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Epidemiology of childhood diseases

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INTRODUCTION

Children under 15 comprise about one third of the world population, with three quarters living in less developed countries. Children's health varies enormously across the world. In 2003 the under-5 mortality rate was 6 per 1000 in industrialized countries but 175 per 1000 in sub-Saharan Africa.[1]

Understanding the patterns of health and disease is important in planning health and social policies and in monitoring change over time. It is important to recognize the limitations of the data that are available. If the statistics are to be useful for comparing between areas and over time, effective systems must be in place to collect the data and there must be consistency of definitions. In many parts of the world, such systems are rudimentary, although considerable progress has been made in ensuring agreed definitions at least for the principal measures of birth and mortality. The World Health Organization is an excellent source of regularly updated health data which can be accessed on their website[1] and this chapter draws heavily on these data and can be assumed to be the source where no other reference is given.

This chapter will review the patterns of mortality and morbidity amongst children and examine the major determinants of health at a population level. These patterns vary widely between countries. This chapter will discuss mainly the extremes, with data drawn from the rich industrialized nations and the poorest nations, largely in sub-Saharan Africa. Many countries will of course have rates of mortality and patterns of disease lying between these extremes.

In describing the health of children at a population level we are usually forced to rely on measures of mortality or morbidity. Measures of health rather than disease are philosophically attractive but have proved problematic in practice. Although a number of tools have been developed to measure quality of life in childhood their application at a population level has been limited and they have mainly proved useful in clinical trials or in the investigation of the effects of specific conditions.

MORTALITY RATES

DEFINITIONS

Any infant who breathes, has a heart beat or pulsation of the umbilical cord is defined as a 'live birth', irrespective of gestation or the duration of the signs of life. It seems likely that at least some very premature infants who fulfill this definition are not in fact registered as live births and that, as the frontiers of neonatal intensive care have been pushed back over time, this proportion has changed. In the UK a stillbirth is defined now as being 'a child born at 24 or more weeks post conception who shows no signs of life', although, up until 1992, the definition required that they were born at least 28 weeks' post conception.

The definitions of the various perinatal, neonatal and infant mortality rates (IMRs) are shown graphically in Figure 2.1. The denominator for the stillbirth and perinatal mortality rates is the number of still and live births while that for the other rates is the number of live births.

The under-5 mortality rate, widely used, particularly in poorer countries, is defined as the annual number of deaths in children under 5 years of age per 1000 live births. Age-specific death rates are the number of deaths in an age group per 1000 individuals in that age group.

PATTERNS OF MORTALITY

There have been dramatic changes in life expectancy in developed countries over the last century. In 1901, the average life expectancy for women in the UK was 48 years, but by 2004 it was 81 years. Life expectancy for men in the UK, although lower than for women, at 76 years, has also risen greatly[2] (except where specifically referenced, UK data are from the Office of National Statistics, whose website gives access to an enormous range of current and historical data). Although death rates at all ages have declined, much of this change has been due to the rapid decrease in deaths in childhood, particularly in the first half of the century. Changes in death rates during childhood over time for England and Wales are shown in Figure 2.2.[2]

In Tanzania by contrast the life expectancy for women in 2004 was 49 and for men, 47. Much of the difference in life expectancy between the UK and Tanzania is driven by differences in childhood mortality, particularly mortality under the age of 5. The probability of dying between 15 and 60 years of age per 1000 population was 102 in the UK and 5.5 times higher (552 per 1000) in Tanzania. However, the under-5 mortality rate in the UK in 2004 was 6 per 1000 live births and 126 in Tanzania, 21 times higher. All these figures are for males, rates for females showing similar patterns but lower absolute rates. Not only are the relative differences larger in childhood but each childhood death contributes more to the total years of life lost and hence the life expectancy figures.

Not only are absolute mortality rates higher in poorer countries but the pattern of change over time is also different. Globally the under-5

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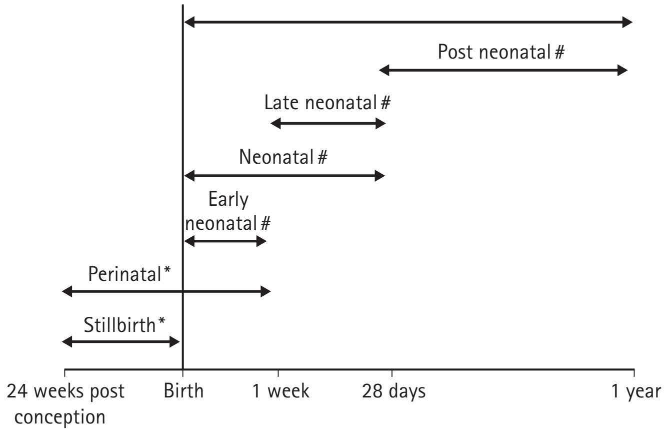


Fig. 2.1 Definitions of mortality rates in the neonatal period and infancy.

