The decline in child mortality: a reappraisal

Omar B. Ahmad,[1] Alan D. Lopez,[2] & Mie Inoue[3]

The present paper examines, describes and documents country-specific trends in under-five mortality rates (i.e., mortality among children under five years of age) in the 1990s. Our analysis updates previous studies by UNICEF, the World Bank and the United Nations. It identifies countries and WHO regions where sustained improvement has occurred and those where setbacks are evident. A consistent series of estimates of under-five mortality rate is provided and an indication is given of historical trends during the period 1950–2000 for both developed and developing countries.

It is estimated that 10.5 million children aged 0–4 years died in 1999, about 2.2 million or 17.5% fewer than a decade earlier. On average about 15% of newborn children in Africa are expected to die before reaching their fifth birthday. The corresponding figures for many other parts of the developing world are in the range 3–8% and that for Europe is under 2%.

During the 1990s the decline in child mortality decelerated in all the WHO regions except the Western Pacific but there is no widespread evidence of rising child mortality rates. At the country level there are exceptions in southern Africa where the prevalence of HIV is extremely high and in Asia where a few countries are beset by economic difficulties. The slowdown in the rate of decline is of particular concern in Africa and South-East Asia because it is occurring at relatively high levels of mortality, and in countries experiencing severe economic dislocation. As the HIV/AIDS epidemic continues in Africa, particularly southern Africa, and in parts of Asia, further reductions in child mortality become increasingly unlikely until substantial progress in controlling the spread of HIV is achieved.

Keywords: infant mortality, trends; cause of death, trends; health surveys; models, statistical; European region, South-East Asia, Africa, Americas, Latin America, Western Pacific.

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Introduction

The 20th century witnessed dramatic declines in mortality in almost all countries of the world, regardless of initial levels, socioeconomic circumstances and development strategies. In the advanced economies the declines were already apparent at the end of the 19th century. In the developing countries, substantial declines did not take place until shortly after the end of the Second World War. The magnitude of the initial declines in the developing countries was so impressive as to engender widespread speculation during the 1960s and 1970s that the mortality gap between the developed and developing countries would narrow significantly by the end of the 20th century (*1*). This view was encouraged by the fact that some of the most pronounced reductions were occurring in countries with relatively low gross national product (*1, 2*).

Since the downward trend in mortality appeared to be a worldwide phenomenon, little interest was shown in critically defining the specific factors responsible for it. Consequently, both national and donor resources were aimed more broadly at achieving further reductions. For instance, various child survival programmes, such as USAID's Child Survival Initiative, set loosely defined strategies for achieving certain child mortality targets among participating countries. The achievement of these targets was principally sought through improvements in immunization coverage, greater use of oral rehydration therapy, improvement in the health and nutritional status of mothers and children, and a reduction in the number of high-risk births (e.g. GOBI,[a] EPI,[b] and CCCD[c]). The specific strategies for achieving these broad sets of objectives were left to individual countries.

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[1] Demographer, [2] Coordinator,[3] Statistician, Burden of Disease Team, Global Programme on Evidence for Health Policy, World Health Organization, 1211 Geneva 27, Switzerland. Correspondence should be addressed to Dr Ahmad.

[a] Growth Monitoring, Oral Rehydration Therapy, Breast-feeding and Immunization (UNICEF).

[b] Expanded Programme on Immunization (WHO).

[c] Combating Childhood Communicable Diseases (United States Centers for Disease Control and Prevention).

General optimism gave way to some pessimism when surveys conducted during the early 1980s were interpreted as showing that the initial rapid decline in mortality had begun to taper off in some countries, and that in a few there was strong evidence of the onset of stagnation or reversal (3–6). However, these conclusions were viewed with a degree of scepticism (7). While some levelling off in the rate of decline in mortality was to be expected at relatively low levels of mortality, the slowdown in these countries appeared to be occurring at relatively low levels of life expectancy. It was suggested that the rapid rate of decline observed earlier was not sustainable, given the slow rate of economic development, the impact of the AIDS epidemic, and the infusion of a very narrowly defined set of sophisticated technology-driven public health interventions (3, 4). It was argued further that the focus on vaccine-preventable diseases and oral rehydration therapy, as opposed to a more comprehensive, broadly based set of community health programmes, had led to substitution effects in morbidity and mortality. In other words, children were saved from measles and diarrhoea only to die from causes not covered by these interventions (8–10). Where substantial, substitution effects were likely to have a significant effect on the rate of decline in mortality.

Such concerns prompted research into the nature, pattern and determinants of mortality decline among children. Some workers sought an explanation for the phenomenon at the individual level by examining individual biological, social, behavioural, demographic and economic characteristics (11–13). Others set out to elucidate the mechanisms through which various determinants affected child mortality (14, 15). Attempts were also made to explain observed differences in terms of differentials in environmental, cultural and material living conditions of children or families (16–18).

Failure to identify the causal pathways linking child mortality and its proximate and distal determinants led to a further proliferation of child survival interventions. For instance, in 1990 the World Summit for Children laid down a target for the year 2000 of 70 deaths per 1000 live births among children under 5 years of age or of reductions of a third if these yielded lower mortality rates. This was to be achieved through improved birth weights and a reduction in the prevalence of malnutrition (19). In order to monitor progress in these matters it became necessary to have accurate and timely assessment and reporting of trends in infant and child mortality. Such reporting was also necessary if countries were to mobilize resources so as to meet all child health challenges promptly and efficiently.

There have been several attempts to assess mortality levels and trends among children under 5 years of age. They include:

- a review of child mortality data for sub-Saharan Africa up to the mid-1980s (20);
- a review of estimates and projections of the global under-five mortality rate for the period 1950–2025 (21);
- a review of child mortality in the developing world (7);
- a compilation of a child mortality database for developing countries (22);
- a review of child mortality for the period 1960–90 (23);
- comparative studies on infant and child mortality (24, 25);
- a review of child mortality for the period 1960–96 (26).

These analyses yielded various estimates of deaths among children under 5 years of age. For instance, as part of the Global Burden of Disease Study, the number of deaths in this age category was estimated to be 12.8 million in 1990, all but 200 000 of them in developing regions (27). The earlier UNICEF review, covering the period 1960–90, yielded an estimate of 11 million childhood deaths in 83 developing countries during 1992 (23). The most recent review by UNICEF, covering the period 1960–96, produced an estimate of 10.9 million childhood deaths in 94 developing countries during 1996 (26). The numbers are not directly comparable but they suggest a substantial reduction in overall mortality among children under 5 years of age.

The continued focus on child survival by the global public health community, the increasing availability of data, and the apparent dramatic declines in child deaths suggest the need for a reappraisal of child mortality trends. The present paper aims to review the evidence and describe current levels and trends on the basis of data for both developing and developed countries. The specific aims are to examine, describe and document country-specific trends in under-five mortality rates in the 1990s and to identify those countries and regions where sustained improvement has occurred and those where there have been setbacks. In many respects our analysis updates previous work by UNICEF, the World Bank and the United Nations (21, 23, 26). It also adds to these studies by providing a consistent series of estimates of under-five mortality rates and by indicating historical trends for the period 1950–2000 in both developed and developing countries.

Data and their quality

The probability of dying between birth and the exact age of 5 years (the under-five mortality rate) is expressed per 1000 live births. It is widely recognized as the most appropriate indicator of the cumulative exposure to the risk of death during the first five years of life. It has a number of advantages over the infant mortality rate as a composite measure of health risks at young ages. In particular, the indirect demographic techniques for measuring the under-five mortality

rate are more robust and less sensitive to assumptions about the underlying patterns of mortality than the infant mortality rate (28, 29). Moreover, the risk of death from several of the diseases that are principal causes of infant mortality remains high in the early years of childhood. It is thus also an appropriate outcome measure for assessing the impact of various intervention programmes aimed at improving child survival.

Data obtained from the complete registration of births and deaths provide the best possible basis for the direct estimation of child mortality. Unfortunately, such data are available for only 55–60 countries.[d] Where necessary, data have been corrected for underreporting. Many countries, especially in Africa but also in parts of Asia and Latin America, lack functioning vital registration systems. Estimates of childhood mortality in these countries are therefore largely based on cross-sectional surveys that collect complete birth histories from respondents. In a few cases, longitudinal demographic surveillance systems provide routine data. Such systems typically track and record all vital events in a well-defined sample of a national population. They are, however, very expensive to establish and maintain and often cover a non-representative sample, which makes their usefulness limited. In the absence of such sources of data, indirect estimates of child mortality levels and trends may be obtained from information on children ever-born and the proportion surviving by age of mother (30). This information has been widely collected in censuses and surveys.[e]

Given the data limitations, issues of data quality and comparability of estimates can be expected to hinder the international analysis of both trends and differentials in child mortality within and between major regions. In any country there are likely to be variations in estimates at a given time and across time, depending on the number of sources and on differences in methods of estimation. For many developing countries, data for the earlier periods, especially those from censuses, are often of relatively poor quality because of substantial errors of closure.[f] For these countries, data from the World Fertility Survey and the Demographic and Health Survey programmes are often the best available. Nonetheless, these sources may still be affected by a number of errors, the most important being omissions of births and deaths, misreporting of ages at death, and misreporting of maternal ages. The omission of vital events is probably the most serious error, occurring most frequently for children not living with their natural mothers, and for children who have died, especially those who died many years before the survey date. Since women of reproductive age are the basic sampling units in these surveys, their premature death excludes their children from the studies. Such children often have an elevated mortality risk and their exclusion tends to bias child mortality downward. This has a potentially serious effect in situations where HIV/AIDS accounts for a significant proportion of maternal deaths, and, as a consequence, efforts to assess the impact of AIDS on childhood mortality can be seriously impeded.

