**Food, Agriculture, and the Environment Discussion Paper 30**

# Overcoming Child Malnutrition in Developing Countries:

## Past Achievements and Future Choices

*Lisa C. Smith*
*Lawrence Haddad*

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

2020 VISION

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February 29, 2000

Dear Reader:

This report was launched at a widely attended 2020 Vision Policy Seminar at IFPRI on February 24, 2000, where we presented our findings and Charles F. MacCormack, president of Save the Children, commented on them. The report prioritizes the investments needed by sector and by region to best improve child nutrition by 2020. These sector-level investments relate to factors such as increasing the food supply, improving access to education for girls, raising women's status, and improving access to clean water. The report also found that national income growth and democratic decisionmaking processes play an essential facilitating role.

A very useful discussion at the policy seminar about the implications of our work for investments in more direct nutrition programs ensued. The discussion clarified that the sector investments should be regarded as medium-term efforts that support but do not substitute for more direct nutrition interventions. Examples of such direct interventions include community-based nutrition programs to improve home-based caring practices and micronutrient supplementation and fortification programs. We expect investments at the sector level to enhance the performance of these direct interventions. For example, women with improved education and status are better able to interact with community-based nutrition promoters and to act upon the information they receive.

Action at both of these levels—direct and indirect—is crucial if significant reductions in child malnutrition in South Asia and Sub-Saharan Africa are to be realized in the next generation.

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About 167 million children under five years of age  almost one-third of the developing world s children  are malnourished. If they survive childhood, many of these children will suffer from poorer cognitive development and lower productivity. As adults, their ability to assure good nutrition for their children could be compromised, perpetuating a vicious cycle. What will it take to eradicate child malnutrition in developing countries?

As Lisa Smith and Lawrence Haddad point out in this 2020 Vision discussion paper, *Overcoming Child Malnutrition in Developing Countries: Past Achievements and Future Choices,* we must first understand the causes of malnutrition and delineate which are the most important before we can identify and act upon those areas of intervention that will be most successful in reducing malnutrition. Toward that end, their path-breaking research identifies and assesses the contribution of each key determinant to reductions in child malnutrition over the past quarter century. The most startling and important finding is that improvements in women s education have contributed by far the most, accounting for 43 percent of the reduction in child malnutrition between 1970 and 1995, while improvements in per capita food availability contributed about 26 percent. In a signal service to policymakers, Smith and Haddad also evaluate the potential of these factors to further reduce malnutrition during the next two decades to 2020 and lay out the key policy priorities for each major developing region. By shedding light on which areas of intervention will be most successful in overcoming child malnutrition in developing countries, this research will contribute to realizing the 2020 Vision of a world where hunger and malnutrition are absent. To share the analytical and methodological advances of this path-breaking research, IFPRI is also publishing a technical version of this report as a research report titled *Explaining Child Malnutrition in Developing Countries: A Cross-Country Analysis,* available in February 2000.

Per Pinstrup-Andersen
Director General

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# 1. Exploring the Causes of Malnutrition

Although the share of children who are malnourished has gradually been declining over the past 25 years, the actual number of malnourished children is still rising in many countries. In 1995, 167 million children under five years old almost one-third of developing-country children were estimated to be underweight. Malnutrition[1] causes a great deal of human suffering both physical and emotional. It is a violation of a child s human rights (Oshaug, W. Eide, and A. Eide 1994). It is associated with more than half of all deaths of children worldwide (Pelletier et al. 1995). And it is a major waste of human energy. Adults who survive malnutrition as children are less physically and intellectually productive and suffer from more chronic illness and disability (UNICEF 1998). The personal and social costs of continuing malnutrition on its current scale are enormous.

But in order to reduce malnutrition, one must understand its causes. It seems obvious that a child will be underweight if he or she does not have enough food, but the causes are much more complex and interrelated than that. They range from factors as broad as political instability to those as specific as diarrheal disease. And the solutions proposed are just as wide-ranging. Policymakers and researchers endlessly debate which of the many causes of malnutrition are most important, and which areas of intervention will be most successful in reducing it. The overall objective of the study that underlies this paper is to answer those questions.

While the prevalence of malnutrition in the developing world as a whole fell from 46.5 percent to 31 percent between 1970 and 1995, about 15 percentage points in all, progress in reducing malnutrition has varied greatly from one region to another (Table 1). Malnutrition has declined the fastest in South Asia (by 23 percentage points) and the slowest in Sub-Saharan Africa (4 percentage points), but the pace of change is decelerating. During 1970 85 the prevalence of malnutrition fell by 0.8 percentage points per year; during 1985 95, it fell by only 0.3 points. The situation is particularly troubling in Sub-Saharan Africa where the prevalence of underweight children actually increased from almost 29 percent in 1990 to 31 percent in 1995. Since 1970, the prevalence of underweight children has decreased in 35 developing countries, held steady in 15, and increased in 12, with most of the countries with increases in Sub-Saharan Africa (WHO 1997).

Why have some countries and regions done better than others in combating child malnutrition? The study uses cross-country data to determine which of the various broad determinants of child malnutrition are most important in each region and the developing world. It also aims to unravel the answers to a number of puzzling questions that are currently under debate: (1) Why has child malnutrition been rising in Sub-Saharan Africa? (ACC/SCN 1997); (2) Why are child malnutrition rates in South Asia so much higher than those in Sub-Saharan Africa (in other words, what

[1]Malnutrition is associated with both undernutrition and overnutrition. In this paper the term refers to *undernutrition* as measured by underweight rates. A child is considered underweight if he or she falls below an anthropometric cutoff of 2 standard deviation below the median weight-for-age Z-score of the National Center for Health Statistics/World Health Organization international reference.

**Table 1 Trends in child malnutrition in developing countries, by region, 1970 95**

| Region | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | Change, 1970 to 1995 |
|---|---|---|---|---|---|---|---|
| | | | (percent) | | | | (percentage points) |
| Percent of children malnourished | | | | | | | |
| South Asia | 72.3 | 67.7 | 63.7 | 61.1 | 53.4 | 49.3 | 23.0 |
| Sub-Saharan Africa | 35.0 | 31.4 | 28.9 | 29.9 | 28.8 | 31.1 | 3.9 |
| East Asia | 39.5 | 33.3 | 30.0 | 26.5 | 23.5 | 22.9 | 16.6 |
| Near East and North Africa | 20.7 | 19.8 | 17.2 | 15.1 | n.a. | 14.6 | 6.1 |
| Latin America and the Caribbean | 21.0 | 17.0 | 12.2 | 10.6 | 11.4 | 9.5 | 11.5 |
| All regions | 46.5 | 41.6 | 37.8 | 36.1 | 32.3 | 31.0 | 15.5 |
| | | | (millions) | | | | (millions) |
| Number of children malnourished | | | | | | | |
| South Asia | 92.2 | 90.6 | 89.9 | 100.1 | 95.4 | 86.0 | 6.2 |
| Sub-Saharan Africa | 18.5 | 18.5 | 19.9 | 24.1 | 25.7 | 31.4 | +12.9 |
| East Asia | 77.6 | 45.1 | 43.3 | 42.8 | 42.5 | 38.2 | 39.4 |
| Near East and North Africa | 5.9 | 5.2 | 5.0 | 5.0 | n.a. | 6.3 | +0.4 |
| Latin America and the Caribbean | 9.5 | 8.2 | 6.2 | 5.7 | 6.2 | 5.2 | 4.3 |
| All regions | 203.8 | 167.6 | 164.3 | 177.7 | 176.7 | 167.1 | 36.7 |

Sources: 1975, 1980, and 1985 prevalences and numbers of malnourished children are from Table 1.2 of ACC/SCN 1992; 1990 and 1995 estimates are from WHO 1997, Table 6. Where the regions differ in these sources from the five listed, population estimates were used to make appropriate region-specific approximations. The 1970 figures are predicted using the underlying-determinant model regression results presented in this paper. The source for the population data used to calculate the numbers of underweight children for 1970 is United Nations 1996. Large jumps in numbers of underweight children between successive five-year periods (for example, East Asia in 1970 and 1975) may be explained by the use of differing sources of population estimates.

Notes: A child under five (0 59 months) is considered malnourished if the child falls below an anthropometric cut-off of 2 standard deviations below the median weight-for-age Z-score of the National Center for Health Statistics/World Health Organization international reference. n.a. is not available.

explains the so-called Asian enigma ) (Ramalingaswami, Jonsson, and Rohde 1996; Osmani 1997)?[2] (3) How important a determinant of child malnutrition is food availability at a national level? (Smith et al. 1999; Haddad, Webb, and Slack 1997a); (4) How important are women s status and education? (Quisumbing et al. 1995; Osmani 1997; Subbarao and Raney 1995); (5) How important are national political factors (such as democracy) and national incomes, and through what pathways do they affect child malnutrition? (Anand and Ravallion 1993; Pritchett and Summers 1996). Addressing these questions should help policymakers use resources wisely to reduce child malnutrition as quickly as possible between now and 2020.

The study employs the highest quality, nationally representative data on child underweight currently available for the period 1970 95 to undertake a cross-country regression analysis of the determinants of child malnutrition. Although a number of cross-country studies have been undertaken in recent years, this study differs from past studies in four important ways. First,

[2]Indicators such as per capita food availability, health environment quality, and national income which are thought to be key factors influencing children s nutrition are much higher in South Asia than in Sub-Saharan Africa, but a much larger share of children in South Asia are malnourished. Why? This is the Asian enigma.

extreme care has been taken in assembling, cleaning, and documenting the data used. For the conclusions to be credible, the quality of the child malnutrition data must be of high quality. However, little attention has been paid to this issue outside of the World Health Organization s excellent *WHO Global Database on Child Growth and Malnutrition* (WHO 1997), from which most of the data are drawn. Second, the econometric techniques are more rigorous than those in most other studies. Third, in drawing out the implications of the empirical analysis, the study goes beyond the simple generation of elasticities to estimate the contribution of each nutrition determinant to reductions in child malnutrition over the past 25 years. Fourth, national food availability projections from IFPRI s IMPACT model (Rosegrant, Agcaoili-Sombilla, and Perez 1995), together with assumptions about future values of other child malnutrition determinants, are used to project levels of malnutrition in the year 2020 under pessimistic, optimistic, and status quo scenarios. Key policy priorities for each developing region are laid out.

This paper summarizes the findings of the study and reviews the current state of child malnutrition in the developing world. For a comprehensive discussion of the analysis and methodology used to analyze the relative importance of the various causes of malnutrition, the reader should see the companion volume to this paper *Explaining Child Malnutrition in Developing Countries: A Cross-Country Analysis,* IFPRI Research Report 111, by Lisa C. Smith and Lawrence Haddad, February 2000.

# 2. Determinants of the Nutritional Status of Children

The conceptual framework underlying this study (Figure 1) is adapted from the United Nations Children s Fund s framework for the causes of child malnutrition (UNICEF 1990, 1998) and the subsequent extended model of care as presented in Engle, Menon, and Haddad (1999). The framework is comprehensive, incorporating both biological and socioeconomic causes, and encompasses causes at both micro and macro levels. It breaks the determinants of child nutritional status into three levels of causality: immediate determinants (the most proximate level), underlying determinants, and basic determinants (the deepest level).

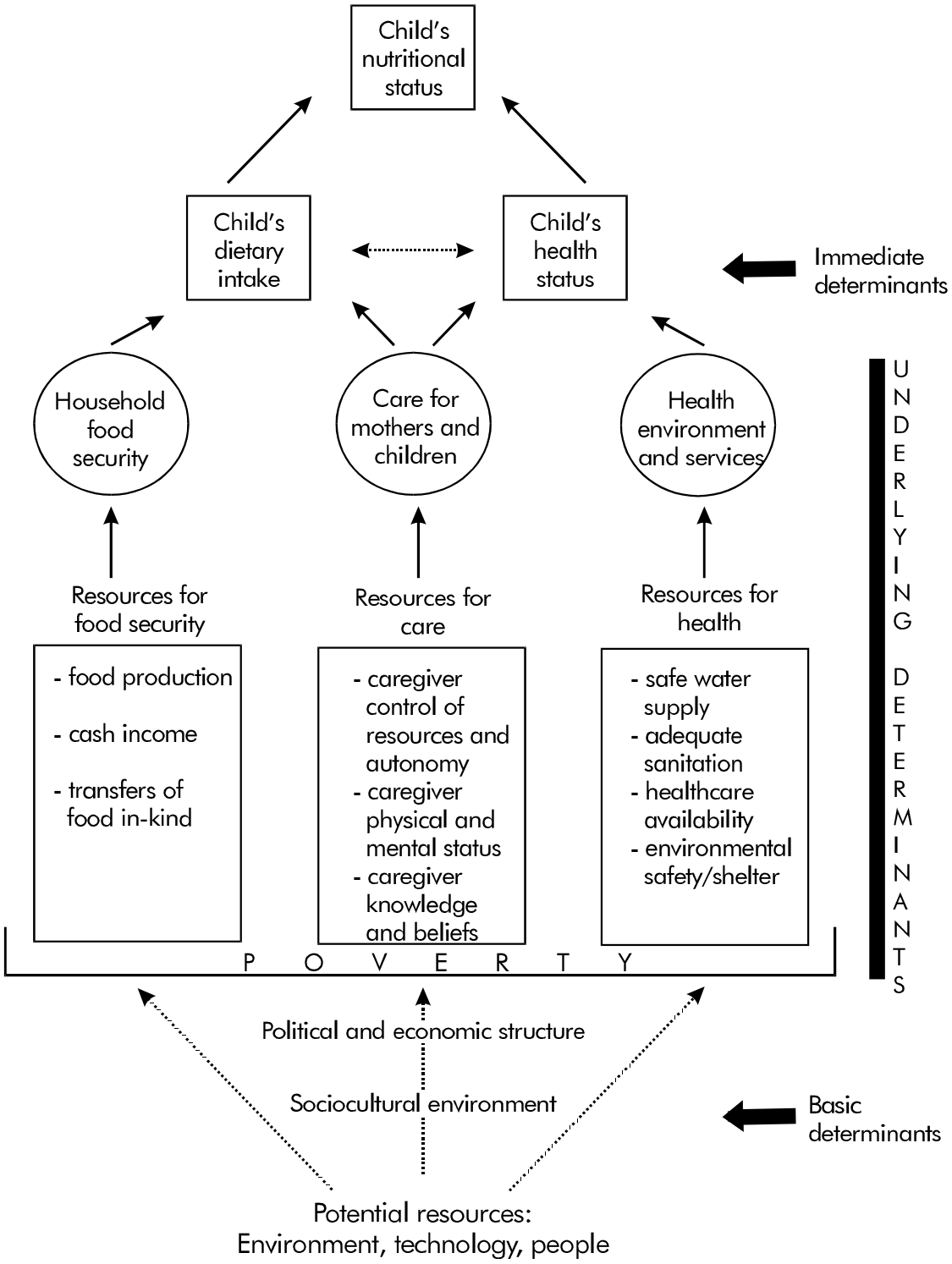
The *immediate determinants* of child nutritional status manifest themselves at the level of the individual human being. They are dietary intake (energy, protein, fat, and micronutrients) and health status. These factors themselves are interdependent. A child with inadequate dietary intake is more susceptible to disease. In turn, disease depresses appetite, inhibits the absorption of nutrients in food, and competes for a child s energy. Dietary intake must be adequate in quantity and in quality, and nutrients must be consumed in appropriate combinations for the human body to be able to absorb them.

The immediate determinants of child nutritional status are, in turn, influenced by three *underlying determinants* manifesting themselves at the household level. These are food security, adequate care for mothers and children, and a proper health environment, including access to health services. Associated with each is a set of resources necessary for their achievement.

Food security is achieved when a person has access to enough food for an active and healthy life (World Bank 1986). The resources necessary for gaining access to food are food production, income for food purchases, or in-kind transfers of food (whether from other private citizens, national or foreign governments, or international institutions). No child grows without nurturing from other human beings: this aspect of child nutrition is captured in the concept of care for children and their mothers, who give birth to children and who are commonly their main caretakers after they are born. Care, the second underlying determinant, is the provision in households and communities of time, attention, and support to meet the physical, mental, and social needs of the growing child and other household members (ICN 1992). Examples of caring practices are child feeding, health-seeking behaviors, support and cognitive stimulation for children, and care and support for mothers during pregnancy and lactation. The adequacy of such care is determined by the caregiver s control of economic resources, autonomy in decisionmaking, and physical and mental status. All of these resources for care are influenced by the caregiver s status relative to other household members. A final resource for care is the caregiver s knowledge and beliefs. The third underlying determinant of child nutritional status, health environment and services, rests on the availability of safe water, sanitation, health care, and environmental safety, including shelter.

A key factor affecting all underlying determinants is poverty. A person is considered to be in absolute poverty when he or she is unable to satisfy basic needs for example, to obtain adequate food, health care, water, shelter, primary education, and community participation (Frankenberger

**Figure 1 Conceptual framework guiding empirical analysis**




Sources: Adapted from UNICEF 1990, 1998; and Engle, Menon, and Haddad 1999.