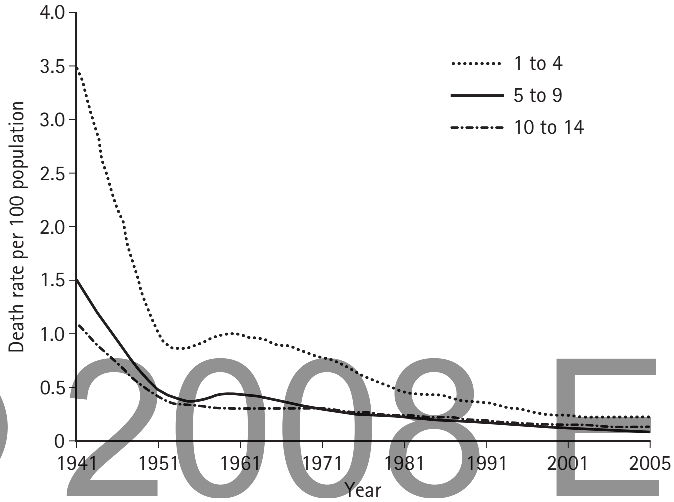


Fig. 2.2 Death rates in children in England and Wales over time.[2]

mortality rate fell from 198 in 1000 in 1960 to 80 in 1000 in 2003. This hides a huge variation in the rate of decline, with the least progress generally being made in countries which started with the highest rates. In 93 countries containing 40% of the world's population, < 5 mortality is declining fast, in 51 (48% of the population) progress is slow and in the remaining 43 (12% of the population), mostly clustered in sub-Saharan Africa, rates are stagnant or rising (Table 2.1).

Table 2.1 Changes in under-5 and infant mortality rates per 1000 live births over time by region[1]

	Under-5 mortality rate		Infant mortality rate	
Region	1960	2003	1960	2003
Industrialized nations	39	6	32	5
Developing countries	224	87	142	60
Least developed countries	278	155	127	54
Sub-Saharan Africa*	278	175	165	104
World	198	80	127	54

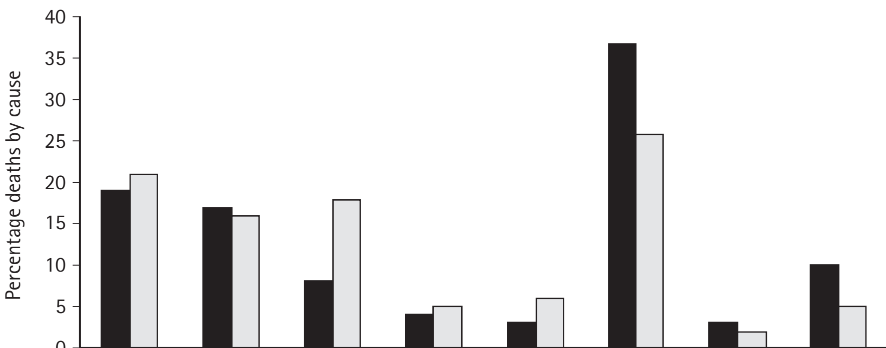
*Most countries in sub-Saharan Africa are included within the category 'least developed countries' but the region is shown separately to emphasize the slow rate of improvement.

MORTALITY IN POOR COUNTRIES

The burden of mortality in children in poor countries is extraordinary. In sub-Saharan Africa some 10% of infants die in the first year of life (compared to around 0.5% in Europe) and over 15% before their 5th birthday. The proportions of deaths related to major causal groups is shown in Figure 2.3 for under-5s in Africa and in western Europe[3]. Nearly three quarters of these deaths are due to six causes: (1) pneumonia (19%), (2) diarrhea (18%), (3) neonatal sepsis or (4) pneumonia (10%), (5) preterm delivery (10%) or (6) asphyxia at birth (8%). It is estimated that undernutrition is an underlying cause in over 50% of deaths in under-5-year-olds.

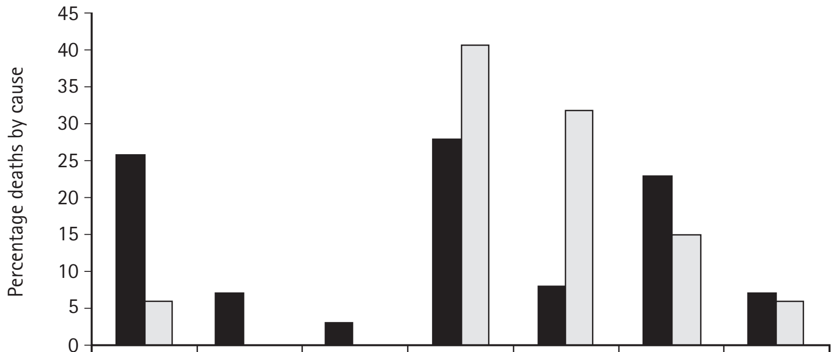
The first year of life is the most dangerous period of childhood and globally 40% of under-5 deaths occur in the neonatal period. The proportion is lower in Africa (26%) because of the higher burden of deaths in the post-neonatal period, although the neonatal death rates are highest here. As in the resource rich world, the consequences of prematurity and low birth weight are important causes of neonatal deaths in resource limited countries but infections (including neonatal tetanus) are also important (Fig. 2.4).[3] The high risks related to underlying poverty are exacerbated by the lack of services. In Africa only 40% of women deliver with skilled care and in South Asia less than 30%.[4]

Communicable diseases are responsible for around half of the under-5 deaths in the world and nearly two thirds in Africa. Malaria is particularly important in Africa with 94% of all malaria deaths occurring in this region. A similar picture is seen with deaths from human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS) where 89% of deaths are in Africa although this picture is likely to change as the prevalence of the infection rises in poor countries of Southeast Asia. The deaths of over 400 000 children per year due to measles is depressing considering the availability of a cheap and effective vaccine which



	Pneumonia	Diarrhea	Malaria	Measles	HIV/AIDS	Neonatal causes	Injuries	Other
■ World	19	17	8	4	3	37	3	10
□ Africa	21	16	18	5	6	26	2	5

Fig. 2.3 Percentage of deaths of under-5-year-olds by cause in the world and in Africa 2000–2003.[3]



	Infection	Neonatal tetanus	Diarrhea	Prematurity	Congenital anomalies	Birth asphyxia	Other
■ Africa	26	7	3	28	8	23	7
□ Western Europe	6	0	0	41	32	15	6

