35-54 years, and with adjustment of the rates to the same standard populations (Tables 3 and 4). Because of the higher rates in males than in females, the material is presented for the sexes separately. In Figure 4 and Table 3 the death rates from selected important causes of death in males are shown for the two 20-year age spans. In early adult life, 15-34 years, external causes (accidents and violence) caused more than half the male death rate in four of the five cities. Malignant neoplasms and diseases of the heart were responsible for from 7 to 27 per cent of the age-adjusted death rates.

Bristol had the most favorable death rate and practically all the excess mortality in Caracas and San Francisco, as compared with Bristol, was due to accidents, suicide, and homicide. In the other two cities, Guatemala City and Santiago, mortality from accidents and violence was also very high; in addition the group comprising alcoholism, alcoholic psychosis, and cirrhosis of the liver (treated as a single group

Figure 4  
Annual Age-Adjusted Death Rates from Important Causes of Death per 100,000 Population for Males 15-34 Years and 35-54 Years in Five Cities, Inter-American Investigation of Mortality, 1962-1964

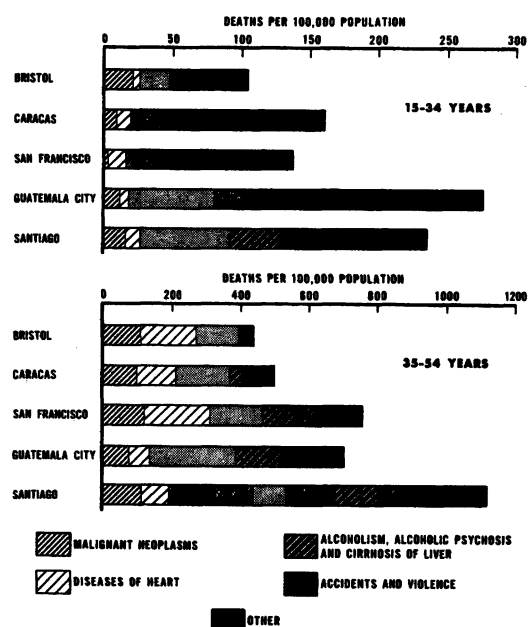


Table 3

Annual Age-Adjusted Death Rates from Important Causes of Death per 100,000 Population, for Males 15-34 Years and 35-54 Years of Age, in Five Cities, Inter-American Investigation of Mortality, 1962-1964

Cause of Death	15-34 Years					35-54 Years				
	Bristol	Cara-cas	San Fran-cisco	Guate-mala City	San-tiago	Bristol	Cara-cas	San Fran-cisco	Guate-mala City	San-tiago
All causes	104.8	160.6	137.3	275.3	234.7	436.7	499.8	756.0	702.4	1116.9
Tuberculosis (001-019)	-	5.8	-	20.7	20.4	7.6	13.8	11.0	52.4	157.8
Malignant neoplasms (140-205)	20.8	8.8	2.9	11.1	15.5	107.2	98.5	121.1	76.1	110.7
Diseases of heart (400-443)	4.8	10.1	13.0	6.4	10.7	163.8	113.7	189.3	58.8	79.2
Alcoholism, alcoholic psychosis, and cirrhosis of liver (307, 322, 581)	-	1.2	5.3	26.4	37.5	3.2	34.5	160.9	132.8	291.6
Vascular lesions affecting central nervous system (330-334)	1.2	1.6	1.9	4.7	3.1	25.6	24.4	17.6	16.3	35.1
External causes (E800-E999)	57.3	111.6	94.8	147.9	105.6	38.4	93.6	130.0	181.2	198.9
Motor vehicle accidents (E810-E825, E830-E835)	33.1	17.2	38.3	39.1	36.1	11.4	19.4	24.8	65.1	68.2
All other accidents (E800-E802, E840-E962)	12.4	17.5	29.6	30.4	29.0	8.7	22.1	27.5	47.1	58.2
Suicide (E963, E970-E979)	10.8	15.0	16.0	30.6	19.4	18.3	17.4	63.1	27.0	34.7
Homicide (E964, E965, E980-E999)	1.0	61.9	10.9	47.8	21.1	-	34.7	14.6	42.0	37.8
All other causes	20.7	21.5	19.4	58.1	41.9	90.9	121.3	126.1	184.8	243.6

since 84.2 per cent of all cirrhosis deaths at these ages in these cities were known to be associated with alcoholism) appeared as a significant cause. Tuberculosis also contributed to the excessive mortality.

