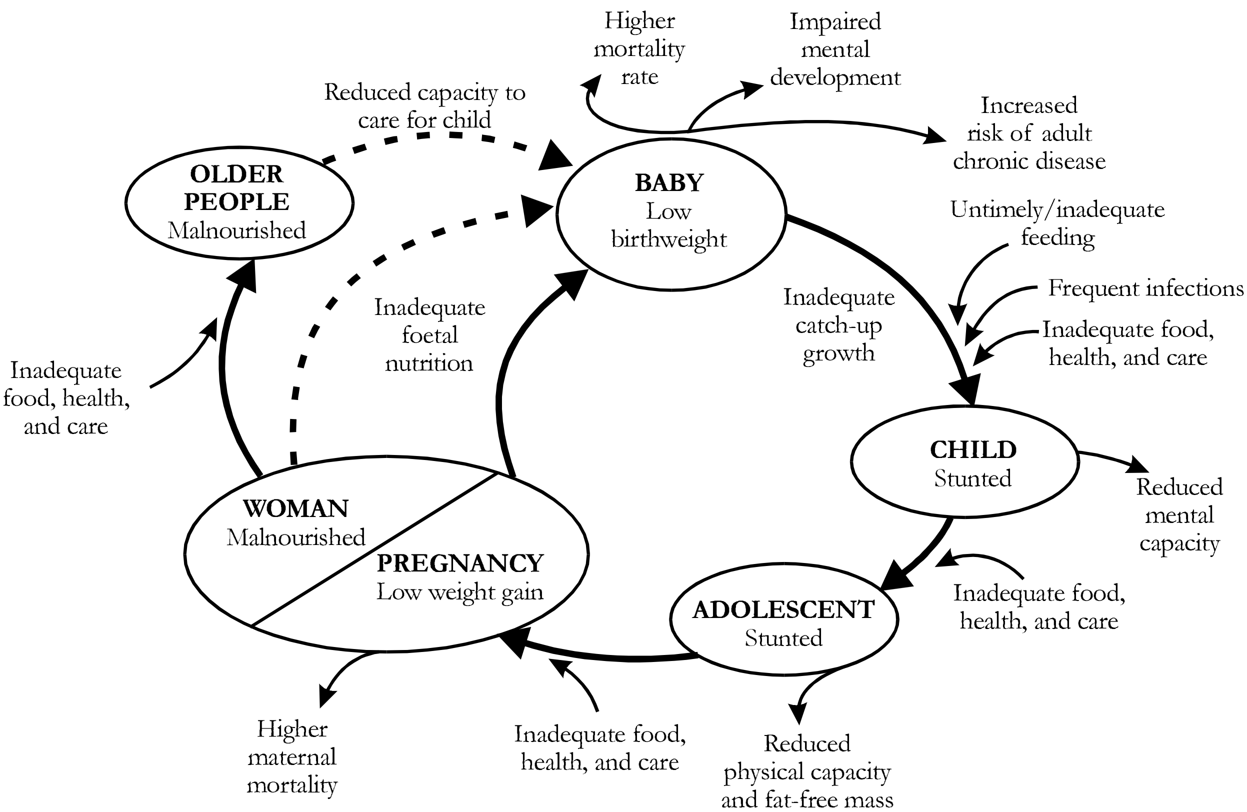
1 NUTRITION THROUGHOUT THE LIFE CYCLE

Nutrition challenges continue throughout the life cycle, as depicted in Figure 1.1. Poor nutrition often starts *in utero* and extends, particularly for girls and women, well into adolescent and adult life. It also spans generations. Undernutrition that occurs during childhood, adolescence, and pregnancy has an additive negative impact on the birthweight of infants. Low-birthweight (LBW) infants who have suffered intrauterine growth retardation (IUGR) as foetuses are born undernourished and are at a far higher risk of dying in the neonatal period or later infancy. If they survive, they are unlikely to significantly catch up on this lost growth later and are more likely to experience a variety of developmental deficits. A low-birthweight infant is thus more likely to be underweight or stunted in early life.

The consequences of being born undernourished extend into adulthood. Epidemiological evidence from both developing and industrialized countries now suggests a link between foetal undernutrition and increased risk of various adult chronic diseases the foetal origins of disease hypothesis. [1]

FIGURE 1.1 : Nutrition throughout the life cycle



Source: Prepared by Nina Seres for the ACC/SCN-appointed Commission on the Nutrition Challenges of the 21st Century.

During infancy and early childhood, frequent or prolonged infections and inadequate intakes of nutrients particularly energy, protein, vitamin A, zinc, and iron exacerbate the effects of foetal growth retardation. Most growth faltering, resulting in underweight and stunting, occurs within a relatively short period from before birth until about two years of age.

Undernutrition in early childhood has serious consequences. Underweight children tend to have more severe illnesses, including diarrhoea and pneumonia. There is a strong exponential association between the severity of underweight and mortality.[2] It has been estimated that out of 11.6 million deaths that occurred in 1995 among children under five in developing countries, 6.3 million (54%) were associated with low weight-for-age. The majority of these deaths can be attributed to the potentiating effect of mild to moderate undernutrition.[3]

The nutrition and health of school-age children in developing countries have only recently begun to receive attention. A long-standing assumption has been that by school age a child has survived the most critical period and is no longer vulnerable. However, many of the infectious diseases affecting preschool children persist into the school years. Until recently, data on the nutritional status of school-age children were not routinely collected, despite growing evidence, first, that malnutrition was widespread in this age group, and second, that these nutritional problems adversely affect school attendance, performance, and learning.

In adolescence, a second period of rapid growth may serve as a window of opportunity for compensating for early childhood growth failure, although the potential for significant catch-up at this time is limited. Also, even if the adolescent catches up on some lost growth, the effects of early childhood undernutrition on cognitive development and behaviour may not be fully redressed.[4] A stunted girl is thus most likely to become a stunted adolescent and later a stunted woman. Apart from direct effects on her health and productivity, adult stunting and underweight increase the chance that her children will be born with low birthweight. And so the cycle turns.

It is imperative to prevent foetal and early childhood undernutrition. Nutrition interventions in pregnancy and early childhood can result in improvements in body size and composition in adolescents and young adults. Improvements in both physical and intellectual performance were also found in a study by the Institute for Nutrition for Central America and Panama (INCAP).[5]

Investing in maternal and childhood nutrition will have both short- and long-term benefits of huge economic and social significance, including reduced health care costs throughout the life cycle, increased educability and intellectual capacity, and increased adult productivity. No economic analysis can fully capture the benefits of such sustained mental, physical, and social development.

The life cycle provides a strong framework for discussing the challenges facing human nutrition. Although information is available on preschool children in most regions, the paucity of data for other age groups precludes sub-regional and regional descriptions of the nutritional problems faced at these periods of the life cycle.

The causes of malnutrition are complex. Underlying the immediate causes of malnutrition will be a failure of either the main food, health, or care preconditions for good nutrition. The widely used food-health-care conceptual framework, shown in Appendix 1, offers an analytical tool for portraying causes of malnutrition and is used throughout this report.

For the most part, the results in this *Fourth Report* are presented according to the regions and sub-regions defined by the United Nations Population Division. A listing of the countries within each sub-region is provided in Appendix 2. These sub-regions are different from those used by the ACC/SCN since 1987. The objective of this change is to help standardize the use of common regions and sub-regions among UN agencies. WHO began to use this classification in 1993. Data described in this chapter derive from stable national populations. The nutritional status of refugees and internally displaced populations is described in Chapter 5.

1.1 Intrauterine Growth Retardation (IUGR)

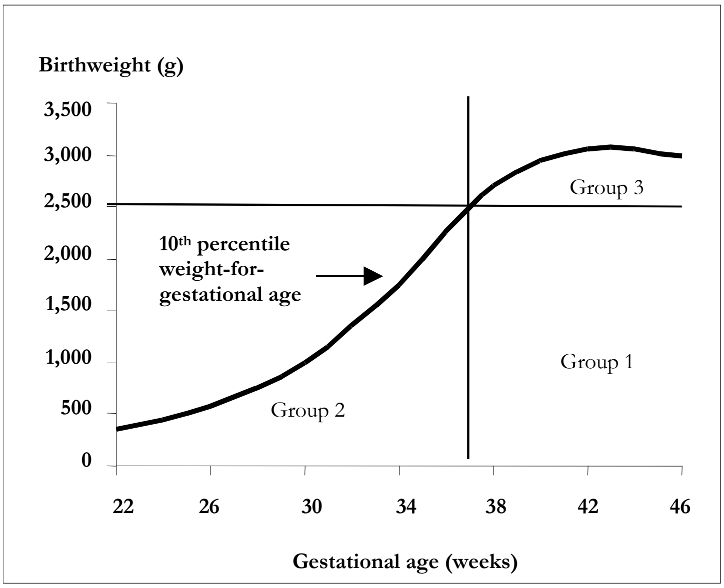
IUGR refers to foetal growth that has been constrained by an inadequate nutritional environment *in utero* and, thus characterizes a newborn that has not attained its growth potential. These infants are disadvantaged before they enter the world. Although the classification of IUGR is still based on insufficiently standardized reference data,[6] there are three distinct groups, as depicted in Figure 1.2. The reference curve in this figure is the 10th percentile of a reference population and takes into account gestational age.

