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Risks and the Road to Health
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Child Survival: 
Risks and the Road to Health

Prepared by
The Demographic Data for Development Project

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March 1987
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Editors Note:

Infant and Child Mortality Rates

This report clarifies the presentation and interpretation of infant and child mortality rates in two ways: first, mortality rates are reported as percentages. Second, child mortality rates are reported as the percentage of children born who die between exact ages 1 and 5. Because the denominator for both rates is the same, infant and child mortality rates are additive, i.e., adding infant mortality rates to child mortality rates provides percentages of children born who die before age 5.
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I World Patterns and Rates of Child Survival</td>
<td>1</td>
</tr>
<tr>
<td>Major Impediments to Child Survival and Strategies for their Removal</td>
<td>9</td>
</tr>
<tr>
<td>II Diarrheal Disease</td>
<td>10</td>
</tr>
<tr>
<td>III. Vaccine-Preventable Diseases</td>
<td>16</td>
</tr>
<tr>
<td>IV Acute Respiratory Infection</td>
<td>22</td>
</tr>
<tr>
<td>V Malaria</td>
<td>25</td>
</tr>
<tr>
<td>VI Malnutrition</td>
<td>31</td>
</tr>
<tr>
<td>VII High-Risk Fertility Behavior.</td>
<td>39</td>
</tr>
<tr>
<td>Socioeconomic Factors and Child Survival</td>
<td>45</td>
</tr>
<tr>
<td>VIII Education and Literacy</td>
<td>46</td>
</tr>
<tr>
<td>IX Availability of Modern Health Services</td>
<td>51</td>
</tr>
<tr>
<td>X Income Per Capita and Government Expenditures</td>
<td>54</td>
</tr>
<tr>
<td>XI Food Availability.</td>
<td>56</td>
</tr>
<tr>
<td>XII Water Supply and Sanitation Facilities.</td>
<td>59</td>
</tr>
<tr>
<td>Child Survival Summary Chart</td>
<td>61</td>
</tr>
<tr>
<td>Selected Bibliography.</td>
<td>65</td>
</tr>
</tbody>
</table>
Appendices

Appendix 1: Child Survival Statistics .................................................................75

Table 1: Numbers of Infants and Children Age 1-4 if 1980-85 Mortality Levels Continue .................................................................76

Table 2: Percent and Numbers of Children Dying before Age 1 and Age 5 if 1980-85 Mortality Levels Continue ..................................................78

Table 3: Numbers of Infants and Children Age 1-4 if Mortality Levels are Reduced to Reach Year 2000 Goals ..........................................................80

Table 4: Year 2000 Goals for Reduced Infant and Child Mortality, and Numbers of Children Dying before Age 1 and Age 5 if Mortality Levels are Reduced ..................................................82

Table 5: Country Populations and Basic Demographic Indicators ..................84

Table 6: Women of Reproductive Age, Fertility Rates, and Births ..................86

Table 7: Immunization and Health .................................................................88

Table 8: Nutrition: Breastfeeding, Percent Malnourished, and Food Production Per Capita .................................................................90

Table 9: Education Indicators ........................................................................92

Table 10: Economic and Water and Sanitation Indicators .................................94

Appendix 2: Methodology of Projections .......................................................97

Appendix 3: Definitions and Sources of Data ..................................................98

Appendix 4: Countries and Regions ...............................................................101
## List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-A</td>
<td>Percent of Total Population Under Age 5 by Region</td>
</tr>
<tr>
<td>I-B</td>
<td>Numbers of Children Under Age 5 by Region at 1980-85 Mortality Levels and at Goals for Year 2000 Reduced Mortality Levels</td>
</tr>
<tr>
<td>I-C</td>
<td>Number of Child Deaths at 1985 Mortality Levels and at Reduced Mortality Levels</td>
</tr>
<tr>
<td>2-A</td>
<td>Diarrhea Mortality as a Proportion of Mortality from All Causes: Rural Bangladesh</td>
</tr>
<tr>
<td>2-B</td>
<td>Estimated Annual Episodes of Childhood Diarrhea and Average Number of Days of Diarrheal Illness-Developing Regions and Selected U.S. Example</td>
</tr>
<tr>
<td>2-C</td>
<td>Estimated Median Diarrheal Episodes Per Year by Age</td>
</tr>
<tr>
<td>2-D</td>
<td>Oral Rehydration Solution</td>
</tr>
<tr>
<td>2-E</td>
<td>Estimated Access and Use of ORT in Developing Regions</td>
</tr>
<tr>
<td>2-F</td>
<td>Impact of Hygiene Education on the Incidence and Duration of Diarrheal Illness: Guatemala</td>
</tr>
<tr>
<td>3-A</td>
<td>Annual Child Deaths from Vaccine-Preventable Diseases and Deaths Prevented by Immunization in Developing Countries</td>
</tr>
<tr>
<td>3-B</td>
<td>Neonatal Mortality With and Without Health Intervention.</td>
</tr>
<tr>
<td>3-C</td>
<td>Measles Case Fatality Rates by Age-Percent of Infected Children Who Die From Measles-West Africa</td>
</tr>
<tr>
<td>3-D</td>
<td>Immunization Coverage by Region-Percent of 1-Year-Olds Fully Immunized.</td>
</tr>
<tr>
<td>3-E</td>
<td>Immunization Coverage and Incidence of Immunizable Diseases for Selected Developing Countries, 1974-1984</td>
</tr>
<tr>
<td>4-A</td>
<td>Acute Respiratory Infection Mortality by Nutritional Status Philippine Hospital Cases</td>
</tr>
<tr>
<td>4-B</td>
<td>Incidence of Acute Respiratory Infection Among Children With and Without Ocular Symptoms of Vitamin A Deficiency: Indonesia</td>
</tr>
<tr>
<td>5-A</td>
<td>The Life Cycle of Malaria</td>
</tr>
<tr>
<td>5-B</td>
<td>Impact of Malaria Control on Infant Health and Survival: Comparison of Treated and Untreated Villages in Kenya, 1970-1973</td>
</tr>
<tr>
<td>5-C</td>
<td>Global Trends in Malaria: Number of Cases Reported, 1974-1984</td>
</tr>
<tr>
<td>5-D</td>
<td>Regional Trends in Malaria: Number of Cases Reported, 1974-1984</td>
</tr>
<tr>
<td>6-A</td>
<td>Risk of Death by Nutritional Status: Children Age I-36 Months</td>
</tr>
<tr>
<td>6-B</td>
<td>Infant Mortality by Birth Weight.</td>
</tr>
</tbody>
</table>
List of Maps

Map 1A  World Child Mortality Rates ................................................................. 8
Map 5A  Epidemiological Assessment of Status of Malaria, 1984 ....................... 26
Map 11A 1983 Per Capita Food Production as a Percent of 1969 to 1971 Production ... 57