1996). The effects of poverty on child malnutrition are pervasive. Poor households and individuals are unable to achieve food security, have inadequate resources for care, and are not able to make use of (or contribute to the creation of) resources for health on a sustainable basis.

Finally, the underlying determinants of child nutrition (and poverty) are, in turn, influenced by *basic determinants,* which include the potential resources available to a country or community, limited by the natural environment, access to technology, and the quality of human resources. Political, economic, cultural, and social factors affect the utilization of these potential resources and how they are translated into resources for food security, care, and health environments and services.

# 3. Data and Methods

## Explanatory Variables

This study focuses on the underlying and basic determinants of child malnutrition. Explanatory variables representing all three of the underlying determinants described in the conceptual framework food security, care for mothers and children, and the health environment and services are considered. In addition, two variables representing the basic economic and political determinants of child malnutrition national income and democracy are considered. The choice of variables is guided by the conceptual framework (Figure 1), the experience of past studies, and data availability. A key determinant poverty is excluded from the analysis because of insufficient data.

### *Underlying Determinant Variables*

Unfortunately, no cross-national data on food security from nationally representative household survey data are available. However, data do exist for one of its main determinants: *national food availability*. This variable is used as a proxy, even though it does not account for the important problem of food access, which is also essential for the achievement of food security (Sen 1981; El Obeid et al. 1999).

Similarly, there are no cross-national indicators of maternal and child care that cover the time span of the study. *Women s education* and *women s status relative to men s* are chosen as proxies for this factor. The education level of women, who are the main caretakers of children, has several potentially positive effects on the quality of care. More educated women are better able to process information, acquire skills, and model positive caring behaviors than less-educated women. They make better use of health care facilities, interacting more effectively with health care providers and complying with treatment recommendations, and they are more likely to keep their living environment clean. More educated women tend to be more committed to child care, interacting more with the children in their care and stimulating them. Finally, education increases women s ability to earn income, but this increases the opportunity cost of their time, which tends to mitigate against some important caregiving behaviors, for example, breast feeding (Engle, Menon, and Haddad 1999).

A lower status of women relative to men restricts women s opportunities and freedoms, providing less interaction with others and less opportunity for independent behavior, which restricts the transmission of new knowledge and damages self-esteem and expression (Engle, Menon, and Haddad 1997). It is a particularly important determinant of two resources for care: mothers physical and mental health and their autonomy and control over resources in households. The physical condition of women is closely associated with the quality of caring practices, starting even before a child is born. A woman s nutritional status during childhood, adolescence, and pregnancy has a strong influence on her child s birthweight and subsequent growth (Martorell et al. 1998; Ramakrishnan, Rivera, and Martorell 1998). A woman who is in poor physical and mental health provides lower quality care to her children after they are born, including the quality of breast feeding. In general, when the care a child s mother receives suffers, the child s care suffers as well (Ramalingaswami, Jonsson, and Rohde 1996; Engle, Menon, and Haddad 1999).

While women are more likely to allocate resources at the margin to the interests of their children than are men, the lower their autonomy and control over resources relative to men s, the less able they are to do so (Haddad, Hoddinott, and Alderman 1997; Smith and Chavas 1997). In short, low status relative to men restricts women s capacity to act in their own and their children s best interests.[3]

Women s education and relative status also play a key role in household food security. In many countries women are highly involved in food production and acquisition. The household decisions made in these areas are influenced by women s knowledge regarding the nutritional benefits of different foods and their ability to direct household resources toward food for home consumption (Quisumbing et al. 1995). Thus the effects on child malnutrition of women s education and women s status relative to men s will partially reflect the influences of these variables on food security as well as on care of mothers and children.

*Access to safe water* is used as the indicator for health environment and services. Improvements in water quantity and quality have been shown to reduce the incidence of various illnesses, including diarrhea, ascariasis (roundworm), dracunculiasis (guinea worm), schistosomiasis, and trachoma (Hoddinott 1997). This variable was chosen as a proxy for health environment and services because it is the variable for which the most data are available, and because it is highly correlated with other measures of the quality of a country s health environment and services: countries with high access to safe water are likely to have good health environments and health services overall.

## *Basic Determinant Variables*

To broadly capture the availability of resources in countries, *per capita national income* is used as a measure, under the hypothesis that income plays a facilitating role in all of the underlying factors considered. A rise in national income may enhance the health environment and services as well as women s education by increasing government budgets. It may boost national food availability by improving resources available for purchasing food on international markets, and for countries with large agricultural sectors, it reflects the contribution of food production to overall income generated by households. It may improve women s relative status directly by freeing up resources for augmenting women s lives as well as men s. Finally, a plethora of recent studies have shown that the relationship between growth in national income and poverty is negative (see, for example, Ravallion and Chen 1997; Roemer and Gugerty 1997).

The political context within which child malnutrition is determined is accounted for by using *democracy* as an indicator. As for national income, it is hypothesized that democracy plays a facilitating role in all of the underlying factors considered. The more democratic a government, the larger the percentage of government revenue that may be spent on education, health services, and income redistribution. The more democratic a government is, the more likely it is to respond to the needs of *all* of its citizens, women s as well as men s, indirectly promoting women s relative status. With respect to food security, the work of Drèze and Sen (1994) and others clearly points to the importance of democracy in averting famine.

[3]This paper focuses on women s status relative to men s, rather than their absolute status, as much work indicates that it is the former that governs both women s power and control over resources in household decisionmaking as well as the general value placed on women s well-being at a societal level (Haddad, Hoddinott, and Alderman 1997; Smith 1998; Kishor and Neitzel 1996).

Democratic governments are more likely to honor human rights including the right to food and nutrition (Haddad and Oshaug 1998) and to encourage community participation (Isham, Narayan, and Pritchett 1995), both of which may be important means to reducing child malnutrition.

The estimation technique used in this study allows us to consider explicitly only observed variables that change over time. However, one can implicitly control for unobserved time-invariant factors (see Chapter 4) that affect child malnutrition as well. Some important determinants of child malnutrition identified in the last section fall into the latter category, for example, climate and sociocultural environment.

## How the Variables Are Measured

The analysis is based on data for 63 developing countries over the period 1970 96 (for a list of the countries included, see Table 2). The dependent variable is the prevalence of children under five who are underweight for their age. The availability of high-quality, nationally representative survey data for underweight children is the limiting factor for inclusion of countries. Data for the explanatory variables are matched for each country by the year in which the underweight data are available. For statistical reasons, only countries for which child malnutrition data are available for at least two points in time are included. The total number of country-year observations is 179. The average number of observations per country is 2.8. The average number of years between observations for a country is 6.9.

All South Asian countries are included in the sample, and more than half of the countries in Sub-Saharan Africa, East Asia, and Latin America and the Caribbean (LAC). The Near East and North Africa (NENA) region, for which only 5 of 14 countries are included, has the poorest coverage. Overall, the sample covers 57 percent of the developing countries and 88 percent of the 1995 population of the developing world. Although the data were not purposefully sampled in a random manner, the authors believe that they are adequately representative of the population of developing countries.[4]

The measures employed for the explanatory variables, their definitions, and sample summary statistics are given in Table 3. Here, a brief description is given of each, along with their sources. Fuller descriptions are provided in the companion IFPRI research report (Smith and Haddad 2000).

As indicated earlier, the prevalence of underweight children under age five is used as a measure of child malnutrition. This measure represents a synthesis of height-for-age (long-term growth faltering or stunting) and weight-for-height (acute growth disturbances or wasting) data.[5] The largest share of the data, 75 percent, are from the *WHO Global Database on Child Growth and Malnutrition* (WHO 1997). These data have been subjected to strict quality control standards for inclusion in the database. The rest of the data are from ACC/SCN (1992, 1996) and World Bank (1997a).

For per capita national food availability, data for the countries daily per capita dietary energy supplies are used. This measure is derived from

[4]It is possible that countries with low rates of child malnutrition and high incomes are better able to conduct national surveys of malnutrition. If so, these countries would be overrepresented in the sample. However, it is also possible that national-level malnutrition surveys are carried out in low-income countries with high rates of malnutrition because institutions with external funding sources are more interested in studying them.

[5]While in the past national-level data on stunting and wasting were more rare than data on underweight, they are becoming increasingly available and more widely employed as indicators of child malnutrition (see ACC/SCN 1997 for the first review of trends in stunting, for example). Future cross-country panel data studies of the causes of child malnutrition will be able to use both of the indicators, which are likely to have different determinants (Victora 1992; Frongillo , de Onis, and Hanson 1997).

**Table 2 Regional, country, and population coverage of the study**

| Region | Number of countries | Share of countries covered | Share of population covered[a] | Number of observations | Country (years in parentheses) |
|---|---|---|---|---|---|
| | | (percent) | | | |
| South Asia | 5 | 71 | 98 | 16 | Bangladesh (82, 85, 89, 96), India-rural (77, 91), Nepal-rural (75, 95), Pakistan (77, 85, 90, 95), Sri Lanka (77, 80, 87, 93). |
| Sub-Saharan Africa | 26 | 58 | 83 | 65 | Benin (87, 96); Burkina Faso (87, 92); Cameroon (77, 91); Comoros (91, 95); Congo, Republic of (77, 87); Congo, Democratic Republic of (75, 86, 89, 94); Côte d Ivoire (86, 94); Ethiopia-rural (83, 92); Ghana (87, 93); Guinea (80, 95); Kenya-rural (82, 87); Lesotho (76, 81, 94); Madagascar (83, 92, 95); Malawi (81, 92, 95); Mauritania (81, 87, 90); Mauritius (85, 95); Niger (85, 92); Nigeria (90, 93); Rwanda (76, 92); Senegal (86, 92); Sierra Leone (74, 77, 90); Tanzania (87, 91, 96); Togo (76, 88); Uganda (77, 88, 95); Zambia (72, 85, 88, 92, 96); Zimbabwe (84, 88, 94). |
| East Asia | 8 | 57 | 94 | 26 | China (87, 92, 95), Indonesia (78, 87, 95), Laos (84, 94), Malaysia (83, 86, 90, 95), Myanmar (80, 83, 90, 95), Philippines (73, 82, 87, 93), Thailand (82, 87, 90), Viet Nam (80, 87, 94). |
| Near East and North Africa | 5 | 31 | 37 | 14 | Algeria (87, 92, 95), Egypt (78, 88, 92, 95), Jordan (75, 90), Morocco (87, 92), Tunisia (74, 88, 94). |
| Latin America and the Caribbean | 19 | 68 | 85 | 58 | Bolivia (81, 89, 93), Brazil (75, 89, 96), Chile (78, 82, 86, 95), Columbia (77, 86, 89, 95), Costa Rica (78, 82, 89, 94), Dominican Republic (86, 91), El Salvador (88, 93), Guatemala (77, 80, 87, 95), Guyana (71, 81, 93), Haiti (78, 90, 94), Honduras (82, 87, 93), Jamaica (78, 85, 89, 93), Mexico-rural (74, 79, 89), Nicaragua (80, 93), Panama (80, 92), Peru (75, 84, 91, 96), Trinidad and Tobago (76, 87), Uruguay (87, 92), Venezuela (81, 87, 90, 94). |
| Developing countries | 63 | 57 percent of the developing countries | 88 percent of the developing-country population | 179 | |

Source: Population data, United Nations 1998; regional grouping of developing countries, Smith and Haddad 2000.
[a]These percentages are calculated from countries 1995 populations.

## Table 3 Variable definitions and sample summary statistics

| Variable | Definition | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Prevalence of child malnutrition | Percent of children under five less than 2 standard deviations below the median weight-for-age Z-score of the NCHS/WHO international reference | 24.6 | 15 | 0.9 (Chile 1995) | 71.3 (India 1977) |
| Access to safe water | Percent of population with access to safe water (percent) | 56.2 | 23.7 | 6 (Ethiopia 1983) | 100 (Mauritius 1985) |
| Female secondary school enrollment | Gross female secondary school enrollment rate (percent) | 33.8 | 22.5 | 2.5 (Uganda 1977) | 88 (Uruguay 1992) |
| Female-to-male life expectancy ratio | Ratio of female life expectancy at birth to male life expectancy at birth | 1.062 | 0.03 | 0.97 (Nepal 1975) | 1.15 (El Salvador 1988) |
| Per capita dietary energy supply | Daily per-capita dietary energy supply (kilocalories) | 2,360 | 331 | 1,592 (Ethiopia 1992) | 3,284 (Egypt 1995) |
| Per capita GDP | Per capita gross domestic product (in purchasing power parity adjusted 1987 U.S. dollars) | 2,306 | 1,779 | 306 (Ethiopia 1992) | 8,612 (Chile 1995) |
| Democracy | Combined index of political rights and civil liberties (measured on a scale of 1 to 7 points, 1 = least democratic) | 3.5 | 1.7 | 1[a] | 7 (Costa Rica 1978, 1982, 1989) |

[a] The countries for which the democracy index number is 1 are: Algeria (1995), Benin (1987), China (1992, 1995), Ethiopia (1983), Guinea (1980), Haiti (1994), Laos (1994), Mauritania (1995), Myanmar (1990, 1995), Uganda (1977),Viet Nam (1980, 1987, and 1994), and Zaire (1986).

food balance sheets compiled by the United Nations Food and Agriculture Organization (FAO) from country-level data on the production and trade of food commodities (FAO 1998).

For women s education, female gross secondary school enrollment rates are used as a measure. The data are from the United Nations Educational, Scientific, and Cultural Organization s UNESCOSTAT database (UNESCO 1998).

The measure used for women s status relative to men s is the ratio of female life expectancy at birth to male life expectancy at birth.[6] Life expectancy at birth is defined as the number of years a newborn infant would live if prevailing patterns of mortality at the time of his or her birth were to stay the same throughout his or her life. This measure was chosen because discrimination against females at all stages of life and inequity in investments in women relative to men are reflected in differences in life expectancy. The source for life expectancy data is *World Development Indicators* (World Bank 1998).

To measure access to safe water, the percentage of a country s populations with access to safe water is used, defined as the population share with reasonable access to an adequate amount of water that is either treated surface water or water that is untreated but uncontaminated (such as water from springs, sanitary wells, and protected boreholes) (World Bank 1997b). The data are from various years of UNICEF s *State of the World s Children* and reports from the World Health Organization (WHO 1996).

For per capita national income, real per capita gross domestic product (GDP), expressed in purchasing power parity-comparable 1987 U.S. dollars, is used. The data are from the World Bank s *World Development Indicators* (World Bank 1998).[7]

For degree of democracy, an average of two seven-point country-level indexes from Freedom House (1997) are used. One is of political rights and one of civil liberties,[8] and each is given an equal weight. The combined index ranges from 1 to 7, with 1 corresponding to least democratic and 7 to most democratic.

## Estimation Methods

The estimations of the effects on child malnutrition of the hypothesized determinants are based on multiple linear regression techniques.[9] Specifically, a panel-data econometric technique, country fixed-effects estimation, is used. The technique controls for country-specific factors that vary little over time factors such as climate, characteristics of countries physical environments (soil type and topography, for example), and deeply embedded cultural and social mores. From a practical stand-

[6]There is no agreed-upon measure of women s status . Most measures available in the literature are multiple-indicator indexes (UNDP 1997; Kishor and Neitzel 1996; Mohiuddin 1996; Ahooja-Patel 1993).The extension of human life is associated with an enhanced quality of life. Inequalities in life expectancy or mortality favoring males (beyond international biological norms) reflect discrimination against females and entrenched, long-term gender inequality (Sen 1998; Mohiuddin 1996). The gender life expectancy ratio was chosen as a measure of women s relative status for two main reasons: (1) it is a good indicator of the cumulative investments in females relative to males throughout the human life cycle; (2) data are readily available for the countries and years included. The ratio of female-to-male infant mortality would be an even better index, not being influenced by public health risks such as cigarette smoking in adults, but such data were not available for sufficient countries and years.

[7]These data are only reported for 1980 to the present. To arrive at comparable purchasing power parity (PPP) GDP per capita figures for the 1970s data points, it was necessary to impute growth rates from the data series on GDP in constant local currency units and apply them to countries 1987 PPP GDPs.

[8]Political rights enable people to participate freely in the political process, including choosing their leader freely from among competing groups and individuals. Civil liberties give people the freedom to act outside of the control of their government, including developing their own views, institutions, and personal autonomy (Ryan 1995).

[9]See Smith and Haddad (2000) for a detailed description of the methods employed.

point, it is carried out by including in the estimating equations a dummy variable for each of the 63 countries in the sample.

In conformity with the conceptual framework, two child malnutrition regression models are separately estimated, an underlying determinants model and a basic determinants model. The underlying determinants model explores the effects of national food availability, women s education and status, and access to safe water on the prevalence of malnutrition. The basic determinants model explores the effects of national income and democracy. As discussed in the appendix on methodological issues and past findings, when determinants lying at different levels of causality are included in the same regression equation, biased estimation results. Therefore, the models are kept separate to avoid this problem. It is then possible to explore the ways in which the basic determinants work *through* the underlying determinants to affect child malnutrition.