In the next 20-year age span (35-54 years) malignant neoplasms and diseases of the heart caused a major proportion of the male death rate in four of the cities. The death rate from diseases of the heart in San Francisco was much higher than in the three Latin American cities. This high rate is principally accounted for by coronary heart disease. The death rate from this cause was also high in Bristol. As pointed out recently by Reid (4) the recorded mortality from arteriosclerotic heart disease among U.S. white males is substantially higher than among British males. The difference in rates in these two cities, however, was not significant. Table 5 shows for each city two sets of age-adjusted death rates from arteriosclerotic heart disease, the first based on the death certificates and the second on the final assignments of cause made by the medical referees after review of all available information. In the age span here considered negligible changes occur in Bristol for both sexes, but in

San Francisco the death rates, particularly of males, were reduced following review. Thus the differences between these two cities became less marked. Although in Guatemala City and Santiago the rates for both sexes increased slightly on final assignment, the disparity between them and the two English-speaking cities remains considerable, a fact which confirms one of the observations that led to this investigation.

In the age group 35-54 years violence and the various forms of alcoholism were responsible for excessive death rates in San Francisco, Guatemala City, and Santiago and together they accounted for much of the excess over the rate in Bristol. The importance of alcoholism has been recognized in San Francisco and Santiago; however, the additional data collected in this investigation resulted in many more deaths being attributed to alcoholism and alcoholic cirrhosis of the liver. Of the deaths certified as due to cirrhosis of the liver, alcoholism had been mentioned in only 33.3 per cent, whereas after the investigation, of those classed to this cause 84.2 per cent were associated with alcoholism. Also, the excessive death rates from external causes in these cities of the Americas could

Table 4

Annual Age-Adjusted Death Rates from Important Causes of Death per 100,000 Population, for Females 15-34 Years and 35-54 Years of Age, in Five Cities, Inter-American Investigation of Mortality, 1962-1964

Cause of Death	15-34 Years					35-54 Years				
	Bristol	Caracas	San Francisco	Guatemala City	Santiago	Bristol	Caracas	San Francisco	Guatemala City	Santiago
All causes	52.3	88.2	109.1	143.2	143.7	258.6	363.5	425.1	462.8	528.5
Tuberculosis (001-019)	-	4.3	4.1	23.9	14.2	4.4	12.1	1.1	35.5	31.1
Malignant neoplasms (140-205)	8.5	10.5	15.2	10.8	14.8	117.0	135.0	119.1	133.5	131.4
Diseases of heart (400-443)	0.7	4.9	3.1	9.3	5.8	50.5	61.6	45.9	46.8	49.9
Alcoholism, alcoholic psychosis and cirrhosis of liver (307, 322, 581)	1.2	0.8	13.2	4.7	5.0	0.9	4.7	104.0	21.8	81.2
Vascular lesions affecting central nervous system (330-334)	-	1.1	9.8	0.6	3.1	21.2	24.2	26.8	23.1	37.9
Complications of pregnancy, delivery and puerperium (640-689)	1.2	17.7	-	24.9	38.3	1.3	6.5	1.8	15.9	27.8
External causes (E800-E999)	24.2	24.6	46.6	13.8	26.3	20.9	20.3	65.7	16.1	27.6
Motor vehicle accidents (E810-E825, E830-E835)	9.8	3.6	11.8	2.8	5.4	8.1	8.7	10.3	5.9	6.8
All other accidents (E800-E802, E840-E962)	6.1	4.5	7.2	2.6	7.8	1.5	2.8	21.3	2.6	8.1
Suicide (E963, E970-E979)	7.3	11.5	13.6	2.4	11.3	10.3	6.1	25.5	3.8	9.8
Homicide (E964, E965, E980-E999)	1.0	5.0	14.0	6.0	1.8	1.0	2.7	8.6	3.8	2.9
All other causes	16.5	24.3	17.1	55.2	36.2	42.4	99.1	60.7	170.1	141.6

not have been as clearly defined on the basis of the information on the death certificate. In some Latin American cities, the external cause of injury is not routinely recorded on death certificates and thus the high death rates from motor vehicle accidents have not been generally recognized or publicized. These excessive death rates from accidents, suicide, and homicide indicate serious problems in several of those cities. San Francisco appeared to have an unusually high suicide death rate in the age period 35-54 years. Political disturbances in 1962 adversely affected the homicide rate in Caracas.

Similar data on mortality in females in the two 20-year age spans are provided in Figure 5 and Table 4. External causes did not result in the high death rates which were noted for males in four of the cities. However, in the 20-year age span 35-54 years the group of deaths due principally to alcoholism contributed significantly to mortality in both San Francisco and Santiago. The death rates in the five cities

from malignant neoplasms and heart disease did not vary significantly. In the three Latin American cities death rates from complications of pregnancy, delivery, and the puerperium were many times in excess of those in the two English-speaking cities; in Santiago half of these deaths were the result of abortions. Tuberculosis also played a role in the higher death rates of females in Guatemala City and Santiago.