Fig. 2.4 Percentage of neonatal deaths by cause in Africa and western Europe 2000–2003.[3]

Table 2.2 Proportion < 5 deaths by cause in the 42 countries in which 90% of all < 5 deaths occur which are potentially preventable[5]

Disease or condition	% total deaths	% preventable
Diarrhea	22	88
Pneumonia	21	65
Malaria	9	91
HIV/AIDS	3	48
Measles	1	100
Neonatal disorders	33	55

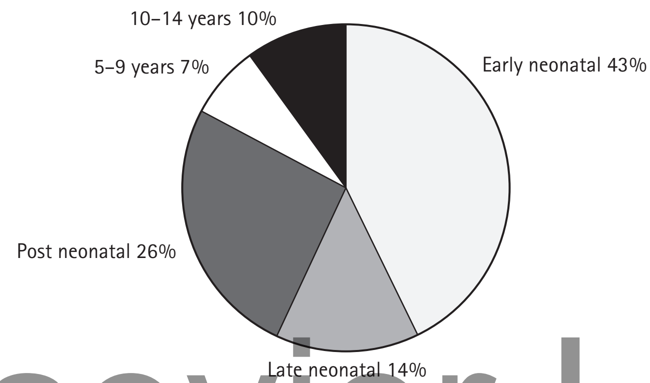


Fig. 2.5 Proportion of deaths in childhood by age of occurrence (England and Wales 2005).[2]

has virtually eliminated deaths from this condition in countries with high vaccine coverage.

The vast bulk of these deaths are related directly or indirectly to poverty. Knowledge already exists about effective interventions for both treatment and prevention, which could substantially reduce this burden. It has been estimated that about two thirds of these deaths could be prevented by a small number of key interventions of proven effectiveness which could feasibly be introduced in low-income countries (Table 2.2).[5] The interventions considered are relatively cheap and simple including measures such as the use of oral rehydration fluid in diarrhea, insecticide treated materials for the prevention of malaria, antibiotics for neonatal sepsis and pneumonia and encouragement of high rates of breast-feeding.

CHILDHOOD MORTALITY IN THE INDUSTRIALIZED WORLD

Of all deaths in childhood in the UK (ages 0–14), 73% occur within the first year of life, 50% within the first month and 38% within the first week (Fig. 2.5).[2] The decline in the rate of stillbirths and infant mortality in England and Wales is shown in Figure 2.6. The rates for stillbirth after 1992 are not strictly comparable because of the change in definition mentioned earlier. The decline in infant mortality reflects declines in both neonatal and post-neonatal mortality rates.

In the neonatal period, a substantial proportion of deaths are related to congenital anomalies and prematurity (Fig. 2.4). Congenital anomalies are an important cause of death in the neonatal period although the birth prevalence of many anomalies appears to have declined, particularly that of anomalies of the central nervous system. While part of this decline appears to relate to the widespread introduction of screening for neural tube defects in pregnancy there has also been a substantial decline in incidence, possibly related to changes in diet or the use of periconceptual folate supplements.

Congenital anomalies remain an important cause of death after the neonatal period, accounting for 22% of all deaths between 1 month and 1 year of age in England and Wales in 2005. As with older children,

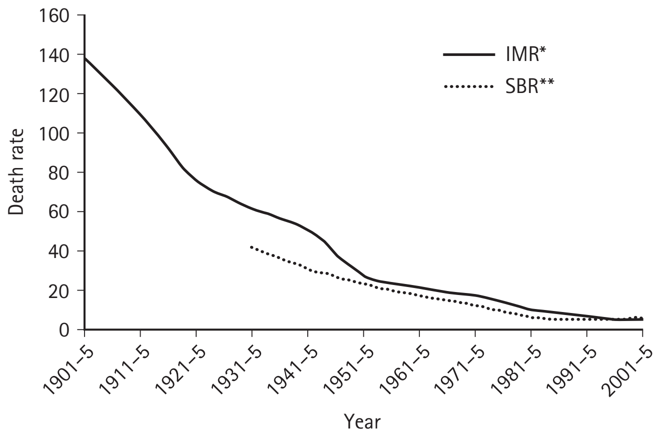


Fig. 2.6 Changes in stillbirth and infant mortality rates over time (England and Wales).[2] * Per 100 live births. ** Per 100 live and stillbirths.

injuries and poisoning are responsible for a significant number of deaths in the first year of life, but in this age group, the much higher rates of death from other conditions mean that they are responsible for a relatively small proportion of all deaths.

Even within the industrialized world there are substantial variations in IMRs (Table 2.3)[1]. While there is an obvious relationship between mortality rates and wealth there are some surprising anomalies. For example, the USA has an IMR more than twice that of Sweden. To some extent, this appears to reflect differences in IMRs in different population groups within the same country. In the USA, in 2002, the IMR for infants born to non-Hispanic black mothers was 2.4 times higher than

Table 2.3 Infant mortality rates in some selected industrialized countries (2002)[1]

Country	IMR (per 1000 live births)
Sweden	3.3
Norway	3.5
Austria	4.1
France	4.1
Germany	4.2
Italy	4.5
The Netherlands	5.1
Ireland	5.1
UK	5.2
Canada	5.4
New Zealand	5.6
United States	7.0

