THE INTER-AMERICAN INVESTIGATION OF MORTALITY* COMPARABLE MORTALITY STATISTICS FOR TWELVE CITIES

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Observed variations in the mortality experience of different populations form the basis of much epidemiological research. Deductions and hypotheses made in the light of such variations have always to be qualified by taking into consideration reasons other than epidemiological which might account for some or all of the observed differences. These reasons include differences in terminology, variations in the experience and qualifications of the individuals who certify death, different standards of medical care and facilities, and national habits of diagnosis procedures, classification, and coding of causes of death. As far as England and Wales and the United States of America are concerned, it has been shown that there are important terminological differences involving, in particular, certain chronic respiratory conditions (*J. Amer. med. Ass.*, 1960), and variations in diagnostic and certification habits can result in the allocation within major groups of diseases of different underlying causes of death (Reid and Rose, 1964). There is no reason to suppose that such differences are not wide-spread.

Puffer and Verhoestraete (1958) investigated, on behalf of a World Health Organization (WHO) Study Group on Atherosclerosis, mortality rates from cardiovascular diseases in 24 countries. Wide variations were found and the need for strictly comparable data was stressed. Following on the recommendations of this Study Group (WHO, 1958), an investigation into arterial pathology in the Americas was

begun and to increase the significance of any observed variations a parallel investigation into death certification was proposed. The object of this was to collect by means of a standard questionnaire all available evidence which would allow for the allocation of as reliable an underlying cause of death as possible. A summary of the methods and results of this investigation is given here; a full report is in preparation by the Pan-American Health Organization.

MATERIAL AND METHOD

The investigation was confined to deaths occurring between the ages of 15 and 74 years and large cities with sophisticated medical services were chosen to increase the likelihood that a complete medical history would be obtainable for each death studied and that for a high proportion additional evidence provided by surgery, histology, autopsy, and pathological and radiological investigations would be available. The cities selected (shown on the map in Fig. 1, opposite) include ten from Central and South America, one from the United States, and one (Bristol) from England. About 4,000 deaths from each city were to be studied over the course of 2 years, this number being obtained either by including all deaths (four cities), or by means of an appropriate systematic sampling procedure where the annual number of deaths in the specified age group was expected markedly to exceed 2,000. It was recognized that the smallest city, Ribeirão Preto, would provide only about 1,200 deaths in the 2-year period, but it was, nevertheless, included in the investigation in order to study the known excessive mortality from cardiovascular disease in that area thought to be due to cardiopathy resulting from Chagas' disease (South

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FIG. 1.—Cities collaborating in the Inter-American Investigation of Mortality.

American trypanosomiasis). For administrative reasons the study did not take place at exactly the same time in all twelve cities, the starting dates varying from January 1, 1962, to October 1, 1962. In each city, however, the investigation covered a period of two years.

In each city the co-operation of a Principal Collaborator was obtained and he assumed the responsibility of recruiting and supervising a small team of medical and social investigators to carry out the field work*. At regular intervals the certificates of death were collected; those referring to persons outside the age limits or not normally resident in the city were rejected and the remainder were included in the study either directly or after the appropriate sampling procedure. In Bristol, every fourth death was eliminated, so that the sample comprised 75 per cent. of all deaths between the ages of 15 and 74 years; deaths of Bristol residents occurring outside the City were sampled and included when the notifications were received at quarterly intervals from the Registrar General. In each city where sampling was necessary, tests were made from time to time to ensure that the sample was truly representative of the total deaths as far as age, sex, and district of the city were concerned.

The questionnaire which was completed for each death included in the Investigation was designed to allow the true underlying cause of death to be determined with as much certainty as possible. The first part was completed by a social worker with information provided by a relative and included details of the residential and occupational history of the deceased and the names of individuals who, or institutions which, had provided medical attention. The second part was completed by a medical investigator from medical records supplemented by interview with an attending physician and included a summary of the clinical history with details of any special investigations, histology, or autopsy reports. A summary page included the original classification of the underlying cause of death and a classification made by the Principal Collaborator or the medical investigator in the light of the information obtained; these two classifications might or might not be the same. The completed questionnaires were then sent to the central office of the Investigation at the Pan-American Health Organization Headquarters in Washington.

