

## Child survival I

## Where and why are 10 million children dying every year?

Robert E Black, Saul S Morris, Jennifer Bryce

**More than 10 million children die each year, most from preventable causes and almost all in poor countries. Six countries account for 50% of worldwide deaths in children younger than 5 years, and 42 countries for 90%. The causes of death differ substantially from one country to another, highlighting the need to expand understanding of child health epidemiology at a country level rather than in geopolitical regions. Other key issues include the importance of undernutrition as an underlying cause of child deaths associated with infectious diseases, the effects of multiple concurrent illnesses, and recognition that pneumonia and diarrhoea remain the diseases that are most often associated with child deaths. A better understanding of child health epidemiology could contribute to more effective approaches to saving children's lives.**

Substantial reductions in child mortality occurred in low-income and middle-income countries in the late 20th century, but more than 10 million children younger than 5 years still die every year.<sup>1,2</sup> In this article, the first in a series of five, we consider reasons for these deaths and provide recommendations for how they can be prevented.

Rates of decline in worldwide child mortality peaked in about 1980.<sup>1</sup> In 1990–2001, the number of child deaths fell by 1·1% every year, compared with 2·5% per year during 1960–90.<sup>3</sup> Although this deceleration might be expected in areas that had already achieved low rates of mortality, such slowing has also occurred in high-rate regions. Sub-Saharan Africa had the highest child mortality in 1970–74, but in the years since has had the slowest fall in rate.<sup>1</sup> South Asia also had a high rate of child deaths in the 1970s, and despite a 50% drop in mortality, almost one in ten children in this region still dies before their fifth birthday.<sup>1</sup>

Child mortality varies among world regions, and these differences are large and increasing. In 1990, there were 180 deaths per 1000 livebirths in sub-Saharan Africa and only 9 per 1000 in industrialised countries—a 20-fold difference.<sup>4</sup> In 2000, this gap had increased to 29-fold with mortality rates of 175 and 6 per 1000 children in sub-Saharan Africa and industrialised countries, respectively.<sup>4</sup>

The World Summit for Children in 1990 called for a worldwide reduction in child mortality to below 70 deaths per 1000 livebirths (or a one-third reduction if this yielded a lower mortality rate) by the year 2000.<sup>4</sup> Unfortunately, investments in health systems and interventions necessary to achieve such a reduction in the 1990s were not

commensurate with needs. The mortality reduction target was reached for only five of 55 countries with an under-5-year mortality rate of 100 or more in 1990.<sup>4</sup>

In 2002, as part of the millennium development goals for health, nations pledged to ensure a two-thirds reduction in child mortality by 2015, from the base year 1990.<sup>5</sup> In addition to setting such a goal, the global public health community must critically assess how it can be accomplished. A realistic picture of a country's epidemiological profile and the capabilities of its health system is needed before appropriate public health interventions can be developed and implemented.

Development of these interventions also requires an understanding of the determinants of child mortality. These determinants include, at the most distant level, socioeconomic factors, such as income, social status, and education, which work through an intermediate level of environmental and behavioural risk factors.<sup>6</sup> These risk factors, in turn, lead to the proximal causes of death (nearer in time to the terminal event), such as undernutrition, infectious diseases, and injury. In this paper, we will focus on proximal causes of death and on selected environmental and behavioural risk factors. The fourth article in this series will address the socioeconomic determinants of child mortality.

### Where do most child deaths occur?

The estimate for global child deaths in 2000 is 10·8 million.<sup>7</sup> In this series, data from 2000 will be used throughout because they are most complete for this period and little has changed in the past 2 years. About 41% of child deaths occur in sub-Saharan Africa and another 34% in south Asia.<sup>7</sup> Because there is substantial variation in death rates within these regions, planning for health interventions should take place at a national level. The incomplete and unreliable nature of these

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### Search strategy

The search strategy for the model used to estimate proportionate causes of death has been described.<sup>32</sup> Estimates of the importance of risk factors were taken from published results.<sup>12</sup> For our comorbidity analyses we also contacted researchers and directors of demographic surveillance areas in low-income and middle-income countries.