Another problem is the misreporting of birth dates, which may affect trends in mortality, especially if the misreporting varies according to whether a child is alive or not at the time of the survey. Age preference, typically for ages ending in 0 or 5, is a less serious but much commoner problem. A much more serious form of age misreporting consists of systematic transfer into adjoining ages.

Typically, the women selected for analysis from these censuses and surveys are currently married and under 49 years of age. Consequently, information about the mortality of children is limited to those born to progressively younger women, at the time of the births, as the reference period extends further into the past. Such age truncation could adversely affect and distort time trends, and is biased towards capturing mortality in the most recent times. Sampling errors also affect the estimates obtained.

The analysis reported here has been facilitated by compilations of data from the six major reviews carried out by UNICEF, the United Nations and the World Bank. It covers 171 of the 191 Member States of WHO. Populations below 100 000 have been excluded from the trend analysis although they have been included in the overall estimate of child mortality for 1999.

Methods

Child mortality estimation

The under-five mortality rate has been chosen as the indicator of child mortality because it provides the best means of capturing mortality risks during the most vulnerable years of childhood. The estimates for developing countries are, in general, drawn from previous studies (7, 20–26), and also from country reports of the World Fertility Survey and the Demographic and Health Survey programmes. The methods used for estimation depend on the type of data available. Where mortality data are derived from complete birth histories, direct techniques based on the life table approach are applied. In this case, specific probabilities of dying are computed from reported deaths and the numbers of children of a particular age exposed to the risk of dying during a specified period, e.g. 5, 10 or 15 years before a survey. Alternatively, the synthetic cohort method may be used to derive risks of child death. The procedure for calculating synthetic cohort probabilities of dying is based on an approach developed by Somoza (31) and modified by Rutstein (32). Probabilities of dying are built up from probabilities calculated for specific age intervals: less

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[d] A list of countries with functioning vital registration systems can be obtained from the authors.

[e] A list of various sources of non-vital registration data included in the current study can be obtained from the authors.

[f] Also called residual errors, referring to the difference between the expected and the enumerated population.

than 1 month, 3–5 months, 6–11 months, 12–23 months, 24–35 months, 36–47 months and 48–59 months. This method has been used for almost all the direct estimates based on birth history data which are presented in the present study. For countries lacking appropriate information, estimates of under-five mortality rates were computed from published information (*33*). For countries with consistent series of vital registration data, mostly developed countries, the estimates of mortality in this age group are taken from the 1999 WHO life tables.

Indirect techniques developed by Brass (*30*) and modified by Sullivan (*34*) and Trussell (*35*) can be used to obtain childhood survivorship probabilities when the only data available are information on children ever born and the proportion of them surviving to respondent mothers of reproductive age. The procedure allows the conversion of the proportion of children who have died, reported by women of each age group, to probabilities of dying between birth and exact ages of childhood ($_xq_0$),[g] after adjusting for the influence of the different age patterns of fertility. The application of this method requires the choice of a family of the Coale & Demeny model life tables (*29*); hence the estimates of $_xq_0$ obtained can be significantly affected by the choice of model. As indicated earlier, estimates of the under-five mortality rate are less sensitive to the model chosen than are estimates of the infant mortality rate. Coale & Trussell have developed a procedure for estimating the time location of each of the standard estimates (*36*).

In addition to knowing the risk of death among children under 5 years of age it is often useful to know the absolute number of deaths in this age group in individual countries and globally. The number of child deaths for any given calendar year is obtained by multiplying the risk of death ($_5q_0$) for that year by the corresponding estimated annual number of live births. This approach, however, tends to over-estimate deaths slightly in a growing, non-stationary population, especially if the number of births increases each year (*26*). In estimating the number of deaths among children under 5 years of age in 1999 we used the WHO life table estimates of the central death rate in conjunction with the estimated population aged 0–4 complete years derived from the UN's 1998 demographic assessment (*33*).

Trend analysis

When different data sources and methods of estimation are used, estimates of child mortality for a particular reference period tend to differ substantially because of both sampling and non-sampling errors. They may also be dependent on the choice of methods as well as on violations of methodological assumptions. The magnitude of the differences increases with the degree of variation in the data sources and methods of analysis. This makes it somewhat difficult to analyse trends. Various techniques have been reported for obtaining a series of consistent estimates of child mortality over time from such data. They range from "hand smoothing" to more sophisticated regression techniques. For the present analysis we chose an approach that included both a systematic evaluation of data quality and plausibility followed by simple averaging over all plausible data points for a given year or set of years.

A data point is considered valid for inclusion if based on vital registration, time series from maternity history, or a time series based on children ever born and those surviving. For the latter it was decided to exclude all indirect estimates based on information from mothers in the two youngest age ranges, 15–19 years and 20–24 years. When working with data classified by age it has generally been found that reports of women under 20 years are not a good basis for estimation (*28*). Furthermore, children born to younger mothers have a higher risk of dying than those born to women aged 25–34 and thus tend to produce an upward bias in estimates of the under-five mortality rate. In cases where two or more sets of estimates are available for an overlapping period, a set is excluded if it diverges completely from other mutually consistent series from more than one independent source. Mortality estimates for each five-year interval were obtained by unweighted averaging of all estimates resulting from the first two steps. This had the disadvantage that trends were based on unequal amounts of information at different points in time. Where data were completely lacking, estimates based on UN data (*33*) were graphically compared with estimates produced by Hill et al. (*26*). Where the two estimates differed substantially a compromise was selected so as to maintain consistency with the computed trend line. Table 1 gives estimates of under-five mortality rate for five-year periods from 1955–59 to 1995–99 and estimates for 1999 together with the corresponding uncertainty intervals.

Results

Table 2 shows the distribution of deaths among children aged 0–4 years in 1999 by WHO regions and within each region according to five mortality strata.[h] These strata were developed to distinguish countries on the basis of their relative levels of child mortality ($_5q_0$) and adult mortality ($_{45}q_{15}$).[i] Based on this analysis, an estimated 10.5 million children aged 0–4 years died

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[g] Implies the probability of dying between birth and exact ages of childhood, e.g. $_1q_0$ is the probability of dying between birth and exact age 1, $_2q_0$ is the probability of dying between birth and exact age 2.

[h] This study was undertaken as part of work on estimating the WHO life tables for 1999, which was needed for the assessment of health systems performance in *The World Health Report* 2000 (*37*). The life tables and the estimates of child mortality therefore had to be prepared for WHO regions, and that is how they are reported here. The composition of each WHO region and mortality subregion is given elsewhere (*37*).

[i] $_{45}q_{15}$ is read as "45" "Q" "15", corresponding to the adult mortality rate or, more technically, to the probability of dying between the ages of 15 and 60 years.

in 1999, about 2.2 million or 17.5% fewer than a decade earlier (*27*). Of these deaths, 99.3% occurred in countries other than those characterized by very low child mortality and very low adult mortality (stratum *A*), and even when the countries of Eastern Europe with comparatively high adult mortality were included the share of child deaths globally in what can be termed developed countries barely exceeded 2%. An estimated 3.8 mil-lion child deaths occurred in Africa alone, 36% of the world total, and there were 2.5 million in India and 750 000 in China.

Globally, a newborn baby in 1999 had about a 6.7% chance of dying before reaching the age of 5 years (Table 1, Fig. 1); the corresponding values for 1990, 1980 and 1950 were 9.6% (*27, 38*), 12% (*38*) and 25% (*38*). Differences in the risk of child death across broad regions of the world and different mortality strata are summarized in Fig. 2. On average about 15% of children born in Africa are expected to die before reaching their fifth birthday. This compares with 3–8% in many other parts of the developing world and less than 2% in Europe. The disparity is even wider when countries are grouped according to the five mortality strata. Countries in the very high mortality strata (*D, E*) have approximately 15 times the mortality risk of those in the very low mortality stratum (*A*).