List of Fact Sheets

Fact Sheet 1  Child Mortality and Numbers of Deaths by Region
A:  Deaths of Children Under Age 5 as a Percent of All Deaths, 1985 .................. 3
B:  Percent of Deaths Occurring in Each Region, 1985 ............................... 3
C:  Percent of Children Dying Before Age 1 and Before Age 5 .................. 3

Fact Sheet 2  Births by Region
A:  Percent of World Births Occurring in Each Region ............................. 4
B:  Number of Births During 1985-2000 ....................................................... 4
C:  Average Number of Children Women Bear ......................................... 4
D:  Number of Women of Reproductive Age, 1985-2000 ......................... 4

Fact Sheet 3  Geographic Inequalities in Child Mortality
A:  Mortality of Children of Urban, Educated, Professional Parents, and of Rural, Uneducated, Agricultural Parents ........................................... 5
B:  Percent of Children Dying Before Age 5: Range and Average for Regions and Selected Countries ................................. 5
C:  Percent of Children Dying Before Age 5: Range and Average for Rural and Urban Areas of Selected Countries ............................ 5

List of Tables

Table 7A  Percent of Married Women Age 15-44 Who Do Not Want to Become Pregnant and Who Know About and Use Contraception ...................... 43
Table 12A  Reduction in Diarrheal Morbidity Rates Attributed to Improvements in Water Supply or Excreta Disposal ........................................ 60
World Patterns and Rates of Child Survival
WORLD PATTERNS AND RATES OF CHILD SURVIVAL

A child born in one of the high-mortality African and Asian countries today is on average 20 times more likely to die before reaching age 5 than a child born in the United States, Japan, or Sweden. The "accident" of geographic location of birth—and the risk of dying that accompanies this accident—have little or nothing to do with genetic inheritance and nothing at all to do with choice by the child. The level of childhood mortality in developing countries signals both alarm and opportunity: alarm because of the startlingly greater risk of death children face in these countries; opportunity because we have the means at hand to dramatically reduce childhood mortality.

The scarcity and uneven distribution of health facilities and services and the marginal economic and human resources that invite infant and childhood disease occur within distinct world and country boundaries, as shown in Fact Sheet 1. Of every 100 children born in Africa, 12 die before age 1; 10 of every 100 infants die in Asia, 9 in the Near East, and 6 in Latin America and the Caribbean. In Japan and Sweden, by contrast, fewer than 1 percent of newborns fail to reach their first birthday. The U.S. rate is slightly higher than 1 percent; the average for all developed countries is closer to 2 percent. The death of a child, a relatively rare tragedy for parents in developed countries, is a frequent occurrence in the developing world. In Egypt, for example, two-thirds of women experience the death of one or more children by age 50.

In 1985 there were 570 million children under 5 in the world, a total higher than the population of the African continent. They account for almost 12 percent of the world's total population, as seen in Figure 1-A. During the 15 years between 1985 and 2000, approximately 2 billion children are projected to be born. Of this number, 87 percent (1.8 billion) will be born in the developing world. At 1980-85 levels of infant and child mortality in these countries, 240 million of these children can be expected to die before age 5. If mortality levels were instead comparable to those of developed countries, 87 percent, or 207 million of these children, would live. This is a child population almost as large as the total number of inhabitants in 1985 of the United Kingdom, West Germany, France, and Poland.

The wide variations in risk of death between developed and developing regions are also seen within regions. While nearly 20 percent of all African children die before reaching age 5, this proportion rises to 31 percent in Sierra Leone and falls to a relatively low 13 percent in Zimbabwe. Variations among countries within world regions are shown in Fact Sheet 3.

Large differences in levels of childhood mortality often occur within the same country. Regional differences within these countries are often as large or larger than those between countries and world regions. Consistent differences are found both between urban and rural areas of countries and among the urban and rural areas themselves. As shown in Fact Sheet 3, the risk of dying before age 5 in a rural area can be twice that of an urban area in the same country. Further, the highest mortality levels found in urban areas within a country are often higher than the levels of better-off rural areas.

These dramatic differences in levels of infant and childhood mortality underlie worldwide concern for the tremendous inequities in children's opportunities to survive and be healthy. Yet these geographical inequities are in one sense cause for hope. Although a country may be located in a developing region, it does not necessarily follow that it will have high child mortality rates; some countries in each region already have relatively low rates. Moreover, varying rates within countries indicate that low childhood mortality can and is being achieved.

The major impediments to child survival have been identified, as have many strategies for removing these impediments. Infectious and parasitic diseases, malnutrition, and the risks associated with high levels of fertility are the major obstacles. Because they flourish in poverty, lasting solutions to these problems may require long-term socioeconomic development. Nonetheless, for every major impediment to child survival, we now have the means, within current resources, to rapidly and dramatically reduce the terrible burden of illness and death on the world's children. Among the most effective are oral rehydration therapy, mother and child immunizations, and wader spacing of births, which can save millions of lives and prevent untold suffering in developing countries between now and the end of the century.

MORTALITY REDUCTION TARGETS

Increased understanding of the various impediments and the possibilities for their removal, heightened by the remarkable achievements of child survival projects in various countries, is stimulating national and international efforts to lower childhood death rates. Of the various targets for reductions in infant and child mortality by the year 2000 that have been suggested, this report uses the following: In countries where rates of infant mortality are above 12.5 percent, the target is to reduce this number to 7.5 by
Fact Sheet 1 — Child Mortality and Numbers of Deaths by Region

A: Deaths of Children Under Age 5 as a Percent of All Deaths, 1985

The 11.9 percent of world's population under age 5 contributed almost one-third of all deaths.

B: Percent of Deaths Occurring In Each Region, 1985

10 million infants died during 1985

Mortality during the first year of life exceeds mortality during ages 1-4. Globally, there are 2 infant deaths for each death of a 1-4-year-old. Higher levels of overall mortality are associated with proportionately higher levels of child mortality. In Africa, the ratio of infant to child deaths is 1.6 to 1. In developed countries the ratio is 6.6 to 1.

C: Percent of Children Dying Before Age 1 and Before Age 5

1980-85 Mortality Level

Goal for Year 2000

Reduced Mortality Level

Gods for reduced mortality would still not bring levels of child mortality in developing regions to 1980-85 levels of mortality in developed regions.

*Excluding China

Source: Data are included in Tables 1, 2, 3, and 4 of Appendix A.
Fact Sheet 2 — Births by Region

A: Percent of World Births Occurring in Each Region

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Africa</td>
<td>10.7%</td>
<td>13.5%</td>
<td>12.7%</td>
</tr>
<tr>
<td>Near East</td>
<td>7.6%</td>
<td>5.9%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Asia*</td>
<td>27.5%</td>
<td>15.3%</td>
<td>9.5%</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>35.5%</td>
<td>23.5%</td>
<td>19.7%</td>
</tr>
<tr>
<td>Developed Countries</td>
<td>7.4%</td>
<td>9.4%</td>
<td>15.3%</td>
</tr>
</tbody>
</table>

Including China, more than 50 percent of the world's children are projected to be born in Asia between 1985 and 2000. Due to an increasing number of women of childbearing age and high birth rates, the percentage of the world's children born in Africa is expected to increase rapidly.