Countries ranked by total number of child deaths	Number of child deaths*	Under-5-year mortality-rate rank†	Countries ranked by under-5-year mortality rate	Under-5-year mortality rate (per 1000 births)	Number of child deaths rank
India	2 402 000	54	Sierra Leone	316	36
Nigeria	834 000	17	Niger	270	12
China	784 000	88	Angola	260	11
Pakistan	565 000	43	Afghanistan	257	8
D R Congo	484 000	9	Liberia	235	51
Ethiopia	472 000	21	Mali	233	16
Bangladesh	343 000	57·5	Somalia	225	22
Afghanistan	251 000	4	Guinea-Bissau	215	70
Tanzania	223 000	23	D R Congo	205	5
Indonesia	218 000	76·5	Zambia	202	27
Angola	169 000	3	Chad	200	33
Niger	156 000	2	Mozambique	200	13
Mozambique	155 000	11·5	Burkina Faso	198	20
Uganda	145 000	36	Burundi	190	44
Myanmar	132 000	43	Malawi	188	25
Mali	128 000	6	Rwanda	187	42
Brazil	127 000	92	Nigeria	184	2
Kenya	125 000	39	Mauritania	183	59
Sudan	116 000	45·5	Central African Republic	180	54
Burkina Faso	104 000	13	Guinea	175	41
Iraq	104 000	34	Ethiopia	174	6
Somalia	100 000	7	Côte d'Ivoire	173	24
Yemen	97 000	43	Tanzania	165	9
Côte d'Ivoire	97 000	22	Benin	160	46
Malawi	96 000	15	Equatorial Guinea	156	89
Madagascar	93 000	30·5	Cameroon	154	28
Zambia	88 000	10	Djibouti	146	88
Cameroon	83 000	26	Swaziland	142	85
Philippines	82 000	88	Togo	142	55
South Africa	77 000	66·5	Senegal	139	45
Nepal	76 000	54	Madagascar	139	26
Egypt	76 000	80	Cambodia	135	39
Chad	73 000	11·5	Lesotho	133	73
Iran	71 000	82·5	Iraq	130	21
Mexico	70 000	101·5	Gambia	128	79
Sierra Leone	69 000	1	Uganda	127	14
Turkey	66 000	80	Haiti	125	52
Ghana	65 000	49	East Timor	124	90
Cambodia	63 000	32	Kenya	120	18
Viet Nam	63 000	91	Zimbabwe	117	43
Guinea	62 000	20	Eritrea	114	63
Rwanda	54 000	16	Yemen	110	23

\*Number of deaths estimated by multiplying the number of livebirths<sup>6</sup> by the under-5-year mortality rate<sup>7</sup> and by a life-table based adjustment factor that slightly reduces the number of deaths if the yearly number of births has increased over the previous quinquennium and slightly increases it if births have fallen.<sup>8</sup> †Decimal places indicate that two countries were equally ranked.

Table 1: Countries ranked by total child (under-5-year) deaths or by under-5-year mortality rates in 2000

data in many countries can make this task difficult, so assessment of the needs and possible interventions for more homogeneous groups of countries is also worthwhile.

A few countries account for a very large proportion of all child deaths. In fact, half of worldwide deaths in children younger than 5 years occur in only six countries, and 90% in 42 countries (table 1).<sup>7-9</sup> However, the order of countries differs when ranked by child mortality rate rather than by number of deaths, in that countries in sub-Saharan Africa with quite small population sizes dominate the highest ranks (table 1); thus, the first 42 countries ranked by mortality rate constitute only 44% of child deaths worldwide.

Figure 1 shows that deaths are concentrated in some regions, in particular south Asia and sub-Saharan Africa. Even within countries, spatial variation in mortality rates can be large. In India, for example, the 1998-99 national family health survey found that mortality rates for children younger than 5 years varied from 18·8 per 1000 births in Kerala to 137·6 per 1000 in Madhya Pradesh.<sup>10</sup>

Although most child deaths in these countries occur in rural areas, urban slum populations can have especially high child mortality rates. For example, children in the slums of Nairobi, Kenya, have mortality rates much higher than rural Kenyan children (150·6 per 1000 livebirths *vs* 113·0, respectively).<sup>11</sup>