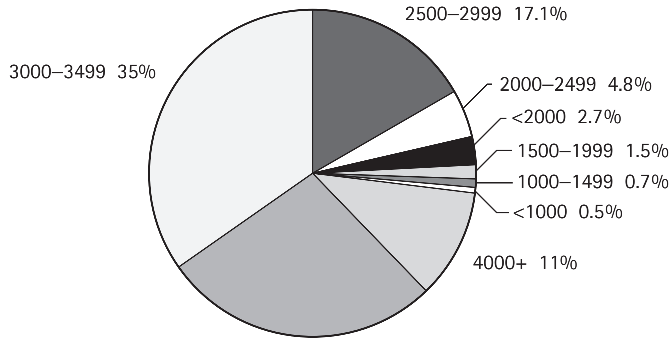


Fig. 2.8 Proportion of live births by birth weight in grams, England and Wales (2004).[2]

in non-Hispanic white, and different states reported IMRs ranging from 5.0 in New Hampshire to 11.3 in the District of Columbia.[6]

Birth weight, reflecting both gestation and intrauterine growth, is the strongest predictor of the risk of death in the first year of life (Fig. 2.7). In large part, differences in mortality between, for instance, Sweden and the UK and between different ethnic groups in the USA are accounted for by differences in the birth weight distribution. The proportion of babies by birth weight group in England and Wales in 2004 is shown in Figure 2.8. In recent decades there has been a small overall increase in mean birth weight in many industrialized countries, largely accounted for by an increase in the proportion of babies born weighing more than 3500 g. There has also, however, been an increase in the proportion of babies born weighing less than 2500 g, in the USA from 6.7% of live-born infants in 1984 to 8.1% in 2003. This partly reflects increasing numbers of twins and higher order births, which in the USA now comprise over 3% of all births.[6]

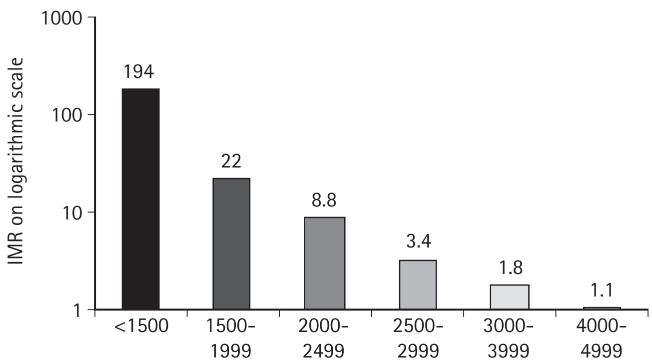


Fig. 2.7 Infant mortality rate (IMR) by birth weight (England and Wales 2004).[2]

The risk of death drops rapidly after the first year of life; in the UK to around 21 per 100 000 children aged 1–4 and to 9 per 100 000 aged 5–14 compared to a risk of death in the first year of life of 520 per 100 000 live births. Death rates then begin to rise again after the age of 15, particularly in boys and largely as a result of the increasing risk of injuries.[2]

As shown in Figure 2.2, the risk of death from all causes in childhood has been falling throughout the last 50 years. Rates of death from unintentional injury in children have also fallen, but injury and poisoning still remain responsible for the greatest proportion of deaths in older children. Table 2.4 compares the most common attributable causes of death in children aged 1–14 in 1955, 1985 and 2005, in England and Wales. Very similar patterns are seen in the USA[6] although unintentional injury rates are higher than in England and Wales and homicide is a more important cause of death in children. In 2000 in the USA, homicide accounted for some 5.8% of deaths in children aged 1–14 compared to 2.0% in England and Wales.[1] Amongst adolescents aged 15–19 in the USA in 2003, accidents were responsible for 49.7% of deaths, homicide for 13.9% and suicide for 10.9%.[6] In both the UK and USA the risks of non-intentional and intentional injuries are substantially higher in boys than in girls.

MORBIDITY IN CHILDHOOD

Morbidity data are more difficult to obtain, especially in poorer countries, and to interpret than mortality data, which are generally easily available and reasonably reliable. However such data are essential if a picture of the health of the population can be built up.

HEALTH SERVICE USE

Children are heavy users of health services and routine service data can provide useful information about patterns of morbidity. A number of different sources of health service data are available in the UK, some

Table 2.4 Percentage deaths age 1–14 by leading causes in order of frequency in 1955, 1985 and 2005 in England and Wales[2]

1955		1985		2005	
Category	%	Category	%	Category	%
Injury and poisoning	25.0	Injury and poisoning	33.6	Injury and poisoning	20.5
Respiratory disease*	13.0	Congenital anomalies	15.3	Malignant disease	20.0
Malignant disease	11.7	Malignant disease	14.0	Diseases of the CNS	13.9
Infectious disease	9.4	Diseases of the CNS	9.4	Congenital anomalies	11.3
Congenital anomalies	8.7	Respiratory disease	6.2	Respiratory disease*	8.1
Diseases of the GIT	4.1	Infectious diseases	4.0	CVS disease	6.6

derived directly from the use of services and some from special surveys such as the annual 'General Household Survey', which includes self-reported health and use of services.[7] Somewhat confusingly, these often cover different components or combinations of components of the UK. All these routine data have to be interpreted with some caution. Changes in admission rates over time for instance may reflect changes in classification either by health professionals or those who code the data, changes in thresholds for admission or real changes in incidence.

Admission of children to hospital is relatively common. In the UK, in 2002, around 11% of 0–4-year-olds and 4% of 5–15-year-olds reported being admitted to hospital at least once in the previous year.[7] There has been a steady decline in both the proportion and the average length of stay in hospital over time. The two most important reasons for admission in 5–14-year-olds are respiratory conditions, (including asthma), and injuries, each accounting for about 16% of admissions.