Global trend

Marked reductions in childhood deaths occurred during the second half of the 20th century. Globally, the median under-five mortality rate declined from around 150 per 1000 live births in the 1950s to around 40 per 1000 in the 1990s (Fig. 3). However, the range of values remained relatively unchanged over the same period (Table 3). For instance, in 1955–59 the range was between 21 per 1000 live births in Sweden and 381 per 1000 in Sierra Leone. The range for 1995–99 was between 5 per 1000 in Finland, Luxembourg, Norway, and Sweden and 334 per 1000 in Niger. When one excludes outliers, however, a marked reduction in the degree of heterogeneity is observed.

The rate of decline in childhood mortality is a key issue of concern to development agencies and the global public health community. With economic reversals, political instability and the advent of the AIDS epidemic, progress in reducing child mortality might well be expected to have slowed down dramatically over the last few decades. The rate of the decline globally, as measured by the trend in the percentage decline between succeeding quinquennia, increased dramatically between 1960 and 1979, reaching a peak of 12% in the second half of the 1970s. It remained at this level throughout the 1980s. A substantial slowing of the rate of decline in child mortality marked the period following the mid-1980s (Table 3, Fig. 3).

The regional variations around this broadly favourable global trend are summarized in Table 4 and Fig. 4. With reference to both broad regional

Fig. 1. **Average percentage of under-five deaths by WHO regions and mortality strata, 1999**

1 = WHO regions   2 = WHO mortality strata   *WHO 00251*
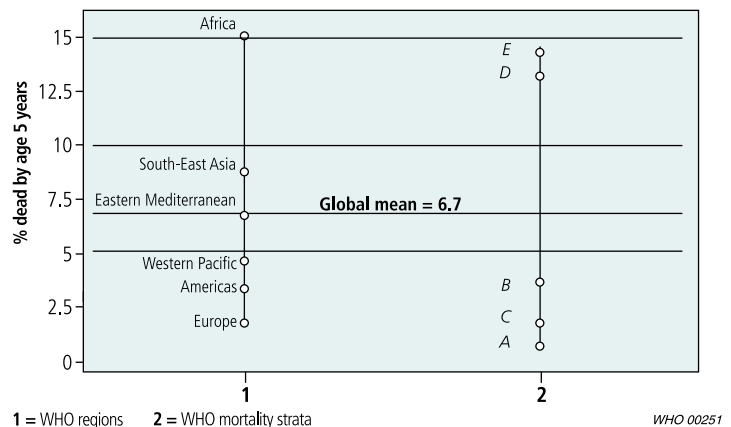
groupings and mortality strata it can be seen that there were very different paths of decline in child mortality over the last four decades. For example, whereas the level of under-five mortality in stratum *B* was similar in 1995–99, ranging from 28 to 40 deaths per 1000 live births, except for the Western Pacific Region where it was 64 per 1000, the extent of decline since 1955–59 was greatest in the Eastern Mediterranean countries and least in the Americas and the European Region. A similar pattern is observed for the countries classified in stratum *D* in each region, suggesting that, despite the wide disparity in current levels of child mortality worldwide, the differences were even greater several decades ago. Fig. 4 shows the variation in the mortality rate by region for the periods 1970–74, 1980–84 and 1990–94. The main findings were as follows.

- All regions experienced sharp reductions in the median under-five mortality rate between 1970 and 1994.
- Throughout the period, Europe had the lowest under-five mortality rate, followed by the Americas and the Western Pacific, the Eastern Mediterranean, South-East Asia and Africa in that order.
- By the early 1970s:
  - the median under-five mortality rate in Europe was below 50 per 1000 live births;
  - the Western Pacific and the Americas had median mortality rates below 100 per 1000 births;
  - the estimate for Africa was over 200 per 1000 live births;
  - the Eastern Mediterranean and South-East Asia had median mortality levels of approximately 160 per 1000 live births.
- The region that experienced the steepest sustained decline was the Eastern Mediterranean, where the median mortality rate dropped from about 170 per 1000 in 1970–74 to below 50 per 1000 in 1990–94.
- The region with the poorest performance was Africa.

Table 1. **Global trends in 5-year estimates of under-five mortality rate, 1955–99, and WHO estimates for 1999**

Country	Mortality rate (per 1000)									Estimates for 1999	Uncertainty intervals estimates
	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99		
Afghanistan	368	350	330	321	308	301	285	275	271	264	(214–317)
Albania	106	91	80	71	64	62	61	59	56	55	(40 –73)
Algeria	262	229	201	187	147	112	66	60	56	49	(38–63)
Angola	350	328	307	285	265	246	228	207	205	201	(173–238)
Argentina	74	71	68	61	51	36	29	26	24	22	(17–27)
Armenia	54	42	29	26	27	26	35	24	23	18	(11–26)
Australia	27	24	22	21	15	12	11	8	7	6	(5–7)
Austria	53	40	30	26	19	15	11	9	7	6	(5–7)
Azerbaijan	86	69	54	49	52	55	49	41	36	29	(20–40)
Bahamas	72	58	47	40	36	31	30	26	23	23	(18–28)
Bahrain	170	146	102	76	65	42	34	26	22	22	(18–25)
Bangladesh	257	241	238	236	219	189	152	124	118	115	(101–133)
Barbados	117	77	50	39	31	22	20	16	14	11	(7–14)
Belarus	36	25	19	16	18	20	17	14	14	14	(8–21)
Belgium	42	32	25	21	16	13	11	9	8	8	(5–9)
Belize	113	98	84	71	61	51	46	42	37	28	(21–35)
Benin			244	250	222	202	186	172	157	153	(134–174)
Bhutan	307	292	260	255	236	198	151	125	118	114	(101–130)
Bolivia	284	251	244	237	190	159	137	113	94	86	(75–101)
Bosnia and Herzegovina	105	81	58	46	34	31	26	19	19	20	(15–25)
Botswana	183	165	153	131	100	79	61	81	92	98	(92–106)
Brazil	184	165	148	128	110	87	64	54	48	45	(33–57)
Brunei Darussalam	89	76	62	43	37	27	20	14	12	11	(7–14)
Bulgaria		39	37	31	27	21	18	18	18	19	(15–23)
Burkina Faso		306	288	271	252	230	207	183	180	177	(151–206)
Burundi	281	252	230	227	202	179	175	198	168	168	(144–197)
Cambodia	259	238	223	257	423	237	185	154	135	134	(113–149)
Cameroon		237	236	203	193	160	135	130	125	122	(106–136)
Canada	38	31	23	20	15	11	9	8	7	6	(4–7)
Cape Verde	179	143	120	110	85	94	80	75	64	53	(46–60)
Central African Republic		317	276	216	196	178	163	160	150	148	(129–166)
Chad	325	308	292	272	252	226	204	191	174	175	(143–213)
Chile	157	147	103	79	53	33	25	17	15	10	(7–13)
China	225	194	140	104	75	50	46	42	38	38	(29–48)
Colombia	170	132	115	89	64	48	36	32	28	29	(24–34)
Comoros			185	163	166	145	134	118	106	103	(83–124)
Congo	208	180	164	135	130	128	120	112	108	107	(89–127)
Côte d'Ivoire		271	252	213	177	163	152	145	136	135	(114–161)
Costa Rica	117	101	83	68	46	27	20	16	15	14	(9–19)
Croatia	51	37	29	25	22	21	18	14	12	8	(5–11)
Cuba	55	48	44	37	24	21	18	12	11	9	(6–11)
Cyprus	57	50	35	28	22	17	13	10	9	9	(6–12)
Czech Republic	22	22	18	15	14	13	13	11	7	6	(4–8)
Democratic Republic of the Congo		267	248	231	215	205	191	178	164	162	(141–185)
Democratic People's Republic of Korea	109	97	90	61	59	56	53	50	101	100	(91–109)
Denmark	27	24	19	14	11	9	10	8	7	7	(5–9)
Djibouti		281	262	243	202	196	193	184	170	166	(147–202)
Dominican Republic	159	146	141	123	101	92	70	56	53	49	(42–58)
Ecuador	173	179	147	133	105	82	61	43	40	37	(30–44)
Egypt			244	222	188	154	126	106	87	73	(63–84)
El Salvador	213	180	163	155	131	108	70	52	41	39	(31–46)
Equatorial Guinea	310	294	282	248	238	232	209	175	140	139	(115–164)
Eritrea	284	262	242	222	206	182	161	152	140	139	(121–159)
Estonia	26	19	18	18	19	22	19	15	13	12	(7–16)
Ethiopia			241	236	224	205	205	194	184	183	(162–207)
Fiji	110	92	77	62	53	43	31	28	23	22	(11–42)
Finland	32	24	18	14	11	8	7	6	5	5	(4–5)
France	36	26	21	17	14	12	10	8	6	6	(4–8)
Gabon	254	240	229	220	198	180	164	128	92	90	(73–109)
Gambia	349	358	331	309	241	209	153	125	100	98	(85–114)
Georgia	73	58	43	39	32	33	28	20	19	18	(11–27)
Germany	34	29	25	22	18	14	9	7	6	6	(5–7)

