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Causes of Death in Industrial and Developing Countries: Estimates for 1985–1990

Alan D. Lopez

Information about the cause structure of mortality has for many years served as the cornerstone for monitoring health progress and for the determination of health priorities. Over the years, information systems on routine causes of death have been established in many countries and, throughout the industrial world at least, these have evolved to the point at which there is now virtually complete coverage of deaths and medical certification. A handful of developing countries, primarily in Latin America and East Asia have achieved comparable standards of reliability of their cause-of-death statistics. In several other countries, considerable progress has been achieved toward obtaining reasonably reliable mortality information for at least the urban populations, although calculation of mortality rates is often impeded by lack of information about the population at risk. For the majority of developing countries, however, the reliability of cause-of-death data emanating from vital registration systems—where they exist—is sufficiently poor essentially to preclude their use for assessment of the national health situation.

In the absence of reliable information on medically certified causes of death, countries are increasingly adopting lay reporting schemes to obtain at least a broad overview of health conditions in populations in which deaths are not routinely recorded or medically certified. This technique has undoubtedly generated useful information for several populations, but it has not been nearly as widely exploited as, for example, the indirect techniques for assessing levels of mortality on the basis of information from women about children ever born and children surviving. As a result, global and regional patterns of mortality by age and sex can be, and have been, established with some confidence, whereas the cause structure of mortality, for at least half of the world's population, is, at best, uncertain.

One method of estimating causes of death in countries without reliable information is to develop a model of the epidemiological transition based on the experience of the industrial countries. Hakulinen and others (1986), for example, estimated a series of cause-specific regression equations to predict the level of mortality for a given cause (among twelve broad cause-of-death groups) from information about the crude death rate. Perhaps the greatest limitation of this method is that it implicitly assumes that the cause-level relationship is invariant over time. This is unlikely to be the case in contemporary developing countries, where modernization, social and economic change, and the infusion of medical technology have undoubtedly altered the nature and severity of disease epidemics. Adjustment of the estimates generated by the model on the basis of a critical appraisal of available epidemiological information, as has been done in Indonesia, for example (see Hull, Rohde, and Lopez 1981), increases the reliability of the estimates. This type of complementary analysis is clearly quite complicated at a global, or even regional, level, however, and hence the indirect estimates of cause-of-death patterns should be viewed only as a first approximation to the underlying epidemiological environment. The method followed in this chapter of estimating the global and regional mortality situation in 1985 is one of progressively assembling nationally representative mortality patterns according to the degree of confidence in their reliability.[1] Thus the first section of the chapter deals exclusively with the industrialized market and nonmarket countries. The market economies include the following:

Australia	Greece	New Zealand
Austria	Iceland	Norway
Belgium	Ireland	Portugal
Canada	Italy	Spain
Denmark	Japan	Sweden
Finland	Luxembourg	Switzerland
France	Malta	United Kingdom
Germany, Fed. Rep.	Netherlands	United States

The countries listed below are considered industrial nonmarket economies:

Albania	German Dem. Rep.	Romania
Bulgaria	Hungary	U.S.S.R.
Czechoslovakia	Poland	Yugoslavia

These thirty-three countries in 1985 accounted for a population of about 1.2 billion people (that is, 1,200,000,000) or approximately 25 percent of the world total.[2] Some 11 million deaths occur each year in these countries (out of a global total of roughly 50 million), virtually all of which are medically certified.[3] There remain, however, important differences in diagnostic and coding practices among these countries due to differences in medical training, availability of diagnostic aids, and the like. Percy and Muir (1989), for example, in their study of the international comparability of cancer mortality data in seven industrialized countries, found that cancer deaths were typically overreported by 3 to 4 percent compared with the United States. The largest difference was estimated for France, where coding procedures resulted in a 10 percent higher death rate for cancer than would have been the case if the procedures in use in the United States had applied. The implications of artifacts such as these for comparative mortality analyses could be quite substantial. For example, the age-adjusted cancer death rate for France in 1984 was 139.5 per 100,000, or about 5 percent more than what was observed in the United States (132.4 per 100,000). After allowing for coding differences, the French cancer death rate was recalculated by Percy and Muir at 127.5 per 100,000, almost 5 percent less than the rate for the United States. Although these artifacts are likely to be less of a problem for aggregate analyses, such as those reported in this study, it must be kept in mind that the resulting cause-of-death pattern, even for industrial countries, is not exact. Nonetheless, for broad cause-of-death groups at least, the structure of mortality can be reasonably well established from the data available.

The estimation of cause-specific mortality for the developing regions of the world is even less precise. Global estimates of disease-specific morbidity and mortality have been prepared by several technical programs in the World Health Organization. These estimates are frequently based on studies carried out at the community level in various developing countries and then extrapolated to yield regional and global figures. This is clearly a very imprecise method, but in the absence of vital registration there is little alternative but to "evaluate and extrapolate." In addition, cause-of-death data are available for a number of developing countries, particularly in Latin America, and provided the coverage and reliability of the information is known, even approximately, these data can be exploited to estimate national cause-of-death patterns. Regional and global estimates can then be obtained, although this aggregation introduces an additional degree of uncertainty into the estimates because of missing data for some countries. For some large populations in the developing world, cause-of-death information is now becoming available which is of sufficient quality and representativeness to permit reasonable estimates of the epidemiological situation for the country as a whole. China now has routine mortality data, almost all of which is medically certified for over 100 million people in rural and urban areas in the eastern half of the country, where the bulk of the population resides. India also has implemented a rural survey of causes of death. It is based on lay reporting of the cause of death, with verification on a sample basis by physicians at district primary health care centers. Obviously, reliable information about the mortality pattern for these two countries will have a significant effect on the estimation procedure for all developing countries. Indeed, in 1985, one-half of the population of the developing world were living in China and India as shown in table 2-1.

Table 2-1. Population of the Developing World

Region	*Population (millions)*	*Percentage of total population*
Sub-Saharan Africa	456	12.4
Middle East/North Africa	376	10.2
Latin America/Caribbean	402	11.0
India	765	20.9
China	1,065	29.0
Other Asia/Pacific	604	16.5
Total	3,668	100.00

Source: Author.

Causes of Death

The causes of death selected for mortality estimation are shown in table 2-2, along with the corresponding codes of the International Classification of Diseases (ICD). For the ninth revision of the ICD (ICD-9), the codes refer to items in the Basic Tabulation List, whereas for ICD-8, the numbers refer to diseases and injuries included in list "A." Both of these are summary or "short" lists and are used by WHO to collect and store mortality information. In some cases, the items available in the summary lists do not correspond exactly to the composition of cause-of-death categories defined on the basis of the detailed rubrics of the ICD. The discrepancies are generally minor, however, and in any case will have much less effect on the estimates than the artifacts and uncertainties mentioned above.

Eight broad categories of causes of death are considered:

- Infectious and parasitic diseases
- Neoplasms
- Diseases of the circulatory system and other selected degenerative diseases[4]
- Chronic obstructive lung diseases (principally chronic bronchitis and emphysema)
- Complications of pregnancy
- Perinatal conditions
- Injury and poisoning (all external causes)
- All other causes

For the industrial countries at least, the remainder category has been further disaggregated into "other specific causes" and "symptoms and ill-defined conditions." For some categories, namely, infectious and parasitic diseases, diseases of the circulatory system, and the remainder category, estimates of mortality from more specific conditions listed in table 2-2 have also been attempted. This was done because disease-specific esti-

Table 2-2. Causes of Death and Corresponding Categories in the International Classification of Diseases, Injuries, and Causes of Death (ICD)

Cause of death	*ICD-8 List A*	*ICD-9 Basic Tabulation List*
Main Categories		
Infectious and parasitic diseases	A1–44, A90–92, A99	01–07, 320–322
Neoplasms	A45–61	08–17
Circulatory system and certain degenerative diseases	A64, A80–88, A98, A102, A105–106	25–30, 181, 341, 347, 350
Chronic obstructive pulmonary (lung) disease	A93, A96	323–326
Complications of pregnancy	A112–118	38–41
Perinatal conditions	A131–135	45
Injury and poisoning	A138–150	E47–E56
Ill-defined causes	A136, A137	46
Other causes	Other codes	All other codes
Infectious diseases		
Diarrhea	A1–5, A99	01
Tuberculosis	A6–10	02
Acute respiratory infection	A15–17, A89–92	033–035, 320–322
Measles	A25	042
Polio	A22–23	040, 078
Yellow fever, dengue, and encephalitis	A26–27	044–045
Malaria	A31	052
Schistosomiasis and filariasis	A39, A41	072, 074
Intestinal parasites	A42–43	075–076
Circulatory and degenerative diseases		
Ischemic heart disease	A83	27
Cerebrovascular disease	A85	29
Other cardiovascular diseases	A80–82, A84, A86–88	25, 26, 28, 30
Diabetes	A64	181
Certain degenerative diseases (nephritis, cirrhosis, ulcers)	A98, A102, A105, A106	341, 347, 350
Other disorders		
Mental disorders	A69	210–212
Oral health diseases	A97	330
Micronutrient deficiency	A62–63, A67	180, 193, 200
Malnutrition	A65	190–192

Source: International Classification of Diseases, Injuries, and Causes of Death.

mates are undoubtedly of much greater relevance for determining health priorities than an aggregate of conditions which may require substantially different strategies for prevention and control.