B: Number of Births During 1985-2000 (in thousands)

- Latin America & Caribbean: 194,314
- Asia*: 312,163
- Developed Countries: 402,513
- Africa: 268,073
- Near East: 152,509
- Asia*: 71,838

More than 2 billion children are projected to be born in the world between 1985 and 2000. Some 87 percent, or 1.5 billion, will be born in developing countries.

C: Average Number of Children Women Bear

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</thead>
<tbody>
<tr>
<td>Africa</td>
<td>6.6</td>
<td>5.1</td>
<td>4.2</td>
<td>3.9</td>
</tr>
<tr>
<td>Near East</td>
<td>2.2</td>
<td>3.5</td>
<td>4.2</td>
<td>5.3</td>
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<tr>
<td>Asia*</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>2.2</td>
<td>3.4</td>
<td>4.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Developed Countries</td>
<td>3.9</td>
<td>4.2</td>
<td>4.5</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Fertility of women in developing countries is almost twice that of women in developed countries. In some African countries women bear enough children to replace their generation fourfold, while in some European countries and the United States, fertility is below replacement level.

D: Number of Women of Reproductive Age: 1985-2000 (in millions)

- 1985: Africa 101, Near East 132, Asia* 192, China 257, Latin America & Caribbean 453, Developed Countries 503
- 1990: Africa 101, Near East 132, Asia* 192, China 257, Latin America & Caribbean 453, Developed Countries 503
- 1995: Africa 101, Near East 132, Asia* 192, China 257, Latin America & Caribbean 453, Developed Countries 503
- 2000: Africa 101, Near East 132, Asia* 192, China 257, Latin America & Caribbean 453, Developed Countries 503

The number of women of reproductive age will increase through the end of the century, reflecting momentum from higher birth rates in the past. As a result, the total number of births occurring each year is projected to grow, despite overall declines in fertility taking place in all regions of the world.

*Excluding China

Source: United Nations (Data are included in Table 6 of Appendix I.)

Demographic Data for Development Project
Fact Sheet 3 — Geographic Inequalities in Child Mortality

A: Mortality of Children of Urban, Educated, Professional Parents and of Rural, Uneducated, Agricultural Parents

- Mortality of children of urban, educated, professional parents
- Increased mortality of children of rural, uneducated, agricultural parents

<table>
<thead>
<tr>
<th>Country</th>
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<td>12.3</td>
<td>28.2</td>
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<td>Peru</td>
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</tr>
<tr>
<td>Nepal</td>
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<td>23.9</td>
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<tr>
<td>Bangladesh</td>
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<td>Kenya</td>
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<td>22.5</td>
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<td>Haiti</td>
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<td>25.9</td>
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<tr>
<td>Pakistan</td>
<td>13.9</td>
<td>19.8</td>
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<td>Indonesia</td>
<td>10.2</td>
<td>14.6</td>
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<tr>
<td>Sudan</td>
<td>12.4</td>
<td>24.9</td>
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<td>Colombia</td>
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<td>Panama</td>
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<td>11.0</td>
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<td>Syria</td>
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<td>9.8</td>
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<tr>
<td>Guyana</td>
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<td>10.1</td>
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<td>Sri Lanka</td>
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<td>9.8</td>
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<td>Trinidad &amp; Tobago</td>
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<td>8.6</td>
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<td>Malaysia</td>
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<td>7.8</td>
</tr>
<tr>
<td>Jamaica</td>
<td>11.5</td>
<td>6.3</td>
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The risk of death for a child is associated not only with urban or rural residence, but is very importantly with the education and work status of his or her parents. Mortality levels of children of urban, educated, professional parents are often less than one-fourth of those of rural children with less educated parents working in agriculture.


B: Percent of Children Dying Before Age 5:
Range and Average for Regions and Selected Countries

- Highest country
- Regional average
- Lowest country

The range of national child mortality levels within each region is very wide. It is notable that all regions have at least one country with mortality below 2 percent, and that mortality is never above 25 percent in the Near East, and Latin America and the Caribbean.

*Excluding China

Source: UNICEF (2014) are included in Table 2 of Appendix I.

C: Percent of Children Dying Before Age 5:
Range and Average for Rural and Urban Areas of Selected Countries

- Urban
- Rural
- Highest Area
- National Average
- Lowest Area

Within countries, different regions experience different levels of child mortality. Generally, mortality in urban areas is lower than in rural areas.


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the year 2000. Current rates of 10.0 to 12.5 percent are targeted to fall to 5.0, and where rates are below 10.0 the goal is to halve the current rate. These targets are the basis for projecting the numbers of children likely to survive, based on continuing the 1980-85 mortality rates and achieving the improved targeted rates (a discussion of the methodology appears in Appendix 2).

Estimates of the number of children who would live, based on year 2000 target rates, are shocking for each country in Appendix 1. The numbers of additional children that would survive within each region of the developing world are shown in Figure 1-B. During the year 2000 the death toll would be cut by 3.3 million children in Africa, 684,000 in the Near East, 3.8 million in Asia (excluding China), and 586,000 in Latin America. If China is included, the total number of children whose lives would be saved in developing countries exceeds 8.9 million; a number greater than the 1985 population of Sweden. These numbers are illustrated in Figure 1-C.

A MODEL OF CHILD SURVIVAL
Why do so many children die? There is no simple answer. Disease and malnutrition cause millions of children to die. Is cutting the death rate then essentially a matter of preventing disease and malnutrition? Many agree that this approach is sound, but others argue that it tends to ignore the social
context in which disease and malnutrition occur; that biological answers cannot explain the huge differences in child mortality around the world, nor the fact that a disproportionate burden of disease, malnutrition, and death falls on children in developing nations. They contend that these are the symptoms of a single overriding disease—that of poverty—and that the only lasting solution to the problem is to alleviate the poverty in which these children live.

Both arguments of this historic debate are valid. There is a biological cause for every death. A child drinks water from a contaminated well and dies from severe dehydrating diarrhea. The bacteria cause the dehydration; the dehydration precipitates the death. But poverty plays a crucial role: a tragic outcome might have been avoided had the community been able to provide clean water; or had the mother been able to read the directions on an oral rehydration salts packet. Poverty paves the way for both the disease and the eventual death.

Bringing about the child survival revolution therefore requires systematic understanding of both aspects of child mortality—social and biological—and their interaction in the world. If child survival is to be improved at the rapid rates we now know are possible, it is essential to take action on the comprehensive model now being developed by leading authorities in the field, which takes account of both factors. The following pages, which borrow from this model, are devoted to both the immediate determinants of child mortality and the socioeconomic context in which children live. This includes the general categories of nutrition, infection, and maternal factors that put children at risk, as well as health attitudes and resources that influence child mortality through preventive and curative actions. Each chapter in the first section describes a major impediment to child survival and existing technologies that can be used to remove it. The second section focuses on major socioeconomic resources and their importance. How successful we are in overcoming these impediments and developing these resources will determine how many of tomorrow's children live or die.