Country	Mortality rate (per 1000)									Estimates for 1999	Uncertainty intervals estimates
	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99		
Ghana	217	208	193	179	164	151	138	120	116	114	(95–135)
Greece	51	45	39	28	24	17	12	9	8	8	(6–9)
Guatemala	233	193	185	161	143	124	103	75	61	51	(40–63)
Guinea	339	322	306	290	275	259	252	224	206	205	(180–230)
Guinea-Bissau	328	313	307	301	292	257	236	220	204	202	(175–236)
Guyana	152	131	117	103	95	94	83	84	75	67	(51–84)
Haiti	290	245	223	219	207	183	156	159	134	116	(101–135)
Honduras	205	197	177	159	112	94	72	51	41	40	(33–46)
Hungary	61	47	44	40	31	20	20	15	11	11	(9–15)
Iceland	24	21	17	15	12	8	7	6	6	4	(2–7)
India	242	232	212	199	184	162	139	119	103	101	(84–118)
Indonesia	218	212	190	164	139	117	102	79	63	58	(49–70)
Iran, Islamic Republic of	239	226	228	198	154	111	78	63	52	45	(36–55)
Iraq		158	126	113	84	74	59	92	60	61	(50–79)
Ireland	40	33	26	22	18	12	10	8	7	7	(4–9)
Israel	39	33	30	27	23	17	13	11	8	8	(7–8)
Italy	60	50	38	30	19	14	11	9	8	6	(5–7)
Jamaica	77	72	58	53	41	37	34	31	28	27	(21–32)
Japan	49	34	22	16	11	9	7	6	5	5	(4–6)
Jordan		139	121	99	74	59	45	37	26	27	(21–36)
Kazakhstan	102	84	65	64	58	53	49	46	43	42	(29–58)
Kenya	225	192	169	150	124	110	103	94	98	100	(87–112)
Kuwait		106	69	52	42	33	23	22	20	18	(14–23)
Kyrgyzstan	127	112	101	92	85	79	75	73	72	71	(56–87)
Lao People's Democratic Republic	269	266	266	267	243	217	193	169	147	135	(112–163)
Latvia	29	27	25	20	20	20	16	17	18	19	(11–32)
Lebanon	95	78	55	63	40	44	41	37	31	28	(19–37)
Lesotho	209	199	195	182	164	151	148	145	141	141	(119–164)
Liberia	291	283	278	247	237	227	212	204	204	205	(176–240)
Libyan Arab Jamahiriya	296	251	196	114	68	55	43	39	38	37	(27–49)
Lithuania	27	25	23	19	17	17	14	16	14	13	(7–21)
Luxembourg		39	24	20	14	14	10	8	5	6	(4–9)
Madagascar		185	182	179	177	174	172	169	167	168	(141–198)
Malawi	366	355	338	318	274	262	245	237	231	219	(196–248)
Malaysia	115	86	64	53	39	26	19	19	15	14	(11–17)
Maldives	248	220	193	165	137	117	106	95	91	88	(76–102)
Mali		483	420	366	318	281	260	249	241	235	(214–260)
Malta	49	37	30	27	19	16	12	11	10	8	(4–13)
Mauritania	259	245	231	208	193	181	185	182	178	179	(157–204)
Mauritius	113	95	92	78	55	33	28	24	21	21	(10–39)
Mexico	149	125	114	102	87	65	51	41	32	24	(18–36)
Mongolia	212	189	166	148	129	126	122	122	121	114	(88–144)
Morocco			191	178	152	129	104	87	68	65	(54–76)
Mozambique		279	281	282	288	265	242	213	197	193	(164–225)
Myanmar	246	219	196	165	143	137	143	145	133	134	(112–157)
Namibia		160	143	128	115	103	96	92	107	113	(100–126)
Nepal	300	272	243	212	187	187	153	131	117	113	(95–134)
Netherlands	23	20	17	14	12	10	9	8	6	7	(5–7)
New Zealand	32	27	22	20	17	15	14	10	9	8	(6–10)
Nicaragua	202	182	177	166	136	102	74	57	50	47	(40–54)
Niger	321	308	293	290	295	305	316	334	334	335	(310–363)
Nigeria	277	257	232	205	197	192	192	177	175	172	(148–199)
Norway	25	22	19	15	11	10	10	7	5	6	(4–7)
Oman	329	295	57	228	140	61	33	20	17	18	(16–20)
Pakistan		210	183	169	154	149	139	124	106	99	(90–111)
Panama	96	84	73	61	50	42	37	34	33	34	(28–40)
Papua New Guinea	210	198	139	103	105	110	116	123	118	118	(92 –139)
Paraguay	96	84	79	78	69	54	44	35	34	35	(28–42)
Peru	249	218	196	164	141	114	91	72	62	49	(42–56)
Philippines		100	87	78	72	67	56	49	44	45	(36–52)
Poland	77	54	40	34	28	24	18	16	13	12	(10–14)
Portugal	127	109	78	61	37	24	18	13	11	8	(5–10)
Qatar	220	194	168	132	107	59	36	27	23	19	(16–22)
Republic of Korea	152	114	71	47	21	18	16	14	12	11	(8–16)

Country	Mortality rate (per 1000)									Estimates for 1999	Uncertainty intervals estimates
	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99		
Republic of Moldova	84	57	45	46	46	44	32	23	23	19	(13–25)
Romania	90	67	71	47	41	32	35	26	25	26	(20–32)
Russian Federation	33	25	23	27	29	27	24	22	22	22	(14–30)
Rwanda	245	196	198	216	226	213	182	230	190	176	(149–206)
Samoa	233	197	163	135	112	97	75	40	27	27	(23–30)
Saudi Arabia	262	235	207	181	113	78	47	35	28	21	(18–23)
Senegal	295	288	286	273	237	197	163	145	130	130	(114–149)
Sierra Leone	381	396	377	350	341	336	327	320	316	312	(271–367)
Singapore	65	41	29	25	15	14	10	7	5	4	(2–6)
Slovakia	25	23	21	21	18	17	14	12	11	11	(8–14)
Slovenia	30	25	25	22	17	16	12	9	6	5	(3–7)
Solomon Islands	185	151	114	91	75	65	57	52	50	48	(43–53)
Somalia	315	293	274	255	247	236	217	220	204	201	(173–245)
South Africa	217	199	176	133	89	80	69	55	65	76	(60–92)
Spain	59	42	31	20	19	12	10	8	7	6	(5–8)
Sri Lanka	125	96	85	73	56	40	32	25	23	22	(16–29)
Sudan	202	196	182	154	141	138	134	137	112	110	(86–147)
Suriname	97	87	74	62	54	49	44	39	33	31	(23–39)
Swaziland	223	220	213	191	148	131	108	90	100	102	(85–119)
Sweden	21	19	15	12	9	8	8	6	5	5	(3–6)
Switzerland	30	27	21	16	12	10	9	8	7	6	(4–9)
Syrian Arab Republic	219	170	147	110	90	69	55	50	45	42	(32–55)
Tajikistan	144	132	110	104	94	86	79	72	65	64	(51–79)
The former Yugoslav Republic of Macedonia	134	107	79	69	57	56	48	32	24	25	(18–34)
Thailand	166	136	104	88	73	53	40	38	35	34	(24–45)
Togo	276	262	234	205	185	166	150	135	133	132	(108–161)
Trinidad and Tobago	82	56	49	44	38	30	21	16	13	9	(5–13)
Tunisia		240	213	187	129	99	65	46	37	34	(26–41)
Turkey	210	207	208	189	158	127	88	59	44	44	(39–50)
Turkmenistan	150	130	109	103	100	97	90	84	82	80	(58–108)
Uganda	237	206	190	174	184	184	202	197	165	159	(142–180)
Ukraine	27	24	22	24	24	22	19	16	16	14	(10–20)
United Arab Emirates		163	114	83	65	43	32	23	19	18	(15–23)
United Kingdom	29	27	22	19	16	13	11	8	7	7	(5–7)
United Republic of Tanzania	247	234	224	209	189	166	157	137	150	153	(134–170)
United States of America	32	29	24	21	17	14	13	11	9	8	(7–8)
Uruguay	62	56	57	51	52	36	28	25	20	18	(13–23)
Uzbekistan	124	104	86	81	75	70	66	51	45	43	(30–60)
Vanuatu	227	194	168	146	111	90	78	69	65	61	(53–70)
Venezuela	111	78	67	68	54	40	31	29	25	23	(19–26)
Viet Nam		85	77	74	65	65	55	46	40	35	(28–44)
Yemen	325	305	277	260	206	176	154	132	113	111	(92–137)
Yugoslavia		102	73	54	42	34	28	30	26	26	(20–32)
Zambia	222	211	194	168	156	158	186	194	173	169	(149–190)
Zimbabwe	164	158	155	137	113	100	86	80	115	118	(101–134)
Means for:											
African Region	264	254	237	218	199	183	169	160	152	150	(130–174)
Region of the Americas	140	121	108	96	80	65	52	44	38	34	(27–41)
Eastern Mediterranean Region	238	204	181	158	127	106	89	81	71	67	(56–83)
European Region	63	53	44	38	33	29	25	21	19	18	(13–24)
South-East Asia Region	222	202	181	162	143	125	107	93	90	88	(75–103)
Western Pacific Region	154	128	106	94	90	72	62	54	48	46	(37–56)
Global means	180	160	143	128	112	97	84	76	70	67	(56–80)