Causes of Death in Industrial Countries in 1985

Tables 2-3, 2-4, and 2-5 summarize the cause-of-death structure for the industrialized world as a whole (table 2-3) as well as for the groups of industrial market economies (table 2-4) and the industrial nonmarket economies (table 2-5) separately.

All Industrial Countries

The structure of mortality shown in table 2-3 for the industrialized countries as a whole is very much what one would expect for a population with an average life expectancy of seventy-four years. Of the 11.05 million deaths reported for these countries during 1985, 7.63 million, or approximately 70 percent, occurred at age sixty-five and over. Another 2.3 million were at age forty-five through sixty-four. That is, almost 10 million (90 percent) of the 11 million deaths were at age forty-five and over. In contrast, there were 355,000 infant and child deaths below age five (3.2 percent of the total), 275,000 of which occurred among infants. The vast majority of these infant deaths in turn occurred very early in life (typically within the first week) and were due to various perinatal and congenital conditions which are difficult to eliminate. Nonetheless, further progress in reducing this toll of over 350,000 young-child deaths each year can be expected through the reduction of inequalities in access to, and use of, prenatal care and infant and child health services among different sectors of the population. Indeed, reduction of such inequalities is central to the health-for-all-strategies in these countries and applies not only during infancy and childhood but at later ages as well.

Infectious and parasitic diseases (including acute respiratory diseases) claimed just over half a million deaths in the industrialized countries about 1985, two-thirds of which were among the elderly (sixty-five years and over). Even so, 110,000 of these deaths were among children below the age of five, with all but about 6,000 of these occurring in the nonmarket coun-

Table 2-3. Causes of Death in Industrial Countries, 1985

Cause of death	Number (thousands)			Percentage		
	Males	Females	Total	Males	Females	Total
Infectious and parasitic diseases	266	240	506	4.7	4.4	4.6
Acute respiratory infections	184	184	368	3.3	3.4	3.3
Tuberculosis	30	10	40	0.5	0.2	0.4
Neoplasms	1,263	1,030	2,293	22.5	18.9	20.8
Circulatory and certain degenerative diseases	2,720	3,210	5,930	48.6	59.0	53.7
Ischemic heart disease	1,199	1,193	2,392	21.4	21.9	21.7
Cerebrovascular disease	590	914	1,504	10.5	16.8	13.6
Diabetes	59	94	153	1.1	1.7	1.4
Complications of pregnancy	0	4	4[a]	0.0	0.1	0.0
Perinatal conditions	60	40	100	1.1	0.7	0.9
Chronic obstructive lung diseases	245	140	385	4.4	2.6	3.5
Injury and poisoning	536	236	772	9.6	4.3	7.0
Ill-defined causes	115	132	247	2.1	2.4	2.2
All other causes	397	410	807	7.1	7.5	7.3
Total	5,601	5,444	11,045	100.0	100.0	100.0

a. Estimated at 6,000 due to under-reporting.
Source: Calculated from WHO mortality database.

tries. It should be emphasized here that this category does not include deaths coded to acquired immunodeficiency disease (AIDS) because it was not possible to distinguish these deaths from other causes in the mortality data reported to WHO. Still, the number of new AIDS cases reported for the industrialized countries about 1985 was less than 30,000, and hence the mortality from AIDS would not have altered dramatically the overall total of deaths from infectious and parasitic diseases. Rather, acute respiratory infections, primarily pneumonia among the elderly, account for about two-thirds of the deaths from infections in industrial countries. Another 40,000 deaths are attributable to tuberculosis, primarily at age forty-five and over. Acute respiratory infections and tuberculosis are thus the principal causes of death from infectious diseases in industrial countries, accounting for four-fifths of the half-million deaths still due to infections in the industrialized world.

In these countries, cancer, primarily malignant neoplasms, claims the lives of 2.3 million persons each year, 55 percent of which are males. Cancer too has a relatively high average age at death, with 1.4 of the 2.3 million deaths occurring beyond age sixty-five. Nonetheless, there is still very substantial scope for preventing premature death from neoplastic diseases. Of the remaining 900,000 cancer deaths, all but a handful (15,000) occurred between the ages of fifteen and sixty-four.

The causes of cancer are still very much a matter of investigation, but in countries such as the United States, where

Table 2-4. Causes of Death in Industrialized Market Countries, 1985

Cause of death	Number (thousands)			Percentage		
	Males	Females	Total	Males	Females	Total
Infectious and parasitic diseases	152	156	308	4.3	4.8	4.5
Acute respiratory infections	115	126	241	3.3	3.8	3.5
Tuberculosis	9	4	13	0.3	0.1	0.2
Neoplasms	888	719	1,607	25.1	21.9	23.6
Circulatory and certain degenerative diseases	1,682	1,773	3,455	47.6	54.1	50.7
Ischemic heart disease	730	595	1,325	20.6	18.1	19.4
Cerebrovascular disease	334	467	801	9.5	14.2	11.8
Diabetes	48	73	121	1.3	2.2	1.8
Complications of pregnancy	0	1	1	0.0	0.0	0.0
Perinatal conditions	24	18	42	0.7	0.5	0.6
Chronic obstructive lung diseases	168	86	254	4.7	2.6	3.7
Injury and poisoning	288	143	431	8.1	4.4	6.3
Ill-defined causes	83	99	182	2.3	3.0	2.7
All other causes	251	284	535	7.2	8.7	7.9
Total	3,536	3,279	6,815	100.0	100.0	100.0

Source: Calculated from WHO mortality database.

Table 2-5. Causes of Death in Industrialized Nonmarket Countries, 1985

Cause of death	*Number (thousands)*			*Percentage*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
Infectious and parasitic diseases	114	84	198	5.5	3.9	4.7
Acute respiratory infections	68	58	126	3.3	2.7	3.0
Tuberculosis	21	6	27	1.0	0.3	0.6
Neoplasms	375	312	687	18.2	14.4	16.2
Circulatory and certain degenerative diseases	1,038	1,437	2,475	50.3	66.4	58.5
Ischemic heart disease	469	598	1,067	22.7	27.5	25.2
Cerebrovascular disease	255	448	703	12.4	20.7	16.6
Diabetes	12	21	33	0.6	1.0	0.8
Complications of pregnancy	0	3	3	0.0	0.2	0.1
Perinatal conditions	35	23	58	1.7	1.1	1.4
Chronic obstructive lung diseases	77	54	131	3.7	2.5	3.1
Injury and poisoning	248	93	341	12.0	4.3	8.1
Ill-defined causes	32	33	65	1.6	1.5	1.5
All other causes	146	126	272	7.1	5.8	6.4
Total	2,065	2,165	4,230	100.0	100.0	100.0

Source: Calculated from WHO mortality database.

cigarette smoking has been prevalent for several decades, it has been estimated that roughly one-third of cancer deaths can be directly attributed to cigarette smoking (Doll and Peto 1981). Recent estimates (WHO 1991a) have attributed 42 percent of all male cancer deaths and 8 percent of female cancer deaths in the industrial countries to cigarette smoking. Dietary factors are also thought to account for a similar proportion (one-third) of cancer deaths. Other behavioral factors have been causally associated with certain sites of the disease, including excessive alcohol consumption (esophagus, pharynx), reproductive and sexual behavior, occupation, and pollution.

By far the leading type of cancer causing death in the industrialized world today is lung cancer. Almost 500,000 lung cancer deaths were diagnosed in industrial countries in 1985, three-quarters of them among males. Other leading types of cancer include stomach cancer (380,000 deaths), breast cancer (165,000 female deaths), and prostatic cancer (95,000 male deaths). Overall, since 1950, there has been relatively little change in nonlung cancer mortality—death rates have risen slightly for males and declined slightly for women. Lung cancer mortality, almost all of which can be attributed to cigarette smoking (USDHHS 1989), has risen dramatically in industrial countries during the last forty years or so (see figure 2-1), although there are signs that the epidemic, at least among males, has stabilized in several countries, including the United States, Australia, Switzerland, and the former Federal Republic of Germany (Lopez 1989). Male lung cancer death rates in these countries may soon begin to decline, as they have already begun to do in England, Wales, and Finland. Among women, by contrast, death rates from lung cancer are rising virtually throughout the industrialized world as a result of the widespread adoption of cigarette smoking among women during the 1950s and 1960s.