### Risk factors for child mortality

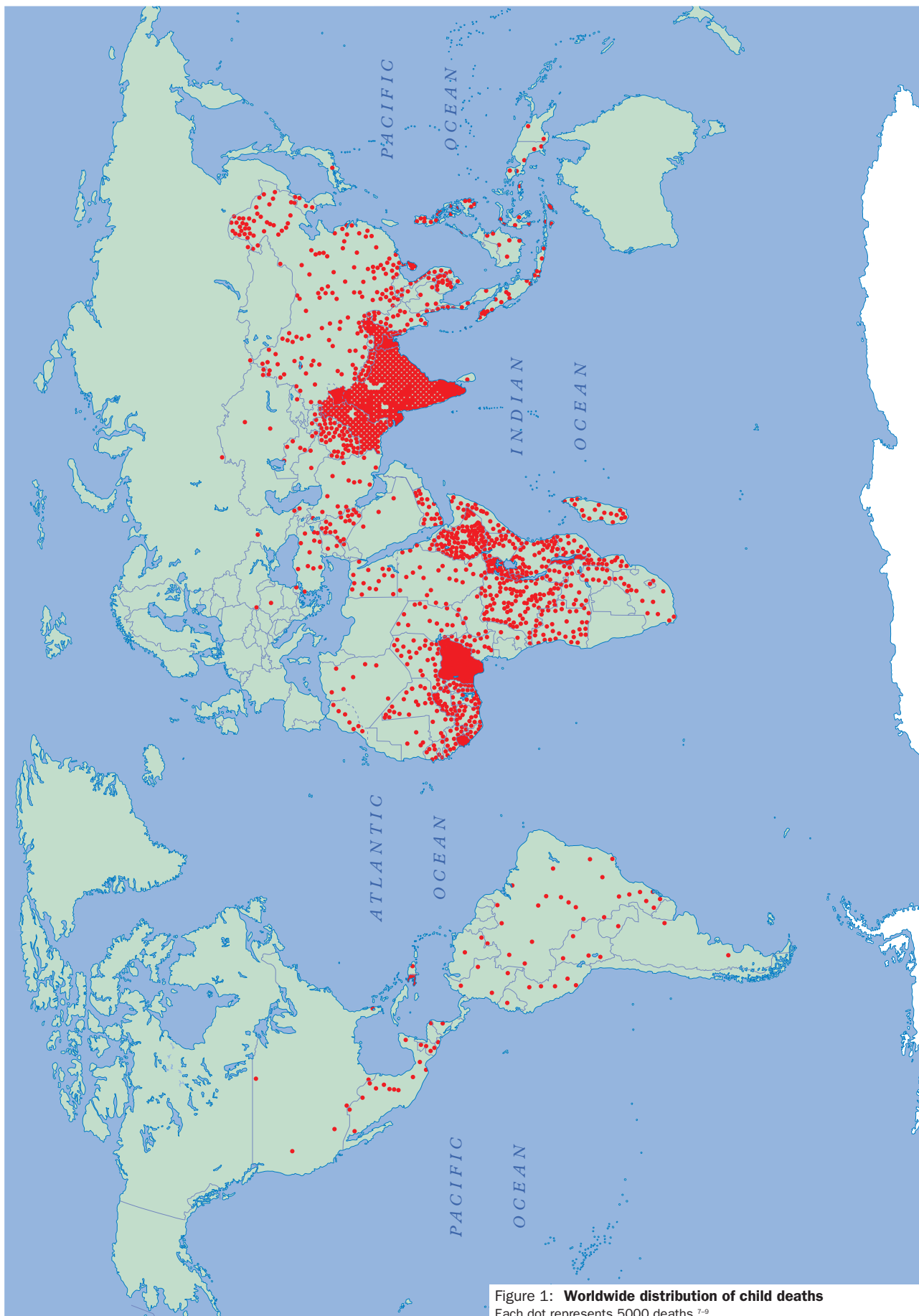
Unhygienic and unsafe environments place children at risk of death.<sup>2,12</sup> Ingestion of unsafe water, inadequate availability of water for hygiene, and lack of access to sanitation contribute to about 1·5 million child deaths and around 88% of deaths from diarrhoea.<sup>2,12</sup> Other health-related behaviours, such as birth spacing, are also important risk factors for child mortality.<sup>13</sup>

Infants aged 0-5 months who are not breastfed have seven-fold and five-fold increased risks of death from diarrhoea and pneumonia, respectively, compared with infants who are exclusively breastfed.<sup>14</sup> At the same age, non-exclusive rather than exclusive breastfeeding results in more than two-fold increased risks of dying from diarrhoea or pneumonia.<sup>15</sup> 6-11-month-old infants who are not breastfed also have an increased risk of such deaths.<sup>16</sup>

Child deaths are commonly the result of several risk factors. In the future, the joint effects of two or more risk factors on each underlying or associated cause of death should be estimated together.<sup>17</sup> Thus, the total effect of interventions to prevent or mitigate the effects of various sets of risk factors could be established.

### Underlying causes of death

WHO's work on the global burden of disease, consistent with the International Classification of Diseases (ICD),



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stipulates one cause of death, which is considered to be the “disease or injury which initiated the train of morbid events leading directly to death”.<sup>18</sup> This measure ensures that the sum of deaths from all possible causes will not exceed the total number of child deaths. However, such a classification oversimplifies the situation in low-income and middle-income countries where serious illnesses commonly occur sequentially or concurrently before death.

Measles is often complicated by pneumonia or diarrhoea. In studies in Bangladesh, the Philippines, and Uganda it was noted that in children with an illness serious enough to require admission to hospital, 50–79% of measles cases were followed by pneumonia or diarrhoea, which were the reasons for admission.<sup>19–21</sup> Decreases in the immune and non-immune host defences as a consequence of measles lead to a high rate of these subsequent infectious diseases, and also to a higher case fatality rate when they do occur. Likewise, children with AIDS have increased susceptibility to diarrhoea, pneumonia, tuberculosis, and other infections. These diseases also have a higher case fatality rate in people with AIDS compared with those without AIDS. In these examples, measles or AIDS would be judged by ICD rules to be the underlying cause of death and subsequent infections would be associated causes of death.