Three groups of countries were thus distinguished. In the first group, mortality levels were already relatively very low and further dramatic declines were therefore unlikely. This group is made up of countries in the European Region, the Region of the Americas, and the Western Pacific Region. The second group comprises countries in the Eastern Mediterranean Region, where the under-five mortality rates dropped rapidly from very high initial values to very low levels, thereby limiting the possibility of further rapid reductions. The third group consists of the countries in the African Region and the South-East Asia Region, where the initial mortality levels were high, the magnitude of the declines was very small, and

Table 2. Distribution of deaths by WHO regions and WHO mortality strata, 1999

WHO regions	Distribution of deaths by WHO regions	% distribution of deaths by WHO regions	WHO mortality strata[a]	Total deaths by strata	% distribution by strata
African Region	3 806 000	36.2	D	1 843 000	17.5
			E	1 963 000	18.6
Region of the Americas	453 000	4.3	A	33 000	0.3
			B	300 000	2.9
			D	120 000	1.1
Eastern Mediterranean Region	1 511 000	14.4	B	133 000	1.3
			D	1 378 000	13.1
European Region	226 000	2.2	A	26 000	0.3
			B	146 000	1.4
			C	54 000	0.5
South-East Asia Region	3 502 000	33.3	B	314 000	3.0
			D	3 188 000	30.3
Western Pacific Region	1 029 000	9.8	A	9 000	0.1
			B	1 020 000	9.7
Total	**10 527 000**	**100.0**	**–**	**10 527 000**	**100.0**

[a] A = very low child mortality and very low adult mortality; B = low child mortality and low adult mortality; C = low child mortality and high adult mortality; D = high child mortality and high adult mortality; E = high child mortality and very high adult mortality.

there was a major slowing in mortality decline. These are also the regions with severe economic dislocations. Provided that the HIV/AIDS situation does not worsen, it is conceivable that improvements in their political and socioeconomic circumstances could result in further substantial reductions in mortality.

Trends within regions and relative performances

Countries were grouped according to the relative change between their most recent average level of mortality and the level two decades earlier. Countries in each region were categorized as follows according to the decline in under-five mortality rate achieved during the period between 1980 and 1999:

- increased mortality;
- declines of 0–4%, 5–9%, 10–14% and so on at 5% intervals to the highest category of over 50% decline.

The results are shown in Table 5.

African Region. In Africa the mean mortality rate dropped from about 264 deaths per 1000 live births in 1955–1959 to about 152 per 1000 in 1995–1999, a decline of about 42% (Table 6). This compares with a decline of between 60% and 72% in the other regions over the same period. Table 6 also shows the sluggish nature of the rate of the decline, from 4% to a peak of 9%. Furthermore, the degree of heterogeneity within the region, as indicated by the variance, has remained relatively unchanged over the last four decades (Table 6). Thus for 1955–59 the range of mortality rates was from 113 per 1000 in Mauritius to 381 per 1000 in Sierra Leone. For 1995–99 the range became even wider, from 21 per 1000 in Mauritius to 334 per 1000 in Niger.

Africa had the worst performance, more than half the countries achieved declines of less than 20%.

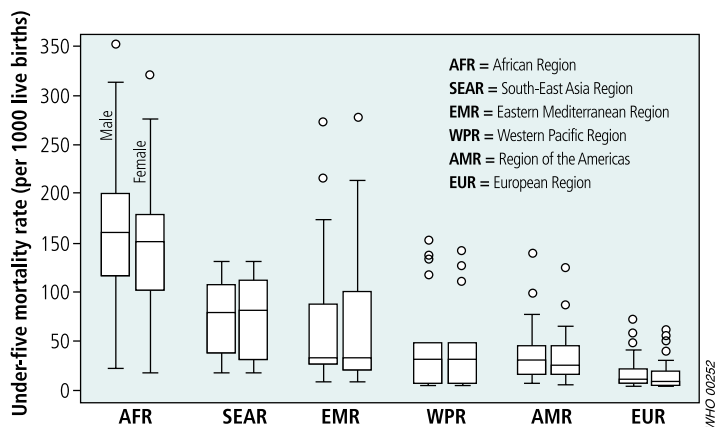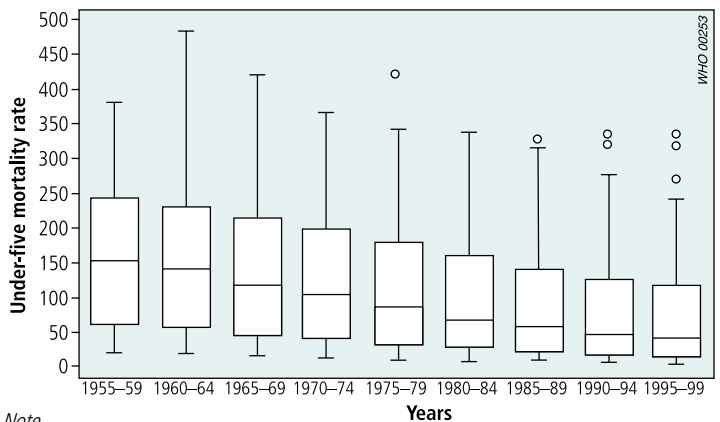**Fig. 2. Distribution of under-five mortality by WHO regions and sex, 1999**

AFR = African Region
SEAR = South-East Asia Region
EMR = Eastern Mediterranean Region
WPR = Western Pacific Region
AMR = Region of the Americas
EUR = European Region

Fig. 3. Global trend in under-five mortality rate (per 1000 live births), WHO Member States, 1995–99

Note
Each boxplot consists of a central box with vertical bars (whiskers) extending from its lower and upper ends. The lower end of the box marks the level of mortality below which the lowest 25% of observations lie (1st quartile or Q1). The upper end marks the level of mortality below which the lowest 75% of the observations are found (3rd quartile or Q3). The line across the box marks the median or middle observation (2nd quartile or Q2). The distance between Q1 and Q3 is the interquartile range or IQ (= Q3–Q1). The vertical bars (whiskers) extend to a distance equivalent to 1.5 times the interquartile range (1.5 x IQ). Points beyond this range represent outliers and are individually plotted. (If the farthest observation lies at a distance of less than 1.5 x IQ the end of the bar is rolled back to that point.)

Table 3. **Summary of global trend in under-five mortality rate, 1955–1999**

Period	Number of countries	Mean U5MR[a]	SD[b]	Minimum	Maximum	Interquinquennial decline (%)
1955–59	145	159.3	102.0	20.6	381.0	–
1960–64	166	149.8	101.1	19.0	483.0	− 6
1965–69	171	136.6	96.1	15.0	420.0	− 9
1970–74	171	122.6	90.9	12.0	365.5	−10
1975–79	171	108.0	87.2	9.0	422.9	−12
1980–84	171	94.7	79.5	7.8	336.0	−12
1985–89	171	83.7	74.9	6.6	326.5	−12
1990–94	171	76.2	72.7	6.0	333.7	− 9
1995–99	171	70.4	69.2	4.6	334.0	− 8

[a] Under-five mortality rate.

[b] Standard deviation.

Table 4. **Global trends in quinquennial estimates of under-five mortality rate by WHO regions and mortality strata, 1955–1999**

WHO regions	Mortality strata[a]	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99
African Region	D	285	277	256	237	218	200	183	169	159
	E	236	227	214	195	176	162	153	149	144
Region of the Americas	A	42	36	31	26	19	15	13	10	9
	B	125	107	93	82	67	54	43	36	32
	D	238	211	195	180	154	127	104	86	73
Eastern Mediterranean Region	B	210	176	147	119	85	59	42	34	28
	D	302	256	230	213	187	173	157	151	132
European Region	A	41	34	27	22	17	13	11	9	7
	B	107	89	75	66	58	53	47	40	36
	C	47	37	31	30	29	27	23	20	19
South-East Asia Region	B	169	148	126	108	89	70	58	47	40
	D	244	225	204	185	166	149	128	113	112
Western Pacific Region	A	52	40	31	25	19	15	12	9	8
	B	200	162	135	120	117	93	81	71	64
Total	–	**159**	**150**	**137**	**123**	**108**	**95**	**84**	**76**	**70**

[a] A = very low child mortality and very low adult mortality; B = low child mortality and low adult mortality; C = low child mortality and high adult mortality; D = high child mortality and high adult mortality; E = high child mortality and very high adult mortality.