Newborns in Group 1 are born after at least 37 weeks of gestation and weigh less than 2,500 g

at birth. In most populations this is the largest group of newborns affected by intrauterine growth retardation. Group 2 newborns are preterm and weigh less than the 10th percentile at birth. Newborns in Group 3, a smaller group, weigh less than the 10th percentile (fall below the curve) but have a birthweight greater than 2,500 g.

In most circumstances in developing countries, it is not possible to determine the gestational age of an infant. Also, reference curves adjusted for gestational age are not widely employed. Therefore, low birthweight (< 2,500 g) is often used as a proxy for IUGR. Incidence rates of low birthweight help to characterize nutritional status during foetal life for populations, but they do not go far enough. This is because the incidence of low birthweight among *preterm* infants will overestimate poor growth due to nutritional causes (Group 2). On the other hand, incidence rates of low birthweight among *term* infants will underestimate poor growth due to nutritional causes in term infants because not all infants falling below the 10th percentile reference curve are captured (that is, Group 3). In this report we focus on the largest group of IUGR infants, those in Group 1, because this is the only group for which reasonably good data are available.

FIGURE 1.2 : Different types of intrauterine growth retardation (IUGR)



Source: Adapted from 7.

Comparing Prevalences and Numbers

Table 1.1 presents a picture of IUGR globally and by region, as far as available data permit. (Statistical methods are described in Appendices 3 and 4.) In the year 2000 it is estimated that 11.0% of newborns in developing countries, or 11.7 million infants, have low birthweight at term.[a] These children are born undernourished with little chance of fully catching up. This is a major global human development problem with profound short- and long-term consequences for individuals, communities, and whole populations. Population-wide interventions aimed at preventing foetal growth retardation are urgently needed in many developing countries.

Low birthweight at term is especially common in South Central Asia, where 20.9% of newborns are affected; this sub-region accounts for about 80% of all affected newborns worldwide. Low birthweight is also common in Middle and Western Africa, where 14.9% and 11.4% of infants have low birthweight at term, respectively. Data are not sufficient to prepare estimates for other parts of Africa. Low birthweight at term is less common in Latin America and the Caribbean than in other parts of the developing world. Incidence rates average 6.5% for this region as a whole and 6.2% for South America.

In all regions the total number of newborns with IUGR is higher than the number affected by low birthweight. IUGR, defined as all newborns falling below the reference curve in Figure 1.2, probably affects about 24% or approximately 30 million newborns per year in developing countries.[b,7]

These estimates suffer from important qualitative and quantitative constraints owing to limitations of the available data. In some regions only a small proportion of infants are born in a health care facility where birthweight can be measured. However,

[a] Low birthweight at term is also referred as IUGR-LBW in some publications.

[b] This estimate is based on total live births for 1995.

TABLE 1.1 : Estimated incidence of low birthweight and expected number of affected newborns, 2000

UN regions and sub-regions	LBW (Groups 1 and 2)[a] Incidence (%)	LBW (Groups 1 and 2)[a] Number (thousand)	LBW at term (Group 1)[a] Incidence (%)	LBW at term (Group 1)[a] Number (thousand)
Africa	*n/a*	*n/a*	*n/a*	*n/a*
Eastern	n/a	n/a	n/a	n/a
Middle	21.3	853	14.9	597
Northern	n/a	n/a	n/a	n/a
Southern	n/a	n/a	n/a	n/a
Western	17.2	1,451	11.4	962
Asia[b]	*18.0*	*13,774*	*12.3*	*9,344*
Eastern[b]	5.8	1,250	1.9	409
South Central	28.3	10,917	20.9	8,062
South-East	10.3	1,190	5.6	647
Western	8.3	417	4.5	226
Latin America and the Caribbean	*11.5*	*1,329*	*6.5*	*755*
Caribbean	11.7	91	6.7	52
Central America	12.3	422	7.2	247
South America	11.1	816	6.2	456
Oceania[c]	*15.0*	*29.2*	*9.8*	*19*
Melanesia	15.4	29	9.9	19
Micronesia	n/a	n/a	n/a	n/a
Polynesia	4.0	0.2	0.2	0.03
All developing countries[d]	*16.4*	*17,436*	*11.0*	*11,677*

Sources: 8 (incidence of LBW); 7 (incidence of LBW at term). Number of newborns affected was obtained by applying incidence estimates to the total number of live births, obtained from 9.

Notes: Data for LBW and LBW at term refer to birthweights < 2,500 g. n/a = not available because coverage of live births < 80%.

[a] Groups defined in Figure 1.2.

[b] Excludes Japan.

[c] Excludes Australia and New Zealand.

[d] Weighted average of incidences in each country

the estimates represent a valid attempt to quantify the magnitude and geographical distribution of foetal undernutrition for advocacy and public health purposes. The limitations point to the need to improve the availability and quality of gestational age and birthweight data.

Causes

In developing countries, the major determinants of growth retardation *in utero* are nutritional: inadequate maternal nutritional status before conception, short maternal stature (principally due to undernutrition and infection during childhood), and poor maternal nutrition during pregnancy (low gestational weight gain, primarily due to inadequate dietary intake). Maternal nutrition during pregnancy is especially important. Low pregnancy weight gain may account for more than 14% of growth retardation *in utero*; further, in populations with a high prevalence of short stature, low maternal height accounts for about 18.5%.[10] Prevalence rates are high where pre-pregnancy weight-for-height is low undernourished women obtain a greater benefit than other women from a given gestational weight gain.[11]

Diarrhoeal diseases, intestinal parasitosis, and respiratory infections are common in developing countries and may also have an important impact on IUGR. These illnesses may be associated with an impaired foetal growth of, on average, 45 g per birth.[12] Where it is endemic, malaria is a major determinant of IUGR. Infants born to women with placental malaria have a mean deficit in birthweight of about 170 g.[13] Furthermore, the effects of cigarette smoking are becoming a significant factor in some developing countries.[14]

The immediate causes of IUGR often operate simultaneously with more deeply rooted underlying and basic causes. These causes relate to the care of

women, access to and quality of health services, environmental hygiene and sanitation, household food security, educational status, and poverty.

In industrialized countries, cigarette smoking is the most important determinant of IUGR, followed by low gestational weight gain and low pre-pregnancy body mass index.[12] The etiological roles of pre-eclampsia, short stature, genetic factors, and alcohol and drug use during pregnancy are well established but are quantitatively less important. In industrialized countries, the contribution of socioeconomic factors to IUGR incidence remains unknown after controlling for the factors discussed above.[14]

The etiological roles of micronutrients in IUGR remain to be clarified in developing and industrialized countries. Some have argued that randomized trials are required to define the possible effects of folate, iron, calcium, vitamins D and A, magnesium, and zinc, especially in developing countries.[15] Others argue that the use of multiple vitamin and mineral supplements by women in developing countries is an important strategy to improve micronutrient status and benefit women s health, pregnancy outcome, and child health.[16] The NAS suggests that a strategy to promote increased consumption of multiple micronutrients simultaneously would be more effective than the promotion of a select few.[17]

Consequences

It has been estimated that for term infants weighing 2,000 2,500 g at birth, the risk of neonatal death is four times higher than for infants weighing 2,500 3,000 g, and ten times higher than for infants weighing 3,000 3,500 g.[18] In developing countries with a high prevalence of low weight at birth, IUGR infants account for the majority of neonatal deaths. Although the association between IUGR and increased mortality is strongest during the immediate neonatal period (seven days), it extends beyond this time. Furthermore, there is an increased risk of diarrhoea in term infants below 2,500 g and an increased risk of pneumonia in IUGR infants in developing countries.[18]

IUGR has significant long-term consequences on body size, composition, and muscle strength. IUGR newborns in industrialized countries partially catch up relative to controls during the first two years of life. However, this is usually not enough to compensate for prenatal growth retardation. These infants will be about 5 cm shorter and 5 kg lighter in adulthood.[19 21] In Guatemala, IUGR newborns also showed partial catch-up during the first two years of life and then maintained their achieved place in the growth distribution. Guatemalan IUGR infants were shorter, lighter, and weaker than non-IUGR controls as adolescents and young adults and were also about 5 cm shorter and 5 kg lighter as adults.[22]

Some, but not all, studies evaluating neurodevelopmental outcomes in IUGR infants have shown the presence of neurological dysfunction, particularly in males of low socioeconomic status. Neurological dysfunction is associated with attention deficits, hyperactivity, clumsiness, and poor school performance.[23] The effects on cognitive development and behaviour in the first six years of life are still unclear, although deficits in cognition have been found in children with very low birthweights.[24]

Most immune functions have been shown to be impaired in IUGR infants. The greater the foetal growth retardation, the greater the impairment of the immune competence. This impairment may be sustained through childhood.[25 27] One study links disproportionate foetal growth to altered immunoglobulin E concentrations in adult life,[28] and another links it to autoimmune thyroid disease.[29]

There is evidence of associations between retarded foetal growth and blood pressure, noninsulin-dependent diabetes, coronary heart disease, and cancer in adult life. Barker s foetal origins of disease hypothesis posits that nutritional insults during critical periods of gestation and early infancy, followed by relative affluence, increase the risks of chronic diseases in adulthood as described in Box 1.1.[1] The nutrition transition that is, the shifts in dietary patterns and lifestyle that have resulted from urbanization and rapid economic development may accelerate the emergence of adult consequences of early undernutrition.[30]

1.2 Undernutrition in Preschool Children

This section describes the estimated prevalence and number of preschool (under five years old) children suffering from stunting, underweight, and wasting at global, regional, and sub-regional levels.