A number of tests have been performed to gauge the accuracy of the estimates and whether they differ across the developing-country regions (for details see Smith and Haddad 2000). One test determines whether any important variables have been left out of the analysis. Another tests for potential endogeneity of the explanatory variables, using an instrumental variables technique. Finally, a test for parameter stability determines whether there are significant differences across the developing regions.[10]

[10]The test for omitted variables bias is the Ramsey Regression Specification Error Test (RESET). A Hausman-Wu test is used to test for endogeneity of the explanatory variables. To identify appropriate instruments for undertaking this test, candidate instrument sets are subjected to relevance and overidentification tests. The parameter stability tests are Chow *F*-tests (see Smith and Haddad 2000).

# 4. New Evidence from Cross-Country Data, 1970 95

## Descriptive Analysis

The regional levels and trends of underweight prevalence in the 63-country sample closely follow those for the developing countries as a whole in Table 1. South Asia had the highest prevalence throughout the period, roughly double that of the region in second place, Sub-Saharan Africa (Table 4). More than half of all South Asian children under five years old were underweight for their age. Roughly one-third were underweight in Sub-Saharan Africa and one-fifth in East Asia. The proportion of underweight children was smaller in Near East and North Africa (NENA) and Latin America and the Caribbean (LAC). The regions whose child malnutrition rates declined the most from the 1970s to the 1990s are South Asia and East Asia. Sub-Saharan Africa is the only region for which underweight rates have increased during the period.

Turning to the underlying-determinant explanatory variables, NENA and LAC had the highest access to safe water, over 70 percent, while Sub-Saharan Africa had the lowest, at 37.5 percent, which amply illustrates the high degree of inequality across the regions (Table 4, column 2). Access to safe water has improved substantially during the study period. It has more than doubled for the full sample, starting at 36 percent in the 1970s, increasing quickly to 62 percent in the 1980s, and rising to 69 percent by the 1990s (Table 5). Rates of improvement were greatest for East Asia and South Asia.

With respect to women s education, at 16 percent, Sub-Saharan Africa had the lowest rate of enrollment of females in secondary schools (Table 4, column 3). The rate was also low in South Asia, where only 24 percent of women of eligible age were enrolled. For the entire sample, female secondary school enrollment rates improved steadily, rising from 22 percent in the 1970s to 45 percent in the 1990s. Nevertheless they are still quite low: less than half of the women in developing countries complete a secondary school education.

The measure of women s status relative to men s, the ratio of female-to-male life expectancy, was by far the lowest in South Asia, with men s and women s life expectancies being roughly equal (Table 4, column 4). Women s life expectancy in the developed countries is on average six to seven years longer than men s (Mohiuddin 1996). The ratio of women s life expectancy to men s in Norway, for example, is 1.08. Thus South Asia s ratio of 1.01 is extremely low. Sub-Saharan Africa, East Asia, and NENA had ratios of 1.06, 1.05, and 1.04, respectively rates well below those of developed countries. LAC had the highest ratio of the developing-country regions, which, at 1.09, is on a par with the developed countries. The ratio has improved or remained fairly steady in all regions except Sub-Saharan Africa. Over time, the ratio for the developing countries as a whole increased from 1.02 in the 1970s to 1.05 in the 1990s (Table 5).

Per capita dietary energy supplies (DES) were lowest in South Asia and Sub-Saharan Africa over the study period. The minimum daily dietary energy requirement for an active and healthy life is about 2,150 kilocalories (FAO 1996). These regions *supplies* (not intake) barely surpassed this requirement (Table 4, column 5). The mini-

**Table 4 Regional comparison of child malnutrition prevalences and explanatory variable means, 1970s to 1990s**

| Region/decade | Child malnutrition (1) | Access to safe water (2) | Female secondary school enrollment (3) | Female-to-male life expectancy ratio (4) | Per capita dietary energy supply (5) | Per capita GDP (6) | Democracy (7) |
|---|---|---|---|---|---|---|---|
| | (percent) | (percent) | (percent) | | (kilocalories) | ($PPP) | (1=least democratic) |
| South Asia | **61.0** | **60.5** | **23.8** | **1.010** | **2,187** | **863** | **4.59** |
| 1970s (n = 4) | 69.1 | 29.8 | 16.3 | 0.987 | 2,023 | 728 | 4.38 |
| 1980s (n = 6) | 61.8 | 51.9 | 14.2 | 1.020 | 2,042 | 719 | 3.25 |
| 1990s (n = 6) | 55.7 | 81.3 | 31.5 | 1.022 | 2,332 | 990 | 5.16 |
| Sub-Saharan Africa | **31.0** | **37.5** | **15.6** | **1.061** | **2,164** | **879** | **2.57** |
| 1970s (n = 10) | 27.2 | 24.7 | 8.5 | 1.069 | 2,207 | 1,358 | 1.77 |
| 1980s (n = 26) | 26.5 | 35.0 | 14.6 | 1.066 | 2,117 | 1,031 | 2.02 |
| 1990s (n = 29) | 33.7 | 40.4 | 17.0 | 1.060 | 2,184 | 740 | 2.96 |
| East Asia | **23.0** | **64.5** | **47.9** | **1.051** | **2,595** | **1,874** | **1.69** |
| 1970s (n = 2) | 45.0 | 19.7 | 25.8 | 1.050 | 2,007 | 1,402 | 3.0 |
| 1980s (n = 13) | 26.8 | 63.8 | 39.2 | 1.053 | 2,502 | 1,483 | 2.30 |
| 1990s (n = 11) | 19.4 | 67.8 | 54.4 | 1.049 | 2,686 | 2,132 | 1.25 |
| Near East and North Africa | **11.0** | **75.5** | **52.5** | **1.043** | **3,058** | **2,527** | **2.81** |
| 1970s (n = 3) | 16.5 | 72.5 | 34.0 | 1.042 | 2,710 | 1,547 | 3.32 |
| 1980s (n = 4) | 10.1 | 69.3 | 46.4 | 1.043 | 3,018 | 2,746 | 3.09 |
| 1990s (n = 7) | 10.8 | 79.4 | 59.7 | 1.043 | 3,157 | 2,637 | 2.55 |
| Latin America and the Caribbean | **12.0** | **71.8** | **44.8** | **1.094** | **2,647** | **4,740** | **4.73** |
| 1970s (n = 12) | 18.9 | 59.5 | 33.3 | 1.086 | 2,620 | 4,713 | 4.06 |
| 1980s (n = 26) | 11.4 | 79.0 | 47.2 | 1.096 | 2,675 | 4,871 | 5.14 |
| 1990s (n = 20) | 8.3 | 73.3 | 51.4 | 1.098 | 2,636 | 4,607 | 4.79 |

Notes: The means reported in this table are calculated based only on the country-year pairs included in the study data set. They are population-weighted. The numbers for the regions (in bold) are for the entire time period.

**Table 5 Variable means for the 1970s, 1980s, and 1990s, and correlations with the underweight rate**

| Variable | 1970s | 1980s | 1990s | Change 1970s to 1990s | Percent change 1970s to 1990s | Correlation with underweight rate[a] |
|---|---|---|---|---|---|---|
| Child malnutrition (percent) | 50.7 | 29.0 | 28.5 | 22.2 | 43.8 | . . . |
| Access to safe water (percent) | 36.3 | 61.6 | 69.0 | 32.7 | +90.0 | 0.50 |
| Female secondary school enrollment (percent) | 21.7 | 34.5 | 45.0 | 23.3 | +107.0 | 0.48 |
| Female-to-male life expectancy ratio | 1.024 | 1.055 | 1.047 | 0.023 | +2.3 | 0.43 |
| Per capita dietary energy supply (kilocalories) | 2,187 | 2,440 | 2,564 | 377 | +17.2 | 0.52 |
| Per capita GDP ($) | 1,772 | 1,871 | 1,904 | 132 | +7.5 | 0.59 |
| Democracy (1 = least democratic) | 3.96 | 2.86 | 2.66 | 1.3 | 32.8 | 0.31 |
| Number of observations | 31 | 75 | 73 | . . . | . . . | . . . |
| Number of countries | 29 | 54 | 58 | . . . | . . . | . . . |

Note: The means reported in this table are calculated based only on the country-year pairs included in the study data set and therefore must be considered illustrative. They are population-weighted.
[a] Pearson correlation coefficients. All are significant at the 1 percent level.

mum DES necessary (but not sufficient) for bringing food insecurity to a low 2.5 percent of a country s population is 2,770 kilocalories (FAO 1996). The DES of East Asia and LAC neared this level during the study period; NENA s surpassed it. From the 1970s to the 1990s DES increased in all regions except Sub-Saharan Africa.

South Asia and Sub-Saharan Africa had the lowest per capita national incomes and LAC the highest by far (Table 4, column 6). The only region that experienced negative growth was Sub-Saharan Africa. For the developing countries as a whole, per capita GDP increased by about 7 percent between the 1970s and the 1990s.

The region that has been least democratic is East Asia (Table 4, column 7). Interestingly, South Asia and LAC, while at opposite extremes in terms of underweight, were almost equally democratic over the 25-year period. These regions had the highest democracy index scores. Democracy has improved for South Asia, Sub-Saharan Africa, and LAC; it has deteriorated for East Asia and NENA. It is the only explanatory variable that has declined for the developing-country sample as a whole, with scores falling from about 4.0 in the 1970s to 2.7 in the 1990s (Table 5).

In the last column of Table 5, correlations between underweight rates and each explanatory variable are given. The correlation coefficients for all variables are negative and statistically significant, indicating fairly strong negative associations between child malnutrition and the hypothesized determinants. The variables with the strongest correlations are per capita national income, per capita DES, and access to safe water. The weakest correlation is for democracy. In the next section, multivariate analysis is used to single out the independent effects of changes in each variable, while controlling for the others.

## Multivariate Analysis

Table 6 reports fixed-effects regression results for the underlying determinant and basic determinant models. The coefficients of all of the underlying determinants are statistically significant and negative (column 1). Increased access to safe water (as a proxy for the health environment), increased education and improved status for women (as proxies for maternal and child care and for food security), and increased quantities of food available at a

**Table 6 Country fixed-effects estimation results**

| Variable | Underlying determinants | Basic determinants |
|---|---|---|
| Access to safe water | .076<br>(1.95)* | . . . |
| Female secondary school enrollment | .220<br>(3.41)*** | . . . |
| Female-to-male life expectancy ratio | 71.8<br>(1.74)* | . . . |
| Per capita dietary energy supply (*DES*) | | |
| *DES* ≤2,300 | .0170<br>(3.41)*** | . . . |
| 2,300 < *DES* ≤3,120 | .0024<br>(2.16)** | . . . |
| *DES* >3,120 | .0405<br>(1.35) | . . . |
| Per capita GDP (*GDP*) | | |
| *GDP* ≤ 800 | . . . | .0444<br>(3.15)*** |
| 800 < *GDP* ≤ 4,725 | . . . | .0067<br>(2.63)*** |
| *GDP* > 4,725 | . . . | .0006<br>(3.37)*** |
| Democracy | . . . | 1.27<br>(2.51)** |
| $R^2$ | .947 | .930 |

Notes: The dependent variable is prevalence of child malnutrition measured as the percent of underweight children under age five. The coefficients on the fixed-effects terms are not shown. The number of observations for all regressions is 179 (63 countries). Absolute values of *t*-statistics are given in parentheses.

* Significant at the 10 percent level.

** Significant at the 5 percent level.

*** Significant at the 1 percent level.

national level (for food security) all work to reduce levels of child malnutrition in developing countries. While per capita food availability has a negative relationship with child malnutrition, it has a declining *marginal* effect: at low levels of per capita DES, the relationship is strongest; as levels increase, its effect weakens. This relationship is captured by estimating a regression coefficient for three different ranges of DES. The first segment (DES less than 2,300 kilocalories) has a relatively large coefficient. The coefficient of the last segment (DES greater than 3,120 kilocalories) is not statistically significant, implying that after reaching a level of about 3,100 kilocalories, further increases in per capita DES no longer contribute to reductions in child malnutrition.

Turning to the basic determinants model, the regression coefficients on both per capita GDP and the democracy index are statistically significant and negative (column 2). Both increases in overall income at a national level (regardless of how distributed) and the extent of democracy serve to reduce child malnutrition in developing countries. Per capita GDP exhibits a declining marginal effect on child malnutrition: once $4,700 per capita is passed (which few countries in the sample surpass), further increases in per capita GDP no longer contribute to reductions in

**Table 7 Underlying-determinant variable regressions with basic-determinant variables as independent variables**

| Variable | Access to safe water (1) | Female secondary school enrollment (2) | Female-to-male life expectancy ratio (3) | Per capita dietary energy supply (4) |
|---|---|---|---|---|
| Per capita GDP | .0174<br>(2.85)*** | .0148<br>(3.71)*** | 1.0E-05<br>(1.90)* | .4105<br>(6.26)*** |
| $GDP^2$ | 1.31E-06<br>(2.31)** | 9.32E-07<br>(2.53)** | 8.2E-10<br>(1.67)* | 2.79E-05<br>(4.59)*** |
| Democracy | 3.49<br>(2.87)*** | .981<br>(1.23) | .002<br>(1.57) | 26.28<br>(2.0)** |
| $R^2$ | .835 | .922 | .901 | .902 |
| Adjusted $R^2$ | .740 | .877 | .845 | .846 |

Notes: The number of observations for all regressions is 179 (63 countries). Absolute values of *t*-statistics are given in parentheses. The regressions are estimated using a country fixed-effects spccification.

* Significant at the 10 percent level.

** Significant at the 5 percent level.

*** Significant at the 1 percent level.

child malnutrition, as indicated by a near zero (yet statistically significant) coefficient.

According to the conceptual framework (Figure 1), the basic determinants affect child malnutrition through their influence on the underlying determinants. Fixed-effects regression estimates of the effects of per capita national income and democracy on each underlying determinant are given in Table 7. The per capita GDP coefficients are positive and significant for all of the underlying determinants. The results indicate that the amount of income available per person in a country is an important resource base for investment both public and private in health environments, women s education, women s relative status, and national food availabilities.[11] The coefficient of the democracy index in the safe water access and per capita dietary energy supply equations is significant and positive. Therefore, it seems probable that democratic governments are more likely to direct their budgets to improvements in health environments and food availabilities than nondemocratic ones. They are not more likely to direct public resources toward women s education or to women vis-à-vis men.

How substantial, in a practical sense, are the estimated effects of the underlying and basic determinants on child malnutrition, and how do they compare across determinants? It is difficult to get a sense of the relative strengths of the variables effects just by looking at their regression coefficients. This is because each variable is measured in different units and has a different range. Table 8 translates the results into more meaningful terms. Column (2) gives the increase in each variable that would be required to bring about the *same* reduction in the prevalence of child malnutrition: one percentage point. Each determinant s range, based on the minimum and maximum values observed among developing countries

[11] A significant and negative GDP-squared term for all of the underlying determinants implies that the impact of incremental increases in per capita national income tends to decline as incomes rise.

**Table 8 Comparison of the effects of variables on child malnutrition**

| Variable | Sample (or segment) mean (1) | Increase in variable needed to reduce prevalence of child malnutrition by 1 percentage point[a] (2) | Developing-country range (3) | Number in (2) as a percent of developing-country range (4) |
|---|---|---|---|---|
| Underlying-determinant variables | | | | |
| Access to safe water (percent) | 56.2 | 13.1 | 1 100 | 13.2 |
| Female secondary school enrollment (percent) | 33.8 | 4.6 | 0.5 100 | 4.6 |
| Female-to-male life expectancy ratio | 1.0624 | 0.0139 | 0.97 100 | 9.3 |
| Per capita dietary energy supply (*DES*) (kilocalories) | 2,360 | 101 | 1,522 3,605 | 4.9 |
| *DES* ≤ 2,300 | 2,106 | 59 | . . . | 2.8 |
| 2,300 < *DES* ≤ 3,120 | 2,613 | 425 | . . . | 20.4 |
| *DES* > 3,120 | 3,230 | . . . | . . . | . . . |
| Basic-determinant variables | | | | |
| Per capita GDP ($) | 2,306 | 74.1 | 300 8,612 | 0.89 |
| *GDP* ≤ 800 | 645 | 23 | . . . | 0.3 |
| 800 < *GDP* ≤ 4,725 | 2,102 | 150 | . . . | 1.8 |
| *GDP* > 4,725 | 5,867 | . . . | . . . | . . . |
| Democracy | 3.5 | 0.79 | 1 7 | 13.1 |

Note: Leaders indicate not applicable.
[a] Calculated as 1 divided by the regression coefficients of Table 6.

during 1970 95 is given in column (3), while column (4) gives the number in column (2) as a percent of the determinants ranges, which is a scale-neutral measure of strength of impact.[12]

The estimates indicate that a 13.1 percentage point increase in population with access to safe water would be required to bring about a 1 percentage point reduction in the child malnutrition prevalence. This represents 13.2 percent of the variable s range. By contrast, the required increase in the female secondary school enrollment rate is only 4.6 percentage points, representing only 4.6 percent of its range. Thus the required increase in safe water access to bring about the same reduction in child malnutrition is much higher than the required increase in female enrollments, implying that increases in secondary education for women are likely to have a stronger (more negative) impact on child malnutrition than are increases in access to safe water.