Children are also frequent visitors to Accident and Emergency departments and to general practitioners (GPs).[7] More than 11% of British children report going to an Accident and Emergency department over a 3-month period. Those under 5 visit a GP on average seven times per year and those between 5 and 15, three times per year. Data collected in Scotland suggest that the commonest reasons for these GP visits are upper respiratory tract infections, otitis media, coughs, sore throats and other minor conditions.

CHRONIC DISEASE AND DISABILITY

Data on chronic disease and disability are relatively poor, even in countries with highly developed health systems. In the UK, special studies generally have to be relied upon for this information. Unfortunately there are often problems with the representativeness of the samples and with the quality of the definitions used.

The General Household Survey, mentioned earlier, asks a representative group of people in the UK to report on their own and their children's health. One of the questions asks whether they have a longstanding illness and whether it limits their activities. In 2002, the parents of 20% of boys and 17% girls aged 0–14 said that their child had a longstanding illness and 7% said that this limited their child's activities.[7]

Reliable information on the prevalence of disability in childhood, except for the prevalence of a few well-defined conditions such as Down syndrome, is particularly difficult to find. Such information may also be difficult to interpret, as children's functional abilities form a continuum, and the point at which the child is labeled as 'disabled' is arbitrary. A national survey in the UK, published in 1989, reported 3% of 0–15-year-olds were perceived by their parent as disabled.[8] Clearly such reports depend on the definitions used, the way the data are collected and the population, leading to widely varying estimates. In 1994[9] Boyle et al reported that 17% of US children had developmental disabilities while in 2006[10] Blanchard et al suggested that the figure was 5%. Using multiple methods of ascertainment a study based in Atlanta (roughly 50 000 births/year) has reported on the prevalence of four specific developmental disabilities (Table 2.5).[11]

Table 2.5 Prevalence of selected developmental disabilities in Atlanta (2000)[11]

	Prevalence /1000 children
'Mental retardation'*	12.0
Mild	8.7
Moderate, severe or profound	3.3
Cerebral palsy	3.1
Hearing loss (> 40 dB)	1.2
Visual impairment (20/70 or worse corrected)	1.2

* In Europe the term more commonly used is 'learning disability'. Mental retardation was defined here as IQ <70 (mild = IQ 50–70, moderate/profound = IQ <50).

Estimates of the prevalence of cerebral palsy, the most common form of serious physical disability in childhood, are available from a number of countries. Most recent studies in industrialized countries report rates of cerebral palsy between 2 and 3 per 1000 infants surviving the neonatal period. There is conflicting evidence about trends over time. In the UK, one study reported a change between 1964–1968 and 1989–1993 from 1.68 to 2.45/1000 neonatal survivors.[12] A report combining data from five UK registers of cerebral palsy seems to suggest that rates rose during the late 1970s and then flattened thereafter but is unclear about the extent to which this represents changes in ascertainment.[13] The rate in babies born weighing > 2500 g has remained virtually constant over this period while one large study has reported that in western Europe the rate in very low birth weight babies (< 1500 g) fell from 60.6/1000 live births in 1980 to 39.5/1000 in 1996.[14] There have also been increases in the lifespan of children with cerebral palsy, which will further increase the overall prevalence of cerebral palsy in the population.

The life expectancy of children with a number of other chronic conditions has also increased in the developed world, which is again likely to raise the prevalence of such conditions in the population. A survey carried out in one health district in the UK attempted to ascertain what proportion of children suffer from nonmalignant 'life-threatening' conditions.[15] These were defined as conditions as a result of which the child had at least a 50% likelihood of dying before the age of 40 and included conditions such as cystic fibrosis, chronic renal failure and conditions causing central nervous system degeneration. The overall prevalence among children aged 0–19 was 1.2/1000, suggesting a large burden on families and services.

Mental health problems are extremely common in children and adolescents. A large population survey carried out in Great Britain in 2004 of children aged 5–16 reported that 9.6% had a mental disorder (based on ICD 10 diagnostic criteria).[16] The prevalence rises with age and rates are generally higher in boys than girls except for emotional disorders (Table 2.6). Even apparently milder psychological problems such as behavioral difficulties which would not fulfill the criteria for a mental disorder in young children can have profound effects on the quality of families' lives.

Disabling conditions in poor countries

The prevalence of disabling conditions in children is believed to be disproportionately high in poorer countries although the sources of high-quality data are few.[17] Mung'ala-Odera et al[18] reported that 61 of 1000 6–9-year-old children in one rural area in Kenya had moderate to severe neurological impairment (Table 2.7). The authors point to the relatively low prevalence of cerebral palsy in their population and suggest that this is likely to be related to a high mortality rate in these children in poor communities. The higher rates seen in girls than boys in this study are surprising and unexplained. A study of intellectual disability in children of the same age group in rural South Africa (defined as IQ < 80, mild 56–80, severe < 55) reported the more commonly observed excess in males who were 1.5 times as likely to be affected.[19] The overall reported prevalence was 35.6 of 1000 (mild 29.1 of 1000, severe 6.4 of 1000).

Poverty leads to poor nutrition, recurrent illness and inevitably deficient care as families struggle to survive. In addition to the more obvious

Table 2.6 Percentage of children with a mental disorder by age and gender in Great Britain in 2004[16]

Disorder	5–10 years		11–15 years	
	Boys	Girls	Boys	Girls
Emotional disorder	2.2	2.5	3.9	6.0
Conduct disorder	6.9	2.8	8.8	5.1
Hyperkinetic disorder	2.7	0.4	2.6	0.3
Autistic spectrum disorder	1.9	0.1	1.0	0.5
Any disorder	10.2	5.1	13.1	10.2

Table 2.7 Estimated prevalence of moderate to severe neurological impairment in 6–9-year-olds in rural Kenya per 1000 children[18]

Impairment	Boys	Girls	Total
Epilepsy	37	45	41
Cognitive impairment	27	36	31
Hearing impairment	12	15	14
Motor impairment	5	4	5
Visual impairment	2	2	2
Any impairment	52	79	61

severe forms of disability this poverty of environment means that children fail to reach their developmental potential. Grantham-Macgregor et al estimate that more than 200 million children under the age of 5 fail to reach their potential in cognitive development as a result of poverty.[20] This has serious economic and social consequences for them as individuals and for the societies in which they live.