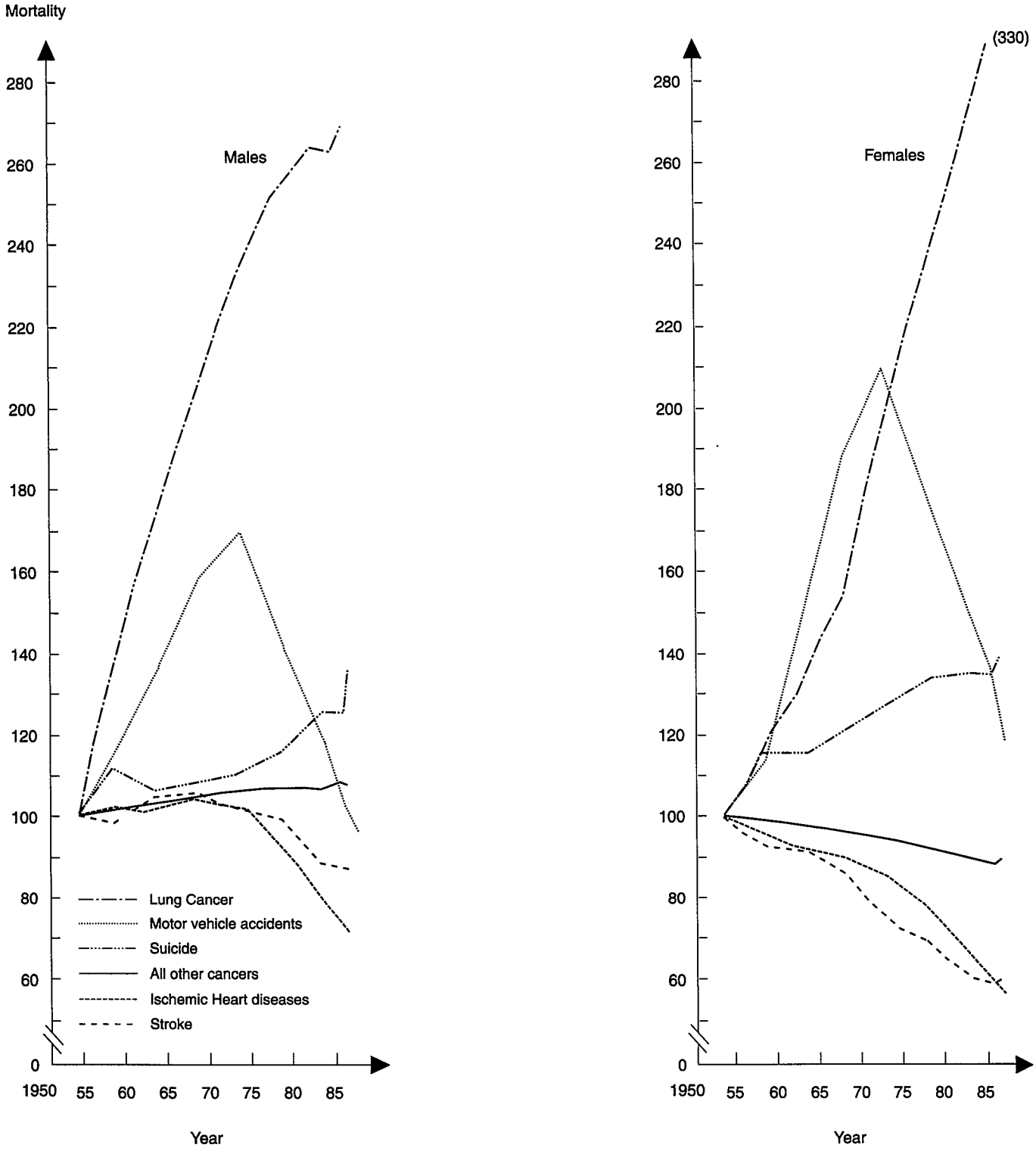
More than one-half of all deaths in industrial countries (5.93 million, or 54 percent) are attributed each year to the circulatory diseases and to certain degenerative diseases. Circulatory diseases alone claim 5.45 million lives each year, or almost exactly 50 percent of the total. More females than males die from circulatory and certain degenerative diseases (3.21 million, compared with 2.72 million), although among what might be termed "premature deaths," males predominate, with roughly 785,000 males succumbing each year to these diseases before the age of sixty-five, compared with 390,000 females.

Of the circulatory diseases, the principal cause of death is ischemic heart disease, which each year claims 2.4 million lives, 1.9 million (or roughly 80 percent) of which occur among those age sixty-five and over. The numbers of deaths are roughly evenly divided between males and females, although premature death from the disease (that is, before age sixty-five) is much (in fact, three times) more common among males. There has been considerable research into the causes of ischemic heart disease and a number of risk factors have been identified, the principal ones being hypertension, cigarette smoking, and elevated serum cholesterol. In countries such as the United States, Australia, and Canada, where health promotion campaigns to reduce the prevalence and severity of risk factors in the population have been in operation for several years, marked declines in death rates, of the order of 30 to 50 percent, have been observed since the late 1960s.

Another leading cause of death from circulatory disease is stroke (cerebrovascular disease), which each year claims the lives of 1.5 million persons in industrial countries, 60 percent of whom are women. Most of these deaths occur at the advanced ages with slightly less than 240,000 deaths occurring before age sixty-five. The sex differential in premature mortality from stroke is less marked than for ischemic heart disease, the proportion of male deaths being only marginally higher than female deaths (55 percent compared with 45 percent).

The principal other cardiovascular disease causing death is nonischemic heart disease, including pulmonary and hyper-

Figure 2-1. Relative Mortality Trends from Selected Causes of Death, by Gender, in Industrial Countries, 1950–86



Note: Mortality in the base period, 1950–54, is set at 100, and mortality in other years is determined in relation to this base.
Source: Lopez 1990b.

tensive heart disease. This category of causes accounted for the death of an additional 1.5 million persons in 1985, almost 900,000 of whom were females. These diseases were also characterized by a high average age at death—1.3 million (87 percent) of the deaths assigned to this category occurred beyond age sixty-five.

The remainder of this broad category of circulatory and degenerative diseases consists of four specific conditions; cir-

rhosis of the liver, diabetes mellitus, ulcer of the stomach and duodenum, and nephritis and nephrosis. Roughly 480,000 deaths are coded each year to these conditions, of which diabetes and cirrhosis of the liver each claim about 150,000. Interestingly, the sex ratio of mortality is reversed for the two diseases. Twice as many females die of diabetes than males, whereas twice as many males die of cirrhosis of the liver. This outcome is certainly consistent with observations on the alcohol consumption patterns of men and women (Capocaccia and Farchi 1988).

The substantial improvements in public health in industrial countries during the course of the twentieth century have virtually eliminated pregnancy-related deaths among women. In 1985 only about 4,500 such deaths were reported in the industrial countries, the vast majority (80 percent) in the nonmarket group. Still, misdiagnosis of maternal deaths is estimated to be of the order of 50 percent in industrial countries (Royston and Lopez 1987), and thus the true mortality from maternal causes is probably closer to 6,000 deaths per year. Virtually all these deaths occur between the ages of fifteen and forty-four and are largely preventable.

Perinatal conditions claimed the lives of 100,000 babies in the industrialized world in 1985, 60 percent of whom were boys. In almost all cases these deaths occur during the neonatal period (up to twenty-eight days after birth) and to a large extent are due to congenital anomalies, birth trauma, and other circumstances of birth. Given the constitutional (rather than environmental) nature of these deaths, it is difficult to see how this mortality can be reduced much further, although the much more common occurrence of such deaths in the nonmarket countries suggests that there is still scope for a reduction in death rates in this group.

A further 1.17 million deaths in 1985 were ascribed to other specific diseases, of which the chronic obstructive pulmonary diseases (primarily chronic bronchitis and emphysema) accounted for almost 400,000. Of these, roughly 250,000 were male deaths. This group of conditions, for which the principal risk factor is cigarette smoking (USDHHS 1989), also tends to claim most lives at the higher ages, with 80 percent of deaths occurring among people age sixty-five and over.

The other remaining broad category of causes of deaths, namely, injury and poisoning (external causes), accounted for about 770,000 deaths in the industrialized world in 1985. Male deaths from violent causes (536,000) were more than twice as common as female deaths from such causes (236,000). Moreover, roughly one-half (260,000) of the male deaths occurred between the ages of fifteen and forty-four, and roughly half that number again (147,000) between forty-five and sixty-four. Only about 17 percent (92,000) of all male deaths due to violence occurred at age sixty-five and over. There is thus considerable scope for additional preventive measures to counter premature male mortality from violence (principally motor vehicle accidents) which each year accounts for almost 10 percent of all male deaths in industrial countries. Mortality from violent deaths among females is much lower (4.3 percent), with almost 50 percent of these deaths occurring among women age sixty-five and over. Accidental falls are a leading cause of death from violence among elderly women.

The quality of cause-of-death statistics for industrial countries as a whole is reflected in the relatively low proportion of deaths for which a specific diagnosis could not be offered.[5] In 1985, the number of deaths coded to the category of signs, symptoms, and ill-defined conditions was approximately 250,000, of which 180,000 were deaths among the elderly. Certainly the ascertainment of a single underlying cause of death in the presence of multiple pathologies, as is often the case for death at advanced ages, is difficult, and the verdict of senility is sometimes applied. Ill-defined conditions account for only about 2.3 percent of deaths overall in the industrial world, and even among the elderly, where they are most common, the percentage is essentially the same. Slightly more female than male deaths are coded to ill-defined conditions, primarily because of the higher average age at death for women.

Industrial Market and Nonmarket Mortality Compared

Tables 2-3 through 2-5 are obviously not appropriate for making mortality comparisons between the industrialized market and nonmarket countries in view of differences in population size and structure between the two groups. Of the 1.17 billion population living in industrial countries, roughly two-thirds (760 million) live in the market economies and the remaining one-third in the nonmarket countries. In order to control for differences in population size and composition, age-standardized death rates have been computed for various causes of death, using the "European" population age structure as the standard. The results are shown in table 2-6.