The required increase in per capita DES for the full sample (101 kilocalories) is 4.9 percent of its range; that of the female-to-male life expectancy ratio (0.0134) is 9.3 percent of its range. Therefore a rough ranking of the underlying determinants in terms of their potency in reducing child malnutrition is: women s education (greatest potency), followed closely by per capita food availability, fol-

[12] A more common measure is elasticity, which gives the percentage change in an outcome variable associated with a 1 percent increase in an explanatory variable. This measure is not used here because it does not account for the fact that the variables being compared have different ranges. It thus gives an inaccurate ranking of their strengths of impact relative to one another. For example, the elasticity of child malnutrition with respect to the female-to-male life expectancy ratio is 3.1, while the elasticity with respect to female secondary school enrollment is 0.17. However, a 1 percent increase in the former represents a very large increase in it (7 percent of the total range) compared to a 1 percent increase in the latter (0.34 percent of the range). Their elasticities, while informative, are thus not comparable.

lowed, third, by women s relative status, and fourth by health environment improvements. Note that for the low DES range (≤ 2,300 kilocalories), per capita food availability would be ranked first and women s education second. For the medium and high DES ranges (> 3,120), however, women s education would be ranked first and per capita food availability last. The policy implications of these rankings will be drawn out more fully in the conclusions (Chapter 8).

For the basic determinants (lower panel of Table 8), per capita national income appears to be a more potent force for reducing child malnutrition than democracy. The required increase in GDP per capita to reduce the prevalence of child malnutrition by 1 percentage point is $74. This is less than 1 percent of the variable s range, a small proportion. In contrast, a very large increase in democracy would be required to bring about the same change: an increase in the index of 0.8 points (13 percent of its range). Per capita national income has a stronger impact than democracy, even for the medium GDP group (between $800 and $4,725). For the high GDP group (>$4,725), however, democracy prevails as the most potent basic determinant because national income has only a minor impact on child malnutrition in this range.

How accurate are the regression estimates reported in Table 6? Concerns about incorrect or biased parameter estimates as the result of either omission of relevant explanatory variables or endogeneity problems appear to be unfounded. Both the underlying- and basic-determinant models pass a test for the absence of bias from omitted variables, suggesting that the major factors determining child malnutrition at these levels of causality have successfully been captured. Instrumental variables (IV) tests for endogeneity of all variables were undertaken, with the exception of the female-to-male life expectancy ratio and the democracy index, which were not tested because of data constraints (Smith and Haddad 2000). The test results indicate that health environment quality, women s education, per capita food availability, and per capita national income are not endogenous in the empirical models of child malnutrition specified. Given these test results, it is assumed that the estimates are as accurate as possible given current data limitations. In addition, that the estimations are based on a sound conceptual framework (Figure 1) and are undertaken with respect to changes over time in the variables provides further assurance that a causal, rather than merely associative, relationship between child malnutrition and the explanatory variable has been identified.

Past studies suggest that there may be differences across the developing regions in the determinants of child malnutrition or in the magnitude of their effects, especially for South Asia. A test for regional differences in the estimates for underlying-determinant coefficients identifies no strong differences. Thus it is assumed that the estimates in Table 6, column (1) apply to all of the regions. Whereas, from a structural standpoint, the relationship between child malnutrition and DES does not differ substantially across the regions, the regions do differ greatly in the *levels* of their per capita DESs. Because the strength of this determinant depends on its level, the regions thus differ greatly in the strength of impact of DES on child malnutrition. Corresponding to their low per capita DESs over the study period, the effects for Sub-Saharan Africa and South Asia are the highest in magnitude. The other regions have substantially higher DES per capita, and thus their coefficient estimates are much lower in magnitude.

For the basic determinants, test results suggest that there are structural differences across the regions in the effects of national income or democracy or both. South Asia, in particular, differs fundamentally from the others. As for per capita food availability, the effect of per capita national incomes on child malnutrition for any region depends on its level. In South Asia and Sub-Saharan Africa, which had the lowest per capita GDPs during the study period, the effect of national income is relatively strong. It is much weaker for East Asia, NENA, and LAC.

The final clue as to whether substantial regional differences exist in the causes of child malnutrition lies in the magnitudes of the country fixed-effects terms included in the regression equations. These terms represent the effects of factors

that have not changed much (over approximately 13-year periods, the average time span covered for a country). A clear result from the analysis is that the influence on child malnutrition of these unobserved factors is much stronger for South Asia than for the other regions. The mean of the fixed-effects coefficients in the underlying-determinants model is 9.6. This means that, independent of the levels of the explanatory variables included in the regression equation, the prevalence of child malnutrition in the developing world would be about 10 percent. The mean of the fixed-effects coefficients for South Asian countries is far above that of the sample and the other regions, at 33.3.

## A Cautionary Note

Because this study employs cross-cutting empirical methods, its results apply only at the very broad level of the developing countries as a whole and, more tentatively, to the developing-country regions. Their applicability to specific populations at more disaggregated levels is unknown. Careful analysis and diagnosis are needed to understand the causes of child malnutrition for each subpopulation of the developing world, whether it be a region, a country, an area within a country, a community, a household, or an individual child.

# 5. How Has Child Malnutrition Been Reduced in the Past?: A Retrospective

Having identified a number of reasons for children to be underweight and estimated the relative strengths of the causes, we can now infer the contributions of each determinant to the reduction in malnutrition that took place over the study period, 1970 to 1995. To do so also requires information on how much each determinant has actually changed during the period. To obtain this information, the data set is expanded to include all available data on the basic and underlying determinant variables at six points in time: 1970, 1975, 1980, 1985, 1990, and 1995. The mean levels of the determinants for each of these years as well as their total change over the study period are given in Table 9.

From this historical information, the estimated contribution of each underlying determinant to reductions in the developing-country prevalence of child malnutrition from 1970 to 1995 is derived (see the first column of the upper panel of Table 10).[13] The total estimated contribution, a reduction of 15.9 percentage points, is quite close to the 15.5 percentage-point reduction estimated for all developing countries in Table 1. Figure 2 summarizes the estimated share of each determinant s contribution to the total reduction in malnutrition. The change in each over the period on an equivalent scale of 100 percent is presented in Figure 3. Note that safe water access increased the most, while the female-to-male life expectancy ratio increased the least.

Improvements in women s education have contributed by far the most to the total reduction in child malnutrition 43 percent (Figure 2). The contribution of improvements in health environments was also substantial, 19 percent. Improvements in per capita food availability contributed about 26 percent due to both a strong effect and fairly substantial increases, from 2,092 kilocalories per capita in 1970 to 2,559 in 1995. The lowest contribution (12 percent) came from improvements in women s status as gauged by the female-to-male life expectancy. While this factor has a potentially strong per unit impact, it has improved little. Together, women s education and relative status have contributed to more than half of the 1970 95 reduction in the prevalence of malnutrition in developing countries. Much of the reduction was thus probably due to improvements in maternal and child care, the main means through which women s education and status influence a child s nutrition. Some of the effects may also be through improved household food security.

Figure 4 traces the contributions of the underlying determinant variables to changes in the prevalence of developing-country child malnutrition for five-year intervals starting with 1970 75 and ending with 1990 95. The change

[13]The fixed-effects parameter estimates of Table 6 are used to formulate a predicting equation for the change in child malnutrition prevalence during 1970 95. This yields the total predicted reduction in the prevalence. The total contribution of each determinant is then calculated as the determinant s regression coefficient multiplied by its change from 1970 to 1995. The percentage contribution of each determinant is calculated as its total contribution multiplied by 100 and divided by the predicted change in the child malnutrition prevalence over the period.

## Table 9 Underlying-determinant and basic-determinant variable means, 1970 95

| Variable | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | Absolute change, 1970 95 | Average annual change, 1985 95 |
|---|---|---|---|---|---|---|---|---|
| Underlying-determinant variables | | | | | | | | |
| Access to safe water (percent) | 30.2 | 45.4 | 52.4 | 60.7 | 69.9 | 70.3 | 40.1 | 0.96 |
| Female secondary school enrollment (percent) | 15.6 | 25.4 | 28.4 | 30.6 | 36.4 | 46.6 | 31.0 | 1.6 |
| Female-to-male life expectancy ratio | 1.022 | 1.026 | 1.033 | 1.040 | 1.045 | 1.048 | 0.024 | 0.0008 |
| Female life expectancy (years) | 55.2 | 58.5 | 60.4 | 63.5 | 65.3 | 66.0 | 10.79 | 0.25 |
| Male life expectancy (years) | 54.0 | 56.9 | 58.5 | 60.8 | 62.4 | 63.0 | 9.04 | 0.22 |
| Per capita dietary energy supply (kilocalories) | 2,092 | 2,089 | 2,226 | 2,380 | 2,472 | 2,559 | 467 | 17.9 |
| Basic-determinant variables | | | | | | | | |
| Per capita GDP (US$ PPP) | 1,011 | 1,163 | 1,361 | 1,378 | 1,673 | 2,121 | 1,111 | 44.8 |
| Democracy (1 = least democratic) | 2.85 | 2.99 | 3.75 | 3.31 | 3.24 | 2.71 | 0.14 | 0.06 |

Notes: These data are population-weighted. They are estimated using data for the countries in the data set only (Comoros was dropped from the sample due to the absence of population data). In some cases where data were not available for a sample country for a particular year, extrapolations were undertaken.

## Table 10 Estimated contributions of underlying- and basic-determinant variables to changes in the prevalence of child malnutrition, by region, 1970 95

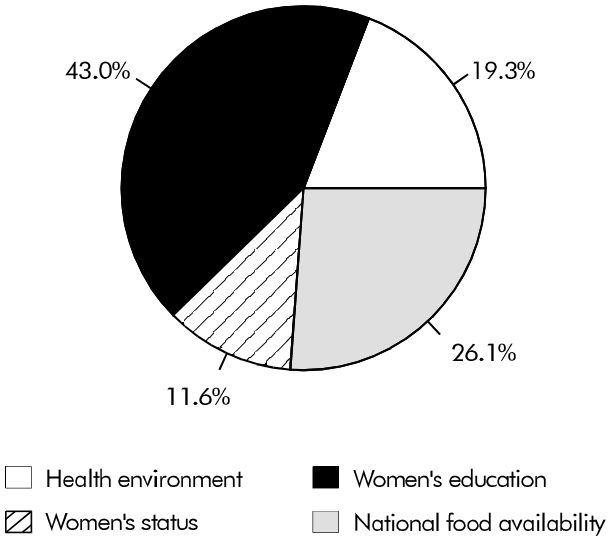
| Variable | All regions | South Asia | Sub-Saharan Africa | East Asia | Near East and North Africa | Latin America and the Caribbean |
|---|---|---|---|---|---|---|
| | | | (percentage-point change in underweight rate) | | | |
| Underlying-determinant variables | | | | | | |
| Health environment | 3.06 | 4.56 | 2.07 | 2.74 | 0.45 | 1.80 |
| Women s education | 6.82 | 4.61 | 3.39 | 9.27 | 9.64 | 6.98 |
| Women s status relative to men s | 1.84 | 3.85 | +1.27 | 1.36 | +0.28 | 1.65 |
| National food availability[a] | 4.14 | 3.44 | 0.048 | 6.11 | 2.34 | 0.77 |
| Total percentage-point change | 15.9 | 16.5 | 4.2 | 19.5 | 12.4 | 11.2 |
| Basic-determinant variables[b] | | | | | | |
| Per capita national income[a] | 7.39 | . . . | . . . | . . . | . . . | . . . |
| Democracy | +0.18 | . . . | . . . | . . . | . . . | . . . |
| Total percentage-point change | 7.2 | . . . | . . . | . . . | . . . | . . . |

Notes: The estimates in this table are obtained by multiplying the coefficients of the proxy variables for each determinant (see Table5) by the change in the proxy over 1970 95. The changes are obtained from Smith and Haddad 2000, Appendix Tables 25 29.

[a] These estimates take into account the changing coefficient of the proxy variable (*DES* and *GDP*) as its level changes.

[b] As discussed in the previous chapter, the regression coefficients of the basic-determinants model cannot be applied to the regions separately due to fundamental structural differences across the regions. Thus, contributions for the basic-determinant variables are not broken down by region.

**Figure 2 Share of reduction in child malnutrition attributed to underlying variables, 1970 95**

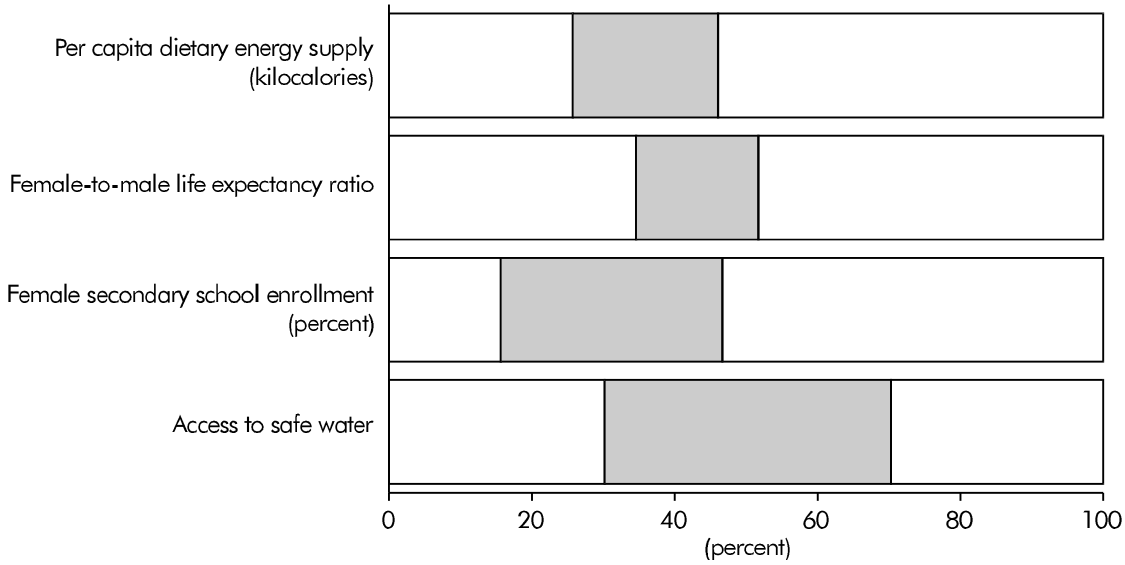



in the prevalence of malnutrition over the five-year periods appears on the vertical axis of the figure. When there was a *reduction* in child malnutrition associated with *increases* in a determinant, the bar falls below zero. A bar value above zero indicates that child malnutrition increased as the result of a reduction in the level of a variable.

There are several points to note:

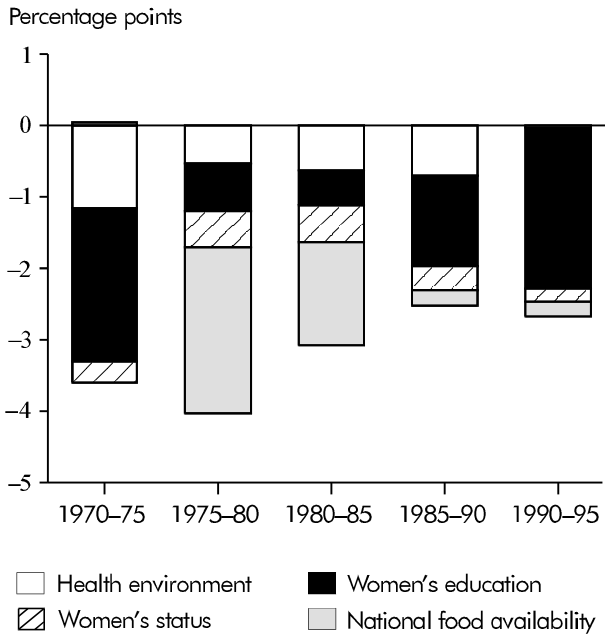
- The prevalence of child malnutrition has declined fairly steadily among developing-country children, dropping about 3.2 percentage points every five years since the early 1970s. The largest reduction, 4.0 percentage points, came in the 1975 80 period. Since then the reductions have been smaller.
- The contribution of improvements in health environments has declined over the 25-year period; in the early 1990s it contributed little.

**Figure 3 Changes in explanatory variables, 1970 95, on an equivalent scale of 100 percent**




Notes: This figure shows the increase in each underlying-determinant variable over 1970 95 on an equivalent scale that allows comparison across variables even though they are measured in different units. Each variable is transformed by equating the minimum of its developing-country range to 0, the maximum to 100, and the in-between numbers to their relative positions on this scale. The variable ranges are given in Table 8, column (3). The shaded area in the bar for each variable starts with its 1970 transformed value and ends with its 1995 transformed value.