In the central office the questionnaires were examined and divided into two groups. The first group consisted of deaths which appeared to be due to a cardiovascular disease, deaths from ill-defined conditions, and deaths where more than one cause seemed to be involved; these questionnaires were studied independently by two medical referees (Dr Dario Curiel and Dr Percy Stocks), each of whom

*In Bristol the Principal Collaborator was Prof. R. C. Wofinden, M.D., B.S., D.P.H., D.P.A., and the team consisted of Dr M. R. Alderson, M.D., B.S., D.C.H., D.P.H., D.R.C.O.G., full-time (now with the Medical Research Council, London), Dr K. E. Faulkner, M.B., Ch.B., D.P.H., D.C.H., part-time, Miss F. H. Chamberlain, S.R.N., S.C.M., Q.N., H.V., full-time (seconded health visitor), and Mrs M. R. Living, full-time secretary.

assigned a cause of death. The questionnaires in the second group, where the cause of death was not in doubt and was not a cardiovascular condition, were reviewed by a physician in the central office who assigned the underlying cause of death in accordance with the rules laid down in the "International Classification of Diseases, 1955" (WHO, 1957).

The referees also worked as far as possible within the International Classification of Diseases (ICD) rules, but where selection of a single underlying cause of death was considered to be impossible or inappropriate, they could each assign two causes, a different weight being applied to each according to whether it was considered more or less likely to be the true underlying cause of death. The operation of this weighting system, together with a more detailed description of the background to and method of the Investigation than is given here, has been described by Puffer, Griffith, Curiel, and Stocks (1965).

The weighted numbers of deaths thus obtained for each 10-year age group were used to calculate by the direct method age-adjusted death rates for the population aged between 15 and 74 years, taking as standard the age-distribution of the composite population of the cities themselves. The effective populations at risk, used in the calculation of age-specific mortality rates, were derived from recent official censuses in each city and allowed for the sampling factors where these had been used and for the fact that the study covered a period of 2 years. In the report which follows, the mortality rates given are annual rates per 100,000 at risk and are corrected to the nearest whole number.

RESULTS

Table I shows for each sex the total number of deaths which were the subject of study, together with the age-adjusted death rate per 100,000 from all causes and the comparative mortality factor (CMF). The CMF expresses the age-adjusted mortality rate for each city as a percentage of the crude death rate for the populations of all twelve cities combined (698 per 100,000 for males and 490 per 100,000 for females). There are wide variations in the rates for different cities and the variations are not necessarily similar for each sex. For example, the female rate for Bogota is nearly twice that for Bristol; while the male rate is relatively only a little higher.

Fig. 2 shows on a logarithmic scale the age-specific mortality rates in Bristol compared with the highest and lowest rates recorded in any of the eleven other

TABLE I
MORTALITY (ALL CAUSES) IN THE INTER-AMERICAN INVESTIGATION

City	Number of Deaths		Age-adjusted Mortality Rate		Comparative Mortality Factor	
	Male	Female	Male	Female	Male	Female
Bogota	1,628	2,001	684	634	98	129
Bristol	2,547	1,715	630	319	90	65
Cali	1,676	1,622	620	510	89	104
Caracas	1,700	1,299	633	397	91	81
Guatemala City	1,793	1,629	696	494	100	101
La Plata	2,317	1,239	687	340	98	69
Lima	2,417	1,961	645	459	92	94
Mexico City	2,200	1,991	727	501	104	102
Ribeirão Preto	619	397	794	492	114	100
San Francisco	2,447	1,418	724	398	104	81
Santiago	2,490	1,831	981	536	140	109
São Paulo	2,532	1,829	621	427	89	87
All Cities	24,366	18,932	698*	490*		

* Crude death rates.

cities. Bristol males under the age of 45 years have the lowest death rates of all, but thereafter the rates increase rapidly until in the 65 to 74-year age group they have the highest rate. On the other hand, Bristol women retain the lowest position in all but the 65 to 74-year age group.