For both males and females, total mortality rates are about 40 percent higher in the nonmarket countries than in the market economies. Death rates from infectious and parasitic diseases are low (of the order of 30 to 60 per 100,000 population) in both groups of industrial countries but are nonetheless still higher in nonmarket countries, especially for males. These higher rates are largely due to the higher tuberculosis mortality among the elderly in the nonmarket group. Interestingly, overall death rates from neoplasms are virtually identical for males in the two country groups but are higher for females in the market economies. This no doubt reflects the rapid rise in female lung cancer mortality in several countries such as the United States, Australia, Denmark, and the United Kingdom, a phenomenon which is much less apparent in Eastern Europe.

Circulatory and certain degenerative diseases contribute most to the higher overall death rates observed in the nonmarket countries. The age-standardized death rate for males in these countries is almost 850 per 100,000, about 65 percent higher than the level observed in the market economies. Among women, the differential is even greater, with death rates from these diseases in Eastern Europe being 80 percent higher overall than in other industrial countries. Moreover, mortality rates in the nonmarket countries are uniformly higher for all major component diseases of the circulatory system, in particular ischemic heart disease and stroke, and for chronic obstructive lung diseases. By contrast, diabetes death rates are higher in the market economies, although the net effect of this differential on comparative mortality for the

Table 2-6. Age-Standardized Death Rates (per 100,000) for Selected Causes, Industrial Country Groups, 1985

	Market economies		Nonmarket economies		Total	
Cause of death	*Males*	*Females*	*Males*	*Females*	*Males*	*Females*
Infectious and parasitic diseases	48.3	28.5	62.0	36.1	57.5	33.9
Tuberculosis	2.7	0.8	12.7	2.6	6.1	1.5
Acute respiratory infections	37.3	22.2	37.6	24.8	41.0	25.2
Neoplasms	264.6	154.4	266.3	136.1	268.7	149.2
Circulatory and certain degenerative diseases	516.7	323.3	847.5	582.2	605.6	405.3
Ischemic heart disease	222.4	108.8	382.1	241.0	265.1	149.5
Cerebrovascular disease	102.7	83.1	210.7	180.0	131.9	114.4
Other cardiovascular diseases	138.1	98.7	203.4	134.5	155.1	110.4
Diabetes	14.2	14.0	8.5	8.6	12.8	12.3
Other degenerative diseases	39.2	18.6	42.8	18.1	40.7	18.7
Complications of pregnancy	n.a.	0.2	n.a.	1.6	n.a.	0.7
Perinatal conditions	7.5	5.8	14.3	9.7	10.5	7.5
Injury and poisoning	79.5	31.8	137.0	41.9	99.2	35.7
Ill-defined causes	26.8	18.7	26.2	14.2	26.5	17.3
All other causes	127.5	72.7	153.4	71.9	136.6	73.6
Total	1,070.9	635.3	1513.6	897.2	1,206.5	724.3

n.a. Not applicable
Note: Data are standardized onto the WHO "European" population structure.
Source: Calculated from WHO mortality database.

category as a whole is negligible in view of the relatively low mortality from diabetes. The remaining degenerative diseases (which include cirrhosis of the liver) exhibit virtually identical mortality levels in the two groups of countries.

The only other significant category of causes of death for which the mortality differential is quite substantial is injuries and poisonings, especially among males. In the nonmarket countries, the male death rate from violence of 137 per 100,000 is more than 70 percent higher than the average in the other industrial countries. Among females, mortality from violence has traditionally been much lower than for males, and hence the relatively large differential in favor of women in the market economies (approximately 25 percent) has comparatively little effect on the overall mortality differential among females in the two groups of countries.

Certainly, a more detailed investigation of specific causes of death would help to shed more light on the underlying factors which contribute to the mortality differentials observed between the market and nonmarket countries. Differences in individual lifestyle, including cigarette consumption, diet, and general health consciousness, no doubt account for a substantial proportion of the differences in mortality. The mortality rates are aggravated by more pervasive environmental factors, such as pollution and occupational hazards for certain cancers and respiratory diseases. Yet any interpretation of aggregate-level mortality differences such as those outlined above must take into account the substantial heterogeneity of the populations being compared. This is particularly true for the nonmarket countries. The former U.S.S.R., which alone accounted for two-thirds of the population of the industrialized nonmarket economies, was itself a very heterogeneous country with mortality profiles for subpopulations which vary from the Central–Eastern European pattern to a structure more typical of Asian countries. At best, therefore, the broad mortality comparisons presented here provide a *summary* perspective on health conditions for roughly one-quarter of the world's population.

Mortality in Industrial Countries: Update for 1990

More recent data for the late 1980s and, for several countries, 1990, are now available at WHO. Not surprisingly, the cause pattern of mortality in 1990 is much the same as for 1985, given the relative inertia of a mortality structure dominated by the chronic diseases.

CANCER. In 1990 there were 2.42 million deaths—1.35 million males, 1.07 million females. The leading type was lung cancer (400,000 males deaths, 120,000 female deaths), followed by colon-rectum cancer (276,000 deaths, both sexes combined), stomach cancer (244,000), breast cancer (175,000 women), and prostatic cancer (105,000 men).

CARDIOVASCULAR DISEASES. During 1990, 5.43 million deaths were coded to this category—2.46 million males and 2.97 million females. By far the largest category was ischemic heart disease (2.33 million), followed by cerebrovascular diseases (stroke) (1.48 million). Other (nonischemic) heart diseases claimed 1.06 million lives in 1990.

CERTAIN DEGENERATIVE DISEASES. Diabetes mellitus caused 170,000 deaths in 1990; ulcer of stomach and duodenum, 50,000; cirrhosis of the liver, 175,000; nephritis, nephrotic syndrome, and nephrosis, 125,000.

CHRONIC OBSTRUCTIVE PULMONARY DISEASES. In 1990 there were 388,000 deaths, 240,000 among men.

INJURIES AND POISONINGS. During 1990, some 865,000 deaths occurred in industrial countries from external causes, the majority (615,000) among males. Motor vehicle accidents claimed the lives of 215,000 persons, of whom 160,000 were males. The other leading cause of violent death was suicide, with 140,000 male deaths and 50,000 female deaths in 1990.

Estimated Cause-of-Death Patterns in 1985

The estimates for specific causes of death in developing countries are summarized in table 2-7 for children and adults separately and are discussed in more detail in this section according to their etiology. Table 2-8 provides an estimated distribution of mortality by broad cause groups within each of four geographic regions, which together encompass the entire developing world. The method of estimation and the sources used are also given in this section. It is immediately apparent that there is a substantial degree of uncertainty in the mortality estimates for specific causes, and hence the estimates must be viewed with considerable caution, particularly for individual diseases.

Quite apart from these more methodological considerations, the vast majority of childhood deaths in developing countries occur within a complex epidemiological environment. Children are often afflicted with multiple infections, which in turn are aggravated by malnutrition and poverty. The estimation of mortality attributable to a single underlying cause is thus extremely difficult in developing countries, where infectious diseases are still common. One must be prepared to accept a considerable degree of overlap between estimates for specific diseases (there is a parallel in the industrial countries but at the other extreme of life, that is, at the advanced ages, when there are often several pathologies present at or about the time of death).

As a consequence, the estimates of mortality from leading causes of death in developing countries are presented here along with these disease interactions. This is clearly a departure from the convention of specifying a *single* underlying cause of death, but it is no doubt much closer to the reality which prevails in many parts of the developing world. Measles is a case in point. The most common complications of measles include pneumonia, diarrhea, and malnutrition. Studies in Latin America (Puffer and Serrano 1973) and Africa (Ofosu-Amaah 1983) have shown that many measles deaths were in fact attributed to complications of the disease, resulting in considerable underascertainment. The quantification of measles mortality shown in table 2-7 explicitly recognizes these relationships between underlying, immediate, and associated causes of death—the global estimate of 2 million measles

Table 2-7. Estimated Causes of Death in Developing Countries, by Age, 1985
(thousands)

Cause of death	*Age*		
	Under five	*Five and over*	*All ages*
Infectious and parasitic diseases	10,500	6,500	17,000
Diarrheal diseases	4,000	1,000	5,000
Tuberculosis	300	2,700	3,000
Acute respiratory diseases	4,300	2,000	6,300
Measles, whooping cough, and diphtheria	1,500	—	1,500
Other acute respiratory diseases	2,800	2,000	4,800
Other measles and whooping cough[a]	700	—	700
Malaria	750	250	1,000
Schistosomiasis	—	200	200
Other Infectious and parasitic diseases	450	350	800[b]
Complications of pregnancy	—	500	500
Perinatal conditions	3,200[c]	—	3,200
Neoplasms	—	2,500	2,500
Chronic obstructive lung diseases	—	2,300	2,300
Circulatory diseases and certain degenerative diseases	—	6,500	6,500
External causes	200	2,200	2,400
Other and unknown causes	700	2,800	3,500[b]
Total	14,600	23,300[d]	37,900

— Negligible

a. Does not include 400,000 measles-related deaths included under diarrheal diseases.

b. Some of these deaths actually may be attributable to malaria. The global estimate of mortality from the disease is between 1 and 2 million annually.

c. Includes an estimated 775,000 deaths from neonatal tetanus.

d. Of these, an estimated 1.6 million deaths occur at ages 5 to 14 years. Diarrheal diseases and acute respiratory disease are each estimated to account for about 300,000 deaths at these ages; another 150,000 or so are due to malaria and tuberculosis. Accidents and violence are a leading cause od death at these ages and may well claim 200,000 to 300,000 lives each year in this age group in developing countries.