**Figure 4 Contributions of underlying-determinant variables to changes in child malnutrition, all regions, 1970 95**

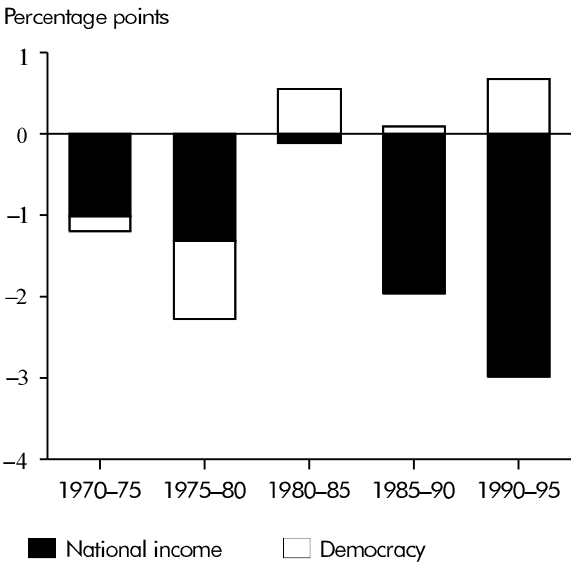



- Women s education made its greatest contribution in the early 1970s and early 1990s. Its contribution dropped dramatically between 1970 and 1980; since then it has gradually increased. This factor contributed 84 percent of the total 2.7 percentage-point reduction in the prevalence of underweight in the early 1990s.
- Corresponding to the world food crisis of the 1970s, per capita food availability declined during 1970 75, leading to a slight *increase* in child malnutrition. As the Green Revolution picked up, the developing countries saw substantial increases in their food supplies. The contribution of food availability to declines in malnutrition were steady and substantial in the late 1970s and early 1980s. Despite continued increases in the late 1980s and early 1990s, the contribution of food availability to reductions in child malnutrition has leveled off because the strength of their impact has declined.
- As improvements in women s status have fluctuated over the 25-year period, so too has their contribution to malnutrition reductions. The greatest contribution was made in the early 1980s; since the late 1980s it has declined considerably.

The bottom panel of Table 10 gives the contribution of the basic determinants. Democracy has actually deteriorated slightly. Despite its potentially positive contribution, its declining trend is associated with a slight increase in child malnutrition. Improvements in per capita national income, however, have been quite large. For the full sample of countries, per capita GDP rose from $1,011 in 1970 to $2,121 in 1995, more than doubling. This large increase, in combination with the strong influence of the variable, has facilitated an estimated 7.4 percentage-point reduction in child malnutrition. The influence of national incomes in reducing malnutrition throughout the developing world over the 25-year period since 1970 has thus been quite strong.

In Figure 5, the contributions of national income and democracy are broken down into five-year periods. While democracy made positive

**Figure 5 Contributions of national income and democracy to changes in child malnutrition, all regions, 1970 95**



contributions in the 1970s, it has declined since then, putting a drag on improvements in child nutrition. Except for the early 1980s, the contribution of national income has increased steadily since the 1970s. Its greatest contribution came most recently: in the 1990 95 period alone it contributed to a 3 percentage-point decline in malnutrition.

Because the strength of impact of the basic determinants differs fundamentally across the regions, specific estimates of their contributions in each region cannot be undertaken. It can be inferred, however, that the contribution of national income has been positive for all regions except Sub-Saharan Africa (where it declined). The contribution of democracy has been positive for Sub-Saharan Africa, NENA, and LAC, but, due to deteriorations in democracy, it has been negative in South and East Asia.

The regions experiences have also differed with respect to the contributions of the underlying determinants, as reported in Table 10.[14] Estimates by region for five-year periods are given in Table 11.

The overall reduction in the prevalence of child malnutrition in South Asia for the 25-year period is estimated to be 16.5 percentage points. The greatest contributions to this reduction have come from increased education of women and improvements in health environments, at about 28 percent each. Improvements in women s relative status have accounted for about 25 percent of the reduction, and improvements in food availability about 20 percent. The factors relative contributions have fluctuated greatly over the study period (Table 11). In the early 1970s, reductions in child malnutrition from improvements in health environments, women s education, and women s relative status were completely undermined by reductions in food supplies. As a result, no progress was made. By the late 1970s food availability had improved: it contributed substantially to the reductions in child malnutrition of the 1980s and early 1990s. In the 1980s malnutrition declined precipitously in the region (by more than 11 percentage points) due to improvements in all of the factors. However, in the 1990 95 period the pace of improvement was severely curtailed by slower growth in health environment improvements and food availabilities.[15] While women in the region continue to have the lowest status compared to men of all developing-country regions (the 1995 female-to-male life expectancy ratio was 1.02), small improvements have made a steady contribution over the 25 years.

The total reduction in Sub-Saharan Africa s child malnutrition rate over the study period is estimated to be only 4.2 percentage points (Box 1). Most of this reduction was brought about by increases in women s education, followed by improvements in health environments. Increased education of women made strong contributions in all periods except for the late 1980s, when enrollments actually declined. Improvements in health environments have made their greatest contribution since 1985. Women s relative status has continually declined in the region since the 1970s, most precipitously after 1985, thus worsening the prevalence of child malnutrition in the region. Changes in food availabilities have played a large, though not always positive, role overall. Substantial improvements in the late 1980s and early 1990s were outweighed by deteriorations during the 1970 85 period.

East Asia has seen the fastest decline in the prevalence of child malnutrition during the study period down 20 points. The greatest contribution to this decline came from increases in women s education, followed by improvements in food availability and health environments. In the early 1970s, child malnutrition declined sharply, by more than 6 percentage points, mostly because of increases in women s education. Pro-

[14]As has been demonstrated, there are no significant differences in the functional relationships between the underlying determinants and child malnutrition. Thus the contributions of these determinants can be quantified using the full-sample coefficient estimates of Table 6, column (1).

[15]This declining contribution is partially due to a declining impact as food supplies increased over the period.

**Table 11 Estimated contributions of underlying- and basic-determinant variables to changes in the prevalence of child malnutrition, by region, 1970 95, for five-year periods**

| Variable/period | All regions (1) | South Asia (2) | Sub-Saharan Africa (3) | East Asia (4) | Near East and North Africa (5) | Latin America and the Caribbean (6) |
|---|---|---|---|---|---|---|
| | | (percentage-point change in underweight rate) | | | | |
| Underlying-determinant variables | | | | | | |
| Health environment | | | | | | |
| 1970 75 | 1.16 | 1.48 | 0.38 | 1.19 | 0.60 | 1.25 |
| 1975 80 | 0.53 | 0.85 | 0.24 | 0.49 | 0.34 | 0.17 |
| 1980 85 | 0.63 | 0.25 | 0.28 | 1.21 | 0.33 | 0.00 |
| 1985 90 | 0.70 | 2.07 | 0.72 | 0.10 | 1.07 | 0.04 |
| 1990 95 | 0.03 | 0.09 | 0.44 | 0.05 | 0.03 | 0.33 |
| Women s education | | | | | | |
| 1970 75 | 2.14 | 0.36 | 0.65 | 3.75 | 1.62 | 1.56 |
| 1975 80 | 0.67 | 0.71 | 0.90 | 0.34 | 2.12 | 1.80 |
| 1980 85 | 0.49 | 1.21 | 1.28 | 0.44 | 2.68 | 1.30 |
| 1985 90 | 1.27 | 1.31 | 0.14 | 1.70 | 2.50 | 0.64 |
| 1990 95 | 2.26 | 1.02 | 0.70 | 3.92 | 0.73 | 1.68 |
| Women s status relative to men s | | | | | | |
| 1970 75 | 0.30 | 0.85 | 0.15 | 0.03 | 0.15 | 0.59 |
| 1975 80 | 0.51 | 0.75 | 0.10 | 0.46 | 0.14 | 0.77 |
| 1980 85 | 0.52 | 0.72 | 0.21 | 0.66 | 0.06 | 0.19 |
| 1985 90 | 0.34 | 0.89 | 0.57 | 0.24 | 0.01 | 0.15 |
| 1990 95 | 0.18 | 0.65 | 0.24 | 0.03 | 0.08 | 0.05 |
| National food availability | | | | | | |
| 1970 75 | 0.04 | 2.67 | 0.86 | 1.17 | 1.04 | 0.22 |
| 1975 80 | 2.32 | 0.47 | 0.12 | 3.60 | 0.56 | 0.45 |
| 1980 85 | 1.44 | 2.55 | 0.92 | 0.89 | 0.35 | 0.07 |
| 1985 90 | 0.22 | 2.34 | 1.09 | 0.21 | 0.33 | 0.04 |
| 1990 95 | 0.21 | 0.74 | 0.63 | 0.24 | 0.06 | 0.13 |
| Total percentage-point change | 15.9 | 16.5 | 4.2 | 19.5 | 12.4 | 11.2 |
| Basic-determinant variables | | | | | | |
| Per capita national income[a] | | | | | | |
| 1970 75 | 1.02 | . . . | . . . | . . . | . . . | . . . |
| 1975 80 | 1.32 | . . . | . . . | . . . | . . . | . . . |
| 1980 85 | 0.11 | . . . | . . . | . . . | . . . | . . . |
| 1985 90 | 1.96 | . . . | . . . | . . . | . . . | . . . |
| 1990 95 | 2.98 | . . . | . . . | . . . | . . . | . . . |
| Democracy | | | | | | |
| 1970 75 | 0.18 | . . . | . . . | . . . | . . . | . . . |
| 1975 80 | 0.96 | . . . | . . . | . . . | . . . | . . . |
| 1980 85 | 0.55 | . . . | . . . | . . . | . . . | . . . |
| 1985 90 | 0.09 | . . . | . . . | . . . | . . . | . . . |
| 1990 95 | 0.67 | . . . | . . . | . . . | . . . | . . . |
| Total percentage-point change | 7.2 | . . . | . . . | . . . | . . . | . . . |

Notes: Estimates are based on the regression coefficients reported in Table 5 and estimated changes in each variable as reported in Smith and Haddad (2000).

## Box 1
# Why Has Child Malnutrition Been Rising in Sub-Saharan Africa?

Sub-Saharan Africa is the only region in which the prevalence of child malnutrition has been increasing. From 1985 to 1995, it increased from 29.9 percent to 31.1 percent (see the table below). Of the four underlying-determinant variables, only one women s relative status as proxied by the female-to-male life expectancy ratio was moving in the wrong direction during the period. Two others, national food availability and women s education both of which remain at extremely low levels were almost stagnant. In addition, national income for the region declined significantly: per capita GDP fell by $52. The decline in this important basic determinant of child malnutrition is responsible for slow progress in all of the underlying-determinant factors and a slight increase in poverty. Therefore, it seems likely that deterioration in women s relative status and per capita national income, along with stagnation in women s education and food availability, at least partially explain the deterioration in child malnutrition in the region. Other factors may be deterioration in the capacity and outreach of government services under the impact of debt and structural adjustment; the rising incidence of HIV/AIDS (Ramalingaswami, Jonsson, and Rohde 1996); and conflict (Messer, Cohen, and D Costa 1998). The decline in the ratio of women s life expectancy to men s is puzzling. It may be because women in Sub-Saharan Africa are more vulnerable to HIV/AIDS than men are, which itself reflects women s lower status (Brown 1996; Howson et al. 1996).

**Trends in the determinants of child malnutrition in Sub-Saharan Africa, 1985 95**

| | 1985 | 1995 | Percentage change, 1985 95 |
|---|---|---|---|
| Child malnutrition (percent underweight) | 29.9 | 31.1 | 4.0 |
| Access to safe water (percent) | 33.5 | 48.8 | 45.7 |
| Female secondary school enrollment (percent) | 16.4 | 19.0 | 15.8 |
| Female-to-male life expectancy ratio | 1.066 | 1.054 | 1.1 |
| Per capita dietary energy supply (kilocalories) | 2,035 | 2,136 | 5.0 |
| Per capita national income (PPP US$) | 830 | 778 | 6.3 |
| Democracy | 2.01 | 2.44 | 21.4 |
| Poverty (percent)[a] | 38.5 | 39.1 | 1.6 |

Sources: Smith and Haddad 2000, Tables 1 and 26. Poverty data are from Ravallion and Chen 1996, Table 5.
Notes: With the exception of the poverty rates, these data are population-weighted means over all countries in the data set in each region. The poverty measure employs an international poverty line of $1 per person per day at 1985 purchasing power parity.
[a] Poverty figures are for 1983 and 1993.

gress since this period has not been as great, but it has continued steadily. The contributions of improvements in health environments and women s relative status declined and were minimal in the 1990s. Improvements in food availability have taken place at a relatively fast pace in East Asia, rising from 1,998 kilocalories per capita in 1970 to 2,720 in 1995. Overall they have contributed to a 6 percentage-point reduction in the prevalence of child malnutrition in the region. Most of the contribution occurred in the 1970 85 period. As per capita dietary energy supplies have increased, their potency in reducing child malnutrition has weakened. Thus, during 1985 95, even though they increased at a fairly fast pace, they made relatively little contribution to reductions in child malnutrition.

Almost all of the reduction in the child malnutrition prevalence of the Near East and North Africa region has come from increases in women s education.[16] The share that can be attributed to health environment improvements has fluctuated the net result being a small contribution of 3.6 percent. Women s relative status deteriorated in most periods, muting improvements in child nutrition. Improvements in food availabilities account for 19 percent of the reduction in child malnutrition. As for East Asia, food availabilities have improved in all periods, but their impact has declined. By 1995, kilocalories per capita per day had reached 3,172, a point at which improvements have little if any further impact.

Latin American and the Caribbean experienced an estimated 11 percentage-point reduction in child malnutrition over the study period, most of which took place during 1970 80. Since then, reductions in child malnutrition have continued at a much slower pace. Like the other regions, the greatest contribution (62 percent) came from expansions in female education. The contribution of improvements in health environments has steadily declined. Strong improvements in women s relative status in the 1970s were followed by very small improvements in the 1980s. By the early 1990s there was a slight decline, muting the overall reduction in malnutrition of the period. Food availabilities improved in the 1970s, but declined slightly in the early 1980s. Their contribution has been minimal since the early 1980s.

[16]The results for this region should be treated with caution given that the majority of countries in the region are not represented in the sample (see Table 2).

# 6. Projections of Child Malnutrition in the Year 2020

Looking forward to the next 25 years, how much is the prevalence of child malnutrition in developing countries likely to decline by the year 2020? How fast is the decline likely to take place? Which regions are likely to experience the greatest improvements in children s nutritional status? Given population growth, are the *numbers* of children who are malnourished likely to increase or decrease?

The future prevalence of child malnutrition obviously depends on the degree of effort exerted to reduce it. To answer these questions, the estimation results in Table 6 are applied to three scenarios based on the projected evolution of the underlying determinants of child malnutrition during 1995 2020.[17] These are a status quo, or do-nothing-different scenario; a pessimistic scenario; and an optimistic scenario.

The evolution of the safe water access, female secondary school enrollment, and female-to-male life expectancy ratio variables under the alternative scenarios relies on various assumptions regarding their average annual increases during 1985 95. Per capita dietary energy supplies rely on projections generated by IFPRI s IMPACT model (Rosegrant, Agcaoili-Sombilla, and Perez 1995).[18] These projections are based on assessments of future developments in the world food situation (including changing prices of food and changes in agricultural productivity) and various assumptions about future agricultural research investments, population growth,[19] and growth in nonagricultural incomes. The levels of each explanatory variable in 1995 and under the alternative scenarios are given in Table 12. Figure 6 maps out the past (1970) and expected evolution of the prevalence of child malnutrition (1970 2020) under the alternative scenarios for the developing countries as a whole.

## Three Scenarios

### *Status Quo Scenario*

In the status quo scenario, safe water access, female secondary school enrollments, and the female-to-male life expectancy ratio improve at the same rates they improved over 1985 95 (see the second column of Table 12). At these rates, the share of the developing-country population with access to safe water would rise from 70 percent in 1995 to 94 percent by the year 2020. The female secondary school enrollment rate would rise from 47 percent to a hefty 87 percent. Corresponding to its slow rate of growth in the previous

[17] See Smith and Haddad (2000) for a more detailed explanation of the procedure employed for generating projections.

[18] The IMPACT model is the International Model for Policy Analysis of Agricultural Commodities and Trade. Developed at IFPRI, it is made up of a set of 35 country or regional models that determine supply, demand, and prices for 17 agricultural commodities.

[19] The 1992 medium population growth rates (United Nations 1993) are employed as the basis for population projections in the IMPACT model. The projections of the numbers of children under five years of age in this report are taken from Rosegrant, Agcaoili-Sombilla, and Perez (1995).

