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Global and Regional Mortality Patterns by Cause of Death in 1980

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Mortality attributable to major causes of death around 1980 has been estimated for different regions in the world. The World Health Organization's mortality data bank has been employed to derive the rates for the developed areas in the world whereas for the developing areas, cause-specific mortality has been estimated on the basis of total mortality using a linear regression method.

For the cause grouping chosen, infectious and parasitic diseases claim one third of all deaths in the world. Although diseases of the circulatory system and neoplasms are the two most common causes of death in the developed countries, more than 50% of all deaths in the world due to these causes occur in the developing world. Mortality due to injury and poisoning is—contrary to that due to the other main causes of death—almost independent of the level of development of the area. The results are aimed to assist the information back-up for health policies concerning the developing world.

Statistics on causes of death are important and widely used for a number of purposes. They may be employed in explaining trends and differentials in overall mortality, in deciding on priorities for health action and the allocation of resources, in designing intervention programmes, and in the assessment and monitoring of public health problems and programmes. Moreover, they give important clues for epidemiological research.

The focus on mortality in public health is not surprising given the overwhelming importance of prevention of 'premature' death and the definitiveness of mortality measurements. Unfortunately, it is particularly in those parts of the world where mortality is still relatively high that cause of death data are either unavailable or, if available, their usefulness is seriously limited by deficiencies in coverage and/or quality. With some justification one may consider the very availability of national, 'reasonably' reliable data on causes of death as a guide to the assessment of a country's level of health and development of its statistical services. One may still infer from the absence of reliable national cause of death statistics that the health status of the country is comparatively poor. No country with a poor health status record (as reflected in mortality-based indicators) has the kind of cause of death statistics it would most urgently require for programming and evaluative purposes.

With these potential uses in mind, a first determined effort has been undertaken by the World Health Organization (WHO) to provide a picture of the global and regional cause of death spectrum. In the following, a brief outline is given on cause-specific mortality in the world, including areas without existing statistics. For details, the reader is referred to the paper by Hakulinen *et al.*[1]

MATERIAL AND METHODS

The methodology employed in this paper involves determining the cause-specific mortality pattern when only the total mortality rate is known. Studying cause-specific mortality from almost 50 populations[2] Preston[3] found that an increased level of total mortality was often associated with a high level of mortality due to infectious diseases and with a lower level of mortality due to neoplasms. He exploited the fact that the age-adjusted cause-specific mortality rates M_i, $i = 1, 2, \ldots, c$, could be expressed in terms of the total mortality rate M by a linear relationship of the form:

$$M_i = a_i + b_i M, \; i = 1, 2, \ldots, c \qquad (1)$$

$$\text{where } \sum_{i=1}^{c} a_i = 0 \text{ and } \sum_{i=1}^{c} b_i = 1.$$

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This regression methodology was applied to the United Nations (UN) areas in the developing world, each consisting of several countries, and to those countries in the developed world (USSR, Albania) not represented in the World Health Organization's (WHO) mortality data bank.[4,5] For other UN areas, data for as close to 1980 as possible from the WHO mortality data bank was used.

For each area, equation (1) was estimated for 'broad' age groups 0, 1–4, 5–14, 15–44, 45–64, and 65 years and over, for both sexes separately. The estimation was based on the historical cause-specific mortality data compiled by Preston *et al*,[2] supplemented with 46 populations from the WHO mortality data bank. For each cause of death, the estimation procedure was conducted only once for the narrow age groups, 0 and 1–4 years. Within the broader age groups, however, the historical source data on M_i and M had to be age-adjusted for the population of the particular UN area in question before the estimation. Consequently, for the broader age groups the estimation had to be done for each UN area separately.