Source: Author's estimates.

Table 2-8. Estimated Causes of Death in Developing Countries, by Region, 1985
(thousands)

Cause of death	Latin America and the Caribbean	Sub-Saharan Africa	Middle East/ North Africa	Asia	Total
Infectious and parasitic diseases	900	4,500	2,400	9,200	1,700
Neoplasms	300	250	200	1,750	2,500
Circulatory diseases and certain degenerative diseases	900	650	550	4,400	6,500
Complications of pregnancy	35	125	80	260	500
Perinatal conditions	300	680	420	1,800	3,200
Chronic obstructive pulmonary diseases	90	60	50	2,100	2,300
External causes	250	350	200	1,600	2,400
Other and unknown causes	425	585	400	2,090	3,500
Total	3,200	7,200	4,300	23,200	37,900

Source: Author's estimates.

deaths in 1985 has been disaggregated into estimates of the components of the disease-complication interaction. Many of these deaths would in turn be associated with malnutrition.

Several other examples could be cited, including the complexity of malarial infection. Severe anemia is often a consequence of repeated attacks of malaria but can also result from hookworm infection and nutritional deficiencies. Although this epidemiological complexity makes the estimation of mortality from specific diseases uncertain, there are clear implications for health interventions. Health care programs primarily designed to control the spread of infection from a single disease can be expected to exert a disproportionate effect on child survival by simultaneously reducing mortality from associated causes.

Infectious and Parasitic Diseases

The basis for the estimates of mortality from specific infectious diseases is given below. Although joint estimates are provided, the very poor quality of the data and information available to make them suggests that they be viewed extremely cautiously. Confidence intervals of the order of 50 percent around each estimate would seem reasonable.

DIARRHEAL DISEASES. In their review of morbidity and mortality from diarrheal diseases based on twenty-four studies in the developing world, Snyder and Merson (1982) estimated that there were roughly 4.6 million childhood deaths (below age five) each year associated with these diseases. Allowing for the effect of oral rehydration treatment in the meantime, and for population growth, the annual number of deaths is currently thought to be about 4.4 million. However, evidence on the case-fatality rate from the disease and the number of episodes (1,300 million per year) suggests just under 4 million childhood deaths.

The distinction between "association" and "cause" is emphasized by the authors. Acute diarrheal diseases are thus estimated to be associated with approximately 4 million childhood deaths, although the actual underlying cause of death may have been some other condition. Childhood mortality in many cases is the result of multiple infections, often aggravated by malnutrition, and the attribution of death to a single underlying cause is often extremely difficult in these circumstances. In the absence of more precise diagnostic information about the underlying cause of death, however, the estimate of 4 million childhood deaths will be taken as indicative of the volume of mortality due to diarrheal diseases, with about 10 percent of these (that is, 400,000) arising as a complication of measles.

Snyder and Merson do not provide estimates of diarrheal disease mortality in the population age five and over. Still, the studies which they reviewed suggest an annual death rate from diarrheal diseases in the adult population of about 1.4 per 1,000 in 1980. Applying this estimate to the estimated adult population in developing countries (excluding China) yields a total of about 3.1 million adult deaths. By contrast, age-specific data on morbidity from diarrheal diseases reported by Snyder and Merson suggest about 0.2 episodes per adult per year. Assuming the same case-fatality ratio as estimated for children (0.3 percent), this yields an estimate of about 1.3 million adult deaths. A third way to estimate diarrheal disease mortality is to use figures on the age-specific death rates from these diseases observed for the industrial countries at levels of life expectancy comparable to that of contemporary developing countries, excluding China (Preston 1976, p. 93). This method suggests a total of about 700,000 adult deaths and, interestingly, a total of about 3.9 million deaths below age five, or roughly the same estimate obtained earlier. In view of this proportionality between child and adult deaths, and the more recent evidence used in the method of case-fatality rate per episode, a figure of about 1 million adult deaths from diarrheal diseases would seem plausible, with about 300,000 of these occurring at age five through fourteen, based on age-specific fatality rates reported in community studies (Kirkwood 1990a).

These estimates are unlikely to be drastically altered by the addition of mortality in China. On the basis of the information

for reporting areas, the number of diarrheal disease deaths among adults is unlikely to exceed 50,000 per year, which is well within the margin of uncertainty of the global estimates derived above.

TUBERCULOSIS. The experience of the WHO Tuberculosis Control Programme suggests that the most reliable estimates of mortality in developing countries are obtained from the case-fatality ratio among detected cases. This is predicated on the knowledge that without appropriate chemotherapy, tuberculosis infection is highly fatal. A review of studies on the proportion of cases detected that are also treated suggests that, overall, the case-fatality rate of the disease in developing countries is probably on the order of 15 percent (Murray, Styblo, and Rouillon, chapter 11, this collection). Applying this to incidence data yields an estimate of about 3 million tuberculosis deaths each year in developing countries. Approximately 200,000 of these deaths occur in China, leaving a total for other developing countries of 2.6 million deaths. Murray, Styblo, and Rouillon (1989) estimate that about 15 percent of these deaths (or 450,000) occur below age fifteen and of these, about two-thirds (or 10 percent of the total) are deaths of children under five. Thus roughly 300,000 childhood deaths (birth through age four) which occur each year in developing countries are estimated to be due to tuberculosis.

ACUTE RESPIRATORY INFECTIONS (ARI). A review of information available to WHO on causes of mortality in young children suggests that between 25 and 30 percent of deaths among the under-fives are attributable to these diseases (Leowski 1986). This estimate is supported by results obtained from longitudinal mortality surveys of communities conducted in Nepal, Pakistan, the Philippines, and Tanzania, using verbal autopsies. Despite the caveats associated with this type of estimation procedure, it is probable that acute respiratory infections account for about 4.3 million child deaths (that is, from birth through age four) each year in developing countries. The rationale underlying this estimate is outlined below.

Essentially, the group of acute respiratory infections can be classified into two broad subcategories, namely, certain vaccine-preventable diseases (measles, tuberculosis, whooping cough, and diphtheria) and other respiratory diseases (primarily pneumonia, influenza, acute bronchitis, and bronchiolitis). Separate estimates of mortality are available for the component diseases of the first category. According to estimates prepared by the WHO Expanded Programme on Immunization, there were approximately 2 million measles deaths and some 600,000 deaths from whooping cough in 1985 among children in developing countries. These estimates were prepared on the basis of assumptions about vaccine effectiveness (95 percent for measles, 80 percent for whooping cough), susceptibility of the unexposed population (100 percent for measles, 80 percent for whooping cough), estimated coverage by immunization, and case-fatality rates.

Information from community-level studies available to WHO indicates that about 1.1 million, or slightly more that half of the 2 million measles deaths, are due to ARI. Similarly, about two-thirds (or 400,000) of the pertussis deaths in 1985 were also attributable to ARI. Evidence from the industrial countries at an earlier stage of the epidemiological transition suggests a mortality ratio of about 0.7 between acute respiratory diseases (influenza, pneumonia, bronchitis) and diarrheal diseases. On this basis, the volume of mortality from the remaining respiratory diseases should be about 2.8 million deaths of children under age five. This yields a total of about 4.3 million for ARI-related deaths under age five.

Acute respiratory infections, particularly pneumonia, also claim a substantial number of lives at older ages. A comparison of age-specific death rates among adults from influenza, pneumonia, and bronchitis with those from diarrheal diseases (Preston 1976) suggests that death rates from the respiratory category are roughly two to four times higher. This would imply an annual toll of between 2 million and 4 million adult deaths from acute respiratory diseases in developing countries each year.[6] Data from China, India, and Latin America, however, suggest that the lower limit of this range is more reasonable, and hence an estimate of 2 million deaths beyond age five from these diseases is proposed. According to survey data for Sub-Saharan Africa reported by Kirkwood (1990b), about 300,000 of these deaths occur from age five through age fourteen.

VACCINE-PREVENTABLE DISEASES. Separate estimates for three of these diseases (poliomyelitis, tuberculosis, and neonatal tetanus) are presented elsewhere in this section. The overwhelming majority of deaths from the remainder are from measles and whooping cough. As mentioned earlier, measles probably claimed about 2 million lives below the age of five in 1985. Of these deaths, 1.1 million were also associated with ARI and another 400,000 with diarrhea. Whooping cough is estimated to have killed about 600,000 children in 1985, and 400,000 of these deaths were likewise associated with ARI. Taken together, the vaccine-preventable diseases either were the cause of, or were closely associated with, 3.7 million deaths of young children in 1985, of which 2 million were from measles, 600,000 from whooping cough, 300,000 from tuberculosis, about 800,000 from neonatal tetanus, and 25,000 from poliomyelitis.

POLIOMYELITIS. The immunization coverage rate for this disease is about 70 percent globally (WHO 1989). It is estimated by WHO that about 70 percent of the world's population lives in polio-endemic areas and that the annual incidence of the disease is about 250,000 cases. Overall, 25,000 deaths per year are estimated to occur from the disease.