Underweight status (one SD or more below the weight expected for that age in an international reference population) and micronutrient deficiencies also cause decreases in immune and non-immune host defences, and should be classified as underlying causes of death if followed by infectious diseases that are the terminal associated causes.<sup>22,23</sup> An analysis of ten longitudinal community-based studies of children younger than 5 years showed that being underweight conferred an additional risk of mortality from infectious diseases.<sup>24</sup> The fraction of disease attributable to being underweight was 61% for diarrhoea, 57% for malaria, 53% for pneumonia, 45% for measles, and 53% for other infectious diseases. Fetal malnutrition, manifested in low birthweight, might contribute in a similar way to neonatal mortality.<sup>24</sup> Relative risks for mortality in children younger than 5 years derived from the ten studies assessed have been used to estimate that 53% of all child deaths could be attributed to being underweight (L Caulfield, personal communication). Of these, 35% of all child deaths are due to the effect of underweight status on diarrhoea, pneumonia, measles, and malaria and relative risks of low maternal body-mass index for fetal growth retardation and its risks for selected neonatal causes of deaths.<sup>12,24</sup>

In children with vitamin A deficiency, the risk of dying from diarrhoea, measles, and malaria is increased by 20–24%.<sup>25</sup> Likewise, zinc deficiency increases the risk of mortality from diarrhoea, pneumonia, and malaria by 13–21%.<sup>26</sup> The fraction of these infectious-disease deaths that are attributable to nutritional deficiencies varies with the prevalence of deficiencies; the highest attributable fractions are in sub-Saharan Africa, south Asia, and Andean Latin America.<sup>12</sup> Correct classification of undernutrition and vitamin A and zinc deficiencies as underlying causes of death will permit a true estimate of the importance of these conditions and recognition that interventions can target both the nutritional condition and the resulting terminal infectious diseases.

## Clinical causes of death

### Classification

All countries need sound epidemiological information to prioritise, plan, and implement public health

interventions. Vital event registration that includes cause-of-death data is used to establish the cause structure of mortality in high-income and some middle-income countries, but these are generally not available for the countries where 90% of child deaths take place. Of these countries, only Mexico records more than 95% of causes of death.<sup>27</sup> Where coverage is incomplete, the poorer segments of the population, which have higher mortality and might have different causes of death, are often under-represented.<sup>28</sup> India and China have attempted to establish sample registration systems, but it is not yet clear whether they are truly representative and correctly classify causes of child deaths. Classification of cause of death in vital registration systems is difficult when large proportions of child deaths are not medically attended, and interviews with family members are needed to establish the cause of death.

Alternatives to the reporting of vital events are use of data from nationally-representative surveys and special study populations. With these, ascertainment of death is usually very complete and post-mortem interviews with family members are used to establish causes of death. Although post-mortem interviews have only moderate sensitivity or specificity for some diagnoses, standard methods for data collection and analysis can improve diagnostic accuracy and comparability.<sup>29</sup>

### Neonatal disorders

Of the 10·8 million deaths worldwide of children younger than 5 years, 3·9 million occur in the first 28 days of life—ie, the neonatal period. The proportion of deaths that occur in this age interval varies systematically according to the overall rate of mortality. For example, our analysis of results from 44 demographic and health surveys<sup>30</sup> showed that in populations with the highest child mortality rates, just over 20% of all child deaths occurred in the neonatal period, but in countries with mortality rates lower than 35 per 1000 livebirths more than 50% of child deaths were in neonates (figure 2). Regression of the proportion of deaths in the neonatal period on the proportion of child deaths due to AIDS in that country showed a strong association. We used a combination of the natural logarithm of the rate of deaths in children younger than 5 years and the proportion of such deaths attributable to AIDS to predict the proportion of deaths in the neonatal period ( $r^2=0\cdot76$ ). Predicted deaths were deducted from the neonatal-plus-other category of deaths.

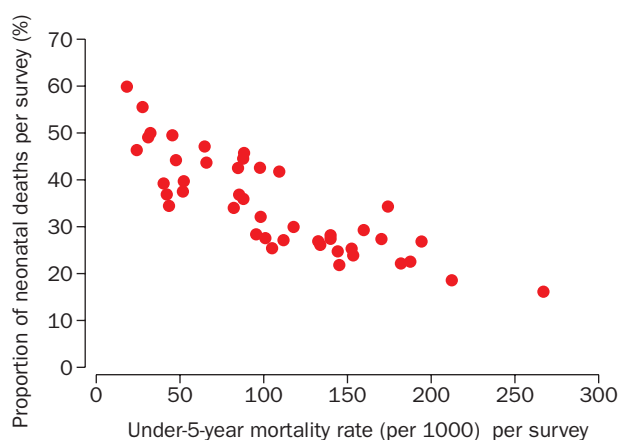


Figure 2: **Relation between under-5-year mortality rate and percentage of these deaths in neonates**

Each dot=one survey.