Perhaps the most important aspect of efforts to improve childhood survival is what might be called "political and social will": the resolve to commit resources at national and international levels and to develop broad-based health and child-spacing programs that will both initiate and sustain the dramatic increases in infant and child survival now within reach.
Major Impediments to Child Survival and Strategies for their Removal

Diarrheal Disease
Vaccine-Preventable Diseases
Acute Respiratory Infection
Malaria
Malnutrition
High-Risk Fertility Behavior
DIARRHEAL DISEASE

PROFILE

Diarrheal disease is the leading cause of infant and child death in the world today. It is also one of the most frequent causes of childhood illness and a major contributor to the problem of childhood malnutrition. In developing regions between one-fourth and one-third of deaths under age 5 have been attributed to this cause. In absolute terms, an estimated 5 million children die from diarrhea every year. At least 60 percent of these deaths result from acute dehydration, which we now know can be readily prevented.

Agent

Diarrhea is only the common symptom of a large number of intestinal diseases. The source of infection may be a virus, a bacteria, or a parasite, or, often, a combination of these. They all share the ability to alter intestinal function, increasing fluid loss from the body and decreasing the retention of nutrients. The severity of an episode varies widely, depending on the type of diarrhea and the intensity of infection. Cholera has a well-earned reputation as the most deadly diarrheal disease. It can kill in a matter of hours and has claimed more lives in recorded history than any single infectious disease, including the bubonic plague. Yet cholera can also be a relatively mild disease, which illustrates the broad range in severity of diarrheal infections. The impact of diarrhea is seen less in the severity of individual cases than in the effects of the recurring mild infections that characterize childhood in many developing countries.

Diarrhea kills primarily through dehydration. Although life-threatening dehydration occurs in only 1 percent of all episodes, it is responsible for 60 to 70 percent of all diarrhea deaths. Without treatment, severe episodes literally wring out body fluids from the victim faster than they can be replaced. The first symptoms of dehydration appear after fluid loss equivalent to 5 percent of body weight. When fluid loss reaches 10 percent, shock often sets in, and the cascade of events that follows can culminate in death unless there is immediate intervention. Rehydration, whether given orally or intravenously, is the only effective therapy.

Transmission Factors

Diarrheal disease is primarily transmitted from person to person via soiled hands and via food and water that have been contaminated by human waste. It is characteristically endemic in areas where sanitation and hygienic habits are poor. Seasonal cycles play an important role. In general, the highest rates of diarrhea occur during the hot and rainy seasons. At high temperatures, bacteria multiply quickly in food and water that have been left standing, and high rainfall facilitates the spread of these organisms. The highest prevalence often coincides with peaks in annual rainfall. One study has found that during the rainy season in The Gambia, the average child suffers from diarrhea more than 25 percent of the time.

Host Factors

Diarrhea can strike at any age. But when diarrhea kills, its victims are almost always children. It is estimated that 80 percent of child deaths from diarrhea occur before the age of 2. The absolute risk of death from diarrhea declines...
through the remainder of childhood, following the general decline for overall mortality. But diarrhea then becomes a more important cause of death in relation to other causes. An analysis of child mortality in Bangladesh is shown in figure 2-A. The proportion of diarrheal deaths rises from 14 percent of all infant deaths to more than 40 percent of all deaths among 1- through 4-year-olds.

The reasons for this increased vulnerability lie in the unique transition children must undergo from their initial state of nutritional and immunological dependence. During the first 4 to 6 months of life, a fully breastfed infant receives both a complete diet and disease protection from breastmilk. Exclusive breastfeeding also spares the infant early exposure to contaminated food and water. The inevitable introduction of supplemental foods, however, requires an adjustment to diseases in the environment—an adjustment not unlike that experienced by travelers in new surroundings. As seen in figure 2-C, the highest rates of diarrhea among children, which occur from the age of 6 months through age 1, coincide with the weaning period.

Diarrhea and malnutrition are so closely related that they may arguably be considered a single complex of diseases. Diarrhea causes malnutrition. During a diarrheal episode a child is likely to eat less, either because of loss of appetite or intentional withholding of food, and absorbs less of the food he does eat due to the effect of the diarrhea itself. At the same time, malnutrition increases the risk from diarrhea. Poorly fed children suffer longer and more severe episodes. Even children who are of normal weight but have selective vitamin A deficiency appear to be more vulnerable to diarrheal attacks. The reciprocal effects of malnutrition and diarrhea tend to multiply each other, together becoming a more powerful agent of death than either one alone.

An isolated case of mild diarrhea carries an imperceptible risk. Yet children in developing countries face multiple episodes of acute diarrhea every year. In some areas the total is as high as 12. The cumulative nutritional deficit from these relentless infections can interrupt normal growth and development and place the child in a precarious nutritional and health status.

GLOBAL IMPACT ON CHILD SURVIVAL

Current knowledge of the true global prevalence of diarrheal disease suffers from a serious shortage of accurate data. Nonetheless, available estimates provide a rough outline of who is at greatest risk and where the problem is most concentrated.

For the year 1984, the World Health Organization estimated that there were over a billion episodes of acute childhood diarrhea and almost 5 million child deaths from this cause alone. More than 90 percent of these episodes and almost all of the deaths occur to children in developing countries. The incidence of acute child diarrhea in the developing world is 3 to 4 times greater than in the United States and other developed countries.

The median diarrheal incidence figures for each region are shown in figure 2-B, which also shows the average number of days during a year that a child in the region might suffer from diarrhea. These estimates, which are conservative, suggest the great burden of illness on children from this disease alone. The estimated annual attack rate for Africa of almost 5 diarrheal episodes per child denotes a formidable health risk. Assuming that each episode lasts an average of 5 to 6 days, a child born in Africa today will spend 1 month of every year with diarrhea. Averages and medians, however, always obscure the variation observed for such a large and diverse area as Africa. Estimated incidence rates over the continent range from 2 to 10 episodes annually. The greatest burden of illness falls on the youngest children and the highest frequency is experienced during
one season of the year. The health risk of diarrhea to young children during peak months in the poorest areas is thus far more serious than the regional figures suggest. These high rates serve as a real barometer for malnutrition, poor sanitation, and marginal health conditions.

THE ROAD TO HEALTH

The loss of life from diarrheal disease is staggering. Yet the potential for saving the lives of children who die from this disease is equally dramatic. Increasing attention has been given to the problem of diarrhea since the development of a simple technique to combat dehydration, which is the principal cause of diarrheal death. The technique is oral rehydration therapy, or ORT

**Oral Rehydration Therapy (ORT)**

ORT is a three-tiered strategy that combines administration of a simple solution of sugar and salts with continued feeding through a diarrheal episode and referral when appropriate.