Age-adjusted death rates from six major cause groups are shown in Table II (opposite).

Table III (opposite) summarizes the results in Bristol by the same six groups and includes a CMF; this index is the age-adjusted death rate in Bristol expressed as a percentage of the death rate from the same group of causes in the universe comprised of the populations of all twelve cities combined. Bristol men have relatively high mortality rates from respiratory diseases, malignancies, and cardiovascular diseases and low rates from tuberculosis and other infectious and parasitic diseases, digestive diseases, and external causes. Bristol women have particularly low rates of death from the infectious and parasitic diseases (CMF=9) and from digestive diseases (CMF=23), and of the four other groups in only one, that of respiratory diseases, does the CMF exceed 100.

FIG. 2.—Death rates from all causes per 100,000, by 10-year age groups.

TABLE II

AGE-ADJUSTED MORTALITY RATES AT AGES 15 TO 74 YEARS PER 100,000 AT RISK BY MAJOR CAUSE GROUPS
Numbers in brackets refer to the code numbers of the "International Classification of Diseases, 1955" (WHO, 1957)

City	Tuberculosis and Other Infectious and Parasitic Diseases (001-138)		Malignancies (140-205)		Cardiovascular Diseases (330-334, 400-468)		Respiratory Diseases (470-527)		Diseases of the Digestive System (530-587)		External Causes (E800-E999)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Bogota	48	34	115	128	223	232	46	47	53	57	125	36
Bristol	10	3	156	97	273	127	78	23	19	10	55	27
Cali	70	59	97	120	184	148	20	19	42	33	129	33
Caracas	40	19	128	114	213	130	19	11	47	25	111	24
Guatemala City	59	45	98	110	106	101	23	13	70	49	169	20
La Plata	22	10	183	103	247	114	31	7	48	26	75	21
Lima	99	57	113	136	195	117	30	16	52	31	79	19
Mexico City	53	28	62	95	162	141	52	28	152	72	125	29
Ribeirão Preto	167	78	138	87	245	189	38	18	41	23	80	24
San Francisco	18	6	128	99	282	127	28	8	94	59	121	58
Santiago	107	34	128	121	210	148	82	33	194	83	157	32
São Paulo	43	20	103	96	256	191	43	19	47	20	64	20

TABLE III

MORTALITY IN BRISTOL BY MAJOR CAUSE GROUPS

Cause Groups	Deaths (weighted)		Age-adjusted Rate per 100,000		Comparative Mortality Factor	
	Male	Female	Male	Female	Male	Female
Tuberculosis and Other Infectious and Parasitic Diseases (ICD 001-138)	37	13	10	3	17	9
Malignancies (ICD 140-205)	635	483	156	97	128	82
Cardiovascular Diseases (ICD 330-334 and 400-468)	1,169	794	273	127	123	79
Respiratory Diseases (ICD 470-527)	354	132	78	23	183	103
Digestive Diseases (ICD 530-587)	80	49	19	10	27	23
External Causes (ICD E800-E999)	134	84	55	27	52	96

TUBERCULOSIS AND OTHER INFECTIOUS AND PARASITIC DISEASES (ICD 001-138)

Diseases in this group are clearly still a major public health problem in some cities. Apart from the excessive mortality from Chagas' disease (ICD 121.1) in Ribeirão Preto, variations in the death rate from diseases in the group as a whole can be seen to be largely a reflection of variations in mortality from tuberculosis (Fig. 3). In each city the death rate for males is higher than that for females and this applies to both tuberculous and non-tuberculous disease.

The rates for Bristol are lowest of all and indeed it is difficult to see how the female mortality rate of 3 per 100,000 could be decreased much further other than by the complete elimination from the community of tuberculosis.

FIG. 3.—Deaths from tuberculosis and other infections and parasitic diseases (ICD 001-138).

— Total ICD 001-138.
 - - - - - ICD 001-019 (Tuberculosis, all forms).