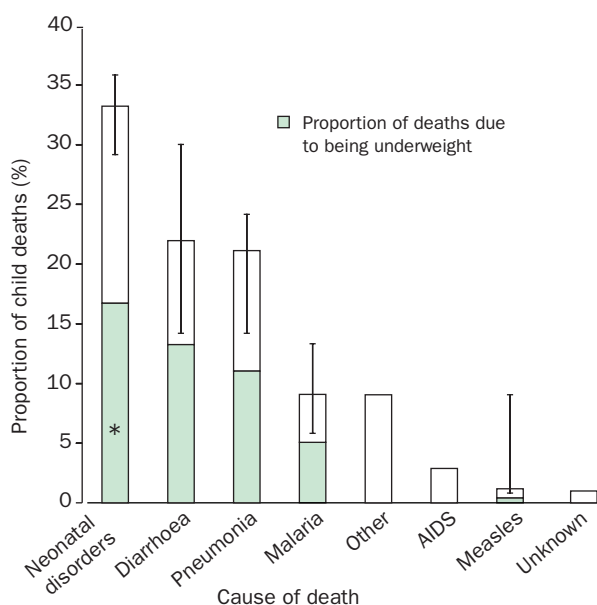


Figure 3: **Distribution of global child deaths by cause**  
 Bars=uncertainty bounds. \*Work in progress to establish the cause-specific contribution of being underweight to neonatal deaths.

There is a paucity of information about the direct causes of neonatal deaths in low-income communities, but it has been estimated that 24% are caused by severe infections, 29% by birth asphyxia, 24% by complications of prematurity, and 7% by tetanus.<sup>31</sup>

#### Distribution of causes of death globally

We used a prediction model to estimate the distribution of deaths in children younger than 5 years by cause for the 42 countries with 90% of all such deaths in 2000.<sup>32</sup> Estimates and uncertainty bounds were: 22% of deaths attributed to diarrhoea (14–30%), 21% to pneumonia (14–24%), 9% to malaria (6–13%), 1% to measles (1–9%), 3% to AIDS, 33% to neonatal causes (29–36%), 9% to other causes, and fewer than 1% to unknown causes (figure 3). No uncertainty bounds are available for the AIDS estimate because the model did not produce these data (country-level estimates from UNAIDS were used).<sup>33</sup> Figure 3 also shows the fraction of deaths attributed to various causes in which the underlying cause was being underweight.

#### Comparison with WHO estimates

Estimates of mortality rates in children younger than 5 years in 2000 by cause are published on the WHO website,<sup>34</sup> and are being revised (C Mathers, personal communication). Estimates available at the time of writing attribute 13% of deaths to diarrhoea, 19% to pneumonia, 9% to malaria, 5% to measles, 3% to AIDS, 42% to neonatal causes (birth asphyxia, low birthweight, and disorders arising in the perinatal period), and 9% to miscellaneous other causes, including non-communicable diseases and injury. Uncertainty bounds for the WHO estimates are not available.

Our estimates are not comparable with those of WHO, because WHO's estimates include all WHO member states rather than only 42 countries. Nevertheless, both sets of estimates are generally consistent. WHO and the prediction model identify pneumonia, diarrhoea, and malaria as causing the greatest numbers of deaths in

#### Distribution of causes of death: comparison of WHO mortality database and cause-of-death model

Uniquely, in the 42 countries where 90% of child deaths take place, Mexico has a vital registration system that is considered complete.<sup>27</sup> Therefore, the coverage of the system is 95% or more and implies that there is unlikely to be any substantial selection bias in the proportional distribution of mortality by cause in children younger than 5 years in the vital registration data. We are, therefore, able to validate the predictions of the cause-of-death model using vital registration-based data from Mexico, provided by the Department of Evidence and Information for Policy of WHO (table 2).<sup>34</sup> The following points are of note.

- The model classes all deaths from infectious respiratory illnesses as pneumonia, on the basis that other respiratory illnesses are very rarely fatal, even in young children.
- The model judges undernutrition to be an underlying cause of most infectious illness, and rejects the idea that a few deaths can be singled out as exclusively attributable to nutritional deficiencies. Those deaths ascribed in the WHO mortality database to nutritional deficiencies (3.1%) are therefore reallocated to infectious causes in proportion to their single disease frequencies.
- The model defines neonatal deaths on the basis of a time period (first month of life), which is expected to be roughly equivalent to the sum of deaths from three categories in WHO data—ie, disorders arising during the perinatal period, congenital anomalies, and tetanus. Sepsis deaths in the neonatal period are included in the model but not the WHO estimates, leading to divergence in these values.
- The WHO mortality database does not include a category of deaths due to undetermined causes, because these are reallocated to all causes in proportion to their frequencies. For the model, 0.1% of deaths were in this category.

In the case of Mexico, the WHO mortality database and the cause-of-death prediction model lead to almost identical conclusions about the proportional distribution of deaths by cause in children younger than 5 years. The model results suggest slightly more neonatal deaths (in part because of the difference in definition of this category), and correspondingly fewer deaths from diarrhoea and pneumonia.

children younger than 5 years. A comparison of proportional mortality by cause derived from the prediction model with the proportions available for Mexico suggests that our model is predicting reasonably well in this context (panel and table 2).