ORT acts to replenish the water and electrolytes lost from the body during a diarrheal episode. Diarrheal organisms normally resist efforts by the body to balance these losses by reducing intestinal absorption of fluid and nutrients. Rehydration therapy is the only effective treatment for dehydration, which in most cases is the ultimate cause of death. For many years, intravenous rehydration was the accepted treatment. It has now been found that a relatively simple mixture of sugar and salts in a liquid solution can be absorbed even during the course of severe illness. Administration of this mixture does not cure diarrhea, but it can maintain or restore the body's critical fluid balance until the infection subsides. Continued feeding during the illness lessens the risk of malnutrition that accompanies frequent episodes. Only in the severest cases of dehydration is intravenous therapy still required.

ORT stands as a model of existing child survival measures that are simple, effective, and low in cost. The ingredients of oral rehydration solution are inexpensive and widely available. The solution itself is simple to prepare once the technique has been learned. And it can be made either from a premixed packet of oral rehydration salts or from common home ingredients (see figure 2-D). In practical teens, this means that this simple yet powerful lifesaving technique can be practiced in the home and disseminated in areas beyond the reach of a hospital or clinic, where the majority of children in the developing world live. Accordingly, ORT has been hailed as the most significant medical advance in child survival since the development of vaccines.

**Expanding ORT Use**

Despite intensive efforts to reach children at risk, ORT is still not in widespread use. Since the technique's introduction in the 1970s, the global supply of oral rehydration salts has increased dramatically. A number of developing countries have begun to manufacture their own packets. But these efforts have only begun to meet the world need. Figure 2-E shows minimum estimates for the proportion of children who have access to centers that dispense packets and the proportion of estimated diarrheal episodes actually treated, using packets or home solution. Minimum estimates assume that countries not reporting have no coverage. Typically, the geographic areas of greatest need have the lowest rates of both access and use. Moreover, available statistics are largely drawn from the small number of countries that gather reliable statistics and, not coincidentally, offer better health services in general. Hence the regional estimates provided here, low as they are, probably do not understimate the actual situation.

Making the lifesaving potential of ORT a reality means placing this practice in the hands of those who need it most. One of the greatest difficulties has been to get peo-
ple to recognize the need for treatment before it is too late. Diarrhea is a common fact of life for many children. Perhaps only 10 percent of cases become dehydrated, and the symptoms of dehydration appear late in the course of the disease. People in local communities, especially mothers, need to learn how and when to give ORT when their children contract acute diarrhea. Caregivers must be carefully taught to use the correct proportions of salts in water, because an over-diluted solution is less effective and one that is too concentrated can be dangerous. The importance of using the cleanest possible water must also be stressed, to avoid exposing the child unnecessarily to further contaminants. But even if safe water is not readily available, the benefits of fluid replacement in diarrhea far outweigh the risk of using contaminated water to make up oral rehydration solution. The crucial role that water plays in disease transmission and health in general is discussed further in chapter 12.

Finally, the spread of ORT can be greatly accelerated by carefully designed and implemented programs. This difficult work is now being undertaken in efforts to make ORT and diarrheal control an integral part of comprehensive health services for children in the future.

### The Importance of Continued Feeding

The solution of sugar and salt may prevent dehydration, but does not address the problem of malnutrition that diarrhea frequently precipitates. Continued feeding through a diarrheal episode plus extra intake during the recovery period are essential if a child is to maintain normal growth and development. It is especially important for children who are still breastfeeding.

Unfortunately, the common response to diarrhea is to stop feeding altogether. It is a problem of conflicting perceptions of this disease. Common sense tells many parents that diarrhea works like a pipe. If you stop feeding things in at the top, they will stop coming out at the bottom. This belief is seemingly confirmed by the observation that diarrhea increases with feeding. Much of the food and liquid ingested during diarrhea is indeed lost. But while gut function is reduced, the body can still absorb over 50 percent of nutrients during a diarrheal episode. Continued feeding in conjunction with oral rehydration is thus best for the child. Even if the diarrhea appears to get worse, feeding is a far better alternative than fasting.

Young children in many parts of the world spend a

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**Oral Rehydration Solution**

<table>
<thead>
<tr>
<th>Oral Rehydration Salt (ORS) Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5 grams Sodium chloride</td>
</tr>
<tr>
<td>20 grams Glucose</td>
</tr>
<tr>
<td>2.9 grams Trisodium citrate dihydrate*</td>
</tr>
<tr>
<td>1.5 grams Potassium chloride</td>
</tr>
<tr>
<td>1 liter of cleanest water</td>
</tr>
</tbody>
</table>

OR

**Home Solution**

| 1 level teaspoon Table salt          |
| 8 level teaspoons Sugar              |
| pinch Baking soda                     |
| pinch Potassium salt                 |
| 1 liter of cleanest water            |

Although the world Health Organization now recommends the use of trisodium citrate, oral rehydration packets substituting 2.5 grams of sodium bicarbonate remain safe and highly effective. Although these increase the effectiveness of home solution, it is still effective without them. Readily available foods such as bananas, orange juice, and green coconut water contain potassium, although relatively large quantities of these foods are needed to replace potassium lost from diarrhea.

significant proportion of their lives with diarrhea. If food or breastmilk were to be withheld for each episode, it would be tantamount to requiring the hardest-hit children to fast for a full month or more out of every year.

Diarrhea Prevention

Handwashing: The ultimate aim of diarrhea control programs is to prevent the disease itself. Improvements in sanitation and water supplies will certainly play an important and necessary role in the permanent reduction of diarrheal illness. But the costs of building these systems and maintaining them once they are built are prohibitive for many areas at current levels of development. Meanwhile, a number of simple preventive measures can have an immediate impact on the incidence of diarrheal disease. The promotion of simple hygienic practices within the household is a good example. Figure 2-F shows the impact of a program in Guatemala to promote health awareness and good hygiene among mothers in the country's Pacific lowlands. The incidence of diarrhea was lower and the length of diarrheal episodes shorter among children of mothers in the program than among children in similar living conditions whose mothers did not participate in the program. The most dramatic results were achieved at the
peak diarrhea season among children under two. Diarrheal incidence in this group declined by 36 percent, and the time spent with diarrhea was reduced by more than half. A simple bar of soap can be a powerful force for child survival.

**Breastfeeding:** The practice of breastfeeding provides a similarly dramatic level of protection from diarrhea. A recent study of diarrhea in Costa Rica found that infants who were exclusively bottlefed in the first 6 months of life contracted diarrhea at 4 times the rate of partially breastfed infants and almost 7 times the rate of exclusively breastfed infants.