**Table 12 Projections to 2020 of the prevalence and numbers of malnourished children under five in developing countries, alternative scenarios**

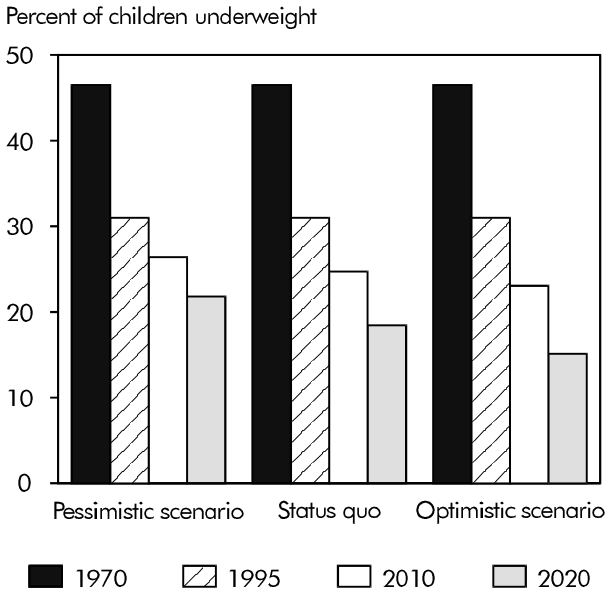
| Variable | 1995 mean (1) | Annual increase in variable, 1985 95 (2) | 2020 scenarios | | |
|---|---|---|---|---|---|
| | | | Status quo (3) | Pessimistic (4) | Optimistic (5) |
| 1. Prevalence of child malnutrition (percent) | 31 | . . . | 18.4 | 21.8 | 15.1 |
| 2. Number of children malnourished (millions) | 167.1 | . . . | 140.3 | 154.8 | 127.6 |
| 3. Access to safe water (percent) | 70.2 | 0.96[a] | 94.3 | 88.3 | 100.0 |
| 4. Female secondary school enrollment (percent) | 46.6 | 1.60[a] | 86.7 | 76.7 | 96.7 |
| 5. Female-to-male life expectancy ratio | 1.047 | 0.00071 | 1.066 | 1.061 | 1.070 |
| 6. Per capita dietary energy supply (DES) (kilocalories) | 2,559 | . . . | 2,821 | 2,662 | 2,978 |

Notes: The estimates in rows (3) through (5) are based on 1985 95 average annual growth rates (given in column 2) calculated from the reported values of the respective variables given in columns (4) and (6) of Table 14. In the status quo scenario, the growth rates are assumed to remain the same for the period 1995 2020. In the pessimistic scenario they are assumed to fall by 25 percent. In the optimistic scenario they are assumed to increase by 25 percent. The estimates for *DES* in row (6) are based on IFPRI IMPACT model projections as reported in Rosegrant, Agcaoili-Sombilla, and Perez 1995. The projections correspond to future developments in food prices, agricultural productivity, research investments, population growth, and growth in nonagricultural incomes.

[a]Percentage points.

10 years, the female-to-male life expectancy ratio would rise only slightly, from 1.047 in 1995 to 1.066 in 2020. Per capita dietary energy supplies would rise from 2,559 to 2,821 kilocalories, which corresponds to current trends in agricultural research investments, population growth, and nonagricultural income growth.

**Figure 6 Three scenarios for the evolution of child malnutrition, 1970 2020**




Given these trends in the underlying determinants, the share of underweight children under five in the developing countries is projected to fall from 31 percent in 1995 to 18 percent in 2020, a total reduction of 13 percentage points. Roughly one-fifth of developing-country children under five would remain malnourished under this scenario. Given current trends in population growth, the projected reduction in the *number* of underweight children under five is quite small, only 27 million children (a 16 percent reduction).

### *Pessimistic Scenario*

Under the pessimistic scenario, the rate of improvement in the nonfood underlying determinants is assumed to decline by 25 percent. This scenario might ensue, for example, if growth in per capita national incomes were to decline or governments were to decelerate public investment in social services. In that case the share of the developing-country population with access to safe water rises to only 88 percent by 2020. The female secondary school enrollment rate rises to

only 77 percent, leaving almost a quarter of all women without any secondary school education. The female-to-male life expectancy ratio rises to only 1.061, with women s status relative to men s improving only slightly.

Per capita dietary energy supplies are assumed to rise to 2,662 kilocalories, an increase of only 4 percent. This latter projection is based on the IMPACT model s low-investment/slow growth scenario in which international donors eliminate public investment in national agricultural research systems and extension services in developing countries and phase out direct core funding of international agricultural research centers. In addition, nonagricultural income growth is reduced by 25 percent from 1990 levels.

The predicted percentage of malnourished children under five in developing countries under this pessimistic scenario is 22 percent. If this scenario were to prevail, only a slight dent in the number of malnourished children would be achieved: a reduction of 12 million, which is only 7 percent below the 1995 numbers.

### *Optimistic Scenario*

In the optimistic scenario the rate of improvement in the percent of the developing-country population having access to safe water is enhanced by 25 percent, leading to universal access by the year 2020. The female secondary school enrollment rate would climb to more than double the 1995 prevalence, reaching 97 percent. The female-to-male life expectancy ratio would rise to 1.07. Corresponding to annual increases of US $750 million in funding for national and international agricultural research and a 25 percent increase in nonagricultural income growth, per capita dietary energy supplies would increase to 2,978 kilocalories (the high investment/rapid growth scenario of the IMPACT model).

Under this scenario the prevalence of child malnutrition in the year 2020 would fall to 15 percent. While this rate is still high, it represents substantial progress over the current prevalence, cutting it in half. The number of malnourished children would decline by almost 25 percent, falling to 128 million.

## Regional Projections

The projections for the developing countries as a whole mask wide variation across the regions. The regional projections in Table 13 are illustrated in Figure 7 (for prevalence) and Figure 8 (for numbers). There are several points to note.

- Under all scenarios South Asia will continue to be the region with the highest prevalence and numbers of malnourished children. However, both will fall rapidly during the 1995 2020 period. In the status quo scenario the most likely prevalence will fall from 49 percent to 37 percent. Despite a slight increase in the total population of children under five (from 174 to 176 million), the number of malnourished children will fall from 86 million to 66 million, a 23 percent decline.
- Little progress in reducing child malnutrition will be made in Sub-Saharan Africa. Under the pessimistic scenario, the prevalence of malnutrition is predicted to *increase* from a 1995 rate of 31 percent to 32 percent in 2020. Even under the optimistic scenario, prevalence would decline by only 5.4 percentage points. Given slow rates of decrease in prevalence and large expected increases in the total number of children under five (101 to 169 million) under all scenarios, the number of malnourished children is expected to increase in the region, rising as high as 55 million under the pessimistic scenario, a number not far below that for South Asia.
- The prevalence and number of malnourished children are expected to decline the fastest in the East Asia region. Under all scenarios the prevalence of malnutrition is nearly cut in half, falling to about 12 percent of the population. No increase is expected in

**Table 13 Projections of the prevalence and number of malnourished children in developing countries, alternative scenarios, by region, to 2020**

| Region | 1995 | 2020 status quo | 2020 pessimistic | 2020 optimistic |
|---|---|---|---|---|
| | | (percent) | | |
| Percent underweight | | | | |
| South Asia | 49.3 | 37.4 | 40.3 | 34.5 |
| Sub-Saharan Africa | 31.1 | 28.8 | 32.4 | 25.7 |
| East Asia | 22.9 | 12.8 | 13.1 | 12.6 |
| Near East and North Africa | 14.6 | 5.0 | 7.4 | 3.7 |
| Latin America and the Caribbean | 9.5 | 1.9 | 4.0 | 0.0 |
| All developing countries | 31.0 | 18.4 | 21.8 | 15.1 |
| | | (millions) | | |
| Number underweight | | | | |
| South Asia | 86.0 | 66.0 | 71.1 | 60.9 |
| Sub-Saharan Africa | 31.4 | 48.7 | 54.6 | 43.3 |
| East Asia | 38.2 | 21.4 | 21.9 | 20.9 |
| Near East and North Africa | 6.3 | 3.2 | 4.8 | 2.4 |
| Latin America and the Caribbean | 5.2 | 1.1 | 2.3 | 0.0 |
| All developing countries | 167.1 | 140.3 | 154.6 | 127.6 |

Notes: The estimates are based on projected future values of the underlying-determinant explanatory variables, defined in Table 3 (see notes to Table 12 and text for further explanation).

the total number of children under five over the period. The number of malnourished children thus will fall precipitously from 38 to around 21 million.

- In the Near East and North Africa region, malnutrition will fall to very low levels, except under the pessimistic scenario, in which almost 5 million children under five will be malnourished.
- Malnutrition will almost be eliminated in Latin America and the Caribbean (although some countries within the region will continue to have high rates).

In line with these trends, the regional configuration of the locations of malnourished children in the developing world is expected to change considerably by the year 2020 (Figure 9). Under the status quo scenario, South Asia s share is predicted to remain high, falling from 51 percent to 47 percent. Sub-Saharan Africa s share is expected to rise from 19 percent in 1995 to almost 35 percent by the year 2020.

**Figure 7 Projections of the percent of malnourished children by region, for three scenarios, to 2020**

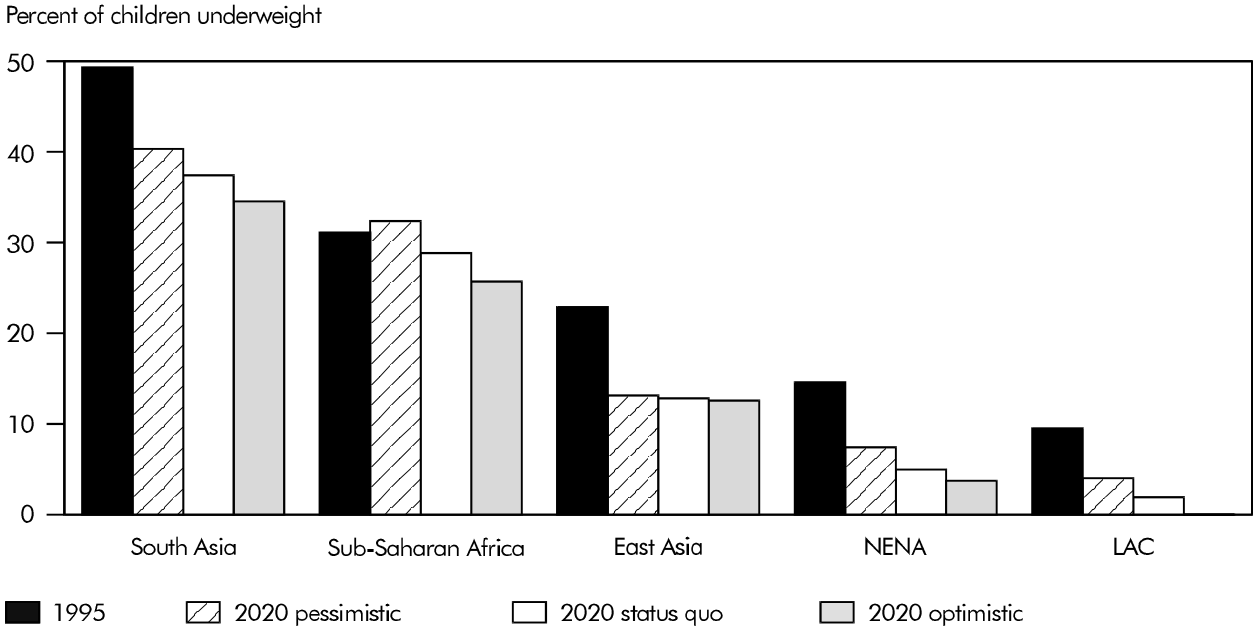



**Figure 8 Projections of numbers of malnourished children, by region, to 2020**

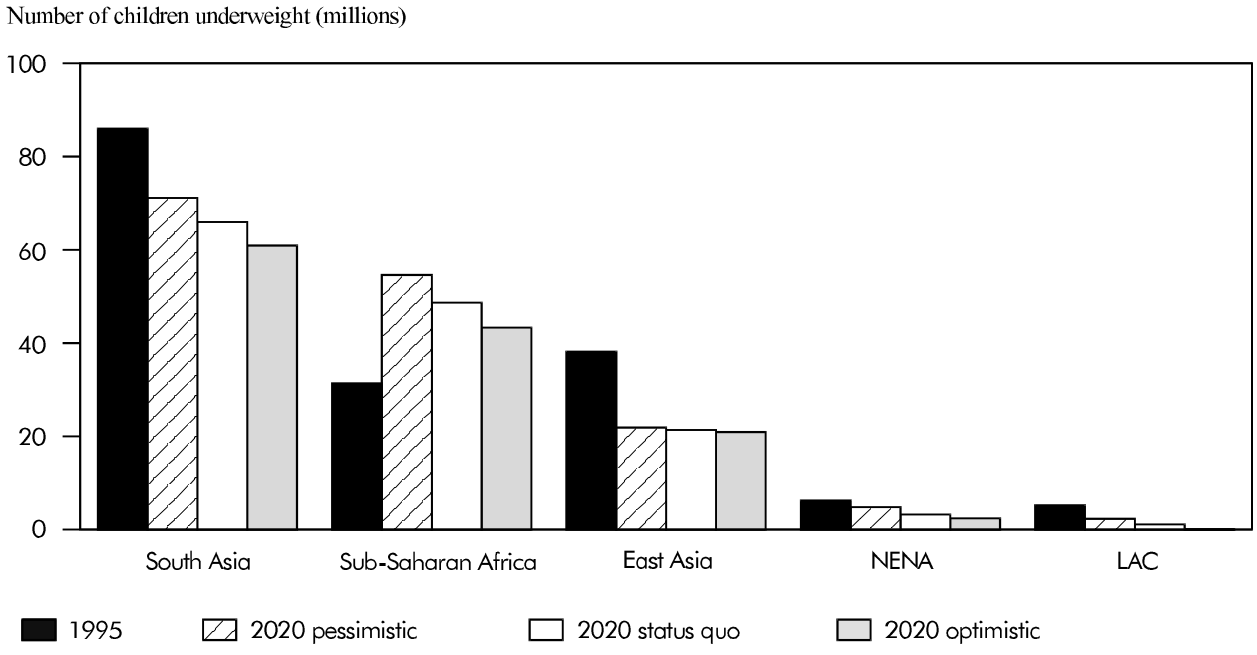
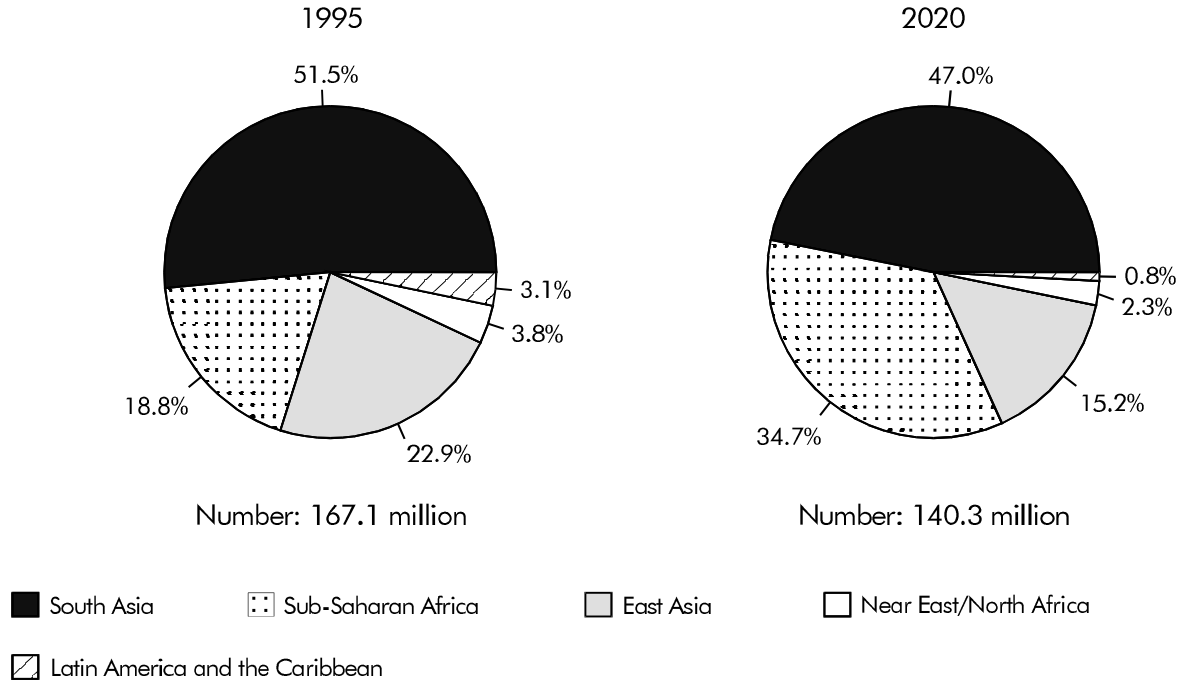


**Figure 9 Regional distribution of malnourished children, 1995 and 2020, status quo scenario**



# 7. Priorities for the Future

Chapters 4 and 5 examined the past record of reductions in child underweight rates and attempted to isolate the contributions of the four variables representing its underlying determinants and two variables representing its basic determinants. Chapter 6 then developed three scenarios for child malnutrition in the year 2020, based on past trends in the underlying-determinant variables. The scenarios are essentially the answer to the question If we continue as in the past (or perhaps do a little more or a little less), what will the future look like? . Even under the most optimistic of the scenarios, the prevalence of child malnutrition in developing countries is expected to be 15 percent in 2020: 128 million children would still be malnourished. But the future doesn t have to look like the past.