A careful analysis of the differences between the estimates produced by the two approaches, and the reasons for these, will contribute to an understanding of the relative strengths and weaknesses of different sources of child mortality data and different methodological approaches, for all-cause child mortality and for major causes. Methodological work is underway and is expected to lead to updated estimates and reproducible methods that can be applied regularly as new and better data on the causes of child mortality become available.

	Proportion of deaths	
	WHO	Model
Neonatal	47.9%	52.6%
Diarrhoea	17.5%	14.1%
Respiratory infections	10.4%	8.2%
AIDS	0.1%	0.3%
Other	24.1%	24.7%

Table 2: **Distribution of causes of death in WHO database and cause-of-death model**

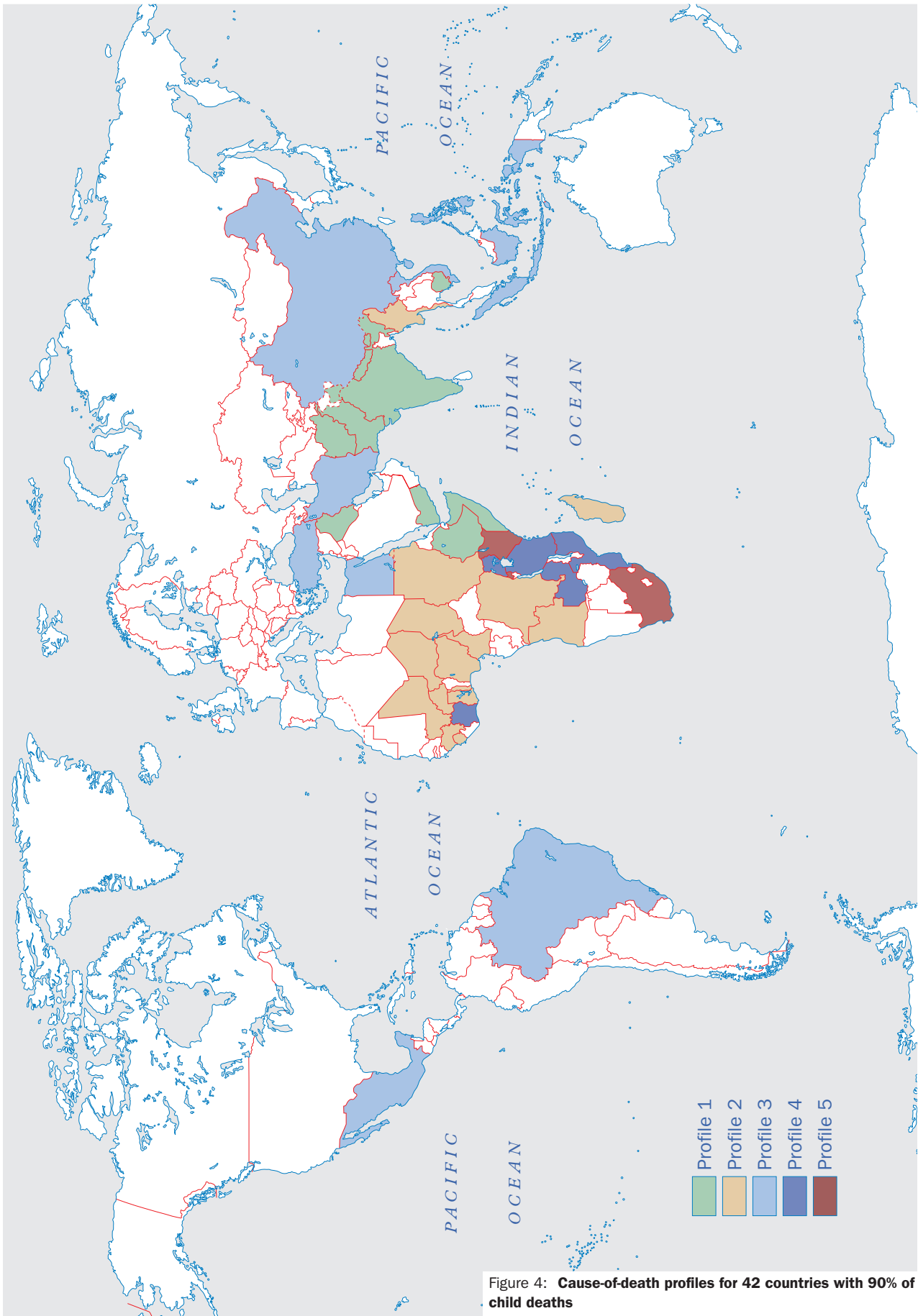


Figure 4: Cause-of-death profiles for 42 countries with 90% of child deaths

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A review of the various models used to estimate under-5-year deaths due to measles is scheduled for later in 2003.