Only Algeria, Gabon, and the Gambia achieved over 40% reduction during the last two decades (Table 5). Countries with only a very modest decline (0–10%) included Burundi, Lesotho, Madagascar, Mauritania, Nigeria, Sierra Leone, and the United Republic of Tanzania. Some countries experienced an increase in child mortality, probably because of the HIV/AIDS epidemic: they included Botswana (16%), Namibia (4%), Niger (1%), Zambia (9%), and Zimbabwe (15%). Increases in child mortality of less than 5% over the 20-year period should probably be interpreted with caution, since sampling errors and data of poor quality might have led to spurious findings.

South-East Asia Region. This region has experienced a moderately sustained reduction in mortality among children under 5 years of age during the last four decades, from about 222 deaths per 1000 live births to about 90 per 1000, and there has been some narrowing of differentials (Table 6). All the countries in the region except the Democratic Republic of Korea and Myanmar experienced reductions of 20% or more over the last two decades (Table 5).

Western Pacific Region. Mean mortality dropped by almost 70% from about 154 per 1000 live births in 1955–59 to about 48 in 1995–99 (Table 6). Only Mongolia and Papua New Guinea failed to achieve major reductions; indeed, Papua New Guinea experienced an increase (Table 5).

Eastern Mediterranean Region. Overall, the mean under-five mortality rate dropped sharply from about 238 per 1000 live births in 1955–59 to about 71 per 1000 in 1995–99 (Table 6). There was, however, substantial variation. In 1955–59 the rate for Cyprus

was 57 per 1000 while that for Afghanistan was 368 per 1000. In 1995–99 the corresponding rates were 9 per 1000 (Cyprus) and 271 per 1000 (Afghanistan), and there was relatively little change in the ranking of countries between these extremes. The countries that contributed to this sustained decline included the Islamic Republic of Iran, Jordan, Oman, Qatar, Saudi Arabia, Tunisia and the United Arab Emirates (Table 5). Much more modest reductions, in the range 5–15%, occurred in Afghanistan, Djibouti, and Somalia.

Region of the Americas. Between 1955 and 1999 the under-five mortality rate fell from about 140 to 38 deaths per 1000 live births, i.e by about 70% (Table 6). This was accompanied by a substantial reduction in heterogeneity (Table 6). The rate of decline was initially slow, increased sharply during the 1970s, and slowed down during the 1980s (Fig. 5). This region had the best overall performance, all countries achieved reductions of at least 20% over the last two decades. Chile, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Mexico, and Trinidad and Tobago experienced sustained declines of more than 50% over the last two decades.

European Region. The under-five mortality rate had already dropped substantially in Europe by the mid-1950s, largely as a result of improved living conditions and the availability of antibiotics. In 1955–59 the mean mortality rate was about 63 per 1000 live births. It dropped to 19 per 1000 over the next 40 years. Intercountry differentials narrowed considerably during the same period. In 1955–59 the range was from 21 per 1000 in Sweden to 210 per 1000 in Turkey. By the end of 1999 the lowest value was 5 per 1000 in Finland, Luxembourg, Norway, and Sweden, and the highest was 82 per 1000 in Turkmenistan. Over the last two decades there were substantial reductions in all countries except Albania, Armenia, Kyrgyzstan, and Latvia.

Discussion

Given the substantial focus of international public health programmes on improving child survival, it is important that periodic reviews of progress be undertaken to identify needs and opportunities for priority action. With improvements in vital registration, demographic surveillance and survey programmes, reasonably reliable estimates of child mortality are now available for many countries.

Despite setbacks to international development efforts and the emergence of major new threats to health, such as the HIV/AIDS epidemic, the overall under-five mortality rate declined by almost 30%[j] during the 1990s, building on a similar decline during the 1980s. Globally, the number of child deaths declined from over 13 million in 1980 to about 10.5 million in 1999. These are, by any standard,

[j] WHO estimate of 67 deaths per 1000 live births in 1999; World Bank estimate of 96 deaths per 1000 live births in 1990 (World Bank, 1993).

Fig. 4. **Distribution of countries by under-five mortality rate, 1970–74 to 1990–94**

Note
Each boxplot consists of a central box with vertical bars (whiskers) extending from its lower and upper ends. The lower end of the box marks the level of mortality below which the lowest 25% of observations lie (1st quartile or Q1). The upper end marks the level of mortality below which the lowest 75% of the observations are found (3rd quartile or Q3). The line across the box marks the median or middle observation (2nd quartile or Q2). The distance between Q1 and Q3 is the interquartile range or IQ (= Q3−Q1). The vertical bars (whiskers) extend to a distance equivalent to 1.5 times the interquartile range (1.5 x IQ). Points beyond this range represent outliers and are individually plotted. (If the farthest observation lies at a distance of less than 1.5 x IQ the end of the bar is rolled back to that point.)

remarkable public health achievements. There are, however, strong suggestions that the rate of decline may have slowed down somewhat. This arises partly because of the already low child mortality levels in the European Region, the Region of the Americas, the Western Pacific Region and the Eastern Mediterranean Region, and also because of an apparent lack of substantial progress in the African Region and the South-East Asia Region. In this connection the following questions should be asked. Are the declines real? If so, what has caused them? What are the prospects for further reductions in child mortality?

With regard to the measurement of childhood mortality trends, the wealth of data from the Demographic and Health Survey programme relating to almost 60 countries has greatly increased confidence in the comparative assessment of child mortality over the last two decades or so. In other countries, routine demographic surveillance systems, such as the Sample Registration System in India, now provide useful, if not very reliable, data on child mortality. Vital registration systems have improved in many developing countries, and even where still deficient they can provide valuable information to complement other sources and inform judgements about likely levels and trends in mortality. Thus while many of the estimates reported here, particularly for the less developed regions, are uncertain, we are reasonably confident that they describe recent trends fairly reliably.

The 1999 estimates are based on life tables produced principally for work on the measurement of health systems performance (*37*). Because a complete life table is a complicated non-linear function of uncertain parameters, we have used Monte Carlo simulation techniques to develop

Table 5. **Percentage decline in under-five mortality rate between 1980 and 1999**

WHO region	Over 50%	45–49%	40–44%	35–39%	30–34%	25–29%	20–24%	15–19%	10–14%	5–9%	0–4%	Increased mortality
African Region	Gambia	Algeria Gabon		Equatorial Guinea Mauritius	Cape Verde Senegal	Comoros Mozambique	Benin Burkina Faso Cameroon Chad Eritrea Ghana Guinea Guinea-Bissau Swaziland	Angola Central African Republic Congo Côte d'Ivoire Democratic Republic of the Congo South Africa Togo	Ethiopia Kenya Liberia Malawi Mali Rwanda Uganda	Burundi Lesotho Nigeria Sierra Leone Tanzania	Madagascar Mauritania	Botswana Namibia Niger Zambia Zimbabwe
Region of the Americas	Chile Ecuador El Salvador Guatemala Honduras Mexico Nicaragua Trinidad and Tobago	Brazil Cuba Peru	Bolivia Colombia Costa Rica Dominican Republic Uruguay	Barbados Canada Paraguay United States of America Venezuela	Argentina Suriname	Bahamas Belize Haiti	Guyana Jamaica Panama					
Eastern Mediterranean Region	Iran Jordan Oman Qatar Saudi Arabia Tunisia United Arab Emirates	Bahrain Cyprus Morocco	Egypt	Kuwait Syria Yemen	Libyan Arab Jamahiriya	Lebanon Pakistan		Iraq Sudan	Djibouti Somalia	Afghanistan		
European Region	Austria Czech Republic Germany Greece Israel Luxembourg Portugal Slovenia Macedonia Turkey	France Hungary Norway Moldova Spain United Kingdom	Croatia Finland Georgia Ireland Poland	Belgium Bosnia and Herzegovina Italy Malta Netherlands Uzbekistan	Azerbaijan Belarus Slovakia Sweden Switzerland	Denmark Ukraine	Iceland Tajikistan Yugoslavia	Bulgaria Kazakhstan Lithuania Romania Russian Federation Turkmenistan	Armenia Latvia	Albania Kyrgyzstan		
South-East Asia Region		Indonesia	Bhutan Sri Lanka	Bangladesh India Nepal	Thailand		Maldives				Myanmar	Democratic People's Republic of Korea
Western Pacific Region	Brunei Darussalam Samoa Singapore	Fiji	Australia Cambodia Malaysia New Zealand	Japan Viet Nam	Lao People's Democratic Republic Philippines Republic of Korea	Vanuatu	China Solomon Islands				Mongolia	Papua New Guinea