Defining Indices and Indicators

- **Stunting.** The anthropometric index height-for-age reflects linear growth achieved pre- and postnatally with its deficits indicating long-term, cumulative effects of inadequate nutrition and/or health. Shortness in height refers to low height-for-age that may reflect either normal

BOX 1.1

The Foetal Origins of Disease

Genes provide a general recipe for making a human being, but the *human being is determined by the ingredients provided by the mother.*

David Barker

The foetal origins of adult disease hypothesis originated in the 1980s when Professor David Barker of the University of Southampton noted a link between low birthweight and the incidence of cardiovascular disease among middle-aged men and women born in the United Kingdom. More than 30 studies around the world have indicated that low-birthweight term infants have a higher incidence of hypertension later in life than those with a normal birthweight, independent of adult social class and other adult risk factors as smoking, drinking, and overeating. Low birthweight, as well as thinness at birth, has also been correlated with glucose intolerance in childhood and noninsulin-dependent diabetes in later life.

In one stark example, semi-starved Dutch women in the closing stages of World War II gave birth to children who as adults were especially vulnerable to diabetes, high blood pressure, and coronary heart disease. This relationship was found to be particularly strongly associated with pregnancies that were subjected to food shortages in the third trimester of pregnancy.

The Barker hypothesis posits that maternal dietary imbalances at critical periods of development *in utero* can trigger an adaptive redistribution of foetal resources, including growth retardation. Such adaptations affect foetal structure and metabolism in ways that predispose the individual to later cardiovascular and endocrine diseases. The correlation between low birthweight and later cardiovascular disease and diabetes may arise from the fact that nutritional deprivation *in utero* programmes a newborn for a life of scarcity. Problems arise when the child s system is later confronted by a world of plenty.

Recent studies have shown a link with immune system development and subsequent risk of infection-related mortality in adulthood. A 1997 analysis of over a thousand deaths in one Gambian community has shown that infants born in the wet season were ten times more likely than infants born in the dry season to die prematurely in adulthood, mainly from infections. The difference was manifested only after adolescence. This phenomenon may be due to abnormal growth of the thymus gland (immune cell producer) or the lymph system (immune cell transporter) during pregnancy.[31]

With regard to future research, there is a need to progress beyond epidemiological associations to greater understanding of the cellular and molecular processes that underlie them. We need to know what factors limit the delivery of nutrients and oxygen to the human foetus, how the foetus adapts to a limited supply, how these adaptations programme the structure and physiology of the body, and by what molecular mechanisms nutrients and hormones alter gene expression. Further research requires a strategy of interdependent clinical, animal, and epidemiological studies.

The foetal origins of disease provide even greater justification for prioritizing nutrition of girls and women, for avoiding *in utero* and *post utero* nutritional imbalances, and for smoothing nutrition transitions. Essentially it calls for a long-term life cycle approach to nutrition improvement. ■

variation in growth or a deficit in growth. Stunting refers to shortness that is a deficit or linear growth that has failed to reach genetic potential as a result of poor diet and disease. Stunting is defined as low height-for-age at < 2 standard deviations (SD) of the median value of the National Center for Health Statistics/World Health Organization (NCHS/WHO) international growth reference.[2] Severe stunting is defined as < 3 SD.

- **Underweight.** The anthropometric index weight-for-age represents body mass relative to age. Weight-for-age is influenced by the height and weight of a child and is thus a composite of stunting and wasting, making interpretation of this indicator difficult. In the absence of wasting, both weight-for-age and height-for-age reflect the long-term nutrition and health experience of the individual or population. Underweight refers to a deficit and is defined as low weight-for-age at < 2 SD of the median value of the NCHS/WHO international reference.[2]
- **Wasting** describes a recent and severe process that has produced a substantial weight loss, usually as a consequence of acute shortage of food and/or severe disease. Chronic dietary deficit or disease can also lead to wasting. The anthropometric index weight-for-height reflects body weight relative to height. Wasting refers to low weight-for-height at < 2 SD of the median value of the NCHS/WHO international weight-for-height reference. Severe wasting is defined as < 3 SD. The statistically expected prevalence of wasting (as with underweight and stunting) is between 2 and 3%, given the normal distribution of wasting rates.[2] This indicator is used extensively in emergency settings.

BOX 1.2

A Growth Curve for the 21st Century

Infants fed according to WHO recommendations and living in conditions that favour the achievement of genetic growth potential grow less rapidly than the NCHS/WHO International Growth Reference,[2] particularly after 4 6 months. A significant discrepancy of approximately half a standard deviation in estimated height status arises immediately before and after 24 months of age. The distributions of weight-for-age and weight-for height are skewed, reflecting a substantial level of childhood obesity. These drawbacks led a WHO Expert Committee on Physical Status in 1995 to recommend the development of a new growth reference.

A multicountry growth reference study specifically designed for this purpose was launched in 1997. Depending on the availability of funds, data collection is expected to be complete in 2003. The study is being undertaken in seven countries in diverse geographical areas, using samples of infants and children whose caregivers follow recognized health recommendations.[32] The research design combines a longitudinal study from birth to 24 months of age of 300 newborns per country, with a cross-sectional study of 1,400 children aged 18 71 months per site. More than 13,000 healthy infants and children will be involved in the study.

The new international growth reference will achieve several aims. Most important, it will provide a scientifically reliable descriptor of physiologic growth and a powerful tool for child health advocates. This will be achieved by applying the highest scientific rigor in a complex field-based project. Another objective will be to stress that human growth during the first five years of life is very similar across groups of children of different ethnic backgrounds. Equally important, the new growth reference will set growth of the breastfed infant as the standard to match. Future prevalence estimates based on the new reference will clearly be affected to the extent that the new reference differs from the current one. ■

Comparing Prevalences and Numbers

Table 1.2 and Table 1.3 show the estimated prevalences and numbers of stunted and underweight children, respectively, for the UN regions and sub-regions.[c] Multilevel modelling the same statistical method described in the *Third Report* was used for this report to develop the trend projections for both stunting and underweight. These tables were prepared for the ACC/SCN by the Department of Nutrition for Health and Development of WHO. All survey data were taken from the WHO Global Database on Child Growth and Malnutrition.[33] The latest available national prevalence rates appear in Appendix 5. The national survey data are of variable quality, and some surveys are more than ten years old.

Data were available from at least one survey for 107 countries for the estimation of stunting prevalences and from 108 countries for the estimation of underweight prevalences. Data were available from at least two surveys for 65 countries for estimation of trends in stunting. For trends in underweight, data were available from two surveys for 68 countries. There are no differences in prevalence rates for boys and girls for stunting, underweight, or wasting, so results are not disaggregated by gender.

Estimates of the numbers of undernourished preschool children were derived by applying the estimated prevalences to the estimated total preschool population for each region and sub-region taken from UN population projections.[9] Thus, estimates of numbers cover all countries within regions, including those that did not have a survey to contribute to the prevalence estimate.

STUNTING

In 2000, it is estimated that 32.5% of children under five in developing countries are stunted. There has been a steady improvement since 1980 when the estimated global prevalence was nearly one half (47.1%). By 2005, the estimated global prevalence will be further reduced to about 29.0%. Still, the numbers are extremely high. Some 182 million preschool children will be stunted in 2000, decreasing to about 165 million in 2005. More than two-thirds (70%) of these children live in Asia (of which 61% are in South Central Asia), while some 24% live in Sub-Saharan Africa.

TABLE 1.2 : Estimated prevalence and number of stunted children, 1980 2005

UN regions and sub-regions	Prevalence of stunting (%)						Number stunted (million)					
	1980	1985	1990	1995	2000	2005	1980	1985	1990	1995	2000	2005
Africa	*40.5*	*39.2*	*37.8*	*36.5*	*35.2*	*33.8*	*34.78*	*38.51*	*41.68*	*44.51*	*47.30*	*49.40*
Eastern	46.5	46.9	47.3	47.7	48.1	48.5	12.88	14.83	17.13	19.28	22.03	24.41
Northern	32.7	29.6	26.5	23.3	20.2	17.0	6.01	6.01	5.55	4.90	4.44	3.86
Western	36.2	35.8	35.5	35.2	34.9	34.6	9.04	10.51	11.99	13.47	14.74	16.03
Asia	*52.2*	*47.7*	*43.3*	*38.8*	*34.4*	*29.9*	*173.37*	*169.72*	*167.66*	*143.49*	*127.80*	*110.19*
South Central	60.8	56.5	52.2	48.0	43.7	39.4	89.36	93.45	93.36	83.62	78.53	72.28
South-East	52.4	47.5	42.6	37.7	32.8	27.9	27.71	26.47	24.24	21.51	18.94	15.78
Latin America and the Caribbean	*25.6*	*22.3*	*19.1*	*15.8*	*12.6*	*9.3*	*13.19*	*11.87*	*10.38*	*8.59*	*6.82*	*5.11*
Caribbean	27.1	24.4	21.7	19.0	16.3	13.7	0.92	0.86	0.81	0.71	0.61	0.51
Central America	26.1	25.6	25.0	24.5	24.0	23.5	3.87	3.81	3.87	3.94	3.92	3.82
South America	25.1	21.1	17.2	13.2	9.3	5.3	8.38	7.35	6.05	4.55	3.16	1.84
Oceania	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
All developing countries	*47.1*	*43.4*	*39.8*	*36.0*	*32.5*	*29.0*	*221.35*	*220.10*	*219.73*	*196.59*	*181.92*	*164.70*

Source: 34.
Notes: Stunting is defined as low height-for-age at < 2 standard deviations of the median value of the NCHS/WHO international growth reference. n/a = not available.