In addition to coefficients a_i and b_i, determined from the historical data, the current (or close to 1980) crude death rates (M) had to be estimated for all of the UN areas concerned. The mortality rates M by broad age group for each UN area were estimated using data on overall mortality, expectation of life[6] and suitable model life tables.[7–9] For details and the results of the sensitivity analysis, see Hakulinen *et al.*[1]

Because the collection of age–sex–cause specific death rates compiled by Preston *et al*[2] was used as an important part of the data base a more detailed cause of death classification than that used by Preston *et al* could not be applied. These data cover a period of over 100 years (1861–1964) and are grouped into 12 broad cause of death categories (Table 1) chosen by the authors to minimize problems of comparability arising from such factors as revisions to the classification list, changing diagnostic fashions and improved diagnostic procedures.

Statistics on deaths from cancer and cardiovascular diseases in the USSR, as well as total mortality, were extracted from official Soviet sources.[11] Cancer mortality from China was taken from the recent Chinese mortality atlas.[12] The figures suggested by the regression methodology for other causes of death in the USSR and China were proportionally adjusted in order not to alter the total mortality estimates employed.

The results are presented for larger aggregates of the UN areas, ie, regions roughly corresponding to continents (Tables 2–4), as well as for developed countries, developing countries and least developed countries separately*. The mortality rates by cause for the 'least developed countries' are weighted averages of the cause-specific mortality rates for the UN areas represented in that group of countries.

RESULTS

For the cause groupings chosen, infectious and parasitic diseases emerge as the most common group of causes of death in the world. One third of all deaths in the world are attributable to this group of causes (Table 2). A further quarter of deaths occur from diseases of the circulatory system. Neoplasms, certain conditions originating in the perinatal period, and injury and poisoning each account for an estimated 5–8% of deaths in the world. Undoubtedly, these percentages are all underestimated since every fifth death at a global level falls into the category of causes 'other and unknown'.

Although 32% of the world's population live in South Asia, about 40% of the deaths in the world occur there (Table 2). This is because the annual death rate of 15.5/1000 is comparatively high, being twice the level estimated for East Asia, for example. In the developed countries annual death rates range from 6.3/1000 (Japan) to 11.5/1000 (Northern and Western Europe). In developing countries the range is from 7.0/1000 (Micronesia–Polynesia) to 20.1/1000 (Middle Africa). The rate in the least developed countries as a whole is 17.1/1000 (Table 2).

Roughly four in every ten deaths in developing countries are attributable to infectious and parasitic diseases (Table 2). The highest percentage of deaths due to infectious and parasitic diseases occurs in Africa (49%) and the lowest in North America (3.6%). Certain conditions originating in the perinatal period account for about 8% of all deaths in developing countries whereas the corresponding proportion is only 1.6% in the developed world. Complications of pregnancy account for less than 1% of deaths in developing countries although this proportion is six times greater than in the developed world. Injury and poisoning has roughly the same relative order of importance as a cause of death in both developed and

* According to the UN classification, developed countries include the United States of America, Canada, all of Europe, Japan, Australia, New Zealand and the USSR. Developing countries include all other countries, of which the least developed countries are Afghanistan, Bangladesh, Benin, Bhutan, Botswana, Burkina Faso, Burundi, Cape Verde, Central African Republic, Chad, Comores, Democratic Yemen, Djibouti, Equatorial Guinea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Laos, Lesotho, Malawi, Maldives, Mali, Nepal, Niger, Rwanda, Samoa, Sao Thome and Principe, Sierra Leone, Somalia, Sudan, Tanzania, Togo, Uganda, and the Yemen Arab Republic.