### Country typologies by major causes of death

The cause structure of deaths in children younger than 5 years is determined by many environmental and behavioural factors that are often proxied by broad geographical groupings—eg, the countries of sub-Saharan Africa are frequently grouped together. We used the prediction model to estimate that in sub-Saharan Africa the distribution of causes of death would be: neonatal disorders (25%), malaria (22%), pneumonia (21%), diarrhoea (20%), and AIDS (8%). This aggregation is misleading because some countries in sub-Saharan Africa have very little malaria, and others have very few AIDS deaths; whereas others are severely affected by malaria, AIDS, or both.

We propose an alternative way to group countries on the basis of the proportions of death from each major cause. In the 42 countries we considered, the proportions of deaths caused by pneumonia and diarrhoea were fairly consistent, whereas the proportions for malaria, AIDS, and deaths in the neonatal period differed strikingly between countries. The method of grouping is based on causes of death and consists of five profiles.

1. Malaria and AIDS each account for fewer than 10% of deaths and neonatal causes for fewer than 40%.
2. Malaria accounts for at least 10%, but AIDS accounts for fewer than 10%.
3. Malaria and AIDS each account for fewer than 10% and neonatal causes for at least 40%.
4. Both malaria and AIDS account for at least 10%.
5. Malaria accounts for fewer than 10% and AIDS for at least 10% of deaths.

The 42 countries accounting for 90% of all under-5-year deaths are represented in each of the five profiles (figure 4). Countries in profile 1 (average under-5 year mortality rate 109 per 1000) account for most deaths; in these countries, 24% of deaths are attributed to each of

diarrhoea and pneumonia and 34% to causes in the neonatal period (figure 5). In profile 2 countries (181 per 1000) 20–26% of deaths are attributed to each of diarrhoea, pneumonia, malaria, and neonatal deaths. In the third largest profile (41 per 1000) diarrhoea and pneumonia account for 23% and 15% of deaths, respectively, but 48% of all deaths are in neonates. Profile 4 (169 per 1000) has 17–19% of deaths attributed to each of diarrhoea and pneumonia and 26% to malaria. In the smallest group, profile 5 (106 per 1000), diarrhoea and pneumonia each account for about 20% of deaths, malaria for 6%, and AIDS for 23%.

Our analysis shows that diarrhoea and pneumonia account for large proportions of deaths in all profiles, even as rates of death fall. Together, they do become somewhat less important at low mortality rates, as in profile 3, in which nearly half of all deaths are in neonates. As mortality rates fall, the proportion of deaths in the neonatal period will increase, which should lead the public health community to increase and improve interventions to prevent deaths in newborns.

### Comorbidity in child deaths

#### Synergy in causes of death

An interaction of two health disorders can have a synergistic effect on mortality—ie, a rate of death that is greater than the sum of the two individual rates of mortality. This has been documented most clearly for the relation between being underweight and infectious diseases.<sup>24,35</sup> For example, children who are mildly underweight ( $-2 \leq z$  scores  $< -1$ ) have about a two-fold higher risk of death than those who are better nourished. This risk increases to 5–8 fold in moderately ( $-3 \leq z$  scores  $< -2$ ) to severely ( $< -3$   $z$  scores) underweight children.<sup>24</sup>

#### Co-occurrence of infectious diseases

Another form of comorbidity is the co-occurrence of two infectious diseases, which can occur by chance. More commonly, however, two diseases occur together because