[c] The majority of the estimated prevalences cannot be compared with those published in the *Third Report* because of the different composition of regions. However, the estimated prevalence for all developing countries and for South America can be compared with the *Third Report*. In both cases, the confidence intervals of the estimates do include the midpoint estimates; thus there is consistency between the two reports.

As previously reported,[35] levels of stunting vary across regions. The highest levels of stunting are estimated for Eastern Africa, where on average 48.1% of preschool children are affected in 2000. This region includes Ethiopia, where a national survey in 1992 found that 64.2% were stunted. National surveys in Malawi (1995) and Zambia (1996/97) found stunting prevalences of 48.3% and 42.4%, respectively. In Eastern Africa, stunting is increasing at 0.08 percentage points per year. This trend, together with high population growth rates, translates into larger numbers of East African children stunted each year. Over the period 2000 to 2005, numbers are expected to increase from about 22 to 24.4 million preschool children stunted.

Although stunting is widespread in South Central Asia, the trend in this region is towards improvement. South Central Asia includes Afghanistan, Bangladesh, India, and Pakistan, which all have high levels of child undernutrition. Central Asian countries, formerly part of the Soviet Union, are also included in this region. These countries report surprisingly high prevalences of stunting: Kyrgyzstan, 24.8% in 1997, and Uzbekistan, 31.3% in 1996. The estimated prevalence for South Central Asia as a whole in 2000 is 43.7%. This rate is decreasing by 0.85 percentage points per year. The number of stunted children declined over the 1990s. If this trend continues, about 6.25 million fewer children will be stunted in South Central Asia by 2005 compared with 2000.

The Western African sub-region has a much lower estimated prevalence than either Eastern Africa or South Central Asia: 34.9% in 2000. However, the prevalence has stagnated over recent years, and population numbers are increasing. The number of stunted children in this region therefore continues to rise. Between 2000 and 2005, the number of stunted children will increase by about one and a half million. To a large extent the trend in this sub-region will be driven by Nigeria, which has by far the largest child population in this group of countries. For Southern Africa, the sub-regional prevalence of stunting is 23.7%, according to surveys carried out in Lesotho, Namibia, and South Africa.[d] It was not possible to estimate a trend for this sub-region, owing to lack of repeated surveys. National prevalences documented in the most recent surveys available for four of the five countries in this sub-region range from 22.5% in South Africa (1994 95) to 44% in Lesotho (1996).

About one-third (32.8%) of South-East Asian preschool children are stunted in 2000. This region has been experiencing the highest rate of improvement, at 0.98 percentage points per year, or a 10-percentage-point reduction between 1990 and 2000. This means that the number of children stunted is falling steadily and will continue to do so; it is projected to drop by more than 3 million between 2000 and 2005. Still, some 19 million children in this region are stunted in 2000. The effects of the financial crisis in this region are discussed in section 4.2.

About one in five preschool children in Northern Africa is stunted, translating into some 4.4 million children. The steady decline in both prevalences and numbers is forecast to continue, resulting in a 3-percentage-point decline between 2000 and 2005. This region comprises seven North African countries, as well as the Sudan. (There are about 4 million internally displaced persons in the Sudan, families normally not reached during national nutrition surveys.) Egypt, with the largest child population in this sub-region, may drive the overall pattern of improvement in the coming years for this group of countries. The most recent survey in Egypt (1997 98) shows that about 24.9% of preschool children are stunted.

The estimated prevalence for Latin America and the Caribbean as a whole (12.6%) continues to decline, by an average of 0.79 percentage points per year in South America. By 2005 only 5.3% of South American preschool children will be stunted. As discussed later in this report, undernutrition is being replaced by overweight in some South American countries. Central America, however, has an estimated prevalence of 24.0% and no significant improvement forecast over the next five years. Indeed the numbers of stunted children in Central America have remained about constant from 1980 to 2000.

UNDERWEIGHT

Underweight, due to chronic undernutrition or to wasting or to both, affects fewer children globally than stunting. However, underweight is still widespread among developing-country children. In 2000 it is estimated that 26.7% of preschool children in developing countries are underweight. Underweight has declined steadily since 1980, when 37.4% of the world s preschool children were underweight. The global

[d] This sub-regional prevalence is based on survey data, not on the model employed for all other estimates, because there is insufficient recent survey coverage in this sub-region.

TABLE 1.3 : Estimated prevalence and number of underweight preschool children, 1980 2005

UN regions and sub-regions	Prevalence of underweight (%)						Number underweight (million)					
	1980	1985	1990	1995	2000	2005	1980	1985	1990	1995	2000	2005
Africa	*26.2*	*26.7*	*27.3*	*27.9*	*28.5*	*29.1*	*22.47*	*26.30*	*30.11*	*34.03*	*38.32*	*42.45*
Eastern	24.9	27.7	30.4	33.2	35.9	38.7	6.92	8.76	11.03	13.42	16.47	19.48
Northern	17.5	16.4	15.6	14.8	14.0	13.2	3.22	3.32	3.27	3.11	3.08	2.99
Western	30.1	31.7	33.3	34.9	36.5	38.1	7.51	9.29	11.23	13.34	15.41	17.66
Asia	*43.9*	*40.2*	*36.5*	*32.8*	*29.0*	*25.3*	*145.95*	*142.95*	*141.31*	*121.03*	*107.91*	*93.16*
South Central	58.1	54.5	50.9	47.3	43.6	40.0	85.35	90.06	90.90	82.40	78.49	73.48
South-East	43.5	39.9	36.2	32.6	28.9	25.3	23.00	22.21	20.60	18.56	16.68	14.27
Latin America and the Caribbean	*14.2*	*12.2*	*10.2*	*8.3*	*6.3*	*4.3*	*7.32*	*6.50*	*5.57*	*4.48*	*3.40*	*2.35*
Caribbean	22.9	20.1	17.2	14.4	11.5	8.7	0.78	0.71	0.65	0.54	0.43	0.32
Central America	15.1	15.2	15.2	15.3	15.4	15.4	2.24	2.26	2.36	2.46	2.52	2.51
South America	13.2	10.7	8.2	5.7	3.2	2.3	4.40	3.71	2.88	1.96	1.08	0.80
Oceania	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
All developing countries	*37.4*	*34.7*	*32.1*	*29.2*	*26.7*	*24.3*	*175.74*	*175.75*	*176.99*	*159.55*	*149.63*	*137.95*

Source: 34.
Notes: Underweight is defined as low weight-for-age at < 2 standard deviations of the median value of the NCHS/WHO international growth reference. n/a = not available.

prevalence will reach 24.3% by 2005. Global numbers will decrease from 150 million to 138 million between 2000 and 2005. The majority of underweight children (52%) live in South Central Asia.

South Central Asia is the worst affected sub-region, with some 43.6% of children underweight. This translates into almost 79 million children underweight. However, prevalence and numbers continue to decline. By 2005 the estimated prevalence will drop a further 3.6% to 40.0%. The number of underweight children has been decreasing since about 1990 and is expected to continue. By 2005 some 5 million fewer children will be underweight.

Both Western and Eastern Africa have lower prevalences (36.5% and 35.9% respectively) than South Central Asia, but the situation is deteriorating. Countries of Eastern Africa are experiencing a rise in underweight of 0.56 percentage points per year, or a full 5-percentage-point increase between 1995 and 2005. During this period numbers have increased by about 6 million. The trend in Eastern Africa is very worrying. Western Africa has seen an increase of 0.32 percentage points per year in recent years. The increase in underweight among Western African children is explained in part by the high rates of wasting in this region, discussed below.

There is much less underweight among North African children (14.0%). This region is more similar to the Caribbean (11.5%) and Central America (15.4%) than to either Africa or Asia. Underweight in South America will have been eliminated by 2005, when the regional prevalence estimate reaches 2.3%. Similar progress is not being achieved in Central America, where there has been no improvement over the past 20 years in either prevalence or numbers. In South-East Asia the estimated prevalence, which has been falling steadily since 1980, is forecast to decrease further by 2005 to 25.3%. Still, some 14 million children in South-East Asia will be underweight.

The World Summit for Children set a global goal of halving severe and moderate malnutrition among children under five between 1990 and 2000. Our analysis indicates that only South America will have achieved this goal. In this region the overall rate has decreased from 8.2% in 1990 to 3.2% in 2000. Progress has been steady and significant in South Central Asia (from 50.9% to 43.6%), but the rate of progress is all too slow. Northern Africa, with higher mean household incomes, has seen very slow progress, from 15.6% to 14.0%. In other parts of Africa, 8.4 million more children are underweight now than in 1990.

WASTING

An estimated 50 million preschool children were wasted in 1995 (Table 1.4). Wasting is not as common as stunting or underweight in any region; the global prevalence is about 9.4%. Wasting rates can change rapidly, however, especially in situations of emergency food shortage and population displacement. This is discussed further in section 5.1.