YELLOW FEVER, DENGUE, AND ENCEPHALITIS. The estimation of annual mortality from these diseases is particularly difficult because of their epidemic nature, which results in considerable fluctuations from year to year. The estimated total mortality from these diseases in 1985 was about 15,000, but it should be noted that yellow fever in Nigeria was comparatively low in that year. Since the number of yellow-fever deaths in Nigeria

during epidemic years can easily reach 10,000, the figure of 15,000 annual deaths from these diseases has been increased to 20,000 in an attempt to allow for epidemic variations.

MALARIA. Estimates of malaria mortality in Africa made some thirty years ago suggested that there were about 1 million deaths each year from the disease. Recent studies, based on active surveillance and intervention projects in Africa, suggest that the global total number of deaths is probably in the range of 1 to 2 million deaths per year. There is much more confidence in this range than in a point estimate, but for the purposes of this study, and without any additional guidance as to what part of the range is more probable, the lower limit has been chosen, yielding an estimate of 1 million deaths per year. Of these, about 500,000 are estimated to occur among children in Africa. The widespread and relatively indiscriminate use of chloroquine as practiced in Africa, keeps mortality down but also favors the selection of chloroquine-resistant parasites. As chloroquine resistance increases in geographic extension, frequency, and intensity, there is a serious threat of rising mortality, because there is no alternative drug that is equally safe and cheap.

Data from lay reporting of causes of death in rural India suggest that about 1 percent of deaths in India, or about 150,000, are due to malaria. Half of these deaths occur among infants and young children. On the basis of age-specific mortality data for certain endemic countries, malaria is also estimated to account for about 150,000 of the 1.6 million childhood deaths each year at age five through fourteen.

SCHISTOSOMIASIS. The prevalence of schistosomiasis is estimated at about 200 million people and is endemic in seventy-six countries. Information about the severity and age-specific prevalence of the disease, however, indicates that the upper limit of the estimated number of persons with severe infection is of the order of 13 million. Assuming a 0.1 percent case-fatality rate (limited to cases of severe infection), this implies a global total of about 13,000 deaths per year. Walsh (1988, p. 15) has estimated an annual mortality of between 250,000 and 500,000, apparently based on the assumption of a case-fatality rate for all cases (not only severe manifestations) of between 0.1 and 0.25 percent. Thus the range of mortality estimates varies from 13,000 to 500,000. An approximate mid-point of the range (200,000 deaths) may be taken as a rough guide to the annual toll of mortality but, as with many other of the diseases under consideration here, the degree of uncertainty is substantial. Information on the likely range of estimates is probably of greater relevance for establishing health priorities than these attempts at providing more precise figures.

SUMMARY FOR INFECTIOUS AND PARASITIC DISEASES. Summing up the estimates for the diseases listed above yields an annual mortality of about 17 million deaths (see table 2-6), about 10.5 million of which are estimated to occur among infants and children less than five years of age. These are undoubtedly the most significant communicable diseases, but other infectious and parasitic diseases, including amebiasis, hookworm, AIDS, and hepatitis B, undoubtedly claim several hundred thousand lives each year (neonatal tetanus is considered with the group of perinatal conditions). It is estimated on the basis of regional estimates for the major component diseases of this category that of these 17 million, slightly more than one-half occur in Asia and about one-quarter in Sub-Saharan Africa. The lowest mortality is estimated for Latin America, where about 900,000 deaths are estimated to have occurred in 1985 from infectious and parasitic diseases.

Complications of Pregnancy, Childbirth and the Puerperium, and Perinatal Conditions

In this section, separate estimates have been provided for two broad categories of cause of death since they are restricted to specific population groups, namely pregnant women (maternal causes) and newborn infants (perinatal conditions).

MATERNAL MORTALITY. It is well known that registered data on maternal deaths generally underestimate the extent of maternal mortality, even in industrial countries (see Ziskin and others 1979; Smith and others 1984; Rubin and others 1981). Mortality models based on these data, such as models of the epidemiological transition, will therefore tend systematically to underestimate deaths due to complications during pregnancy or the birth process, irrespective of the overall level of female mortality. Typically, the higher the level of female mortality, the greater the underestimation of deaths from such causes. As an alternative procedure, selected community-wide studies have been evaluated (see, for example, Fortney and others 1986; Royston and Lopez 1987) in order to estimate the relation between the overall level of female mortality and mortality from pregnancy complications or the birth process in various sociocultural settings. Applying these community-based estimates to estimates of the number of births in major regions leads to an overall estimate of approximately 500,000 maternal deaths in developing countries in 1985. Of these, an estimated 35,000 occurred in Latin America and the Caribbean, 125,000 in Sub-Saharan Africa, 80,000 in the Middle East and North Africa, and about 260,000 in Asia and Oceania.

PERINATAL CONDITIONS. On the basis of community-level data, WHO has estimated the annual number of perinatal deaths each year to be approximately 7.3 million, of which only about 300,000 occur in industrial countries (WHO 1989). Of the remaining 7 million perinatal deaths, the proportion which are early neonatal deaths (birth to six days) appears to vary between 40 and 50 percent in developing countries, according to statistics published in the *United Nations Demographic Yearbook*. This percentage implies an estimate of about 3.2 million early neonatal deaths, almost all of which can probably be attributed to one of the perinatal conditions. Neonatal tetanus alone would account for about one-quarter (or roughly 800,000) of these deaths. Out of a total of 3.2 million deaths, almost 60

percent (1.8 million) are estimated to have occurred in Asia, 680,000 in Sub-Saharan Africa, 300,000 in Latin America and the Caribbean, and about 420,000 in the Middle East–North Africa region (see table 2-8).

Chronic Diseases and Violent Death

Specific mortality estimates for the major non-communicable diseases and violence are discussed below. Although the etiology of the constituent diseases (e.g. different types of cancer) can vary considerably, arguing for more specific estimates, only broad categories of causes are discussed here in view of the uncertain diagnostic accuracy of the cause of death information upon which they are based.

NEOPLASMS. On the basis of incidence data reported to the International Agency for Research on Cancer, Parkin, Läärä, and Muir (1988) have estimated that there were a little over 3.2 million new cases of cancer in the developing world in 1980. This corresponds to an incidence rate of 94.5 per 100,000. Applying this figure to the estimated 1985 population yields a total of about 3.6 million new cases in 1985. This may well be an underestimate, however, as population aging in the developing world will certainly imply an increased burden of illness from cancer, even if the relative levels of prevalence of risk factors were to remain unchanged. This is certainly not the case, as is evident from the dramatic increase in cigarette consumption in developing countries in recent years (WHO 1985). Nonetheless, the figure of 3.6 million new cases in 1985 provides a reasonable, if conservative, benchmark from which to derive estimates of mortality.

A very crude first approximation can be obtained from the observed relation between incidence and mortality in the industrial countries. In 1985 there were an estimated 3.25 million new cases of cancer in the industrialized world and 2.3 million deaths, yielding a mortality-to-incidence ratio of 0.7. If this ratio were to apply in developing countries, the estimated number of deaths would be on the order of 2.5 million. Still, health services for cancer patients are undoubtedly more widely available in industrial countries and are probably more effective in treating the disease. One would therefore expect that not only is the average age at death from cancer lower in developing countries but also the mortality-to-incidence ratio is probably higher than in industrial countries. Thus the annual toll of cancer deaths is no doubt higher than the 2.5 million suggested by this method of estimation, but how much higher is rather uncertain.

In China alone, there are about 1 million cancer deaths each year, according to the mortality data from reporting areas. Lay reporting of the cause of death in rural India suggests that about 4 percent of all deaths in India are due to cancer, and this proportion is confirmed by studies carried out in communities in Andhra Pradesh; Goa, Daman, and Diu; and Maharashtra states. This would suggest an annual mortality from cancer in India of about 400,000 deaths, or 50 per 100,000 population. National data for Latin America and the Caribbean, although incomplete, yield an estimate of about 300,000 deaths per year, which is just under 10 percent of all deaths. The information on overall life expectancy in Sub-Saharan Africa and the Middle East–North Africa region, and the regional incidence estimates reported by Parkin, Läärä, and Muir (1988), suggest levels of cancer mortality comparable to what was observed for India. Such levels yield another 450,000 cancer deaths (neoplasms) in these two regions (table 2-8).

On the basis of the incidence levels for cancer reported by Parkin, Läärä, and Muir (1988), it may be estimated that there were some 300,000 to 400,000 deaths from cancer for the remainder of Asia in 1985. The addition of these deaths yields an overall total of 2.5 million cancer deaths each year in the developing world. This process of aggregation thus leads to an estimate of cancer mortality which is identical to that estimated from the mortality-to-incidence ratio method. The fact that the two estimates do not differ should not be seen as necessarily a verification of either method. The evidence, however, would seem to suggest that the annual number of cancer deaths in the developing world is at least 2.5 million. On the basis of incidence data, the principal sites of cancer mortality in the developing world are stomach, mouth-pharynx, esophagus, and lung among males, and cervix, breast, stomach, and mouth-pharynx (particularly in India) among females.