numerical estimates of the ranges of uncertainty around the life tables. A detailed discussion of the sources of uncertainty and methods for uncertainty analysis for life tables may be found in a separate publication (40). The estimated bounds around the 1999 estimates of under-five mortality rate are shown in 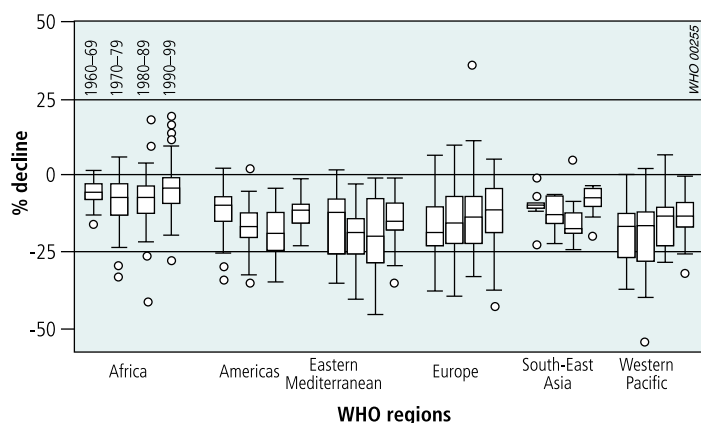Table 1. Globally, the number of child deaths in 1999 almost certainly lies between 9 and 12 million; the greatest uncertainty occurs in respect of Africa and parts of Asia. The global and regional estimates presented here are probably a reasonable reflection of true child mortality levels, and are certainly consistent with previous estimates by the UN and UNICEF.

Table 6. **Summary of regional trends in quinquennial variation in under-five mortality rate, 1955–1999**

WHO region	Period	Number of countries	Mean U5MR[a]	SD[b]	Maximum	Minimum	Interquinquennial decline (%)
African Region	1955–59	32	263.6	63.2	113.1	381.0	–
	1960–64	41	253.8	74.3	95.4	483.0	– 4
	1965–69	44	236.9	67.1	92.3	420.0	– 7
	1970–74	44	217.7	65.0	77.5	365.5	– 8
	1975–79	44	198.7	65.2	54.6	340.5	– 9
	1980–84	44	182.6	63.7	33.4	336.0	– 8
	1985–89	44	169.2	64.5	27.7	326.5	– 7
	1990–94	44	160.1	64.9	23.5	333.7	– 5
	1995–99	44	152.2	61.3	21.0	334.0	– 5
Region of the Americas	1955–59	29	139.9	71.1	32.3	289.6	–
	1960–64	29	121.5	64.0	29.0	251.3	–13
	1965–69	29	108.0	60.9	23.2	244.3	–11
	1970–74	29	96.1	57.9	19.6	236.9	–11
	1975–79	29	79.8	50.1	15.2	207.1	–17
	1980–84	29	65.1	43.7	11.3	183.0	–18
	1985–89	29	52.3	35.9	9.3	155.6	–20
	1990–94	29	43.8	32.8	7.8	159.0	–16
	1995–99	29	37.9	27.6	6.9	134.0	–14
Eastern Mediterranean Region	1955–59	13	238.2	92.4	56.8	368.0	–
	1960–64	20	204.2	79.7	50.0	350.0	–14
	1965–69	22	180.8	78.4	34.8	329.5	–11
	1970–74	22	157.6	77.4	27.7	321.0	–13
	1975–79	22	126.9	71.9	22.4	307.5	–19
	1980–84	22	105.7	72.8	17.3	301.0	–17
	1985–89	22	89.0	72.1	13.5	285.3	–16
	1990–94	22	81.5	71.5	10.3	274.8	– 8
	1995–99	22	70.7	68.3	8.7	271.0	–13
European Region	1955–59	45	62.9	44.1	20.6	210.0	–
	1960–64	48	52.8	39.4	19.0	206.9	–16
	1965–69	48	43.8	35.6	15.0	208.4	–17
	1970–74	48	38.1	32.6	12.0	188.5	–13
	1975–79	48	32.9	28.9	9.0	158.4	–14
	1980–84	48	29.2	26.0	7.8	127.4	–11
	1985–89	48	25.4	22.5	7.1	90.5	–13
	1990–94	48	21.3	19.6	6.2	84.0	–16
	1995–99	48	19.1	18.5	4.6	82.0	–10
South-East Asia Region	1955–59	10	221.6	68.0	108.7	306.7	–
	1960–64	10	201.6	69.0	96.1	292.2	– 9
	1965–69	10	181.1	65.0	85.3	260.2	–10
	1970–74	10	161.7	67.8	61.5	254.6	–11
	1975–79	10	143.2	64.6	56.4	235.7	–11
	1980–84	10	125.5	59.9	39.5	198.4	–12
	1985–89	10	106.9	48.8	32.0	152.9	–15
	1990–94	10	93.0	42.8	25.2	145.0	–13
	1995–99	10	90.2	37.6	23.0	133.4	– 3
Western Pacific Region	1955–59	16	153.6	84.0	27.3	268.7	–
	1960–64	18	128.0	76.7	24.1	266.4	–17
	1965–69	18	106.1	71.3	21.7	266.3	–17
	1970–74	18	93.8	74.3	16.4	266.9	–12
	1975–79	18	89.8	100.8	11.3	422.9	– 4
	1980–84	18	71.5	67.1	8.6	237.3	–20
	1985–89	18	61.7	57.9	6.6	192.5	–14
	1990–94	18	54.0	52.5	6.0	169.0	–12
	1995–99	18	48.5	48.4	5.1	146.7	–10

[a] Under-five mortality rate.

[b] Standard deviation.

Fig. 5. **Per cent decline in under-five mortality rate, WHO regions, 1960–69 to 1990–99**

Note

Each boxplot consists of a central box with vertical bars (whiskers) extending from its lower and upper ends. The lower end of the box marks the level of mortality below which the lowest 25% of observations lie (1st quartile or Q1). The upper end marks the level of mortality below which the lowest 75% of the observations are found (3rd quartile or Q3). The line across the box marks the median or middle observation (2nd quartile or Q2). The distance between Q1 and Q3 is the interquartile range or IQ (= Q3–Q1). The vertical bars (whiskers) extend to a distance equivalent to 1.5 times the interquartile range (1.5 x IQ). Points beyond this range represent outliers and are individually plotted. (If the farthest observation lies at a distance of less than 1.5 x IQ the end of the bar is rolled back to that point.)

What are the prospects for further declines in child mortality? It is important to recognize that reversals in public health are possible and can substantially alter long-term declines in mortality. Two examples are the dramatic increase in adult mortality in the Russian Federation and several other Eastern European countries in the late 1980s and early 1990s, and the emergence of HIV/AIDS as a leading cause of adult mortality. To the extent that children are likely to be more vulnerable to such developments, continued progress is by no means assured. Certainly, the full impact of the HIV/AIDS epidemic on child mortality has not yet been felt. The sluggish pace of decline and the increases observed in the under-five mortality rate in some African countries suggest the possibility of a major slow-down, if not a reversal, of gains in child survival in countries where the seroprevalence of HIV is high. As the epidemic continues to unfold in Africa, particularly southern Africa, further reductions in child mortality are expected to become increasingly unlikely until substantial progress in controlling the spread of HIV is achieved. Moreover, if rates of infection in Asia continue to increase, progress in reducing child mortality will be hindered, as was apparent in Thailand during the 1990s.

Conclusion

Good vital registration offers the best means of monitoring the progress of countries in reducing premature deaths, particularly child deaths. In many developing countries, however, progress in this field can be expected to remain modest because of the cost of maintaining and improving systems for the registration of births and deaths. Nevertheless, the extensive population survey programmes that were established over the last few decades, combined with sample registration and censuses, yield valuable information on child mortality. These data sources, appropriately checked for implausible observations, are now sufficiently common in developing countries to permit levels and trends in child mortality to be estimated with some confidence.

Using these data we have estimated that some 10.5 million children aged 0–4 years died in 1999, about 2 million fewer than at the start of the decade. Reasonable uncertainty bounds on country-specific estimates suggest that the global total was unlikely to be below 9 million or above 12 million. Of these deaths, 98–99% occurred in developing countries. Globally, the mean risk of death before the age of 5 years for a newborn baby is about 6.7%. In Africa, approximately 15% of newborn babies die before their fifth birthday; this compares with 6–10% of newborn babies in South-East Asia and of 4% or fewer in many parts of Latin America, the Western Pacific Region and the Eastern Mediterranean Region.