TABLE 1 *Cause of death categories used for the regression-based estimation procedure.*

Cause of death category*	Corresponding categories in Preston *et al* (1972)	Composition of categories: *ICD-8* (A-list)	*ICD-9* (Basic Tabulation List)
1. *Infections* & parasitic diseases	Respiratory tuberculosis, other infectious & parasitic diseases;	A001–A044	01–07
	Diarrhoea, gastritis, enteritis;	A099	2% of remainder of 34†
	Influenza, pneumonia, bronchitis	A090–A093	320–323
2. *Neoplasms*	Malignant & benign neoplasms	A045–A061	08–17
3. Diseases of the *circulatory system*	Cardiovascular diseases;	A080–A088	25–30
	Certain degenerative diseases (nephritis, cirrhosis of liver, ulcers of stomach and duodenum, diabetes)	A064 A098 A102 A105–A106	181 341 347 350
4. Complications of *pregnancy*, childbirth and the puerperium	Complications of pregnancy	A112–A118	38–39 41
5. Certain conditions originating in the *perinatal* period	Certain diseases of infancy	A131–A135	45
6. *Injury* & poisoning	Motor vehicle accidents;	A138–A150	E47–E56
	Other accidents & violence		
7. *Other* and unknown	All other and unknown causes	all the rest	all the rest

* The words in italics refer to short headings employed in Tables 2–5.

† The ICD-8 categories employed here are reproducible from ICD-9, except 'Gastritis and duodenitis' (A099) in the Infectious diseases category. 2% of the 'remainder' of item 34 in the ICD-9 Basic Tabulation List was used as a corresponding figure, based on the England and Wales comparative study[10] of ICD-8 and ICD-9 carried out in 1978. As the number of deaths in this category is very small compared with all deaths due to infectious diseases, the approximation error is unlikely to affect the global pattern.

developing countries. As expected the proportion of deaths due to diseases of the circulatory system and neoplasms is highest in the developed world. Nevertheless, more than 50% of all deaths due to these two broad groups of causes are estimated to occur in the developing countries.

The category 'other and unknown causes' represents slightly more than 20% of all deaths in developing countries. This category consists of two sub-categories: ill-defined and unknown causes, and the remaining causes not included in the other categories but for which a specific cause of death has been assigned. In North America, for example, where very few deaths are registered with an unknown cause (including senility), the proportion of deaths placed in the category 'other and unknown' causes is more than 10%.

Africa and South Asia show a rather similar estimated pattern of causes of death: high mortality due to infectious and parasitic diseases as well as other and unknown causes of death (Figure 1). In North America and Europe, on the other hand, the highest proportion of deaths occur due to diseases of the circulatory system and neoplasms. The pattern in Latin America, East Asia and Oceania lies somewhere between these two extremes, with the cause of death structure estimated for Oceania lying closer to Europe and North America than to that estimated for the other two regions. Admittedly, in addition to real differences in risk, these structures also reflect differences in population age distributions among the regions.

The death rates by cause are rather similar for males and females (Table 3). Excluding complications of pregnancy which are, of course, an exclusive cause of death among females, the largest differences between the sexes are apparent for the group 'injury and poisoning'. Male mortality from this cause is 2–3 times that for females, irrespective of the level of development of the region concerned.

The average mortality rate in the least developed countries is almost 50% higher than for the developing countries as a whole (Table 3). This difference is largely attributable to the differential impact of infectious diseases. Of the other specified causes of death, the least developed countries show a far higher mortality due to diseases of infancy and maternal causes than the developing countries on average.

The differential in mortality according to level of development is the largest for the younger age groups (Table 4). At ages of 0–14 years, mortality in the least developed countries is approximately 10 times the level in the developed world, whereas at ages 65 and over the corresponding relative risk is only 1.4. For children (0–4 years), this differential is due primarily to differential mortality from infectious and parasitic diseases, certain diseases originating in the perinatal period, and 'other and unknown' causes of death.