MALIGNANCIES (ICD 140-205)

There is considerable variation in male mortality from malignant conditions and this is to some extent related to variations in the death rates from malignant tumours of the trachea, bronchus, and lung (Fig. 4). The remarkably low rate (CMF=51) experienced by the men of Mexico City is worthy of

note and perhaps of further study. There is less variation between cities of death rates from malignancies amongst women.

FIG. 4.—Deaths from malignancy (ICD 140-205).

— Total ICD 140-205.
 - - - - - Malignancies of Trachea, Bronchus, and Lung (ICD 162-163).
 Malignant disease of the Cervix (ICD 171).

The male mortality rate for Bristol is second only to that for La Plata and these two cities have almost identical rates of death from malignancies of the trachea, bronchus, and lung of 60 and 59 per 100,000 respectively. Bristol women, however, have a relatively low death rate from malignancies, the CMF being 82.

The distribution by site of malignancies of the alimentary tract (ICD 150-154) shows some interesting variations (Fig. 5). For instance, although Bristol and Cali males share almost identical mortality rates of 41 and 42 per 100,000 respectively from alimentary cancers as a whole, in Cali 91 per cent. of these are cancers of the oesophagus and stomach (ICD 150, 151) and only 9 per cent. are cancers of the intestine and rectum (ICD 152-154), while in Bristol the proportions are 59 and 41 per cent. Other cities with particularly low proportions of intestinal and rectal cancers are Bogota and Guatemala City, while, in addition to Bristol, San Francisco, La Plata, and

FIG. 5.—Deaths from malignancy of the alimentary tract (ICD 150-154).

arteriosclerotic and degenerative heart disease (Fig. 6). The female populations of these two cities also have an increased tendency to die from these diseases, but their mortality from cardiovascular conditions as a whole is less than average (CMF for Bristol women = 79).

FIG. 6.—Deaths from cardiovascular disease (ICD 330-334 and 400-468).

— Total ICD 330-334 and 400-468.
 - - - - ICD 420-422 (Ischaemic and Degenerative Heart Disease).

RESPIRATORY DISEASES (ICD 470-527)

Deaths from diseases in this group form only a relatively small proportion of total mortality. An exception to this is the mortality rate of 78 per 100,000 for Bristol males, 81 per cent. of which is made up of deaths from bronchitis (Fig. 7, overleaf).

Predominant in the slightly higher rate of death from respiratory disorders for Santiago are deaths from influenza and pneumonia (ICD 480-493) which form 57 per cent. of the total.

Fig. 8 (overleaf) shows the rates of death from bronchitis by 10-year age groups from age 35. Below this age the rates were in general negligible and indeed in some cities there were few deaths from bronchitis under the age of 55 years. The excessive

Mexico City have relatively low proportions of oesophageal and gastric cancer. Variation is also seen between sexes. In each city intestinal and rectal cancers form a higher proportion of all alimentary cancers in females than they do in males, though in seven cities the male mortality rates are in fact the higher. This difference is most marked in Bristol where the male rate exceeds the female by 70 per cent.

CARDIOVASCULAR DISEASES (ICD 330-334 AND 400-468)

The diseases making up this group are the most frequent cause of death in nearly all cities. Again, however, there are marked differences, the rates being highest in San Francisco (males) and Bogota (females) and lowest for both sexes in Guatemala City.

In Bristol, as in San Francisco, the high male rate is largely the result of the excessive mortality from

FIG. 7.—Deaths from respiratory disease (ICD 470-527).
 — Total ICD 470-527.
 ICD 500-502 (Bronchitis).

male rate in Bristol, virtually all of which is due to deaths from chronic bronchitis (ICD 502), becomes apparent in the 45 to 54-year age group and increases markedly in the 55 to 64 and 65 to 74-year age groups. The female rate for Bristol, however, exceeds that of the other cities only in the 65 to 74-year age group.

FIG. 8.—Deaths from bronchitis (ICD 500-502), by 10-year age groups.

DISEASES OF THE DIGESTIVE SYSTEM (ICD 530-587)

Much of the variation observed in death rates in this group is caused by differences in mortality from cirrhosis of the liver, especially when associated with alcoholism (Fig. 9). It is evident that in three cities alcohol is a significant public health problem.