POPULATION DETERMINANTS OF CHILD HEALTH

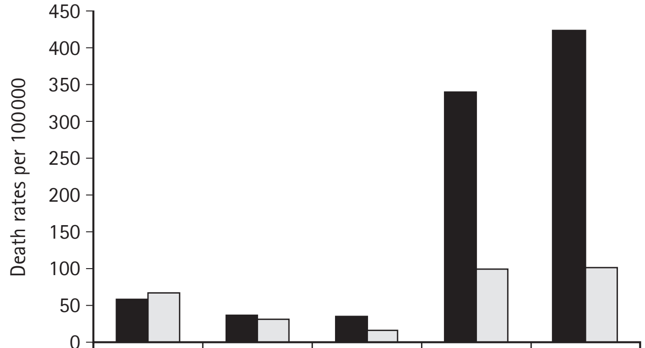
The health of an individual is determined by a complex interaction between genetic factors, health behaviors and environmental influences.

AGE AND SEX STRUCTURE OF THE POPULATION

Between the ages of 5 and 15 the risk of death and severe illness is at its lowest, before rising again. Death rates are higher in boys than girls at all ages in both poor and rich countries (Fig. 2.9 shows the rates by age and gender for England and Wales). The magnitude of the difference varies with age, in the UK rising from around 25% higher in boys from birth until the age of 15 and then becoming more than twice as great in adolescence and early adulthood. Much of this increasing discrepancy between the sexes is due to the much higher rates of unintentional injuries in males, particularly later in childhood and adolescence. The death rates from all injuries and poisoning (which includes the small numbers of deaths due to intentional injuries) in the UK are shown in Figure 2.10, broken down by age and gender.

GENETIC FACTORS

At an individual level there is no doubt that genetic factors play an important role in determining health status. At a population level however, there is little evidence that they have a significant effect on overall health. The genetic differences between human subpopulations are in fact small and it appears that differences in health are largely accounted for



	<1	1–4	5–9	15–24	24–34
■ Males	58	37	35	341	424
□ Females	67	31	16	99	101

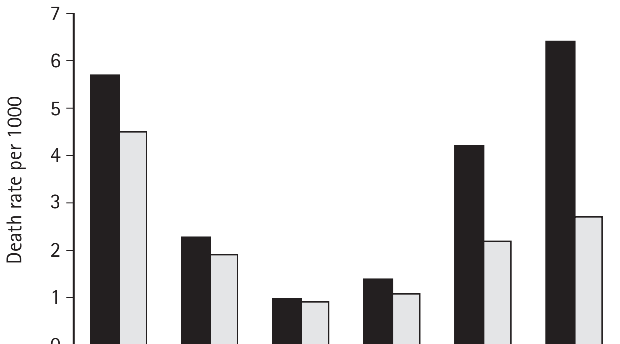
Fig. 2.10 Death rates form injury and poisoning per 100 000 by age and gender in England and Wales (2004).[2]

by environmental and behavioral differences. Clearly there are differences between populations in the frequency of some specific single gene disorders – for instance, sickle cell disease is uncommon in northern Europeans and cystic fibrosis is uncommon in Africans – but these contribute relatively little to the health experience on a population level. In other words, an individual's genetic makeup is important in determining their risk of ill health within a particular subpopulation who share common experiences, but not in explaining the differences between these subpopulations. This is borne out by numerous studies of immigrant populations, which suggest that the longer they spend in a new country and the more they adopt the lifestyle of that country, the more nearly their health experience comes to resemble that of the native population. Most differences that continue to exist between immigrant groups and the native population can be explained on the basis of either behavioral or socioeconomic factors.

BIRTH WEIGHT AND GESTATION

Birth weight, reflecting both gestation and intrauterine growth, is a powerful predictor of mortality (Fig. 2.7) and morbidity (e.g. cerebral palsy, Fig. 2.11)[21] in childhood. Globally 60–80% of neonatal deaths occur in low birth weight infants. In recent years it has been recognized that the effects of suboptimal birth weight may persist throughout life, with links being demonstrated between birth weight and cardiovascular and respiratory disease in adulthood. It appears that these adverse effects have a nearly linear relationship with birth weight rather than simply being associated with the lower extreme of the birth weight distribution.

Many of the determinants of both prematurity and poor intrauterine growth remain to be elucidated, although some specific conditions such as pre-eclamptic toxemia are important in individuals. Poor intrauterine



	<1	1–4	5–9	10–14	15–19	20–24
■ Males	5.7	2.3	1	1.4	4.2	6.4
□ Females	4.5	1.9	0.9	1.1	2.2	2.7

Fig. 2.9 Death rates per 1000 by age and gender in England and Wales (2005).[2]

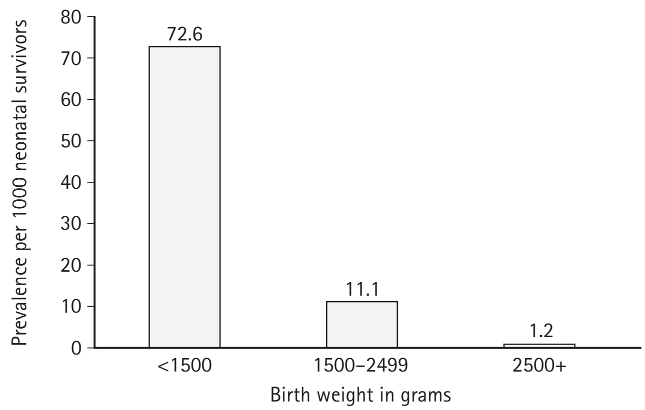


Fig. 2.11 Prevalence of cerebral palsy by birth weight in Europe.[21]

growth is associated with smoking during pregnancy and with socioeconomic deprivation. Diet has often been suggested as a possible cause of intrauterine growth retardation but good evidence for this is lacking, except for the effects of extreme malnutrition.