When mortality from diarrhea among exclusively breastfed infants is compared with mortality among infants experiencing other feeding patterns, an even more striking pattern emerges. During the first 6 months of life, exclusively bottlefed infants are between 5 and 25 times more likely to die from diarrhea than their exclusively breastfed counterparts, and between 2 and 13 times more likely to do so than partially breastfed infants. The level of direct disease protection from breastfeeding declines over the first year. But breastfed children probably remain at a nutritional advantage during the recovery period from a diarrheal episode. The World Health Organization has estimated that breastfeeding promotion programs could yield an 8 to 20 percent reduction in incidence of diarrheal illness and a 24 to 27 percent decrease in deaths from diarrhea. The role of breastfeeding in child survival is discussed in greater detail in the section on Malnutrition.

**Immunization:** Direct vaccination against diarrheal infection may soon provide an important weapon in the control of diarrheal disease. In recent years, substantial resources have been invested in research to develop a new vaccine against rotavirus and an improved vaccine against cholera. Rotavirus is a leading cause of severe, dehydrating diarrhea among children around the world. While rotavirus-associated diarrhea may account for only 6 percent of all diarrheal episodes among children under age 5, it may be responsible for 20 percent of all diarrheal deaths in that age group and as many as half of all episodes that result in dehydration. Several candidates for a vaccine that can be administered orally are currently being tested, with some promising results. Once perfected, a rotavirus vaccine might be given to children in conjunction with oral polio vaccine, thus building on existing immunization programs that have established broad coverage.

Cholera is rare by comparison to other major causes of diarrhea, but its frightening severity and ability to create explosive epidemics make it a logical target for continued vaccine research. A number of oral vaccines are being tested to improve on the duration and efficacy of the current injectable vaccine. Work also continues in developing vaccines against other important agents of diarrhea, including enterotoxogenic E. Coli, Shigella, and Giardia lamblia.

A final prevention strategy against diarrhea takes advantage of the interaction of other disease antagonists with diarrhea in affecting child survival. Diarrhea is a frequent and often fatal complication of measles. The risk of a child's dying from measles combined with prolonged diarrhea is 4 times that of dying from measles alone. Immunization programs aimed at measles should therefore have a tangible impact on the death toll from diarrhea as well. The World Health Organization has estimated that if 60 percent of 1-year-olds were to receive measles vaccinations, the ensuing reduction in mortality from diarrhea among children under age 5 would range from 9 to 18 percent. It is estimated that up to one-fourth of diarrheal deaths could be eliminated by 90 percent measles immunization coverage.
PROFILE
Immunization is one of the most powerful weapons in the arsenal of existing child survival technologies. The World Health Organization's Expanded Program on Immunization (EPI), with the support of USAID, UNICEF, and other major groups, is conducting an ambitious effort to establish universal immunization against six common childhood diseases. They are measles, diphtheria, pertussis, tetanus, poliomyelitis, and tuberculosis. Vaccines against these diseases are for the most part safe, effective, and inexpensive. Widespread immunization in industrialized countries has come close to eliminating these diseases altogether. Real progress has also been made in efforts to reach children in the developing world, as seen in figure 3-A. In 1985 vaccination is estimated to have prevented nearly a million child deaths. Nevertheless, an estimated 3.5 million infants and children continue to die annually from the target diseases and their complications. An equal number are left blind, crippled, or mentally retarded.

AGENT
Measles: Measles is a oral infection that causes more child deaths than all of the other target diseases combined. According to the most recent data available, more than 2 million children died from measles and the diarrhea, pneumonia, and malnutrition that measles precipitates. The disease is characterized by high fever, cough, runny nose, and a blotchy rash that appears over the body 3 to 7 days after the onset of symptoms. The virus is highly contagious and easily spread from person to person. Without immunization, virtually all children will contract measles.

The power of this disease to cause death stems in large part from its devastating effects on the nutritional and immune status of its victims. The fever can quickly deplete the body's reserves of both protein and vitamin A, even in children who are well-nourished. The danger is far greater for children already in a precarious nutritional state. Because protein and vitamin A play a role in maintaining the body's defenses against disease, a child suffering from measles is immunologically compromised, which renders him vulnerable to a cascade of complicating infections. Measles rarely kills alone. It is almost always aided by at least one other disease, most commonly diarrhea or pneumonia. Children who recover are often left with a serious nutritional debt. Measles has frequently been cited as the major precipitating event in severe protein-calorie malnutrition, leaving as many as one-fourth of infected children with a formidable 10 percent weight loss.
**Tetanus:** Tetanus is a highly lethal infection caused by the toxin of the tetanus bacillus. It is responsible for close to one million deaths each year; most of those who succumb are newborn infants. This organism exists harmlessly in the gut of many animals and humans. It is only when the bacillus enters through the skin or an open wound that it becomes fatal. The usual mode of transmission is through exposure to the soil, where excreted tetanus spores can remain intact for years. People of all ages can be susceptible to infection. It is of particular concern to those who live in rural areas and in the unsanitary conditions under which the tetanus bacillus thrives. Vaccination with tetanus toxoid confers immunity for up to 10 years and can provide important protection for older children and adults in high risk areas.

**Neonatal Tetanus:** Tetanus that occurs during the first month of life, or neonatal tetanus, accounts for the greatest number of deaths from this disease. It results primarily from unsanitary practices surrounding birth. The newly cut umbilical stump provides an easy portal of entry for the tetanus bacillus, which can be introduced by contaminated cutting instruments or by the traditional dressings sometimes placed on the umbilical stump. The first sign of neonatal tetanus is inability to feed. In a matter of days, the disease proceeds to general muscular stiffness with spasms and convulsions. Death follows rapidly. Most deaths occur between 4 and 14 days of birth, several days after the first symptoms appear. Without treatment neonatal tetanus is almost uniformly fatal; the assumed case fatality rate is 85 percent. Even when treatment is available, mortality is high because babies are rarely brought to the hospital before severe symptoms have set in.

Until recently, the global significance of neonatal tetanus had gone largely undetected. The death of a child during its first few weeks of life may be hidden from view for cultural reasons. In many traditional societies, a child must survive for a certain period of time after birth before it is acknowledged as a "life." Naming ceremonies and other rituals marking the arrival of a new life are purposely delayed by those accustomed to high rates of infant mortality. The fatalistic attitudes that prevent parents from seeking help also make them unlikely to report the death of a newborn infant. As a result, the problem of neonatal tetanus has been endowed with what has been called a "peculiar quietness," going largely unrecognized as a major cause of infant death.

The true magnitude of neonatal tetanus mortality is uncertain. Current estimates hold that close to 1 million infants die from this cause every year. In some areas it accounts for more than half of all deaths in the first month of life and 1 in 10 deaths during the first year.