Bristol residents of both sexes have the lowest death rates of all cities from diseases of the group as a whole and from cirrhosis with mention of alcoholism.

FIG. 9.—Deaths from disease of the digestive system (ICD 530-587).
 — Total ICD 530-587.
 ICD 581.1 (Cirrhosis of Liver with mention of Alcoholism).

EXTERNAL CAUSES (ICD E800-999)

Mortality rates from external causes again show more variation in men than in women. Accidents (ICD E800-962) are, in general, responsible for the major part of the death rate, but in several cities the other external causes, suicide and homicide (ICD E963-999), are important causes of death in males and are by no means negligible in the women of San Francisco (Fig. 10, opposite).

In Bristol, the female rate (CMF=96) is unremarkable, but the male rate is lower than that of any other city, to some extent because of the infrequency of deaths from homicide (ICD E964, 965 and 980-999).

FIG. 10.—Deaths from external causes (ICD E800–E999).
 — Total ICD E800–E999.
 - - - - - Accidents ICD (E800–e (62)).

DISCUSSION

The main object of the Investigation was to provide some comparable statistics to act as a baseline for epidemiological research. Standardization of the questionnaire and uniform practices of classification and coding go some way to achieve this, but even when a weighting system is used it is not always possible to take into consideration the certainty or otherwise of an assignment of an underlying cause of death. The degree of comparability must in the final analysis depend on the validity of the diagnosis and in the official report of the Investigation attention will be paid to this factor. It seems clear, however, that the Investigation has provided a more accurate basis than has hitherto been available for research into the causation of certain cardiovascular diseases, of malignancies, and of the factors underlying the excessive mortality from alcoholism and external causes in some cities. Such further investigations might take place on a local, national, or international basis.

There are several by-products of the Investigation. Each city has available, perhaps for the first time, accurate information on rates of death by age, sex,

and cause on which to base public health programmes. An accurate estimate can also be made of the reliability of certification by comparing the assignments of the underlying cause from the initial death certificate with those made in the light of the information obtained in the course of the enquiry. This has already been done for Bristol deaths included in the first year of the Investigation (Alderson, 1964). It is likely that it will be possible to suggest ways in which international practices in medical certification and in coding and classification may be improved. Many of those involved in the survey, either as members of the investigating teams or as attendants on patients whose deaths became the subject of study, have improved their knowledge of the theory and practice of death certification and have a better appreciation of the importance of accuracy and completeness in certifying death. The comprehensive data accumulated in the course of the Investigation is already being used in a wide range of epidemiological studies (Griffith, 1966; Correa and Llanos, 1966). Finally, a large-scale investigation into mortality in infancy and childhood, modelled on the adult investigation, has been planned by the Pan-American Health Organization for certain Latin American countries and pilot studies have begun.

SUMMARY

A brief description is given of the events leading up to the Inter-American Investigation of Mortality. This Investigation into deaths occurring in the 15 to 74-year age group took place in the years 1962–4 and was designed to secure comparable mortality statistics for twelve cities, ten in Central and South America, one in the United States, and one in England. This was done by means of a standard questionnaire enquiring into the medical history and final illness followed by central classification and coding of the underlying cause of death. A weighting system applied by two medical referees was used for cardiovascular deaths and for deaths in which the underlying cause was uncertain or ill-defined.

The rates of death thus obtained were standardized for age and the results by sex and cause are summarized in this paper. Attention is drawn to marked variations in mortality rates from six major groups of causes.

The statistics obtained as a result of the Investigation are more truly comparable than any others hitherto available. They should, therefore, provide a more secure basis for epidemiological research, both nationally and internationally. Prominent among the additional uses to which the data obtained might be put is the planning of public health programmes in the individual cities concerned.

The successful participation of Bristol in this survey would not have been possible without the generous and tireless help given by a great many people in the city. In particular, we should like to thank the team mentioned in the footnote on p. 4, hospital consultants (particularly the pathologists), general medical practitioners, the Clerk to the Bristol Executive Council, the Coroner and his Officers, and a number of staff within the Department of Public Health.

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