PHYSICAL ENVIRONMENT

While some specific environmental hazards have been clearly identified, the links between others such as damp, overcrowded housing or atmospheric pollution and ill health have been difficult to determine. Many of these, possibly disadvantageous, conditions tend to occur in combination with each other and with socioeconomic disadvantage, making it difficult to disentangle their effects. Many pollutants in the environment or in food are so widespread that investigation is difficult. It is also possible that it is the interactions between such pollutants that are important, which further complicates attempts to quantify their effects. It could be argued that, in these circumstances, it may be appropriate to accept lower levels of evidence before proceeding to action, sometimes referred to as the precautionary principle, than would generally be required for reaching conclusions about causal links.

SOCIAL FACTORS

Socioeconomic status (SES) is a powerful predictor of health outcome within all societies. Within poor countries, this is unsurprising, given that SES is linked to the availability of basic necessities including food and shelter. What is perhaps remarkable is that the link remains strong even in rich industrialized countries. What may seem equally surprising is that the differences exist, not simply between the poorest members of society and the rest of the population, but, for many important health outcomes, there is something approaching a linear relationship between SES and adverse outcome.

How best to measure SES in childhood remains a source of debate. It is clearly a complicated concept and it seems likely that different aspects of disadvantage will be important for different health outcomes. In the UK, SES has traditionally been measured using an occupational classification. This scheme, first employed around the beginning of the twentieth century, assigned all occupations to six (originally five) groups based on a notion of a hierarchy of status. In 2001 this system was replaced by a new eight-group classification, the National Statistics Socio-economic Classification. Other classifications have been developed based on factors such as maternal education, income, access to material goods such as motor cars or telephones, type of housing and the nature of the area in which the family lives. Although the strength of the association between SES and a particular outcome may vary according to the measure used, the direction of effect is virtually always the same.

The effects of SES are observable from the beginnings of life, with a strong relationship between birth weight and SES. Figure 2.12 shows the proportion of infants born weighing less than 2500 g in SES deciles in one region of the UK (based on the characteristics of the small area in which they live).[22] Perhaps even more striking is the proportion of infants born weighing more than 3500 g (regarded as being an optimum birth weight) in different SES deciles (Fig. 2.13). In both figures there is a clear gradient across the different social groups. The magnitude of this effect is illustrated by the fact that this study reported that, if the whole population had the risk seen in the richest 10%, this would avoid 30% of all births below 2500 g and 32% of births below 1500 g.

In the UK in 1994–1999 the difference in life expectancy at birth between children in the 10% of most deprived areas in the UK and those in the richest 10% was 6 years for boys and 3.2 years for girls.[2]

The differences in infant mortality across social classes are shown in Figure 2.14. Particularly marked differences are seen in mortality from injuries and poisoning between social groups (Fig. 2.15).[23]

Similar differences are seen for most measures of morbidity, where figures are available, with large differences being shown between social groups for the risk of admission to hospital, for severe respiratory infections and for mental disorders (Table 2.8).[16] Finally, SES in early childhood strongly predicts the likelihood of educational achievement, which in turn predicts later job opportunities and income.

SES can of course not be said to directly cause ill health, but rather acts as a marker for various adverse circumstances and behaviors, which are the proximal causes for health outcomes. There is growing evidence that these circumstances cumulate over the life course and that the longer a child spends in adverse social circumstances, the greater the risk of poor health outcome.

HEALTH BEHAVIORS

There is considerable evidence of the deleterious effects of a number of health behaviors by parents and children on the health of children. Smoking by parents, and by children, in particular, is a major cause of many adverse outcomes including intrauterine growth retardation, sudden infant death syndrome and respiratory disease. At least in the UK and USA, smoking is much more common amongst people in poorer social circumstances and is likely to be one of the mechanisms through which SES has its effects on children's health. This close relationship between SES and smoking does, however, hamper efforts to estimate the magnitude of the effect of smoking per se as its effects may be confounded by other adverse circumstances.

Harmful effects of poor diet and lack of exercise in childhood have also been suggested. Very large increases in the proportion of children who are overweight or obese have been reported in the UK and USA. Between 1994 and 2004 in the UK the proportion of 11–15-year-old boys who were obese rose from 14% to 24% and of 11–15-year-old girls from 15% to 26%.[24] As there is substantial tracking between fatness in childhood and adulthood, this may have important implications for