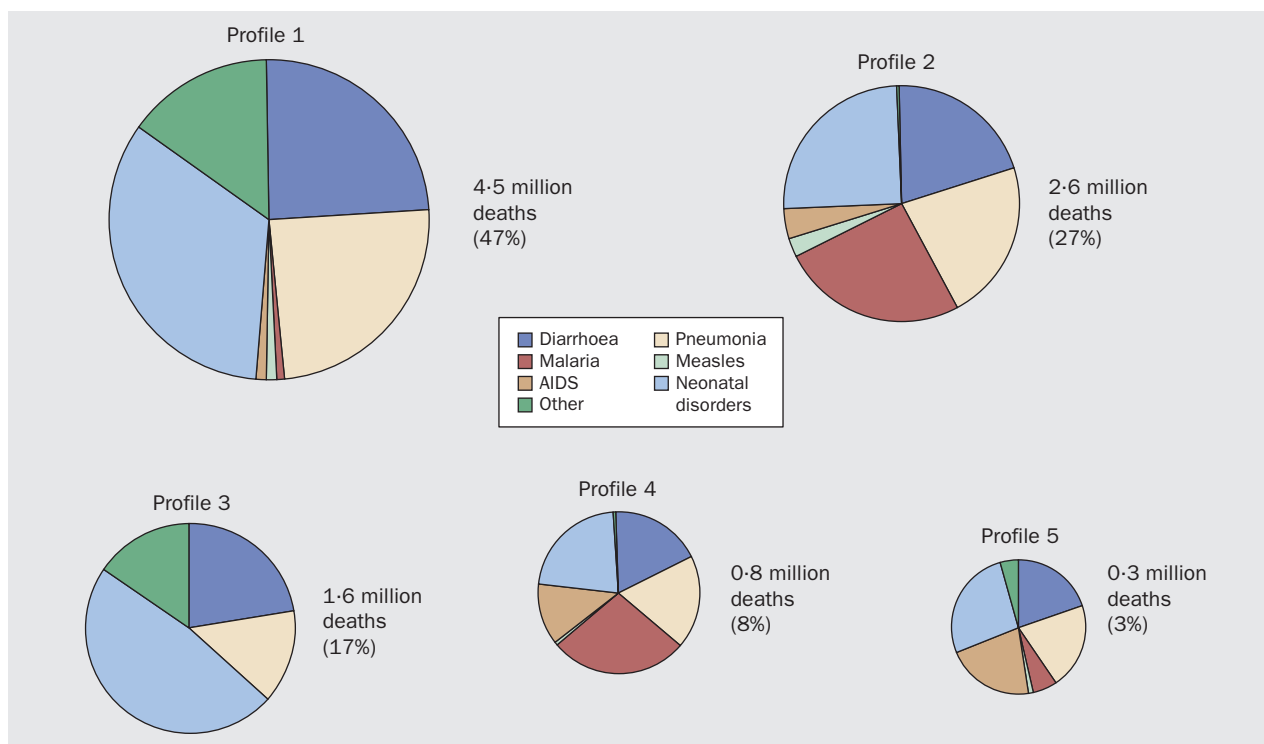


Figure 5: Distribution of child deaths by cause in five profiles for the 42 countries with 90% of global child deaths in 2000

they have the same environmental or behavioural risk factors, such as poor sanitation or no breastfeeding in infancy, leading to increased exposure to infections. This comorbidity may also result in synergism, leading to an increased risk of death.

In the past 10 years, it has become more common for studies to include multiple-cause classifications such as diarrhoea plus pneumonia in the causes of death of young children in low-income countries. We did a systematic search for all studies of causes of death of children younger than 5 years in developing countries<sup>32</sup> and identified eight published studies done in Bangladesh, Egypt, the Philippines, and Guinea.<sup>15,36–41</sup> Unpublished studies from Bangladesh and Haiti were also found (H Perry, personal communication). In these studies, reported proportions of deaths attributed to diarrhoea—as a sole cause or in combination with another cause—varied from 15% to 44%. Deaths from pneumonia varied from 20% to 42%, and deaths attributed to two causes in combination varied from 4% to 16%. These proportions can be combined with the overall risk of a child from the same population dying before their fifth birthday to obtain risks of dying from diarrhoea, pneumonia, or both diseases in combination.

To show that comorbidity is an important public health problem, it needs to be established whether deaths from causes in combination are greater than would be expected if each cause acted independently. Multiplication of the risk of death from diarrhoea by the risk from pneumonia allows estimation of the risk of death expected from the random co-occurrence of the two causes, assuming no shared risk factors and no synergy. In the ten studies we assessed, co-occurrence was between 2·7 and 34·2 (median 8·7) times greater than that expected if synergy and risk factors were not present. This finding suggests either that there are shared risk factors for severe diarrhoea and severe pneumonia, or that the two disorders together synergistically provoke death in affected children. Most likely, both mechanisms operate, because even the most powerful shared risk factors, such as not breastfeeding, could not account for such a substantial increase in risk of death with both causes present.

## Conclusions

Child health epidemiology is developing and increasingly can provide information useful for public health planning, monitoring, and evaluation. Ideally, information on causes and determinants of death would be available for planning at national or subnational levels. Our epidemiological profiles show the extent of variation between major causes of death even within commonly used regional groupings, which highlights the need for disaggregation at regional and global levels to allow public health intervention efforts to be focused appropriately. The availability of valid epidemiological information at country level will be an important determinant of success in meeting and in measuring progress toward the millennium development goal for child survival.<sup>5</sup> Expanded efforts to build capacity and to improve the completeness and accuracy of available data are needed.

Clearly, pneumonia and diarrhoea will continue to be important causes of child deaths until mortality falls to very low rates. Furthermore, nearly two-thirds of deaths in the 42 countries analysed (and 57% of child deaths worldwide) occur in just 19 countries where the predominant causes are pneumonia, diarrhoea, and neonatal disorders—with very little contribution from malaria and AIDS. On the other hand, malaria plays an important part in child mortality in many countries in sub-Saharan Africa. AIDS accounts for more than 10% of

deaths in just three of the 42 countries; however, in some smaller countries, such as Botswana and Zimbabwe, AIDS causes more than half of child deaths.<sup>33</sup>

Undernutrition is the underlying cause of a substantial proportion of all child deaths, and better information on its determinants is needed. The identification of risk factors, detection of underlying and associated causes of death, and recognition of comorbidity can lead to selection of effective and affordable interventions that are appropriate for national delivery systems.

## Contributors

R Black, S Morris, and J Bryce conceived the idea for this article and wrote the paper.

## Conflict of interest statement

None declared.

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