At all ages mortality due to infectious and parasitic diseases varies considerably between areas at different levels of development (Table 4). On the other hand,

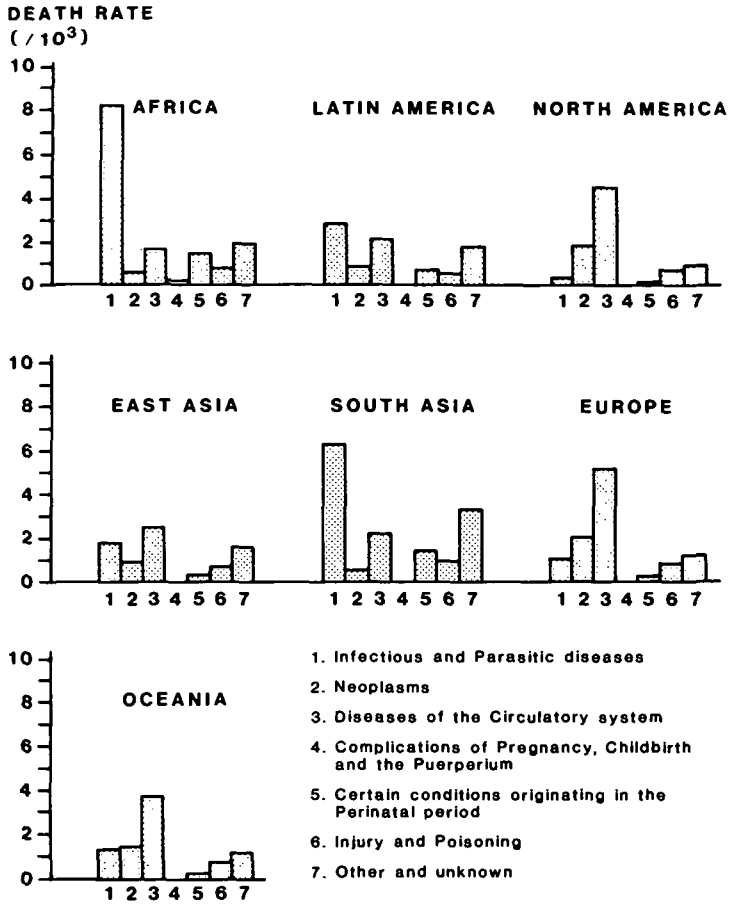

FIGURE 1 *Cause-specific death rates by region, around 1980. The European figures include the USSR.*

TABLE 2 *Global and regional pattern of annual deaths by cause around 1980.*

	All causes		Infections		Neoplasms		Circulatory system		Pregnancy		Perinatal		Injury		Other	
Region	No. of deaths (000)	Death rate (/1000)	Annual No. of deaths (000)	%	Annual No. of deaths (000)	%	Annual No. of deaths (000)	%	Annual No. of deaths (000)	%	Annual No. of deaths (000)	%	Annual No. of deaths (000)	%	Annual No. of deaths (000)	%
World total	50911	11.4	16860	33.1	4255	8.4	13359	26.2	234	0.5	3255	6.4	2673	5.3	10274	20.2
Africa	8562	18.0	4168	48.7	269	3.1	1051	12.3	53	0.6	742	8.7	329	3.8	1949	22.8
Latin America	3197	8.8	992	31.0	288	9.0	789	24.7	15	0.5	265	8.3	202	8.3	646	20.2
North America	2081	8.3	76	3.6	447	21.5	1135	54.5	0	0.0	25	1.2	175	8.4	224	10.8
East Asia	8842	7.5	2034	23.0	939	10.6	2977	33.7	42	0.5	377	4.3	632	7.2	1841	20.8
South Asia	20315	14.4	8894	43.8	881	4.3	3175	15.6	119	0.6	1703	8.4	873	4.3	4670	23.0
Europe[1]	7713	10.3	661	8.6	1398	18.1	4148	53.8	5	0.1	137	1.8	449	5.8	916	11.9
Oceania	201	8.8	36	17.7	32	16.0	85	42.2	0	0.2	6	3.2	14	6.7	28	13.9
More developed	10652	9.4	804	7.6	2042	19.2	5708	53.6	6	0.1	169	1.6	686	6.4	1237	11.6
Less developed	40259	12.1	16056	39.9	2213	5.5	7652	19.0	229	0.6	3086	7.7	1986	4.9	9037	22.5
of which least developed	4832	17.1	2313	47.9	161	3.3	598	12.4	27	0.6	445	9.2	185	3.8	1102	22.8

[1] Including the USSR.