TABLE 1.4 : Prevalence and number of wasted preschool children, 1995

UN regions and sub-regions	Survey countries/ total countries[a]	Population covered by surveys (%)	Prevalence of wasting (%)	Number wasted (million)
Africa	*43/53*	*94.5*	*9.6*	*11.06*
Eastern	16/17	95.8	7.0	2.74
Middle	5/9	84.6	8.6	1.36
Northern	6/6	99.8	7.2	1.46
Southern	4/5	95.9	2.9	0.17
Western	12/16	94.2	15.6	5.33
Asia	*31/46*	*93.7*	*10.4*	*37.87*
Eastern	2/4	94.4	3.4	3.73
South Central	12/14	99.2	15.4	27.27
South-East	5/10	84.0	10.4	5.75
Western	12/18	70.7	5.1	1.12
Latin America and the Caribbean	*21/31*	*97.2*	*2.9*	*1.59*
Caribbean	4/13	64.8	n/a	n/a
Central America	7/8	99.8	4.9	0.79
South America	10/12	99.6	1.8	0.64
Oceania	*n/a*	*n/a*	*n/a*	*n/a*
Developing countries	*99/147*	*94.1*	*9.4*	*50.59*

Source: 34.
Notes: Wasting is defined as low weight-for-height at < 2 standard deviations of the median value of the NCHS/WHO international growth reference. n/a = not available because of insufficient data.
[a] Number of countries that have national surveys out of the total number of countries for each sub-region.

These updated results are similar to those published by WHO in 1997,[e] but there has been a substantial increase in wasting among Western African children. This increase helps explain the high rates of underweight in these countries. Western Africa and South Central Asia have the highest prevalences of wasting (both about 15.5%) followed by South-East Asia (10.4%). Central America presents low levels, and South America and Southern Africa are close to the statistically expected prevalence, implying that wasting is not common in these children.

Exploring the Changes in Preschool Nutrition in Sub-Saharan Africa

The region that has seen the least overall improvement in the nutritional status of its children is Sub-Saharan Africa, where one-half of the 25 countries with more than one national survey indicated a rise in stunting rates.[35]

What explains the differential progress across countries in reducing child malnutrition and the slow progress of this region as a whole? The causes of child malnutrition are complex, multidimensional, and interrelated, ranging from factors as fundamental as political instability and slow economic growth to those as specific in their manifestation as respiratory infection and diarrhoeal disease. This is well illustrated by the framework in Appendix 1. Determinants also differ considerably across geographical areas. Nonetheless, using cross-country regression analysis it is possible to gain a general sense of the relative importance and contribution of some broad causal factors for the developing world as a whole. A recent study undertook such an analysis using national underweight prevalence rates collected from 1970 to 1995 for children under five years of age.[36] This IFPRI study, which is described in Appendix 6, found that women s educational and social status, national per capita food availability, and access to

[e] In 1997, WHO reported sub-regional, regional, and global estimates for the prevalence and number of wasted children under five years old for 1995.[33] These estimates were derived from nationally representative data using a weighted prevalence approach for sub-regions where the proportion of children covered by national surveys was at least 70%. For this *Fourth Report*, WHO has updated these 1995 estimates on the basis of recent data (as of June 1999), although the median survey year for the countries that have nationally representative data does not permit an estimate beyond 1995.

safe water were important underlying determinants of child nutritional status at a global level.

In a further analysis for Sub-Saharan Africa, countries for which data over time were available for some portion of the 1970 to 1995 period were divided into two groups: (1) those with periods of decreased prevalence (improving) and (2) those with periods of increased underweight prevalence (deteriorating). Appendix 7 lists the countries and time periods.

Table 1.5 reports the differences across the two groups in underweight rates and in the factors identified as important determinants of underweight in the preceding global analysis. The average decrease in underweight prevalence for the improving group is 5.5 percentage points, while the average increase for the deteriorating group is 6.0 percentage points. When the intergroup differences among the potential determinants were examined, two were found to be statistically significant: differences in women s relative status and in per capita dietary energy supply.

The proxy variable for women s relative status the ratio of female life expectancy to male life expectancy actually declined for both groups, but the decline for the deteriorating group was five times larger than that for the improving group. One would expect such declines in women s relative status to have had a negative impact on child nutrition for both groups, wiping out some of the gains made through improvements in the other factors considered. Countries that are better able to protect women s status relative to men s will be more likely to experience improvements in child nutritional status.

The female secondary enrollment rate improved for both sets of countries. The increase in the enrollment rate for the improving group is more than double that of the deteriorating group, although this difference is not statistically significant.

Differences in food availability were very important. Improving countries had an average increase in per capita dietary energy supply of 82 kilocalories, compared with an average decrease of 92 kilocalories in the other group. In the case of national income, improving countries had an average increase in per capita gross domestic product (GDP) of US$175, compared with an average decrease of US$82 in the other group, although the difference was not statistically significant. National income is a determinant of investment in health environments, education, improvements in women s status, and food supplies. Slow progress in both food availability and national income in this region is a result not only of rapid population growth, but also of conflict, the debt burden, and the HIV/AIDS epidemic (not measured in this analysis).

TABLE 1.5 : Comparison of Sub-Saharan African countries with periods of increased versus decreased underweight rates over 1970 95

	Group means		P-value for significance of difference in group means
	Countries with periods of decreased underweight prevalence (n = 18)	Countries with periods of increased underweight prevalence (n = 18)	
Change in underweight rate (percentage points)	5.5	6.0	.000*
Change in population with access to safe water (%)	7.4	8.4	.819
Change in female secondary school enrollment rate (%)	5.4	2.0	.122
Change in ratio of female life expectancy to male life expectancy (proxy for women s relative status)	.0025	0.119	.020*
Change in per capita dietary energy supply (kilocalories)	82	92	.008*
Change in per capita gross domestic product (US$ purchasing price parity)	175	82	.141
Change in democracy (index from 1 to 7, 1 = least democratic)	0.5	0.8	.488

Source: Based on 36.

*Statistically significant at least at 5% significance level.

BOX 1.3

Overweight in Children

In industrialized countries several studies report increasing prevalence of obesity in children. Some 23.7% of U.S. preschool children are overweight, and 7.4% are obese.[37] In developing countries, such studies are scarce. Research in Latin America has concluded that the levels of overweight and obesity in children under five in the region are lower than those in the United States, although prevalences in some countries are higher than expected statistically.[38] A clear pattern of change over time in overweight and obesity in Latin American children is not yet discernible.

Sub-regional, regional, and global estimates for the prevalence and number of overweight children under five (> +2 SD of the NCHS/WHO reference median value) have recently been published by WHO.[39] These estimates incorporated new data from 160 nationally representative surveys. A weighted prevalence approach was used for sub-regions where the proportion of children covered by national surveys was greater than 70%. The median survey year for countries that have nationally representative data does not allow for estimates beyond 1995. Summary results of this work are presented in Appendix 8.

An estimated 17.6 million children were overweight in the developing world in 1995. Northern and Southern Africa, Eastern Asia, Central America, and South America had prevalences higher than expected, while Western Africa and South Central and South-East Asia did not. A lack of data prevented estimation of prevalences for other sub-regions. Overall the prevalence of overweight in preschool children in developing countries is low (3.3%). Two regions have both overweight and stunting among their children. Northern Africa has a prevalence of overweight of 8.1%, while 20.2% of children are stunted. Central America has a prevalence of overweight of 3.5%, while stunting affects 24.0%. Countries in these regions are undergoing a rapid nutrition transition, including adoption of western diets that are high in saturated fats, sugar, and refined foods.[30] ■

In sum, this study reveals that the reasons why child undernutrition in many Sub-Saharan African countries has increased over the last 25 years and why the region as a whole has progressed very little are associated with declines in womens relative status, slow progress in improving women s educational attainment, and low per capita food availability and income.

1.3 The Growth of School-Age Children

The physical growth of schoolchildren aged six to nine years of age is the result of both environmental and genetic factors and the interaction between these factors.[42] In poor populations the main factors affecting the physical growth of school-age children are environmental factors experienced before puberty.[43] These include poor food consumption patterns, illness, lack of sanitation, and poor health and hygiene practices.

The potential for catch-up growth among stunted children is thought to be limited after age two, particularly when children remain in poor environments.[44] A recent study in the Philippines has shown that some catch-up between the ages of two and eight and a half years is feasible for children who were *not* born with low birthweight or severely

TABLE 1.6 : Prevalence of stunting among first-grade schoolchildren in Latin America and the Caribbean

Country	Year	Number of children	Prevalence by age group 6	7	8	9	Total
Costa Rica	1997	85,786	4.6	6.4	13.5	23.2	7.5
Belize	1996	22,426	15.8	15.7	14.7	15.4	15.4
Mexico	1993	2,589,577	13.1	19.6	32.7	40.3	18.4
Dominican Republic	1995	188,091	12.1	18.6	24.0	30.9	19.0
Nicaragua	1986	100,265	16.5	23.3	28.9	37.2	23.9
Panama	1994	59,921	17.0	24.0	41.0	51.0	23.9
El Salvador	1988	120,457	20.5	25.9	32.7	37.8	29.8
Ecuador	1992	251,651	n/a	n/a	n/a	n/a	35.2
Honduras	1997	234,111	17.0	28.0	43.0	51.0	40.6
Peru	1993	653,854	n/a	n/a	n/a	n/a	48.0
Guatemala	1986	205,959	35.0	43.6	56.5	67.2	50.6

Sources: 49, 50, 52 60.
Note: n/a = not available.

stunted in infancy.[45] However, stunting at age two years, regardless of whether catch-up was achieved or not, is significantly associated with later deficits in cognitive ability, further emphasizing the need to prevent early stunting.[46] This is further discussed in section 4.1.