Each city has its own distinct pattern of mortality. The Bristol experience is the most favorable for both males and females in early and in middle adult life. The major problems would seem to be motor vehicle accidents in younger, and coronary disease in older men. The second most favorable experience is that of Caracas, and were it not for the high homicide rate due in large part to the political disturbances which coincided with the period covered by the Investigation, male mortality in this city would be similar to that in Bristol in both the younger and the middle adult years. In San Francisco external causes accounted for

Table 5  
Age-Adjusted Death Rates per 100,000 Population at Ages 15-54 Years, by Sex, from Arteriosclerotic Heart Disease, according to Death Certificate and Final Assignment in Five Cities, Inter-American Investigation of Mortality, 1962-1964

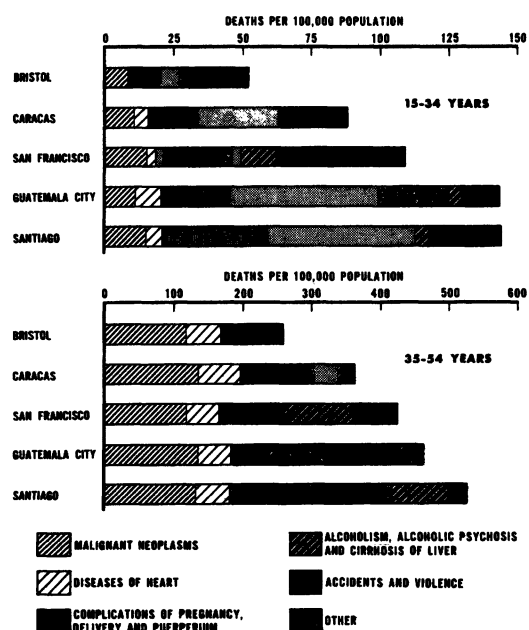
City	Males		Females	
	Death certificate	Final assignment	Death certificate	Final assignment
Bristol	49.1	48.7	9.0	8.9
Caracas	30.3	29.2	11.3	9.0
Guatemala City	7.8	9.2	2.1	2.5
San Francisco	72.5	65.1	11.0	10.0
Santiago	13.0	14.7	4.9	6.4

70 per cent of the male mortality from 15-34 years, while in the following two decades coronary disease and alcoholism in its various forms contributed heavily to the death rate of males. Among females external causes in both age groups and the causes associated with alcoholism in the second period are major problems. The pattern in Guatemala City is characterized by relatively high male rates from tuberculosis, alcoholism and cirrhosis of the liver, and external causes in both age groups, while mortality from cancer and heart disease is comparatively low. Females also have high tuberculosis death rates and maternal mortality is excessive. The notable features in Santiago are the high rates from alcoholism and cirrhosis of the liver, seen in males in both age groups and in females of middle age. Tuberculosis takes a heavy toll, of middle aged men particularly, and maternal mortality is high.

### Summary

Death rates in adult life show wide variations in the five cities included in this study, which reports part of the findings of the Inter-American Investigation of Mortality, undertaken by the Pan American Health Organization. Of the five cities, four (Caracas, Guatemala City, San Francisco, and Santiago) are widely separated in the Americas and the other (Bristol) is in England. The death rates in the three Latin American cities were much lower than those for the corresponding country as a whole in young adult life. The death rate in Bristol was similar to that in England and Wales, while the rate in San Francisco for the age span

Figure 5  
Annual Age-Adjusted Death Rates from Important Causes of Death per 100,000 Population for Females 15-34 Years and 35-54 Years in Five Cities, Inter-American Investigation of Mortality 1962-1964



35-54 years was significantly higher than that in the United States as a whole.

Analysis by causes in two 20-year age spans indicated excessive mortality in these cities among young males 15-34 years of age due principally to external causes (motor vehicle accidents, other accidents, suicides, and homicides). In all cities except Santiago over half of the death rate was due to these external causes. Malignant neoplasms and diseases of the heart were responsible for only a small portion of the death rate. In the next 20-year age span, in addition to external causes, the group comprising alcoholism, alcoholic psychosis, and cirrhosis of the liver (principally alcoholic) was responsible for a high proportion of male deaths in three cities--San Francisco, Guatemala City, and Santiago. Diseases of the heart, mainly coronary heart disease, caused higher death rates in San Francisco and in Bristol than elsewhere. This difference between the English-speaking and the Spanish-speaking cities confirmed one of the observations that led to the Inter-American Investigation of Mortality. Although the differences are even greater at older ages (55-74 years), the disparity is already evident in this age period. By contrast, in the 40-year age span 15-54 years the female death rates from heart disease in all the cities were of approximately the same size.

The causes of mortality in these populations have become more clearly defined through this Investigation, by ensuring that the information in hospital and autopsy records was utilized in the assignment of the cause of death. A system is recommended whereby hospital records on deaths and supplementary reports on autopsies would be combined with the causes stated on death certificates so as to clarify the cause and make the data more useful for preventive action as well as for research.

The Inter-American Investigation of Mortality has shown that collaborative research utilizing standard definitions and procedures is feasible on an international scale. The time has come to utilize new tools combining information from various sources and to make greater progress in the analysis of mortality, which for many years to come will continue to be the most valuable basic data for the geographic study of diseases on a world basis.

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