CHRONIC OBSTRUCTIVE LUNG DISEASE (COLD). Global and regional estimates for this category of diseases are particularly difficult because of the lack of reliable data for the majority of developing countries. The mortality information available from China suggests that as much as 15 percent of all deaths are due to these diseases, which would imply about 1 million deaths. In China, at least, there is some basis for expecting high COLD mortality in view of past smoking patterns, particularly among males, and the very high levels of indoor air pollution emanating from the cooking and heating fuels used (World Bank 1989). In India, data from the lay reporting system in rural areas suggest a COLD mortality figure of about 6 to 8 percent, a proportion which is at least consistent with prevalence studies in specific communities (see, for example, Malik and Wahi 1978). This would imply an additional 700,000 to 800,000 deaths in India alone. Death rates of the order of 40 to 60 per 100,000 have been reported to WHO for other parts of Asia. From these estimates, an additional 350,000 deaths from COLD in the remainder of Asia and the Pacific are estimated for 1985. Data for Latin America suggest that at least 90,000 adults succumbed to these diseases in 1985. On the basis of comparative life expectancy, the annual mortality in Sub-Saharan Africa and the Middle East–North Africa region is estimated at 60,000 and 50,000, respectively, yielding a total for all developing countries of 2.3 million deaths. There is, however, considerable uncertainty associated with this estimate.

CIRCULATORY DISEASES AND SELECTED DEGENERATIVE DISEASES. As for the chronic obstructive lung diseases, perhaps the best way to proceed in estimating global mortality for this group of diseases is by considering the situation in major regions sepa-

rately. In China, available data suggested that there are at least 1 million deaths from stroke alone each year and another million deaths from all forms of heart disease. The estimated total for the four specific degenerative diseases is about 400,000, suggesting an overall total for this category of diseases in China of about 2.5 million deaths per year. In rural areas of India, on the basis of data from the Rural Cause of Death Survey (Indian Office of the Registrar General 1989), diseases of the circulatory system (primarily heart diseases and stroke) account for about 10 percent of deaths. The remaining degenerative diseases make up an additional 2 percent or so of all deaths, suggesting an annual mortality from this category of about 1.1 million.

The group of countries that make up the remainder of Asia (excluding India, China, and western Asia) has an average life expectancy of about fifty-seven years, which, if one uses the indirect mortality estimation techniques described by Hakulinen and others (1986), would imply a relative mortality of about 12 percent due to the cardiovascular and other chronic degenerative diseases. This estimate yields a further 800,000 deaths in the remainder of Asia and the Pacific, or a grand total for Asia of 4.4 million deaths each year.

Data from countries of Latin America, when aggregated and adjusted for underreporting, yield another 800,000 to 900,000 deaths from these causes. Very little information on the extent of mortality from cardiovascular disease is available for the African and Middle East regions, but with life expectancy in these areas typically on the order of fifty to fifty-five years, it is difficult to see how less than 10 percent or so of deaths could be ascribed to these diseases. As a very rough estimate, accompanied by a substantial degree of uncertainty, an additional 1.2 million deaths have been attributed to these causes in the two regions combined as shown in table 2-8. The global total for this category is thus estimated at about 6.5 million deaths per year, of which the four specific degenerative diseases probably claim between 600,000 and 1 million lives each year.

INJURY AND POISONING. In almost all cases, the attribution of death to a violent cause as opposed to a disease is relatively straightforward. This is not to deny that the disaggregation of violent deaths into accidents, suicides, homicides, and other violence is often quite complicated and may well be influenced by sociocultural or legal factors, for example, mitigating against a verdict of suicide in some cultures. In this review attention will be confined to the broad category of violent deaths, and hence for the most part, these considerations would not apply. Moreover, because of the relative ease of distinguishing a violent death from other causes, one can have greater confidence in the data generated by alternative collection schemes, such as lay reporting.

In China, roughly 700,000 deaths from external causes are estimated to occur each year, or about 10 percent of the total. In India, the proportion is less, about 6 percent, or 550,000 deaths, from accidents and violence. Data for Latin America, after adjusting for incomplete coverage, indicate that there were about 250,000 violent deaths in the region in 1985, this being about 8 percent of all deaths. Evidence from other developing regions suggests that violence is less important as a cause of death and a proportionate mortality of about 5 percent is probably not unreasonable. This assumption yields an estimate of 350,000 deaths in Sub-Saharan Africa, 200,000 in the Middle East–North Africa region, and 350,000 in the remainder of Asia. The estimated total number of violent deaths is thus 2.4 million deaths per year for the developing world, of which about 8 to 9 percent (that is, 200,000) are estimated to occur before age five.

Maternal and Childhood Mortality: Update for 1990

The number and relative importance of deaths from chronic diseases among adults in developing countries are likely to have altered very little between 1985 and 1990. But given the natural history of these diseases, one might reasonably expect to see a significant change brought about by child health interventions in this short period of time. According to WHO (1992), this has indeed been the case. The number of infant and child deaths declined to about 12.9 million in 1990. In large part, this decline has been attributed to the rapid improvement in immunization coverage since the mid-1980s (WHO 1992). In 1990, measles was estimated to have caused 880,000 deaths of children under age five in developing countries, down from 2 million in 1985. Relatively few of these deaths were attributable to measles alone (220,000), the majority arising from interactions with acute respiratory infections (480,000) and diarrhea (180,000). Similarly, whooping cough in 1990 was estimated to have caused 360,000 child deaths, 260,000 of which were estimated to have occurred in conjunction with acute respiratory infections. There has also been a dramatic decline in neonatal tetanus deaths, from 800,000 in 1985 to 560,000 in 1990.

By contrast, relatively little change has occurred in the other principal causes of child death. Allowing for the association with measles, diarrheal diseases are estimated to have claimed about 3.2 million children in 1990. Acute respiratory infections, primarily pneumonia, were the cause of 3.5 to 3.6 million child deaths in 1990; if one includes the deaths associated with measles and whooping cough mentioned above, this toll rises to about 4.3 million deaths a year. Mortality from other traditional diseases of childhood, such as malaria, has remained essentially unchanged, as has the category of perinatal conditions (including neonatal tetanus), which, in 1990, are estimated to have caused about 3 million early infant deaths.

Finally, a recent update of the annual number of maternal deaths in developing countries shows relatively little change compared with 1983–85 (WHO 1991b). In 1988–90 the annual number of maternal deaths in developing countries was estimated at just over half a million (505,000), with an approximate 5 percent decline in risk being more than compensated for by a 7 percent rise in the number of women exposed to risk. Maternal mortality appears to have increased by about 10

percent in Africa (170,000 deaths in 1988–90), declined slightly in Latin America (25,000 deaths), and remained unchanged in Asia.

Summary and Conclusions

The estimation of mortality levels, structure, and trends is fundamental to any assessment of the health situation. For several countries, including virtually all the industrialized world as well as a number of countries in Latin America and eastern Asia, reasonably reliable and comparable mortality statistics are available to determine the age, sex, and cause of mortality. In the group of industrial countries, which together made up about one-quarter of the world's population in 1985, the leading causes of death are those conditions for which prevention is largely a matter of personal lifestyle. Diseases such as ischemic heart disease, stroke, cancer, and, in particular, lung cancer, the chronic obstructive lung diseases, diabetes, and cirrhosis of the liver, which dominate the mortality pattern in industrial countries, all have a significant behavioral component. Cigarette smoking, for example, is by far the principal risk factor for lung cancer, chronic bronchitis, and emphysema and is also causally associated to varying degrees with ischemic heart disease, stroke, and several other types of cancer. Indeed, cigarette smoking is probably the leading cause of mortality in the industrial countries, claiming an estimated 2.1 million lives each year (or 20 percent of the total) in these countries. This number can be expected to rise to at least 3 million by the 2020s as the full effect of the smoking epidemic among women is felt (Peto and others 1992).

By and large, the industrial countries, particularly those with market economies, have been very successful in deferring death to higher and higher ages. In these countries, the challenge will be to ensure a comparable delay in the onset of chronic disease, thus minimizing the proportion of the years of life gained which are spent in a state of chronic morbidity or disability. Further reductions in inequalities in health status within national populations will also bring rewards in terms of gains in life expectancy, particularly for adults. Accidental deaths, suicide, and other violence continue to claim a significant proportion (7 to 8 percent) of lives in industrial countries and constitute a very substantial cost to society in terms of potential years of life lost. Behavioral factors—in particular, alcohol abuse—similarly underlie many of these deaths.

Mortality rates from most leading causes of death are significantly higher in nonmarket industrial countries. Indeed, in some cases, most notably Hungary, death rates from major chronic diseases among men have been rising for several years. Information on the prevalence and distribution of risk factors is clearly an essential component of health strategies designed to counter these trends.

Although the health situation in developing countries has been assessed collectively, it is absolutely imperative to keep in mind the heterogeneity of this group when interpreting the estimates of the cause-of-death structure. Mortality levels within the group vary from high-mortality countries in Africa and Asia, where infant mortality rates exceed 200 per 1,000 live births, to countries such as China, Cuba, Argentina, Chile, and Uruguay, where life expectancy is comparable to that observed in many industrial countries. Not surprisingly, the cause-of-death structure in the former category is dominated by the communicable diseases, whereas in the latter group the chronic diseases are of most concern. Other developing countries, with life expectancy in the range of about fifty-five to sixty-five years, are intermediate in their progression through the epidemiological transition. Clearly, in these countries, as with very high-mortality populations where infant and child deaths continue to claim up to 50 to 60 percent of the total, health strategies must continue to focus on the prevention and control of infectious diseases, particularly the diarrheal diseases, respiratory infections, and the vaccine-preventable diseases. Malaria, too, is a leading cause of child death in some areas. Effective primary health care delivery undoubtedly offers the greatest hope for success in rapidly bringing down mortality levels for these diseases.