This chapter asks, for each developing region: What combinations of actions would lead to the greatest reductions in child malnutrition by 2020? In answering this question, it is important to keep three things in mind. First, as the conceptual framework of this paper lays out and the analysis has confirmed, all three underlying determinants food security, mother and child care, and a healthy environment are necessary for a child to achieve adequate nutritional status. Thus strategies for reducing child malnutrition should address all of them. The issue taken up here is the *relative* emphasis that should be placed on the various contributing factors.

Second, both underlying and basic determinants were found to have strong effects on child malnutrition, with the former being dependent on the latter. The question is not which set of determinants should be prioritized: *both* underlying and basic determinants should be the focus of future efforts to reduce child malnutrition.

Finally, actions associated with the determinants considered in this report should be seen as supporting crucial direct nutrition interventions, such as community-based programs to improve home-based caring practices, micronutrient supplementation, and food fortification (see Gillespie, Mason, and Martorell 1996). In addition, the reader should keep in mind that increased per capita dietary energy supplies and per capita national incomes can be brought about not only by raising food supplies and national incomes, but also by reducing population growth.

## Relative Importance of the Underlying-Determinant Variables to Future Reductions in Child Malnutrition

Table 14 compares, for each region, the strengths and potential impacts of the variables chosen to represent the underlying determinants of child malnutrition. In column (2), calculations of the absolute increase in each determinant needed to bring about a reduction in the child malnutrition rate of one percentage point in 1995 are presented.[20] For example, in South Asia an increase in the rate of access to safe water of 13.1 percentage points would have the same effect on child malnu-

[20]The 1995 numbers differ from those presented in Table 8 only for the variable per capita dietary energy supplies. This variable s strength of impact depends on its current level (see Table 6).

## Table 14 Comparison of the strengths and potential impacts of factors affecting child malnutrition, 1995

| Region/variable | 1995 mean (1) | Increase in variable needed to reduce prevalence of child malnutrition by 1 percentage point (2) | Number in (2) as a percent of developing-country range[a] (3) | Percent determinant is below its desirable level[b] (0 100 scale) (4) | Change in prevalence of child malnutrition with increase in determinant to desirable level[c] (5) |
|---|---|---|---|---|---|
| Underlying-determinant variables | | | (percent) | (percent) | (percentage points) |
| South Asia | | | | | |
| Access to safe water (*SAFEW*) (percent) | 79.7 | 13.1 | 13.2 | 20.3 | 1.6 |
| Female secondary school enrollment (*FEMSED*) (percent) | 34.1 | 4.6 | 4.6 | 65.9 | 14.5 |
| Female-to-male life expectancy ratio (*LFEXPRAT*) | 1.023 | 0.0139 | 9.3 | 58.9 | 5.5 |
| Per capita dietary energy supply (*DES*) (kilocalories) | 2,356 | 94 | 4.5 | 46.5 | 3.0 |
| Sub-Saharan Africa | | | | | |
| Access to safe water (*SAFEW*) (percent) | 48.8 | 13.1 | 13.2 | 51.2 | 3.9 |
| Female secondary school enrollment (*FEMSED*) (percent) | 19 | 4.6 | 4.6 | 81.0 | 17.8 |
| Female-to-male life expectancy ratio (*LFEXPRAT*) | 1.054 | 0.0139 | 9.3 | 35.2 | 3.3 |
| Per capita dietary energy supply (*DES*) (kilocalories) | 2,136 | 75 | 3.6 | 60.2 | 5.2 |
| East Asia | | | | | |
| Access to safe water (*SAFEW*) (percent) | 66.5 | 13.1 | 13.2 | 33.5 | 2.6 |
| Female secondary school enrollment (*FEMSED*) (percent) | 59.8 | 4.6 | 4.6 | 40.2 | 8.8 |
| Female-to-male life expectancy ratio (*LFEXPRAT*) | 1.0514 | 0.0139 | 9.3 | 37.4 | 3.5 |
| Per capita dietary energy supply (*DES*) (kilocalories) | 2,720 | 188 | 9.0 | 23.8 | 2.1 |
| Near East and North Africa | | | | | |
| Access to safe water (*SAFEW*) (percent) | 81.5 | 13.1 | 13.2 | 18.5 | 1.4 |
| Female secondary school enrollment (*FEMSED*) (percent) | 57.9 | 4.6 | 4.6 | 42.1 | 9.2 |
| Female-to-male life expectancy ratio (*LFEXPRAT*) | 1.044 | 0.0139 | 9.3 | 42.8 | 4.0 |
| Per capita dietary energy supply (*DES*) (kilocalories) | 3,172 | 333 | 16 | + 4.5 | 0.2 |
| Latin America and the Caribbean | | | | | |
| Access to safe water (*SAFEW*) (percent) | 77.3 | 13.1 | 13.2 | 22.7 | 1.7 |
| Female secondary school enrollment (*FEMSED*) (percent) | 56.5 | 4.6 | 4.6 | 43.5 | 9.6 |
| Female-to-male life expectancy ratio (*LFEXPRAT*) | 1.098 | 0.0139 | 9.3 | 1.9 | 0.18 |
| Per capita dietary energy supply (*DES*) (kilocalories) | 2,777 | 234 | 11.2 | 20.2 | 1.8 |
| Basic-determinant variables[d] | | | | | |
| Per capita GDP (*GDP*) ($ PPP) | 2,121 | 202 | 9.7 | 59.1 | 18.5 |
| Democracy (*DEMOC*) | 2.71 | 0.79 | 11.5 | 71.5 | 5.5 |

Note: The table compares the relative strengths of the underlying-determinant variables to one another and those of the basic-determinant variables to one another. Since the two groups lie at different levels of causality, it is important not to compare the results for variables *across* the groups.

[a] See Table 8 for variable ranges.

[b] The desirable levels of the variables are: *SAFEW*: 100 percent; *FEMSED*: 100 percent; *LFEXPRAT*: 1.1 (this is the average of the highest 20 percent of country-year data points in the sample in terms of female-to-male life expectancy ratios [excluding the highest, which is 1.15 and far above the next highest, 1.12]); *DES*: 3,100 (see text footnote 21 for rationale); *GDP*: The desirable level is set at $4,750. This is the level past which improvements in *GDP* per capita no longer contribute to reductions in child malnutrition; *DEMOC*: 7 (the maximum value of the index).

[c] These numbers are calculated using the regression coefficients in Table 8 columns (3) and (4). For *DES* and *GDP*, each region s number is calculated using country averages.

[d] Because the structural relationship between child malnutrition and basic determinants differs by regions, reliable regional breakdowns cannot be provided.

trition rates as would an increase in per capita dietary energy supply of 94 kilocalories. The different range of values each determinant takes on makes this column difficult to interpret when comparing across determinants. Therefore, the absolute increases in column (2) are standardized by reporting them as a percent of the determinants ranges. This number, given in column (3), is the measure of strength of impact.

In South Asia and Sub-Saharan Africa, food availability (shown as DES) emerges as the determinant that needs to change the least, relative to its existing range, to bring about a 1 percentage-point drop in child malnutrition rates. It is thus the most potent force in reducing child malnutrition. Female secondary school enrollments follow closely. In the other regions, female secondary school enrollments are by far the most potent force for reducing child malnutrition. In all regions except the Near East and North Africa (NENA), access to safe water is the determinant that needs to change the most, relative to its range, to bring about a 1 percentage-point reduction in child malnutrition.

While the numbers in column (3) provide a sense of the relative strength of impact of the determinants, they say nothing about their current distance from desirable levels and hence their scope for bringing about reductions in child malnutrition over the medium-to-long run. The percent that each determinant is below its desirable level (in scale-neutral terms) is given in column (4). The desired levels of safe water access and female secondary school enrollments are assumed to be 100 percent. The desired level of the female-to-male life expectancy ratio is set at 1.01; that of per capita dietary energy supplies is set at 3,100.[21] Column (5) gives the estimated reduction in the prevalence of child malnutrition if each determinant were raised to its desirable level. This number provides a measure of potential contribution.

In all regions, increasing female secondary school education to its desirable level has the largest medium- to long-term potential to reduce child malnutrition. Food availability is second in Sub-Saharan Africa and LAC. Women s relative status is second in South Asia, East Asia, and NENA.

To identify policy priorities for future reductions in child malnutrition for each region, the determinants are ranked in terms of the size of the change required to bring about a 1 percentage-point reduction in child malnutrition as a percentage of the determinants ranges (based on Table 14, column 3); and their potential for reducing it in the medium-to-long term (based on Table 14, column 5). Combining these two sets of ranks, the best estimates (in the absence of cost data) of future policy priorities for addressing the underlying determinants of child malnutrition in each developing region are summarized in Table 15.

In South Asia and Sub-Saharan Africa the top priorities are raising per capita food availability and women s education. In both regions, improvements in per capita food availability have the strongest effect, but women s education also has a strong effect, and it would make the biggest difference if increased to its desirable level. In East Asia, NENA, and LAC, women s education is the top priority, both from the standpoint of strength of impact and scope for reducing child malnutrition. In East Asia, food availability and women s relative status should also receive high priority. In

[21]The desired level of the female-to-male life expectancy ratio is determined as the average of the top 20 percent of the data points in the panel data set, excluding the maximum value (1.15) of El Salvador in 1988, which is an extreme value compared to the other high ratios. There is no widely accepted desirable level of per capita DES from the standpoint of nutritional health. Countries with very high calorie levels also have high levels of obesity, an undesirable trait. For example, in 1995, Western Europe had an average DES of 3,360 (FAO 1998). This study estimates that at a DES of about 3,120 kilocalories, increases in dietary energy supplies no longer serve to reduce child malnutrition levels. Alexandratos (1995) says that 10 percent of a country s population will be undernourished (or food insecure) at DES levels of 2,700 kilocalories. On the other hand, FAO (1996) claims that at a level of about 2,770 only 2.5 percent of the population will be undernourished. An intermediate level of 3,100 kilocalories was chosen here.

## Table 15 Priorities by region for future child malnutrition reduction (underlying-determinant variables)

| Region | Rank of determinants by most potent impact on malnutrition relative to its existing range (1) | Rank of determinants by most potential for impact based on increases to desirable levels (2) | Top Priorities (3) |
|---|---|---|---|
| South Asia | 1. Food availability<br>2. Women s education<br>3. Women s relative status<br>4. Health environment | 1. Women s education<br>2. Women s relative status<br>3. Food availability<br>4. Health environment | 1. Food availability<br>1. Women s education<br>2. Women s relative status |
| Sub-Saharan Africa | 1. Food availability<br>2. Women s education<br>3. Women s relative status<br>4. Health environment | 1. Women s education<br>2. Food availability<br>3. Health environment<br>4. Women s relative status | 1. Food availability<br>1. Women s education |
| East Asia | 1. Women s education<br>2. Food availability<br>3. Women s relative status<br>4. Health environment | 1. Women s education<br>2. Women s relative status<br>3. Health environment<br>4. Food availability | 1. Women s education<br>2. Food availability<br>2. Women s relative status |
| Near East and North Africa | 1. Women s education<br>2. Women s relative status<br>3. Health environment<br>4. Food availability | 1. Women s education<br>2. Women s relative status<br>3. Health environment<br>4. Food availability | 1. Women s education<br>2. Women s relative status |
| Latin America and the Caribbean | 1. Women s education<br>2. Women s relative status<br>3. Food availability<br>4. Health environment | 1. Women s education<br>2. Health environment<br>3. Food availability<br>4. Women s relative status | 1. Women s education<br>2. Women s relative status<br>2. Health environment |

Notes: The rankings in column (1) are based on the numbers reported in Table 14, column (3). The rankings in column (2) are based on the numbers reported in Table 14, column (5). The top priorities in column (3) are based on the highest ranked determinants in columns (1) and (2).

## Box 2
# The (South) Asian Enigma

In South Asia, 50 percent of the children under age five are malnourished; in Sub-Saharan Africa, 31 percent. Why is malnutrition so much higher in South Asia? The huge difference has been called an enigma because South Asia as a region is doing much better than Sub-Saharan Africa for most of the determinants of child malnutrition (see the table below) (Ramalingaswami, Jonsson, and Rohde 1996). There are three possible sources of these differences.

First, the determinants of child malnutrition may be different or have different strengths of impact in the regions. If one determinant is more important in South Asia than in Sub-Saharan Africa, and South Asia is not doing well in that area, then that determinant could be a clue to the enigma. This report finds no major differences in the importance of the underlying-determinant causal factors between the regions. For the basic determinants, some structural differences were evident, but it was not possible to find out which determinant, national income or democracy, was causing the difference.

The second possible source of the difference in child malnutrition rates may be that South Asia is doing worse than Sub-Saharan Africa in the factors studied. As the table shows, South Asia is doing better than Sub-Saharan Africa for all factors except women s status relative to men s. Therefore, it seems likely that women s status is one reason for the higher prevalence of malnutrition in South Asia. The table also indicates that South Asia s poverty rate is slightly higher than Sub-Saharan Africa s, which may explain some of the difference.

**Progress in some determinants of child malnutrition in South Asia and Sub-Saharan Africa, 1995**

| | South Asia | Sub-Saharan Africa |
|---|---|---|
| Child malnutrition (percent) | 49.3 | 31.1 |
| Access to safe water (percent) | 79.7 | 48.8 |
| Female secondary school enrollment (percent) | 34.2 | 19 |
| Female-to-male life expectancy ratio | 1.023 | 1.054 |
| Per capita dietary energy supply (kilocalories) | 2,356 | 2,136 |
| Per capita national income (PPP US$) | 1,136 | 778 |
| Democracy | 4.10 | 2.44 |
| Poverty (percent)[a] | 43.1 | 39.1 |

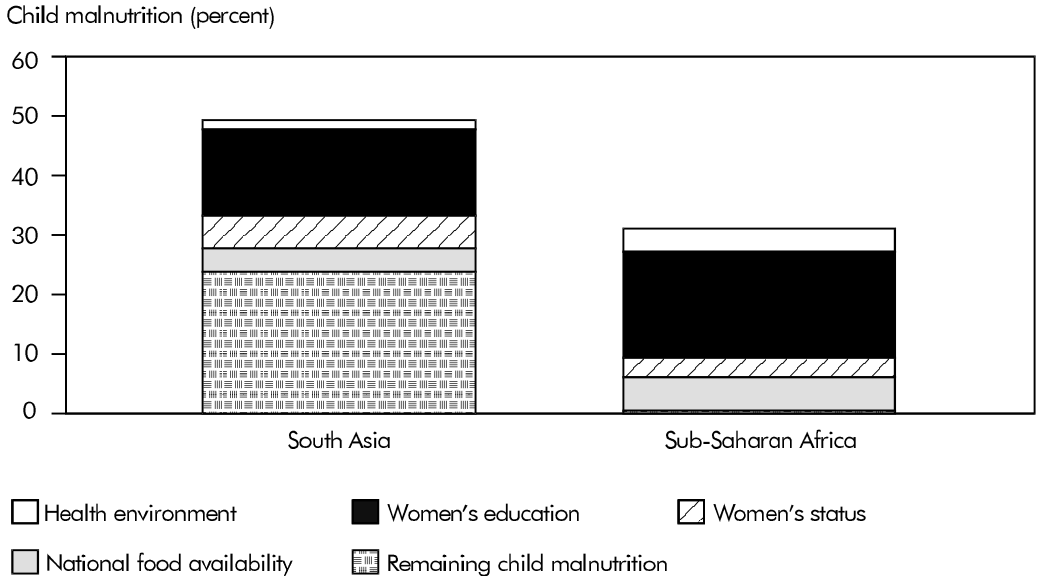
Sources: Smith and Haddad 2000, Tables 1, 25, and 26. Poverty data are from Ravallion and Chen 1996, Table 5.

Notes: With the exception of the poverty rates, these data are population-weighted means over all countries in the data set in each region. The poverty measure employs an international poverty line of $1 per person per day at 1985 purchasing power parity.

[a] Poverty figures are for 1993.

The final source of the difference in child malnutrition rates of the two regions lies in the black box of time-invariant, country-specific factors. Because the data set covers more than one point in time for each country, the effects on child malnutrition of these factors can be estimated, even though it is not possible to determine what they actually are. The factors are found to raise the prevalence of child malnutrition in South Asia well above Sub-Saharan Africa s. To illustrate their importance in the regional differences, the figure below shows how much child malnutrition would remain, if all of the underlying-determinant variables were to reach their desirable levels. In South Asia, malnutrition would remain at 23.8 percent, but it would be only 0.5 percent in Sub-Saharan Africa. Deeply entrenched factors specific to South Asian countries, then, are also key to solving the Asian enigma. In the long run, if child malnutrition is to be overcome in the region, the black box must be opened to find out what these factors are and to implement policies to address them. Some possibilities are the monsoon climate (FAO 1996), recurrent flooding in some countries, overcrowding due to high population density, and cultural beliefs and traditions that hinder optimal breast feeding and timing of the introduction of complementary foods (Ramalingaswami, Jonsson, and Rohde 1996).

**Predicted reductions in child malnutrition and remaining prevalence if underlying-determinant variables reach desirable levels**




Note: At 0.5 percent, remaining malnutrition in Sub-Saharan Africa is too small to show on the figure.

NENA, women s relative status is the second highest priority. In LAC, women s relative status and health environment improvements tie for second. For South Asia, a secondary priority is improving women s status relative to men s, which, because it is so far below desirable levels, has great scope for reducing malnutrition.