TABLE 3 *Annual death rates (/1000) due to major causes of death by sex and level of development of the UN area, around 1980.*

Sex	Level of development	All causes	Infections	Neoplasms	Circulatory system	Pregnancy	Perinatal	Injury	Other
Males									
	World total	11.8	3.8	1.0	3.0	.	0.8	0.9	2.3
	M*	9.9	0.9	2.0	4.9	.	0.2	0.9	1.1
	L	12.5	4.8	0.7	2.4	.	1.0	0.9	2.7
	LS	17.4	8.1	0.6	2.2	.	1.7	1.0	3.9
Females									
	World total	11.0	3.7	0.9	3.0	0.11	0.7	0.3	2.3
	M	8.9	0.5	1.7	5.2	0.01	0.1	0.4	1.0
	L	11.8	4.9	0.6	2.2	0.14	0.9	0.3	2.7
	LS	16.8	8.3	0.6	2.0	0.19	1.5	0.4	3.9

*M = Developed areas
L = Developing areas
LS = Least developed areas

TABLE 4 *Annual death rates (/1000) due to major causes of death by age group and level of development of the UN area, around 1980.*

Age group (years)	Level of development	All causes	Infections	Neoplasms	Circulatory system	Pregnancy	Perinatal	Injury	Other
0–14	World total	12.0	6.4	0.1	0.3	0.00	2.1	0.4	2.8
	M*	2.1	0.5	0.1	0.1	0.00	0.7	0.2	0.6
	L	13.9	7.5	0.1	0.3	0.00	2.3	0.4	3.3
	LS	23.4	13.3	0.0	0.5	0.00	3.5	0.5	5.5
15–44	World total	3.2	1.3	0.2	0.5	0.12	.	0.6	0.5
	M	1.4	0.1	0.2	0.3	0.01	.	0.6	0.2
	L	3.8	1.7	0.2	0.5	0.15	.	0.6	0.6
	LS	5.5	2.8	0.2	0.7	0.23	.	0.7	0.9
45–64	World total	13.9	3.2	2.5	5.1	0.01	.	0.8	2.3
	M	8.5	0.4	2.7	4.1	0.00	.	0.6	0.7
	L	16.9	4.8	2.4	5.7	0.02	.	0.9	3.1
	LS	17.8	5.3	2.3	5.9	0.02	.	0.9	3.4
65+	World total	65.0	8.3	8.4	33.9	.	.	1.6	12.9
	M	57.0	4.0	9.9	35.3	.	.	1.5	6.3
	L	73.2	12.7	6.8	32.5	.	.	1.6	19.6
	LS	77.7	14.7	7.4	32.3	.	.	1.6	21.8

*M = Developed areas
L = Developing areas
LS = Least developed areas

mortality due to injury and poisoning is almost independent of the level of development at ages 15 years and over. Mortality attributable to diseases of the circulatory system increases slightly with increasing socioeconomic development of the area in the age group 65 years and over. In age groups under 65 years this gradient is the reverse: the mortality due to diseases of the circulatory system decreases with increasing socioeconomic development. Mortality due to neoplasms is higher in the developed world than in developing countries, especially at ages 45 years and over.