Prevention is the only viable strategy against this disease. Unlike other diseases discussed in this section, tetanus is not contagious. It can be prevented by immunization and improved sanitary conditions, especially those surrounding maternity care. Immunization strategies against neonatal tetanus hold out the greatest hope for the immediate future. The timing of this disease requires an unorthodox solution. When a pregnant woman is immunized, her fetus also receives immunity. Following birth, the child enjoys this passive immunity for up to 5 months, safely past the period of highest risk. Basic improvements in maternity care also have important implications for child survival. Figure 3-B shows the influence of trained birth attendants and immunization of pregnant women on neonatal mortality from tetanus and from all causes combined. As might be expected, delivery by trained birth attendants reduced neonatal mortality from all causes to a greater extent than immunization against tetanus. Immunization against neonatal tetanus, however, provided virtually complete protection to infants of immunized mothers. Compared with those receiving no special care, newborns in both programs enjoyed a significant reduction of mortality during the first
month of life, 72 percent and 54 percent respectively, which underscores the importance of pre- and postnatal health care.

**Pertussis (Whooping Cough):** Pertussis, an acute bacterial infection of the respiratory tract, claims the lives of nearly 600,000 children each year. Without immunization, the toll in developing countries might be closer to 750,000 child deaths annually. Characterized by a violent cough and whooping sound with inhaled breath, pertussis is a prolonged, exhausting illness. The severest symptoms usually occur over a period of 2 to 4 weeks. A residual cough may last for months. It is highly contagious. On average, 80 percent of children in an unimmunized population will contract this disease. An estimated 1.5 to 2 percent of infected children die from pertussis and its consequences, especially from pneumonia. As with measles, children who recover are often left with a nutritional debt that weakens their resistance to the effects of other illness. More than half of the children in one African study suffered a critical 5 percent weight loss. It took from 1 to 3 months for many of these children to regain their previous weight and resume normal growth. The burden on health from this preventable disease may thus be far greater than can be measured directly.

**Polio:** Polio is more of a crippling than a killer. It is a viral disease spread indirectly from person to person via contaminated food and water. An estimated 272,000 children contracted paralytic polio in 1985 and perhaps one in ten of these died as a result of the infection. Spearheaded by the Pan American Health Organization's drive to eradicate polio from the Americas before the next decade, the world is gaining the edge on this dread disease. The estimated number of cases prevented by polio immunization in developing countries in 1985 was almost half the reported incidence of childhood polio in that year.

Polio was once thought to be a relatively rare disease that occurred more frequently in developed than developing countries. The disease seemed rare because most polio infections are silent. Only one of every 200 children infected goes on to develop paralysis. Amid poor health conditions, frequent exposure to polio virus begins at birth. Recent lameness surveys in developing countries reveal previously unsuspected high levels of crippling polio, comparable to those of the worst epidemics in industrialized countries before the development of vaccines. Some 3 to 10 children per 1,000 are affected in endemic areas.

**Diphtheria:** Since immunization against diphtheria began, this once-dreaded disease has been all but relegated to memory in temperate countries. In the United States, for example, the number of reported cases averaged four per year during the early 1980s, occurring mostly in unimmunized adults. Little is known about the scope of diphtheria in the developing world. Perhaps 5,000 children die each year from this cause. While this death toll is low compared with that of a disease like measles, immunization remains a priority. The infection is severe, killing 10 to 15 percent of its victims. Many children in endemic areas develop an early natural immunity as a result of constant subtle exposure to the bacteria through the skin. Ironically, as health and sanitary conditions improve, such exposure decreases, depriving children of this natural immunity and making them susceptible to the severe respiratory form of diphtheria later in life. Immunization thus becomes a critical factor in preventing the rise of both morbidity and mortality from diphtheria.

**Tuberculosis (TB):** Once the leading cause of death in Europe, tuberculosis now appears to be declining throughout the world. Throughout its history, the disease has been associated with the poverty and crowded living conditions that favor its spread. It is now rare in developed countries, but remains common in developing regions, where it continues to be a major cause of illness and death. Although the true scope of this disease among children is unknown, it is estimated that 30,000 children die from tuberculosis each year.

Tuberculosis is a chronic disease that usually starts in the lungs and may spread to other organs. Most child deaths result from a severe form of the disease known as TB meningitis, which develops when infection spreads to the
layers surrounding the brain. Like polio, most tuberculosis infections are silent. Between 1 and 2 percent of those harboring the bacillus develop outward symptoms each year. But unlike polio, tuberculosis is not self-limiting. Without treatment, the bacillus may persist in the lungs of the victim indefinitely, ready to cause infection later in life. An infected infant has a 10 percent chance of developing disease in later childhood or as an adult.

**Host Factors**

It is striking that the same childhood diseases can be so innocuous in one context and so devastating in another. Their tremendous impact on child survival in developing countries stems from four principal factors: low levels of immunization (discussed in the next section), young age at infection, the presence of malnutrition and other complicating diseases, and lack of available health care.

Age at infection can have a strong influence on the severity of the disease. Childhood diseases tend to strike at much earlier ages in developing countries than in industrialized countries. In poor, densely populated areas, as many as half of children will have suffered measles by their first birthday; virtually all have been infected by age 3. Contributing factors include crowded living conditions that give children early exposure to the outside world. A child who lives in one room with a number of older siblings or who rides on his mother's back to a crowded marketplace is likely to be exposed to most common childhood diseases at a very early age. In developed countries, by contrast, most children first encounter this intensity of exposure when they enter school at age 4 or 5. The pattern of declining fatality rates from measles with increasing age (figure 3-C) shows that an infant with measles is 8 times more likely to die than a 5-year-old with the same infection. Similarly, the risk of death among infants with pertussis is 3 times that of children 1 or older.

The combination of malnutrition and concurrent illness is a recurring theme in discussions of the major determinants of child mortality. The case of measles provides a classic example of the interplay between these factors. Severely malnourished children have been shown to suffer twice the measles mortality of children on adequate diets. Under famine conditions, when the prevalence of malnutrition soars, as many as half of children who contract measles die from it. Most measles deaths follow complicating infections, usually diarrhea and pneumonia. A
Bangladesh study found measles followed by prolonged diarrhea to be four times more likely to be fatal than measles alone. The synergistic effect of the interaction of two diseases thus far outweighs the total of their individual effects.

Lack of health care is another contributor to high fatality rates from childhood diseases. Some of these diseases can be cured medically. Pertussis and diphtheria respond to antibiotics; tuberculosis can be halted by a complex drug regimen; and it is possible to save some children from the grip of tetanus by the use of muscle relaxants and antitoxins. But few in the developing world have access to such advanced medical services, and for other diseases, such as measles or polio, there is no known cure. Immunization is the only alternative. In any case, the continuing lack of available health care is one of the strongest arguments for immunization.

THE ROAD TO HEALTH

We hold the means to prevent millions of child deaths in our hands. The virtual elimination of the six target diseases in industrialized regions puts this goal within reach of the developing world. It is no longer a question of the ability to control these diseases; it is a question of the will to take the necessary steps.