Health environment improvements, in a *relative* sense appear to be a weak force for reducing child malnutrition. This determinant s ranking is low partially because substantial progress has already been made in this area in many regions, compared with other determinants (Table 14, column 4). In an absolute sense it still makes a big difference, however. If universal access to a proper health environment (proxied by safe water) were achieved, the prevalence of child malnutrition would fall by 2.3 percentage points. The numbers of malnourished children would fall by 11.9 million.

## Relative Importance of National Income and Democracy

Democracy is important in facilitating health environment improvements and increases in food availability. Per capita national income is important in maintaining and improving investments in health environment, female education, women s relative status, and per capita food availability, both from the viewpoint of public investments and (through its association with household incomes) investments at the household level. Because strong regional differences in the effects of the basic determinants have been detected, this discussion is limited to their relative importance to the developing countries as a group. A comparison of their strengths and potential impacts is given in Table 14.

At this point in time, raising national incomes would have a stronger effect than enhancing democracy. It would take an increase of $202 in the average national per capita GDP of developing countries to reduce the prevalence of child malnutrition by 1 percentage point, which is 9.7 percent of its range (column 2). By contrast, it would take almost a 0.8 point rise in the democracy index to bring about the same reduction (11.5 percent of its range). The developing-country per capita GDP is currently far below any desirable number. Past a level of about $4,750 the factor loses its force in reducing child malnutrition. Even bringing the developing-country GDP up to this moderate level would have quite a large impact on child malnutrition: its prevalence is predicted to fall by 18.5 percentage points, the number of malnourished children by almost 100 million. The regions that have the longest way to go to reach the $4,750 mark (and thus the most to gain from doing so) are Sub-Saharan Africa, South Asia, and East Asia. Latin America and the Caribbean, as a region, has already surpassed the mark.

Relatively speaking, democracy is not a very strong force in reducing child malnutrition in the developing countries; nevertheless, improving it would make a big absolute difference to child malnutrition. If the democracy index were raised to its desired level (of 7), the prevalence of child malnutrition in the developing countries would fall by 5.5 percentage points. The numbers of children who are malnourished would be reduced by 29.4 million. The regions that have the longest way to go to reach a desirable level of democracy are East Asia, NENA, and Sub-Saharan Africa.

The reader should bear in mind that improvements in national income and democracy only lead to reductions in child malnutrition if they are directed to improvements in the underlying determinants. Given enhanced political will and education, it is possible that they can be even more effectively directed toward them in the future than they have in the past. This analysis gives governments an idea of where to best direct increased national incomes in the interest of children s nutrition. It also suggests target areas where political will and commitment among democratic governments can be instilled.

## A Note on Cost-Effectiveness

On a final note, a full assessment of priorities for the future should ideally take into account the costs of improving the alternative determinants. While the same reduction in child malnutrition could be brought about by a 13.1 percentage-point increase in access to safe water as a 4.6 percentage-point increase in female secondary school enrollment, it is unlikely that these increases would cost the same. Their costs are likely to differ by region and over time. Unfortunately, good quality comparative information on the cost-effectiveness of these different policies is lacking. One can still get a sense of how different the relative costs have to be before the conclusions reached on priorities are altered. For example, if it cost more than 2.8 times as much to increase female secondary school enrollment by 1 percent, compared with the costs of increasing access to safe water by 1 percent, then the latter will be the more cost-effective investment in reducing malnutrition. If the ratio is below 2.8, then female secondary education becomes more cost-effective. Better information on cost-effectiveness should be a key focus of future research on policies to improve child nutritional status.

# 8. Conclusions

Although the percentage of children who are malnourished has declined in many countries of the developing world in recent years, the absolute number of malnourished children is rising in some regions, particularly in Sub-Saharan Africa. IFPRI s 2020 vision is of a world where every person has access to sufficient food to sustain a healthy and productive life and where child malnutrition is absent. This paper aims to determine which of the various causes of malnutrition are most important for the developing countries as a whole and by region, thus enabling policymakers to prioritize their investments and make the best use of available resources to reduce malnutrition now and in the coming years.

## Weighing the Determinants of Malnutrition

Of the four explanatory variables representing the underlying determinants of child malnutrition national food availability, women s education, women s status relative to men s, and access to safe water women s education has the strongest impact on child malnutrition, followed closely by per capita food availability. Increases in women s status relative to men s and improvements in the quality of a country s health environment also have strong effects on child malnutrition and are necessary for reducing it. However, they do not have as strong an influence as women s education and per capita food availability for the developing countries as a whole. It should be noted that as the amount of food available per person in a country increases, the marginal effect of this factor declines, weakening its force. Thus, for some individual countries with abundant food supplies per person, the strength of impact of national food availability is weak in comparison to all of the other underlying-determinant factors.

The variables representing the basic determinants of child malnutrition per capita national income and democracy both have a strong impact on child malnutrition. Increases in per capita national income have a very strong influence because they increase public and private investment in all of the underlying-determinant variables in education or health facilities, for example. Increased democracy leads to reductions in malnutrition by increasing investment in health environment improvements and in per capita food availability. For the developing countries as a whole, per capita national income has a greater impact on child malnutrition than does democracy. However, like per capita food availability, national income has a declining marginal effect. For some countries with high per capita incomes, democracy will be the more potent force for reducing child malnutrition.

Great strides have been made in reducing child malnutrition in the developing countries over the last few decades. From 1970 to 1995, the percent of underweight children under five declined from 46.5 to 31 percent. Corresponding to the strong influence of women s education and the substantial progress made in increasing it over the period, education is estimated to be responsible for 43 percent of this reduction. Improvements in per capita food availability account for about 26 percent of that reduction, while improvements in the health environment account for 19 percent. Because, on the whole, there was little improvement in women s status relative to men s over the 25 years, its contribution while still substantial was the lowest of the four variables 12 percent.

For the basic determinants, improvements in per capita national income have made a very large contribution. They are estimated to be responsible for roughly half of the total reduction in the prevalence of child malnutrition over 1970 95. While increased democracy has great potential for bringing about reductions in child malnutrition, because no progress has been made in this area for the developing countries as a whole, it made no contribution.

## Shifting the Future Focus

If current trends continue, the prevalence of child malnutrition in the year 2020 is projected to remain high. Eighteen percent of all developing-country children under age five, or 140 million children, will still be underweight. South Asia and Sub-Saharan Africa will remain the regions with the highest rates of child malnutrition. A sharp regional shift in the location of child malnutrition is projected: South Asia s share of the total number of children will fall from approximately 51 percent to 47 percent, but Sub-Saharan Africa s share will rise from 19 percent to near 35 percent. The absolute number of malnourished children in Sub-Saharan Africa is expected to be *higher* in 2020 than it was in 1995.

But it is not too late to change this prediction. The findings of this study indicate that significant progress can be made toward reducing child malnutrition through accelerated action in sectors that have not been the traditional focus of nutrition interventions. Efforts to improve women s education, raise food supplies (or reduce population growth or both), bolster women s status, and create healthful environments should be an integral part of strategies for reducing child malnutrition in the future. These initiatives should be seen as complements to more direct nutrition interventions, such as feeding programs and nutrition education.

Any comprehensive strategy for resolving the problem of child malnutrition must include actions to address both its underlying *and* basic causes. This is a key message of this paper. If the economic resources of the developing countries, as indicated by national incomes, cannot be raised, increased investment in health environments, women s education and relative status, and food availability will not be forthcoming. Similarly, if a democratic government is not in place, people will not be able to bring pressure on governments to have their needs met. But just having sufficient income and a democratic government are not enough. Increased national incomes must actually be spent on improvements in the underlying determinants, which requires knowledge of their roles in reducing child malnutrition and political commitment to doing so.

Given resource constraints and knowledge of the costs of alternative interventions, how should policymakers prioritize investments to reduce child malnutrition most quickly in the coming decades? The investments that should receive priority will differ from one geographical area to another because, first, the relative strength of the determinants impacts differ by area, and, second, because geographical areas differ in their current levels of achievement in reaching the desired levels of the determinants. The top priorities in each developing region are based on consideration of these two criteria.

In Sub-Saharan Africa and South Asia the regions with the highest incidence of child malnutrition improvements in per capita food availability and the quality of care for women and children (as represented by women s education) offer the best hope for future reductions in child malnutrition. In South Asia, promotion of improved status for women should also be prioritized. In East Asia, NENA, and LAC, women s education should be given top priority, followed by women s status relative to men s. Additional secondary priorities are food availability for East Asia and health environment improvements for LAC. To maintain the necessary resource base and political will for these investments, investments in national income growth and democratic development must be accelerated as well.

## Contribution to the Resolution of Key Debates

This paper contributes to the resolution of five important questions currently under debate in development policy and research circles. First, why has

child malnutrition been rising in Sub-Saharan Africa? Here, all that can be said is that some of the increase is the result of the declining relative status of women and deterioration in per capita national income (and thus rising poverty). Stagnant per capita food availability and women s education have also held back improvements in child nutrition. Finally, debt and structural adjustment, increasing levels of conflict, and the rise of HIV/AIDS may be partly responsible, although these last factors are not studied in this report due to lack of data.

Second, why are child malnutrition rates in South Asia so much higher than in Sub-Saharan Africa? Women s low status, which is a much worse problem in South Asia than in Sub-Saharan Africa, seems to be a key source of the Asian enigma. Regardless of the levels of the factors influencing child malnutrition that are identified in this paper, however, a large disparity in the prevalences of child malnutrition between the regions would persist. The source of the remaining differences lies in factors that are specific to South Asian countries and that change very slowly over time. These factors are not explicitly identified in this study. Some examples might be the region s monsoon climate, high population densities, and deeply entrenched beliefs regarding child feeding practices.

Third, how important a determinant of child malnutrition is food availability at a national level? When per capita food availability is very low, it is the most important determinant of child malnutrition, more important than any other underlying determinant considered here. As more food becomes available, however, its potency in reducing child malnutrition diminishes. After a certain point is reached, further improvements are unlikely to reduce child malnutrition in the country as a whole. In countries where plenty of food is available, efforts to promote food security must focus on promoting access to adequate food at the household and individual level. The regions in which improved food availability has the most to contribute in the coming decades are again South Asia and Sub-Saharan Africa.

Fourth, how important is care as proxied by women s status and education? This study confirms the now overwhelming evidence that women s education has a strong impact on the nutrition of children. It also establishes that women s status relative to men s is an important determinant in its own right in all developing-country regions. These findings confirm that women play a key role in the etiology of child nutrition. Together, improvements in women s education and status contributed more than 50 percent to the reduction in child malnutrition that took place from 1970 to 1995. More emphasis should be placed on improving them in the future, with particular stress being given to both women s education and status in South Asia and women s education in Sub-Saharan Africa.

Fifth, how important are economic factors (such as national incomes) and political factors (such as democracy), and through what pathways do they affect child malnutrition? This study found that national income levels have a strong influence on child nutrition: countries with higher incomes invested more public and private funds in all four underlying determinants. The research firmly establishes the existence of a significant link between the degree of democracy in countries and lower rates of child malnutrition, working mainly through improvements in health environments and national food availability. Why democracy is important for these two underlying determinants and not for others needs to be better understood, however.

In conclusion, all of the factors studied here women s education and status, national food availability, the health environment, national income, and democracy should be integral parts of future strategies for reducing child malnutrition. Current efforts to stem malnutrition in critical situations through the provision of nutrition safety nets should continue. However, accelerating reductions in child malnutrition now and overcoming it in the future will also require investments that address malnutrition s underlying causes. These investments will support the crucial role of direct nutrition programs at the community level. It is hoped that the findings of this study will aid policymakers as they make choices among such investments.

# *Appendix*
# *Cross-Country Studies: Methodological Issues and Past Findings*

Cross-country studies are a useful complement to single-country case studies mainly because they exploit the fact that some variables that might be important determinants of child nutrition, such as democracy and women s status, may exhibit greater variation between countries than within them. Other variables may only be observed at a national level, for example, national food supplies and incomes. In addition, the use of cross-country data for multivariate analysis identifies weaknesses in data series that might not be identified through the casual observation of trends and two-way tables, thus generating a demand for improved data quality. Finally, cross-country analyses can provide a basis for establishing policy priorities on a regional and global basis.

Several concerns regarding cross-country studies have been raised. First, the quality and comparability of the data themselves have been questioned. Data on different variables may come from different agencies, each of which has its own quality standard and sampling frame. Moreover, variable definitions may not be uniform across countries. For example, the definition of access to safe water may be different in Egypt than it is in Ghana. A second concern is that data availability problems are more pronounced at the national level than they are at the household level. Studies must often employ available data as proxies for variables for which one would like to use a more direct measure.

A third concern regarding cross-country studies relates to their applicability below the national level. Child malnutrition is inherently an individual and household-level phenomenon. Can cross-country data be used to make inferences about household and individual behavior? An implicit assumption is that a country represents a representative citizen. But the use of average data can be misleading if distribution is important and differs across countries (Behrman and Deolalikar 1988). Similarly, results arrived at through the use of cross-national data may not be applicable to individual countries situations, yet it is at the country (and subnational) levels that many policy decisions are made.

Finally, some variables that are influenced by factors outside of the household (exogenous) at the household level must be treated as endogenous at the national level since they reflect choices of national policymakers. For example, while putting health infrastructure into place may reduce child malnutrition, governments may also purposefully target infrastructure expansion programs to areas with high malnutrition. In this case, any positive association between the availability of health services and child nutritional status may not reflect the causal effect of the former on the latter. Thus addressing endogeneity concerns is particularly crucial in cross-national studies (Behrman and Deolalikar 1988).[22] Data scarcities, however, make it particularly difficult to do so, and it is often not done.

[22]In addition to reverse causality, endogeneity problems may arise from (1) the omission of important determinants of child malnutrition that are correlated with the variables included and (2) the simultaneous determination of child malnutrition and one of the explanatory variables by some third unobserved variable.

The quality of the data used in this study is discussed in Chapter 3. Only the best data available have been used to construct variables that as far as possible measure the key variables in the conceptual framework. In Chapter 3 the steps taken here to address endogeneity issues are discussed. Regarding the concern about subnational applicability, one can only say that cross-country studies, while often based on aggregated household-level data, are intended to capture broad global and (for some studies) regional trends. Readers must keep in mind that, at the household level, variation within countries may be wide; policies and programs targeted at a subnational level will have to be formulated with these differences in mind. The same can be said of the concern about the applicability of the results to individual countries.

Past cross-country regression studies relevant to this paper include those that address the determinants of health (an immediate determinant of child nutritional status) and the determinants of child malnutrition, specifically underweight and stunting rates.[23] The main factors examined in the literature on health determinants are per capita national incomes, poverty, female education or literacy rates, and the state of a country s health environment, including the availability of health services. The outcome variables of interest are measures of life expectancy and premature mortality (see, for example, Anand and Ravallion 1993; Subbarao and Raney 1995; and Pritchett and Summers 1996). Most of the explanatory variables considered in cross-country studies of child malnutrition are the same as for health outcome studies. Almost all also include the amount of food available for human consumption, measured as daily per capita dietary energy supply (DES) derived from food balance sheets (such as ACC/SCN 1993,1994; Gillespie, Mason, and Martorell 1996; Rosegrant, Agcaoili-Sombilla, and Perez 1995; Osmani 1997; and Frongillo, de Onis, and Hanson 1997).

The studies point to the potential importance of four key variables as determinants of child malnutrition. These are per capita national incomes, women s education, variables related to health services and the healthiness of the environment, and per capita national food availability. Anand and Ravallion (1993) and Osmani (1997) suggest that, in addition, poverty and variables affecting birthweight, such as women s status, may be key. Many studies also point to the importance of accounting for potential differences across regions; the determinants for South Asia, in particular, may be different from those for the other regions.

The studies present some conflicting results, however. For example, in each of the following studies, at least one factor is not significantly associated with child malnutrition: per capita food availability (Gillespie, Mason, and Martorell 1996), health environment (Osmani 1997; Rosegrant, Agcaoili-Sombilla, and Perez 1995), and women s education (Rosegrant, Agcaoili-Sombilla, and Perez 1995). The studies also differ widely in the implied strength of the impact of the various factors. Their differing conclusions stem from (1) the use of different proxy variables to represent concepts; (2) the use of different data sources; (3) the use of different estimation methods; and (4) the inclusion of different sets of variables in regression equations.

With respect to the latter, most past studies have not taken into account the differing levels of causality through which the various determinants of child malnutrition influence it. The danger of not doing so is illustrated in the study by Anand and Ravallion (1993), who examine the determinants of life expectancy. Their study shows that national income affects health mainly through its influence on government expenditures, social services, and poverty. When both income and these other variables that income determines are included in the regression equation, the implied

[23] See Smith and Haddad 2000 for an in-depth review.

strength of income s impact drops substantially. This downward bias results not because national income is not important, but because its effect is already picked up by the variables it determines. Studies that mix basic, underlying, and immediate determinants in the same regression equation for child malnutrition are likely to underestimate the effects (and statistical significance) of determinants lying at broader levels of causality.

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