School feeding, both breakfast and lunch programmes, has been shown to improve school performance in both developing and industrialized countries.[47] Simply alleviating hunger helps children to perform better. Children who are hungry have more difficulty concentrating and performing complex tasks, even if they are otherwise well nourished. Studies in Jamaica have shown that children who were wasted, stunted, or previously undernourished benefited most from the programmes.[48]

Data on the growth of school-age children that are generated in a consistent manner across countries and over time are difficult to find. The best data sets derive from height censuses beginning in 1979 on children entering primary school (first grade) in 11 countries of Latin America and the Caribbean.[49,50] Height census data of schoolchildren have been used for planning, evaluation, and advocacy in Central America for some time.[51] This information has allowed governments and other organizations and institutions to detect growth retardation, to screen high-risk groups, and to target social interventions for nutrition security and human development.[f]

Stunting is common in schoolchildren in Latin America and the Caribbean (Table 1.6). In four of the countries in this review, more than one-third of children in school are stunted. In Guatemala and Peru prevalences are 50.6% and 48% respectively. Guatemala, Honduras, and Peru show a prevalence of stunting 20 times higher than expected in well-nourished populations. Children living in the northern areas of Central America have particularly high prevalences. These prevalences are similar to those found in other regions by the Partnership for Child Development in a five-country[g] analysis of stunting in schoolchildren.[61]

Primary school begins at age seven throughout Central America. In all countries except Belize, stunting is more prevalent among children who enter school at an older age. In Costa Rica stunting is up to five times higher in nine-year-olds than in six-year-olds. In Honduras, Mexico, and Panama older school entrants have three times more stunting than six-year-olds. Stunting is particularly widespread in Guatemalan nine-year-olds (67.2%).

Trends in stunting of schoolchildren are illustrated in Figures 1.3 and 1.4 for Costa Rica and Honduras. In Costa Rica, stunting dropped from 20.4% to 7.5% over the period 1979 to 1997, indicating a sustained improvement in the quality of life, including better basic health care and other services. This period saw the implementation of a strong food and nutrition security policy, which was effective in

[f] The data presented in this section are from 49, 50, 52 60.

[g] The five countries are Ghana, India, Indonesia, Tanzania, and Viet Nam.

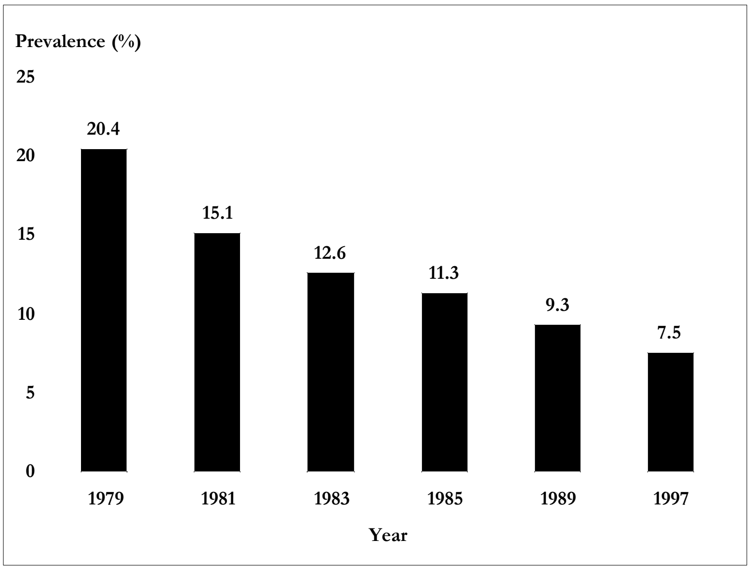
targetting the most socially and economically disadvantaged. In Honduras, on the other hand, the overall increase in stunting was probably related to the economic and sociopolitical crises this country faced during this period.

A higher proportion of boys than girls are stunted in all countries (Figure 1.5). This difference may be due to behavioural patterns associated with gender in Latin America and the Caribbean. In most of the countries, boys aged six to nine in general spend more time outside the home than girls do. Proximity to the household may allow girls better physical access to available food.

Table 1.7 shows prevalences of stunting broken into rural and urban categories for five countries. In all five countries schoolchildren living in rural areas are more stunted than children living in cities, by a wide margin. In Belize, stunting is more than three times more prevalent in rural areas than in urban areas. In Peru, stunting is almost twice as common in rural areas as in cities. This almost certainly reflects differential access to livelihoods and services.

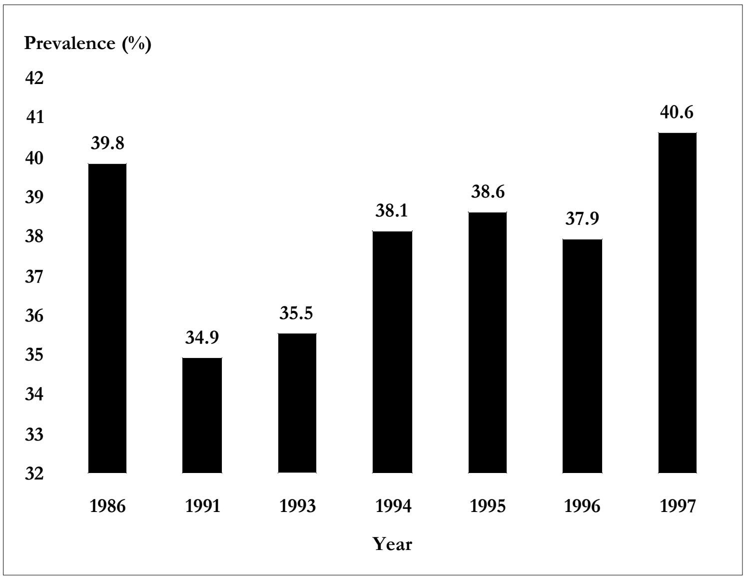
A paucity of data from other regions of the developing world has prevented an analysis of undernutrition in school-age children elsewhere. There are enormous educational and economic gains to be achieved from improving the nutrition and health of school-age children. There are also highly cost-effective means to achieve these aims, including mass application of antihelminthics, delivery of micronutrients (particularly iron and iodine), and treatment of injuries and routine health problems.

FIGURE 1.3 : Prevalence of stunting among first-grade schoolchildren in Costa Rica, 1979 97



Source: 50.

FIGURE 1.4 : Prevalence of stunting among first-grade schoolchildren in Honduras, 1986 97

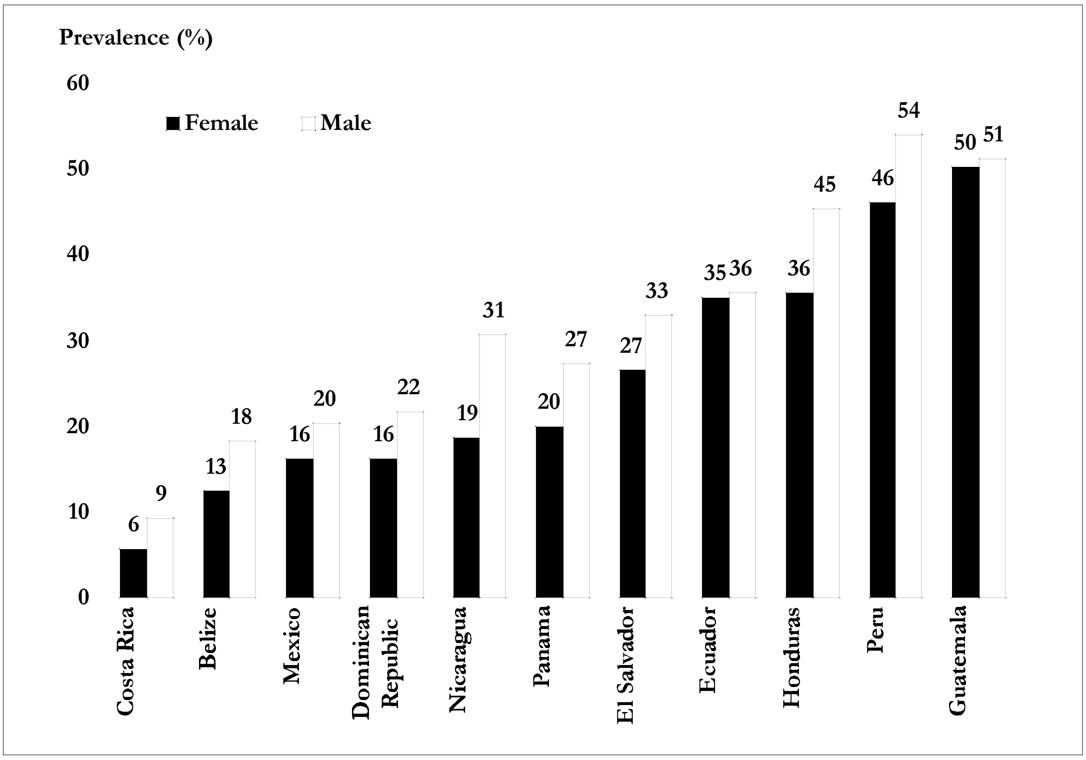


Source: 50.

1.4 Adolescent Nutrition

Adolescence is a transition phase when children become adults. During adolescence hormonal changes accelerate growth in height. Growth is faster than at any other time in the individual s postnatal life except the first year.[62]

FIGURE 1.5 : Prevalence of stunting among first-grade schoolchildren in Latin America and the Caribbean, various years from 1986 to 1997



Sources: 49, 50, 52 60.