Our analysis also suggests that the steady progress in reducing child mortality over the last five decades has continued throughout the 1990s, despite the advent of HIV/AIDS, continued civil strife in some countries and a lack of economic growth in others. Although the rate of decline fell in all regions except the Western Pacific Region during the 1990s, there is no widespread evidence of rising child mortality rates. The notable exceptions are countries in southern Africa, where there is an extremely high prevalence of HIV, and a few in Asia beset by difficult economic circumstances. Nevertheless, the slow-down in Africa and South-East Asia is particularly worrisome because it is occurring at very high levels of mortality and in countries experiencing severe economic dislocation.

The causes of the continued decline need to be better understood if public health programmes are to be more appropriately targeted to ensure that it is maintained. Because of the paucity of reliable data on causes of death in developing countries it is extremely difficult to determine whether the gains can be attributed to the success of specific intervention programmes, changes in childbearing patterns, general social and economic development or, as is likely, to some combination of these and perhaps other factors. Failure to specify the causal pathways linking child mortality and its proximate and distal determinants has led to a further proliferation of child survival initiatives with loosely defined strategies for achieving certain child mortality targets. It is desirable to concentrate more on elucidating the mechanisms through which various interventions operate to lower or raise the risk of child death, and somewhat less on simply identifying the determinants of child survival. It is also desirable to investigate further the reasons for the success or failure of specific interventions.

In many countries the rapid reduction of child mortality remains a priority aim in the field of public health. Investing in research and surveillance systems

to improve knowledge about the causes of declines in child mortality can be expected to ensure that intervention programmes are more appropriately targeted and thus more likely to achieve this aim.

Continued vigilance to protect the gains in child survival prospects is clearly essential. Further gains can be expected as knowledge is translated into effective programmes of action. Provided that major threats to health such as HIV/AIDS and malaria do not increase dramatically over the next few decades, particularly in Africa, current trends suggest that that child mortality might be halved by about 2030. Success is likely to be greatest in those countries where political stability and commitment to service delivery and socioeconomic development are strongest. ■

Résumé

Baisse de la mortalité infanto-juvénile : nouvelle évaluation

Les auteurs de l'article passent en revue les niveaux actuels et les tendances de la mortalité infanto-juvénile à la lumière de toutes les données disponibles pour les pays développés comme pour les pays en développement. Ils se sont particulièrement attachés à examiner, décrire et documenter dans chaque pays les tendances des taux de mortalité chez les moins de cinq ans au cours des années 90, et à identifier les pays et les Régions ayant enregistré une amélioration durable, ainsi que ceux où les reculs sont manifestes. A de nombreux égards, cette analyse réactualise celles qui ont déjà été faites par l'UNICEF, la Banque mondiale et l'Organisation des Nations Unies. Elle les complète par ailleurs en fournissant des séries cohérentes d'estimations de la mortalité chez les moins de cinq ans et en indiquant les tendances historiques pour une période allant de 1950 à 2000, tant pour les pays développés que pour les pays en développement.

Selon les estimations, 10,5 millions d'enfants de 0 à 4 ans sont morts en 1999, soit environ 2,2 millions ou 17,5 % de moins que dix ans plus tôt. Sur ce nombre, on compte 3,8 millions d'enfants (36 %) en Afrique, 2,5 millions en Inde et 750 000 en Chine. A l'échelle mondiale, le risque qu'un enfant décède a diminué de manière marquante en un demi-siècle. En 1999, un nouveau-né courait un risque d'environ 6,7 % de mourir avant l'âge de 5 ans, contre 9,6 % en 1990, 12 % en 1980 et 25 % en 1950. Il existe néanmoins des différences importantes au niveau régional : environ 15 % des nouveau-nés africains mourront avant leur cinquième anniversaire alors qu'ils ne sont que 3 à 8 % dans bien d'autres régions du monde en développement et moins de 2 % en Europe. Ces disparités sont encore plus grandes lorsqu'on regroupe les pays selon les cinq strates établies par l'OMS pour la mortalité. Dans les pays correspondant à la strate où la mortalité est la plus élevée, le risque de mortalité est environ 15 fois plus grand que dans ceux qui se trouvent dans la strate la plus basse.

La vitesse à laquelle la mortalité infanto-juvénile diminue est un point essentiel pour les organismes de développement et la communauté mondiale s'occupant de la santé publique. L'analyse indique une diminution rapide de la mortalité chez les moins de cinq ans avec un pic de vitesse de 1975 à 1980, puis une baisse constante au cours des années 80. Bien que l'on ait observé un ralentissement dans toutes les Régions à l'exception de celle du Pacifique occidental au cours des années 90, rien ne permet véritablement de conclure à une augmentation des taux de mortalité infanto-juvénile, à l'exception notable de l'Afrique australe, qui connaît une prévalence extrêmement élevée du VIH, et de quelques pays asiatiques en proie à des difficultés économiques. Le ralentissement de la baisse est particulièrement préoccupant en Afrique et en Asie du Sud-Est parce qu'il survient alors que les taux de mortalité sont relativement élevés et que les pays font face à de graves bouleversements économiques. Avec l'épidémie de VIH/SIDA qui continue de s'étendre en Afrique, notamment en Afrique australe, et dans certaines régions d'Asie, il devient de plus en plus improbable que de nouvelles diminutions de la mortalité infanto-juvénile soient enregistrées tant que des progrès importants n'auront pas été accomplis pour maîtriser la propagation du virus.

Resumen

Reevaluación del descenso de la mortalidad infantil

Los autores examinan los actuales niveles y tendencias de la mortalidad de niños pequeños a la luz de todos los datos disponibles tanto para los países en desarrollo como para los países desarrollados. Los objetivos específicos son examinar, describir y documentar las tendencias de países concretos en lo referente a las tasas de mortalidad entre los menores de cinco años en la década de 1990, e identificar los países y Regiones donde ha tenido lugar una mejora sostenida y aquellos donde ha habido claros reveses. En muchos aspectos nuestro análisis actualiza otros anteriores llevados a cabo por el UNICEF, el Banco Mundial y las Naciones Unidas. Además complementa esos estudios proporcionando una serie coherente de estimaciones de la mortalidad entre los menores de cinco años y revelando tendencias históricas del periodo 1950-2000 tanto para los países desarrollados como para los países en desarrollo.

Calculamos que en 1999 murieron 10,5 millones de niños de 0-4 años de edad, lo que representa unos 2,2 millones, o 17,5%, menos que diez años antes. De esa cifra, 3,8 millones (36%) corresponden a África, 2,5 millones a la India, y 750 000 a China. A nivel mundial, el riesgo de defunción de los niños ha

descendido marcadamente durante el último medio siglo. En 1999, un recién nacido tenía una probabilidad de un 6,7% de morir antes de alcanzar los 5 años, mientras que las cifras correspondientes a 1990, 1980 y 1950 son del 9,6%, 12% y 25%, respectivamente. Existen sin embargo marcadas diferencias regionales: como promedio, puede estimarse que aproximadamente un 15% de los recién nacidos en África morirán antes de cumplir los cinco años, lo que contrasta con un 3% - 8% en muchas otras partes del mundo en desarrollo y con menos del 2% en Europa. Las disparidades son aún mayores cuando se procede a agrupar los países de acuerdo con los cinco estratos de mortalidad de la OMS. En los países situados en el estrato de mortalidad muy alta el riesgo de defunción es aproximadamente 15 veces mayor que en el de mortalidad muy baja.

Un dato de sumo interés para los organismos que actúan en pro del desarrollo y para la comunidad implicada en la salud pública mundial es la tasa de disminución de la mortalidad infantil. El análisis efectuado muestra una rápida disminución de la mortalidad entre los menores de cinco años, con tasas que alcanzaron su valor máximo en la segunda mitad de los años setenta y permanecieron inalteradas durante los años ochenta. Aunque la tasa de disminución de la mortalidad infantil se aminoró en todas las Regiones, salvo en el Pacífico Occidental, durante los años noventa, no hay muchos datos que apunten a un aumento de las tasas de mortalidad infantil. Excepciones destacables son los países del sur de África, donde la prevalencia del VIH es sumamente alta, y unos pocos países asiáticos acosados por unas circunstancias económicas difíciles. La atenuación de la disminución resulta especialmente preocupante en África y en Asia Sudoriental, porque se está produciendo a niveles relativamentes altos de mortalidad y en países que atraviesan dificultades económicas graves. A medida que avanza la epidemia de VIH/SIDA en África, sobre todo en su parte meridional, y en determinadas zonas de Asia, cualquier reducción adicional de la mortalidad infantil resulta crecientemente improbable, a la espera de que se logren progresos sustanciales en la lucha contra la propagación del VIH.

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