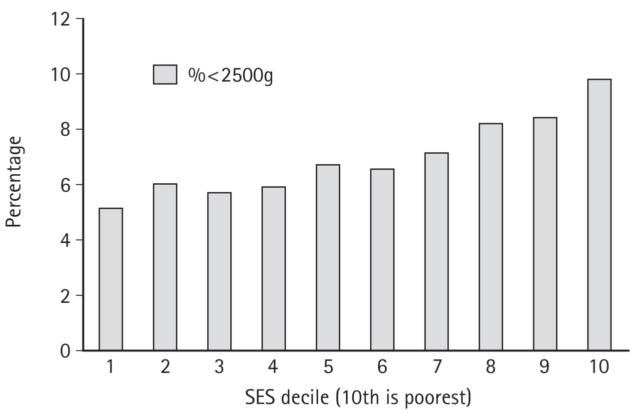


Fig. 2.12 Percentage of births < 2500 g by SES decile in the West Midlands, UK.[22]

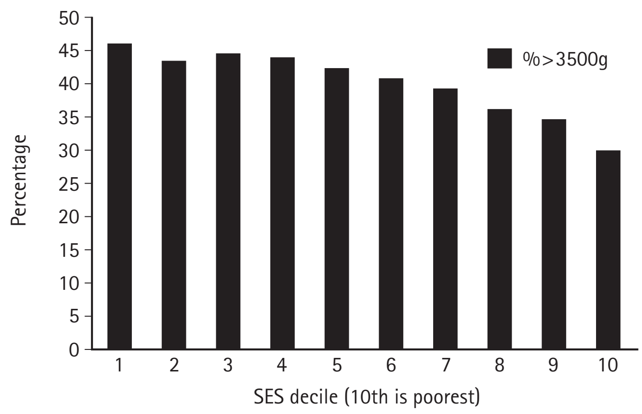
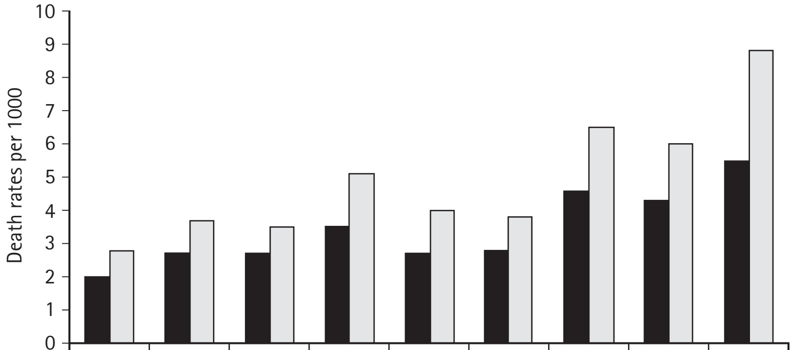


Fig. 2.13 Percentage of births > 3500 g by SES decile in the West Midlands, UK.[22]



	1.1	1.2	2.0	3.0	4.0	5.0	6.0	7.0	Unclass
■ Neonatal mortality	2.0	2.7	2.7	3.5	2.7	2.8	4.6	4.3	5.5
□ Infant mortality	2.8	3.7	3.5	5.1	4.0	3.8	6.5	6.0	8.8

Social class

Fig. 2.14 Neonatal and infant mortality rates by parental occupational social class for jointly registered births in England and Wales (2004).[2]

Fig. 2.15 Deaths in children aged 0–15 from injury and poisoning per 100 000 by occupational social class, England and Wales (2001–2003).[23]

Table 2.8 Percentage of children aged 5–16 with a mental disorder by gender and weekly household income in Great Britain, 2004[16]

Household income	Boys	Girls
< £100	18.4	13.4
£100–199	13.9	13.0
£200–299	17.8	11.5
£300–399	14.8	9.8
£400–499	10.2	6.8
£500–599	10.6	7.1
£600–770	6.0	3.7
>£770	6.7	3.9

the risk of cardiovascular disease and type 2 diabetes in later life. It has been suggested that these increases are likely to reflect declining levels of physical activity and the increasing consumption of convenience foods, although clear etiological evidence is lacking.

HEALTH SERVICES

Until recent years there has been surprisingly little evidence that health services are an important determinant of children's health in richer countries. The obvious exceptions are immunization and public health measures such as the provision of safe water supplies. Even for vaccine-preventable diseases, much of the decline in mortality in these countries preceded the introduction of immunization. It is nonetheless true that immunization has been associated with dramatic declines in deaths from measles, polio, meningococcal disease and other conditions which were major causes of deaths into recent times.

It is clear that the major determinants of child health lie outside the realm of curative services and are related to social and environmental factors. However, in rich societies, the rates of mortality have fallen to very low levels and the importance of the effective management of relatively uncommon conditions has become proportionately more important in determining mortality rates. For instance, the widespread use of antenatal steroids in women in preterm labor and of surfactant in premature infants has led to substantial declines in mortality from idiopathic respiratory distress syndrome in neonates. Similarly, as malignant disease accounts for an increasing proportion of childhood deaths, improvements in cure rates due to medical management can have significant effects on childhood mortality rates.

As discussed earlier, simple interventions by health services have the potential to significantly reduce deaths and morbidity in the poorest communities in the world. The difficulty has been in trying to introduce such services in the face of a shortage of resources and often weak governmental structures which are not always responsive to the needs of the poorest members of society. The 'inverse care law'[25] was first described in the UK in the 1970s and suggested that 'The availability of good medical care tends to vary inversely with the needs of the population served.' Unfortunately this law still applies between countries and between population groups, within even the poorest. For instance, in sub-Saharan Africa and Southeast Asia, amongst the 20% of richest women 86% have skilled care at the birth of their children compared to only 14% amongst the poorest 20%.[4]

While health services can significantly ameliorate the consequences of many diseases they can also lead to an increased prevalence of children with significant morbidity. Some of the children who are saved from death may survive with significant morbidity and may be kept alive for long periods in spite of their disabilities. It is important that clinicians recognize both the importance of factors outside their control in determining children's health and the potential societal consequences of advances in technology.

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