TABLE 1.7 : Prevalence of stunting among first-grade schoolchildren in Latin America and the Caribbean by area of residence

Country	Year of the last height census	Number of children	Prevalence by area (%)		
			Rural	Urban	Total
Belize	1996	22,426	22.5	6.9	15.4
Dominican Republic	1995	188,091	23.1	13.8	19.0
Nicaragua	1986	100,265	30.1	20.1	23.9
Honduras	1997	234,111	47.6	28.2	40.6
Peru	1993	653,854	67.0	35.0	48.0

Sources: 49, 50, 53, 54, 60.

Research has shown that better-nourished girls have higher premenarcheal growth velocities and reach menarche earlier than undernourished girls, who grow more slowly but for longer, as menarche is delayed.[63] Ultimately, these two factors tend to balance out, and total height achieved *during* adolescence may be similar for well-nourished and undernourished adolescents.[64,65] The adult height finally attained, however, may still differ as a result of preexisting childhood stunting.

Because underweight adolescent girls are growing for longer, they may not finish growing before their first pregnancy. In India, for example, up to 67% of girls were classified as at obstetric risk (by weight and height criteria) in their 15th year compared with about 20% in their 19th year.[66] The mean age of first conception was 15.3 years in six large north Indian states.[67] In general, at least 25% of adolescent girls in the developing world have had their first child by age 19 and a great many more shortly thereafter.[68]

Adolescents who are still growing are likely to give birth to smaller infants than mature women of the same nutritional status[2] because of the competition for nutrients between the growing adolescent and the growing foetus[69] and poorer placental function.[70] Calcium status is a particular concern, as the bones of adolescents still require calcium for growth at a time when foetal needs for bone growth are also high.

Adolescent pregnancies also confer a higher risk of maternal and infant mortality and preterm delivery. Maternal mortality ratios for 15- to 19-year-olds in Bangladesh are twice as high as those for 20- to 24-year-olds.[71] These grave risks are further heightened by the fact that pregnant adolescent girls are less likely to use antenatal and obstetric services.

Adolescent growth varies significantly worldwide with many of the differences observed according to chronological age attributable to variation in timing of the growth spurt.[65] There is a dearth of detailed methodological work on the specific cut-offs, predictive values, and attributable risks of adolescent anthropometric indices.[2] More applied research is urgently required in these areas.

Data on adolescent nutritional status are also scarce. The most complete set of studies to date on adolescent nutritional status was carried out by the International Center for Research on Women (ICRW), which compared adolescent stunting rates as part of a multicountry study.[72] Stunting was recorded in 9 of the 11 studies (with prevalences ranging between 27 and 65%). The stunting process occurred in earlier childhood, for these children were stunted as they came into adolescence. Height-for-age did not improve across the eight years of adolescence.

Can undernourished children catch up on incomplete childhood growth during adolescence? There is little evidence to suggest that the growth retardation suffered in early childhood can be significantly compensated for in adolescence. Several types of studies have addressed this question. Some measure the effects of adoption (sudden environmental improvement), and some track changes over time in longitudinal studies.[44] These studies show that some catch-up growth may be possible. Very little work has been completed to determine whether nutritional and health interventions targetted to adolescents will bring about significant improvements. Stunted children are thus more likely than non-stunted children to become stunted adults as long as they continue to reside in the same environment that gave rise to the stunting.

Moreover, even if adolescent catch-up growth could be brought about by an intervention and stunting thus reduced, this would not necessarily rectify all of the problems for which stunting is merely a marker. For example, while a reduction in stunting would probably reduce obstetric risk due to small maternal size, it would not necessarily reverse the effects of early childhood stunting on cognitive function.[46] Both stunting and its functional correlates could, however, be addressed if the environment in which the young child grows is improved within the first two years of life.[44]

The INCAP follow-up study in Guatemala found that nearly 67% of severely stunted and 34% of moderately stunted three-year-old girls later became stunted adult women.[73] In addition, the prevalence of low birthweight was nearly twice as high in infants of women who suffered severe stunting at three years of age compared with those who were not stunted at the same age. Women with greater growth retardation during childhood also had smaller body frames and were thus at greater risk of obstructed labour. In another study in India, early childhood stunting among young girls was found, a generation later, to be significantly related to the birthweights and infant mortality risk of their children.[74]

Examining national anthropometric data in the *Second Report*, the ACC/SCN found a strong correlation between prevalence of underweight among preschool children in the 1970s and the prevalence of underweight in adult women in the 1980s.[75] Furthermore, strong associations existed between prevalence of underweight in adult women and low birthweight prevalence, and between low birthweight (1988) and preschool child underweight (1990) prevalence. These correlations are again broadly indicative of the tendency for smallness to be transmitted from one generation to another.

1.5 Adult Malnutrition

The economic livelihood of populations depends to a large extent on the health and nutrition of adults. In adults, the main cause of a reduction in body weight is a decrease in food intake, often in combination with disease, but when energy intake exceeds energy expenditure, the excess is stored in fat mass. Both underweight and overweight constitute adult malnutrition: once these conditions reach certain levels, the manifestations of adult malnutrition become apparent.

In adults, BMI or body mass index (calculated by dividing weight in kilograms by the square of height in meters) is used to define underweight or overweight. The WHO Expert Committee on Physical Growth has suggested the following classifications: mild underweight (BMI = 17.00 18.49 kg/m^2), moderate underweight (BMI = 16.00 16.99 kg/m^2), and severe underweight (BMI < 16.00 kg/m^2).[2] These three groups are considered to be chronically energy deficient (CED). For overweight, the categories are as follows: Grade 1 (BMI = 25.00 29.99 kg/m^2), Grade 2 (BMI = 30.00 39.99 kg/m^2), and Grade 3 (BMI > 40.00 kg/m^2).

There is only a limited literature on assessing nutritional status in adults and on diagnosing and treating malnourished adults. However, important health effects have been shown for those with BMI values below 18.5 kg/m^2 and for those above 25 kg/m^2. Adults with low body weight allocate fewer days to heavy labour and are more likely to fail to appear for work owing to illness or exhaustion.[76] There seems to be a continuous gradient in work capacity and productivity that is linked to body weight. In developing countries there is some evidence that individuals with a BMI below 18.5 kg/m^2 show a progressive increase in mortality rates as well as increased risk of illness. A recent study among Nigerian men and women has shown that mortality rates among CED individuals who are mildly, moderately, and severely underweight are 40%, 140%, and 150% greater respectively than rates among non-CED individuals.[2,77]

Mid-upper-arm circumference (MUAC) has recently emerged in the literature as a potential screening tool for poor nutritional status in adults. MUAC has been analyzed in adults, and cut-offs have been calculated equivalent to BMI cut-offs for chronic energy deficiency using a range of data sets from developing countries.[78]

At the other end of the spectrum, overweight is associated with an increased prevalence of cardiovascular risk factors such as hypertension, unfavourable blood lipid concentrations, and diabetes mellitus.[79] It is also a major risk factor for the development of gallstones and is related to osteoarthritis in several joints. Overweight and the risk of endometrial cancer increase in direct proportion.[80] Mortality for both men and women is raised among individuals with a high BMI.[81]

A series of studies provides a basis for understanding the dynamic shifts in body composition that have occurred among adults in recent decades. There is now ample documentation that in Latin America, North Africa and the Middle East, and South-East Asia, more overweight than underweight exists among adults.[82,83] The CED:obesity ratio, which reflects the ratio of undernutrition to overnutrition in a population, has shifted dramatically in the past several decades in many countries.[82] Research from Latin America has shown that the burden of obesity is becoming greater among the poor than among the higher-income groups.[84]

Further studies have used available national surveys from 1982 to 1996 from Latin American countries to estimate the prevalence of overweight in women 15 to 49 years old, as well as exploring recent trends.[38] A high level of overweight (a prevalence of 34 49%, excluding Haiti) was found in eight Latin American countries. Trends in obesity for Brazil, the Dominican Republic, and Peru also showed an increase. As for age distribution, studies in Brazil and elsewhere show that obesity is higher among 40- to 50-year-olds than among younger adults. However, obesity rates then begin to decrease with advancing years in most populations.

For this report we have brought together the data for nonpregnant women 20 to 49 years old, from the latest available Demographic and Health Surveys[85] and three national nutrition surveys.[38] Similar national survey data are not available for men. Data from 16 countries in Africa, 10 countries in Latin America and the Caribbean, 3 countries in Asia, and 1 country in North America are presented (Table 1.8).

Underweight is common among women in developing countries. Judging from survey results from South Central Asia, underweight is widespread among women in this sub-region. Some 51.3% of women in Bangladesh are underweight, about half of whom are moderately or severely underweight, with a BMI below 16.99 kg/m^2. In six countries surveyed in Africa mild underweight affects more than 10% of women, and in two countries (Chad and Madagascar) prevalences are greater than 15%. In five countries surveyed in Africa moderate and severe underweight affects more than 3% of women. Except for Haiti, underweight among women in Latin America is less common. For most countries surveyed in this region, prevalences of mild underweight are well below 10%, and moderate combined with severe underweight affects less than 3% of women. Overweight (Grade 1) is seen in about one-third of women in Peru (36.6%), Bolivia (36.1%), and Colombia (31.6%) and affects at least one in four women in all countries surveyed, except for Haiti. Overweight prevalence rates exceed 15% in two African countries, Comoros and Namibia. Nearly one-third of Egyptian women have Grade 1 overweight.