But what is also clear is that the chronic diseases have already emerged as a significant, if not the significant, health problem in a sufficient number of developing countries to warrant increasing attention. There are now at least as many cancer deaths in developing countries as in the industrialized world and at least another 9 million deaths each year in developing countries from other chronic diseases. To some extent, this is an inevitable consequence of progress toward the conquest of infectious diseases. Still, the widespread adoption of cigarette smoking in many parts of the developing world is rapidly eroding some of the gains in life expectancy which have been achieved as a result. Although the annual amount of tobacco-attributable mortality in the developing world is currently less than that of the industrial countries (about 1 million to 1.5 million deaths per year), this death toll is projected to rise rapidly during the next three to four decades to reach 6 million to 8 million in the 2020s (Peto and Lopez 1991). A substantial proportion of this premature mortality is expected to occur in China, where the dramatic increase in consumption of manufactured cigarettes during the last twenty years or so (China now consumes one-quarter of the world total) can be expected to result in 2 million to 3 million smoking-attributable deaths in the 2020s, almost a million of which will be from lung cancer (Peto and Lopez 1991).

The rapidly emerging epidemic of smoking-attributable mortality is one of the principal public health issues which developing countries will face during the next few decades, and in many cases it will be superimposed on a health system still preoccupied with the control of infectious diseases. The inevitability of death thus implies that, although this transition to chronic diseases is to be expected, what is important is that these deaths be postponed to as late in life as possible. As for the industrial countries, effective preventive strategies have a much greater likelihood of achieving this than costly attempts at cure.

Notes

This chapter was prepared while I was a staff member of WHO's Division of Global Epidemiological Surveillance and Health Situation and Trend Assessment. The views expressed here are mine and do not necessarily reflect the opinions or policies of the World Health Organization. Nonetheless, my research has benefited from the contribution and comments of many colleagues at WHO, particularly those in technical programs concerned with the health problems specifically discussed in the chapter. Their contribution is gratefully acknowledged. I should also like to express my sincere gratitude to Dean Jamison for his insistence that this type of assessment should and could be done, and for his very helpful remarks on several earlier versions of it. The paper has also benefited from a critical review by Timo Hakulinen and Althea Hill. In acknowledging the very considerable assistance which I received in the preparation of this chapter, I also accept that any errors and omissions are my responsibility.

1. The year 1985 has been chosen in order to present a mid-decade review. Whenever possible, estimates for 1990 have been included as well.

2. The populations of the former Yugoslavia, the former German Democratic Republic (GDR), and the former U.S.S.R. are shown in this chapter, since they were countries at the time the data were provided to the World Health Organization (WHO).

3. The only industrial country for which cause-of-death data about 1985 are not available to WHO is Albania. This is unlikely to affect the results for the group as a whole, since the total annual number of deaths in Albania is of the order of 17,000, which is less than 0.2 percent of the total for the industrialized world.

4. Namely, cirrhosis of the liver, ulcers of the stomach and duodenum, nephritis and nephrosis, and diabetes mellitus.

5. This diagnostic specificity does not, however, guarantee international comparability due to the reasons mentioned earlier.

6. Some adult deaths from the vaccine-preventable diseases would also be expected, but these are likely to be comparatively few compared with adult mortality from acute bronchitis and pneumonia.

References

Capocaccia, Riccardo, and Gino Farchi. 1988. "Mortality from Liver Cirrhosis in Italy: Proportion Associated with Consumption of Alcohol." *Journal of Clinical Epidemiology* 41(4):347–57.

Doll, Richard, and Richard Peto. 1981. *The Causes of Cancer*. Oxford: Oxford University Press.

Fortney, J. A., Irene Susanti, Saad Gadalla, Saneya Saleh, Susan Rogers, and Malcolm Potts. 1986. "Reproductive Mortality in Two Developing Countries." *American Journal of Public Health* 76(2):134–36.

Hakulinen, Timo, Harold Hansluwka, Alan Lopez, and Tadashi L. Nakada. 1986. "Global and Regional Mortality Patterns by Cause of Death in 1980." *International Journal of Epidemiology* 15(2):226–33.

Hull, T. H., J. E. Rohde, and A. D. Lopez. 1981. "A Framework for Estimating Causes of Death in Indonesia." *Majalaj Demografi Indonesia* 15:77–125.

Indian Office of the Registrar General. 1989. *Survey of Causes of Death (Rural)*. Annual Report, 1987. Series 3, 20. Delhi.

Kirkwood, Betty R. 1991a. "Diarrhoea." In R. G. A. Feachem and D. T. Jamison, eds., *Disease and Mortality in Sub-Saharan Africa*. New York: Oxford University Press.

———. 1991b. "Acute Respiratory Infections." In R. G. A. Feachem and D. T. Jamison, eds., *Disease and Mortality in Sub-Saharan Africa*. New York: Oxford University Press.

Leowski, Jerzy. 1986. "Mortality from Acute Respiratory Infections in Children under 5 Years of Age: Global Estimates." *World Health Statistics Quarterly* 39:138–144.

Lopez, A. D. 1990a. "The Interrelationship between Lung Cancer and Tobacco Consumption: Evidence from National Statistics." In Matti Hakama, Valerie Beral, J. W. Cullen, and D. M. Parkin, eds., *Evaluating Effectiveness of Primary Prevention for Cancer*. Scientific Publication 103, IARC. Lyon: International Agency for Research on Cancer.

———. 1990b. "Competing Causes of Death: A Review of Recent Trends in Mortality in Industrialized Countries with Special Reference to Cancer." *Annals of the New York Academy of Science* 609 (November 2):58–76.

Malik, S. K., and P. L. Wahi. 1978. "Prevalence of Chronic Bronchitis in a Group of North Indian Adults." *Journal of the Indian Medical Association* 70(1):6–8.

Ofosu-Amaah, Samuel. 1983. "The Control of Measles in Tropical Africa: A Review of Past and Present Efforts." *Review of Infectious Diseases* 5(3):546–53.

Parkin, D. M., E. Läärä, and C. S. Muir. 1988. "Estimates of the Worldwide Frequency of Sixteen Major Cancers in 1980." *International Journal of Cancer* 41:184–97.

Percy, Constance, and Callum S. Muir. 1989. "The International Comparability of Cancer Mortality Data: Results of an International Death Certificate Study." *American Journal of Epidemiology* 129(5):934–46.

Peto, Richard, and A. D. Lopez. 1991. "Worldwide Mortality from Current Smoking Patterns." In Betty Durston and Konrad Jamrozik, eds., *Tobacco and Health 1990: The Global War*. Proceedings of the Seventh World Conference on Tobacco and Health, Perth, Australia, April 1–5, 1990. Health Department of Western Australia.

Peto, Richard, A. D. Lopez, Jillian Boreham, Michael Thun, and Clark Heath. 1992. "Mortality from Tobacco in Developed Countries: Indirect Estimation from National Vital Statistics." *Lancet* (23 May) 1268–78.

Preston, S. H. 1976. *Mortality Patterns in National Populations*. New York: Academic Press.

Puffer, R. R., and C. V. Serrano. 1973. *Patterns of Mortality in Childhood*. Scientific Publication 262, PAHO (Pan-American Health Organization). Washington, D.C.

Royston, Erica, and A. D. Lopez. 1987. "On the Assessment of Maternal Mortality." *World Health Statistics Quarterly* 40(3):214–24.

Rubin, George, Brian McCarthy, James Shelton, Roger Rochat, and Jules Terry. 1981. "The Risk of Childbearing Re-evaluated." *American Journal of Public Health* 71(7):712–16.

Smith, Jack C., J. M. Hughes, P. S. Pekow, and R. W. Rochat. 1984. "An Assessment of the Incidence of Maternal Mortality in the United States." *American Journal of Public Health* 74(8):780–83.

Snyder, J. D., and M. H. Merson. 1982. "The Magnitude of the Global Problem of Acute Diarrhoeal Disease: A Review of Active Surveillance Data." *Bulletin of the World Health Organization* 60(4):605–13.

USDHSS (United States Department of Health and Human Services). 1989. *Reducing the Health Consequences of Smoking: 25 Years of Progress. A Report of the Surgeon General*. Rockville, Md.: Centers for Disease Control, Office on Smoking and Health.

Walsh, J. A. 1988. *Establishing Health Priorities in the Developing World*. Boston: Adams Publishing Group for the United Nations Development Programme.

World Bank. 1989. "China: Long-term Issues in Options for the Health Sector."

WHO (World Health Organization). 1985. *World Health Statistics Annual 1985*. Geneva.

———. 1989. *Expanded Programme on Immunization: Update*. May. Geneva.

———. 1991a. "Smoking as a Cause of Cancer." *Tobacco Alert* October:2.

———. 1991b. "New Estimates of Maternal Mortality." *Weekly Epidemiological Record*. 66:345–48.

———. 1992. *Eighth Report on the World Health Situation*. Geneva.

Ziskin, Leah Z., Margaret Gregory, and Michael Kreitzer. 1979. "Improved Surveillance of Maternal Deaths." *International Journal of Gynaecology and Obstetrics* 16:282–86.

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