In the developed countries, the leading causes of death at ages 0–14, according to the categories employed here, are certain conditions originating in the perinatal period (31%) and infectious diseases (26%) (Figure 2). Injury and poisoning is the most common cause at ages 15–44 (41%). Diseases of the circulatory system is the leading cause at ages 45 and over, accounting for an estimated 48% of deaths at ages 45–64 and 62% at ages 65 and over. Neoplasms are estimated as the second leading cause of death for ages 45 and over. In the developing countries, the proportion of infectious diseases is considerably larger, claiming over half (54%) the deaths at ages 0–14, and almost half

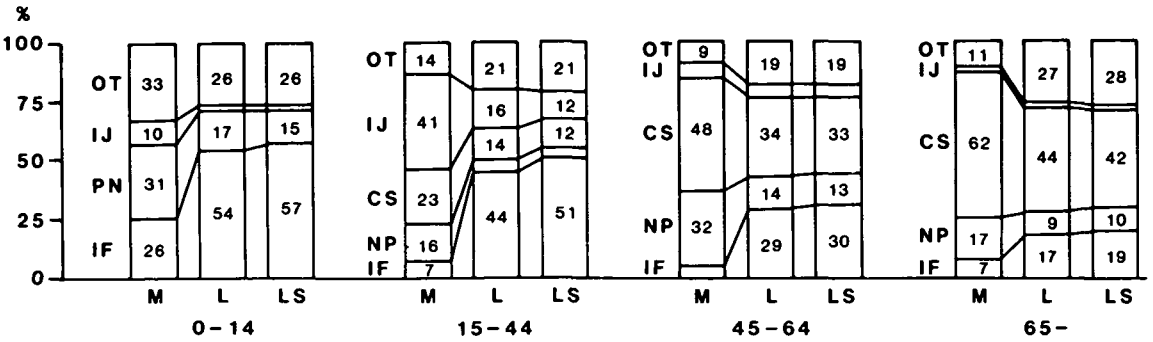

FIGURE 2 *Percentage distribution of major causes of death by age group and level of development of the UN area, around 1980. (M = Developed areas, L = Developing areas, LS = Least developed areas, IF = infections, NP = neoplasms, CS = circulatory system, PN = perinatal, IJ = injury, OT = other categories not specifically mentioned).*

(44%) the deaths at ages 15–44. For ages 45 and over, this proportion decreases and diseases of the circulatory system become the leading cause of death; nonetheless, even at ages 45–64 years, more than a quarter of deaths in developing countries are due to infectious diseases.

DISCUSSION

There are a number of aspects of these results which should be interpreted prudently. The empirical evidence used to derive the model relationships are largely drawn from the experience of the industrialized countries at various stages of development. Those developing countries which were included were mainly from Central and South America. It is highly contentious to suppose that similar structural relationships exist in contemporary developing societies, eg in Africa, given their particular climatic and environmental conditions and the diffusion of modern medical technology. Nonetheless, in areas where knowledge about the cause structure of mortality is extremely limited, the results can at least indicate the relative order of magnitude of the most common health problems.

Moreover, it is far from evident that the variation in cause-specific mortality rates can technically be accounted for by changes in the mortality rate from all causes combined. This is very much dependent on the cause of death concerned. Thus the mortality rate due to infectious and parasitic diseases is strongly positively related to the total mortality rate whereas mortality due to neoplasms seems to be far less dependent on the total mortality level.

Because the present analysis was made age-specifically, and because the standard population for each area was different, the numerical values of the regression coefficients for different areas cannot be compared directly with each other or with those derived by Preston[3] for all ages combined. Nevertheless, many similarities were observed. There was a strong positive association between the total death rate and mortality from infectious diseases in all separate age groups, in agreement with the analysis by Preston conducted for all ages combined. The total mortality had a strong positive association with the death rate from diseases of infancy in ages of less than one year, as well as when measured for all ages combined.

The age-specific analysis also yielded coefficients deviating from those derived by Preston. Preston obtained a weak positive association between the total death rate and mortality from diseases of the circulatory system (as defined in this paper) in females, whereas in males there was a weak negative association. Contrary to this the age-specific analyses resulted in strong positive associations, similar in males and females, within age groups 45–64 years and 65 years and over. Instead of strong negative associations between the total death rate and the death rate from neoplasms derived by Preston, hardly any associations (very weak negative ones only) were found in the age-specific analyses within the age groups 45–64 years and 65 years and over. In spite of the differences in these coefficients, the overall results for all ages combined were only slightly dependent on whether the analysis was conducted for all ages combined, as in Preston's book,[3] or by broad age groups followed by combining, as in this paper (for details see Hakulinen *et al*[1]). The main advantage of the age-specific analysis is that the resulting cause-specific mortality rates also become available by age group.