TABLE 1.8 : Prevalence of underweight and overweight of women 20 49 years old by country

Region/country/ survey year	Sample size	Average age (years)	Underweight (BMI) Severe (%)	Moderate (%)	Mild (%)	Overweight (BMI) Grade 1 (%)	Grade 2 (%)	Grade 3 (%)
Africa								
Benin 1996	2,414	29.44	1.2	2.1	10.8	7.3	2.0	1.2
Burkina Faso 1992	5,243	29.92	0.6	2.3	10.6	5.9	0.7	0.8
Central Af Rep 1995	2,112	28.45	1.2	2.1	12.0	6.0	1.3	0.8
Chad 1997	5,793	28.85	2.1	4.2	13.5	4.5	0.8	1.9
Comoros 1996	924	29.97	0.4	1.2	7.0	16.8	4.7	0.3
Côte d Ivoire 1994	3,077	28.79	0.4	1.5	6.0	11.7	3.2	0.6
Egypt 1996	9,503	29.48	0.1	0.4	1.3	31.1	17.3	2.1
Ghana 1993	1,853	29.52	0.8	1.8	9.0	10.0	3.3	0.1
Kenya 1998	2,816	28.31	0.7	1.4	8.6	10.8	2.2	2.8
Madagascar 1997	2,880	28.89	1.7	3.1	15.1	3.5	0.5	0.1
Malawi 1992	3,527	30.20	0.4	1.3	6.3	8.4	0.8	0.2
Namibia 1992	3,096	30.25	1.1	1.8	9.9	14.7	6.5	1.2
Niger 1998	3,680	29.00	0.9	2.7	15.8	6.5	1.7	0.1
Tanzania 1996	5,573	29.64	0.8	1.5	6.6	10.8	2.4	1.1
Uganda 1995	4,471	28.32	0.5	1.3	7.5	7.6	1.2	1.2
Zambia 1996	5,666	28.87	0.5	0.9	7.1	11.4	2.2	0.5
Latin America								
Bolivia 1998	5,698	30.26	0.0	0.2	0.5	36.1	11.0	0.6
Brazil 1996	3,713	28.93	0.3	1.2	5.1	25.6	9.4	0.5
Colombia 1995	4,101	28.88	0.1	0.5	2.9	31.6	9.1	0.5
Dominican R 1996	3,443	27.90	0.5	0.8	5.1	27.5	9.5	1.0
Guatemala 1995	7,156	29.54	0.3	0.5	2.5	26.7	7.0	0.4
Haiti 1994/95	1,782	30.86	2.0	3.6	13.0	9.1	2.7	0.0
Honduras 1996	837	30.70	1.1	1.0	6.5	24.1	7.7	0.6
Mexico 1987	2,793	32.56	1.0	1.5	5.1	28.2	12.2	0.7
Nicaragua 1998	6,337	28.74	0.2	0.3	3.0	28.4	10.4	1.2
Peru 1996	1,388	30.01	0.0	0.1	0.9	36.6	8.8	0.4
Asia								
Bangladesh 1996	4,743	27.31	9.5	13.5	28.3	2.2	0.4	1.6
Nepal 1996	3,026	28.06	2.9	5.4	19.1	1.7	0.1	0.0
Uzbekistan 1996	1,211	26.83	1.4	1.2	8.5	12.6	3.6	0.1
North America								
USA 1988 94	4,380	34.27	0.1	0.5	3.6	21.6	18.8	3.7

Source: 85.

Note: For severe underweight, BMI < 16.00 kg/m^2; moderate, BMI = 16.00 16.99 kg/m^2; mild, BMI = 17.00 18.49 kg/m^2. For Grade 1 overweight, BMI = 25.00 29.99 kg/m^2; Grade 2, BMI = 30.00 39.99 kg/m^2; Grade 3, BMI > 40.00 kg/m^2.

1.6 Nutrition of Older People in Developing Countries

Populations are ageing. The 20th century has seen an unprecedented transition from high birth and death rates to low fertility and mortality. In 1950 there were about 200 million people over 60 years; by 2025 there will be 1.2 billion, of whom nearly 70% will live in developing countries. The majority of poor older people in developing countries enter old age after a lifetime of poverty and deprivation, poor access to health care, and a diet that is usually inadequate in quantity and quality. For most of these older people, retirement is not an option. Poverty, lack of pensions, deaths of younger adults from AIDS, and rural to urban migration of younger people are among the factors that compel older people to continue working. Adequate nutrition, healthy ageing, and the ability to function independently are thus essential components of a good quality of life.

In 1992, the London School of Hygiene and Tropical Medicine (LSHTM), in collaboration with HelpAge International, began a programme of research on the nutrition of older adults in developing countries. The objectives of the programme were to test simple anthropometric measures of nutritional status, assess functional ability, and examine the risk factors of nutritional vulnerability. Fieldwork was undertaken in three sites: the urban slums of Mumbai, India,[86] a Rwandan refugee camp in Tanzania[87] and rural communities in Lilongwe, Malawi.[88] Other larger-scale research efforts are under way in a number of countries with similar objectives (China, for example, has several longitudinal studies on this topic).

WHO states that conventional BMI cut-offs for defining CED may not be appropriate for older people above 70 years, because of age-related changes in body composition.[2] There are also practical problems with obtaining accurate BMI measurements in this group because of curvature of the spine. The LSHTM group found that a MUAC cut-off of 21.7 cm had a sensitivity of nearly 86% in relation to the BMI cut-off of 16 kg/m^2 and proposed it as an alternative to BMI as part of a screening tool in the acute phase of an emergency. Further studies are urgently needed in this area.

Table 1.9 shows the prevalence of undernutrition by sex in the three studies.[86,89,90] In all three studies, the prevalence of undernutrition increased with age among women. This was most marked in India, where it rose to nearly 60% among women over 70 years. The lower prevalence of undernutrition in the refugee population is probably because the study was conducted in the postemergency phase: the sample represented those who had successfully reached the camp and survived a year in exile.

Nutritional status was related to functional ability. The strongest relationship was with handgrip strength, a measure of the strength of the upper limb. Undernutrition was also found to be associated with higher risk of impairments in psychomotor speed and coordination, mobility, and the ability to carry out activities of daily living independently, even after controlling for age, sex, and disease.

TABLE 1.9 : Prevalence of undernutrition from three studies of older people

	Men	Women
India (Mumbai slums)	35.0%	35.0%
Rwandan refugees	19.5%	13.1%
Malawi (rural Lilongwe)	36.1%	27.0%

Sources: 86, 89, 90.
Note: Undernutrition here indicates a BMI of < 18.5 kg/m^2.

Sarcopenia, the gradual loss of muscle mass with age, appears widely prevalent and has been linked to ageing-related losses of strength, increased risks of morbidity, functional impairment, dependence, and mortality. One recent longitudinal study of 1,504 Chinese adults has shown that energy and protein intake can directly affect this condition.[91]

Research is urgently needed to assess the magnitude of the nutrition problem among older people, including micronutrient status, and to refine techniques for the anthropometric assessment of nutritional status. The appropriateness of conventional BMI cut-offs for older adults needs to be assessed. Nutrient requirements for older people are mostly extrapolated from younger adults in developed countries and assume the reduction in energy expenditure associated with retirement. These requirements may not be correct for poor older people in developing countries. There are also age-related changes that can lead to reduced or altered food intake: physiological changes in the sense of taste, poor appetite (often associated with loneliness, social isolation, depression, or medications), physical factors such as absent or ill-fitting dentures, limited ability to procure or prepare food because of musculoskeletal disorders or other disease conditions, and chronic disease.

There is almost no experience of nutrition interventions for older adults. We have little or no idea of what works, nor do we even know if their nutritional status can be improved or if such improvement would lead to better functional ability. Operational research in these areas is needed to fulfill the right of older adults to adequate nutrition.

Summary

Global progress in reducing undernutrition through the life cycle is slow and patchy across regions. Prevalence rates, particularly of low birthweight, stunting, and underweight, remain high across most sub-regions, particularly in Eastern Africa and South Central Asia.

In South Central Asia, about one in five children born this year will be undernourished at birth the most startling manifestation of the intergenerational transmission of undernutrition. Intrauterine growth retardation is a pivotal indicator of progress in breaking the intergenerational cycle of undernutrition, a prospective marker of a child s future

nutrition and health status as well as a retrospective measure of the nutritional and health status of the mother. Given our increasing knowledge of the implications of being born undernourished for adulthood, it should also be considered a valuable summary indicator of human development.

Overall, more than a third of all children in the developing world remain constrained in their physical growth and cognitive development by undernutrition. The ambitious goal of halving childhood underweight prevalence by the year 2000, set at the 1990 World Summit for Children, will not be achieved by most countries. While the high rates of child undernutrition in South Asia are well known, these continue to drop, albeit not very rapidly. Most disturbing is the fact that two subregions Eastern and Western Africa are actually showing significant increases in prevalence percentages. On the positive side, two subregions the Caribbean and South America will manage to reach the World Summit goal.

Data on the nutritional status of individuals at different stages of the life cycle are slowly becoming available but remain limited. The emergent situation of coexisting undernutrition and overnutrition among adults is notable, as is the extreme paucity of data on older adults, a group that will continue to grow proportionately in developing-country populations. This chapter has described the nature, levels, causes, and consequences of malnutrition proxied by anthropometry as it persists through the life cycle. Basic prevalence data are still needed in many countries.

Although this chapter argues for a particular focus on *preventing* foetal and early childhood malnutrition, the life cycle dynamics of cause and consequence demand a holistic inclusive approach. Adequate nutrition is a human right for all people, and intervening at each point in the life cycle will accelerate and consolidate positive change. The next chapter provides an update on the global, regional, and sub-regional situation regarding micronutrient deficiencies and programmes for their prevention and control.