Because there was very little association between the total mortality and that from neoplasms in the age groups 45–64 years and 65 years and over, it could be argued that for neoplasms the methodology originally suggested by Preston[3] is inappropriate. However, this is

not the case. The small regression coefficients in the case of neoplasms reflect the fact that there is comparatively little variation in death rates due to neoplasms in the world by level of development of the area. A mortality model specified by a constant fits neoplasms very well. The residual variation is caused by factors specific or particular to the areas concerned. These factors are not included in the simple model (1). The coefficient of variation of death rates due to neoplasms at ages 45–64 years was 0.32 for males and 0.22 for females. The corresponding figures for the infectious and parasitic diseases were 1.26 (males) and 1.43 (females).

The methodology was tested as to its sensitivity with regard to the choice of a particular model life table and regression model.[1] On the whole, the results were remarkably consistent suggesting that the methodology is robust enough to yield information useful for global and regional purposes.

It may also be argued that the cause of death categories are too broad to be of much use in determining the need for specific health interventions. However, these results should be viewed as merely a first step providing a convenient framework and managerial tool for consideration of global priorities and strategies. Using these estimates as 'benchmark' figures, more refined estimates may then be obtained by a careful review of available epidemiological and other health information for the country or region concerned. This is, of course, an easier task for national estimates and has been applied in the case of Indonesia by Hull *et al.*[13]

There is a need to use more refined cause of death groupings, particularly the further division of the huge 'residual' group which currently accounts for 20% of all deaths in the world. For the more developed countries, except Albania and the USSR, information derived from WHO's data bank reveals that of the 884000 annual deaths (ie 12% of all deaths in these countries attributed to the residual group), 638000 (9%) are due to various defined causes and 246000 (3%) to ill-defined causes (including senility). In the developing countries, however, this residual group accounts for more than 9 million deaths (almost 23% of all deaths estimated for the developing countries), underlining the need for appropriate research methodologies to further subdivide this group and to arrive at quantitative estimates of the probable impact of the defined causes.

A proportionate analysis of causes by sex and age for each part of the world representing a different level of development shows the relative order of importance of each group of causes of death. However, the use of mortality rates emphasizes the fact that diseases of the circulatory system and neoplasms are an important health hazard in developing countries, too. Similarly, although the proportion of deaths due to injury and poisoning among all causes of death is higher in the developed than in the developing countries, the mortality rate due to external causes is roughly the same in most age groups irrespective of the level of development (Table 4 and Figure 2).

Parkin *et al*[14] have recently calculated estimates of worldwide cancer incidence by site. For Africa, their results are based on the findings reported in this paper. However, for Latin America and Asia, the estimates by Parkin *et al* and those presented here have been arrived at largely independently of one another. The results are comparable in magnitude, although the estimates in this study are slightly lower.

One reason for the lower rates estimated for neoplasms and degenerative diseases might be, as pointed out by Preston,[3] that some of these deaths were concealed in the 'other and unknown' cause of death category. As more than 20% of deaths were classed as 'other and unknown' causes in developing countries, the estimates derived here are probably lower than the real situation.

Admittedly the results are not applicable for all the purposes mentioned in the introduction and may be unsuitable for answering certain specific questions. However, with the basic methodology developed, the procedure can be improved and refined. The estimation of global patterns of causes of death should not be considered as a one-time exercise but rather as an ongoing monitoring and evaluation process. The present effort should not be viewed as the final word but rather as a step towards a better information back-up for health policies in the developing world.

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