Immunization Coverage

The latest available immunization rates for the major regions of the world are shown in figure 3-D. They reflect the progress that has been made and the distance remaining to the goal of universal immunization. Africa lags well behind other regions in terms of overall coverage. Fewer than 40 percent of infants receive full immunization against any of the six target diseases before their first birthday.
Asian countries (excluding China), provide higher levels of coverage of all diseases but measles; immunization against this disease is lower in Asia than in any other region. India, which has more children than any country in the world, has only recently initiated a measles immunization drive. Even when India is excluded from the regional average, measles immunization coverage averages less than 20 percent. China, by contrast, is reported to have reached more than half of all infants with each vaccine; nearly 83 percent are said to be protected against measles. The greatest overall success rates in the developing world have been achieved by Latin America and the Caribbean, where between one-half and two-thirds of infants are reportedly immunized annually against each of the six target diseases.

The World Health Organization's Expanded Program on Immunization (EPI) faces significant challenges. Because the targeted diseases strike in infancy in developing regions, effective immunization must occur before a child's first birthday. Vaccinations must not be given too early, however, because they can be neutralized by the passive immunity inherited from the mother. This leaves a relatively brief period of time during which it is crucial to reach the child. Additional problems include the need to refrigerate vaccines until they can be administered. Breaks in the required "cold chain" have a cumulative effect on vaccine potency, especially on the potency of "live" vaccines such as those against polio and measles. If there are too many breaks, the vaccine becomes useless before it can reach the child. Public awareness may be the most important factor in the success or failure of these programs. Adequate supplies, facilities, and personnel mean little if local communities are not informed of the availability of services or motivated to use them. Dropouts often plague immunization efforts, as when parents who bring in their children for the first inoculation of DPT or oral polio vaccine fail to return for the second or third shot.

Vigorous communication activities that get the message across to the critical audience can be of enormous benefit. Effective communication systems serve three purposes: they educate people about the importance of immunization to children's health, overcome misconceptions that discourage its widespread use, and explain where and when immunization services are available.

Nationally publicized "immunization days," during which thousands-or even millions-of children are immunized have been staged in some countries. These widely publicized efforts tend to reach children who might otherwise have gone unprotected. If these campaigns have a drawback, it is that they may sidetrack efforts to establish thorough systems of routine immunization to protect fixture generations. However successful they may be, single campaigns do not eliminate the ongoing need for immunization. The absolute size of this need is vast. In 1985 there were 103 million infants living in developing countries, only one quarter to one half of whom received immunizations against any of the 6 EPI target diseases. By the year 2000, the number of surviving infants is projected to grow to over 115 million annually. That means that every year there will be almost one million more children to immunize than there were the year before. Overall, a projected 1.8 billion infants will require immunization between 1985 and the year 2000. The goal of universal coverage can be achieved and sustained, but coordinated and systematic efforts will be required to support the necessary special initiatives.

Despite logistical difficulties of immense proportions, there is widespread agreement that the goal of universal immunization of children can be achieved before the end of the century. WHO's Expanded Program on Immunization is receiving broad-ranging support and other international organizations and world leaders have added their voices to the call for universal immunization of children by 1990. The Pan American Health Organization is spearheading a drive to eradicate polio from the Americas by that year. The worldwide demand for vaccines has tripled during the past year, and many countries have staged massive national immunization drives. The series of graphs in figure 3-E shows the impact of immunization on the incidence of disease in selected countries. Increasing immunization rates of children under age 1 accompany a general decline in the pattern of the specific target disease. The benefits of these programs are expected to accrue rapidly. As levels of immunization rise, the number of susceptible children in a given area declines. Above a certain level, different for each disease, transmission can be brought to a virtual halt, which means that even children who have not been vaccinated are sheltered from infections. The analogy has been made of a stone hitting sand. When a child contracts a disease and there is no one for him to pass it on to, the epidemic stops before it begins.
A host of other infectious and parasitic diseases can sterilize children. Some are universal diseases of childhood, others are limited to developing countries. Some are determined by climatic conditions, others by crowding and poor hygienic practices. Their impact on child survival is magnified by malnutrition and little or no access to health care. The following section focuses on the two most important infectious and parasitic diseases that affect children: acute respiratory infection and malaria.

PROFILE

With the exception of diarrhea, no single group of diseases claims as many child lives as acute respiratory infections. These infections are estimated to account for 20 to 25 percent of all child deaths in the developing world. In absolute terms, up to 4 million children die from these infections every year. In some areas, acute respiratory infection outranks diarrheal disease as the leading cause of death under age 5.

Agent

As with diarrhea, acute respiratory infections are caused by a wide variety of disease agents. More than 300 types of bacterial and viral sources have been identified, including four of the vaccine-preventable target diseases (measles, diphtheria, pertussis, and tuberculosis). These infections range in severity from the common cold to bacterial pneumonia.

Acute respiratory infections are traditionally divided into two main categories: those of the upper respiratory tract and those of the lower respiratory tract. The latter group, by far the most important cause of deaths from these diseases, is the focus of current health strategies. Bacterial infection of the lower respiratory tract is particularly dangerous; bacterial pneumonia dominates all forms of these infections as a killer of children. Control of lower respiratory infection is problematic, however, because it is relatively rare by comparison to upper respiratory infection and difficult to diagnose. It often develops from seemingly harmless upper respiratory infections, which have a notorious tendency to invite secondary, complicating illness.

Transmission Factors

Acute respiratory infections are primarily spread from person to person through the air. Their principal transmission factors are high population density, crowded living conditions, and seasonal changes that favor the spread of disease.

The evolutionary theory of disease holds that acute respiratory infections came into being when humans began to form permanent settlements with large numbers of inhabitants. Measles, for example, requires a minimum population of 100,000 in order to remain endemic in an area. Because high population density facilitates the transmission of person-to-person diseases, isolated rural communities that generally lack health benefits, may, in the case of acute respiratory infections, enjoy a health advantage over populous urban areas.

Within households, crowded living conditions also favor the spread of respiratory infection. In the often-primitive traditional dwellings and poor housing where most of the world’s children grow up, it is common for the entire family to sleep in the same room. Infants and young children are thus exposed at early ages to diseases brought into the home by parents and older siblings. Moreover, intimate living conditions can increase the intensity of disease transmission. Both very early age at infection and increased intensity of infection have been implicated in the extraordinarily high fatality rates attributable to acute respiratory infections in developing countries.

Seasonal epidemics of these infections are a universal affliction of our species, regardless of economic classification or political boundaries. Every climate has its season of increased disease transmission. The cold weather “flu season” in temperate climates corresponds to the humid rainy seasons of the tropics.

Host Factors

The principal risk factors for child mortality from acute respiratory infection are young age, low birth weight, and poor nutritional status. Death rates are highest during the first year of life. These infections, particularly pneumonia, are often the leading cause of infant death in impoverished areas. As with other diseases, the deadly power of a severe infection is multiplied by the convergence of such factors as weaning, the gradual loss of passive immunity, and increasing exposure to disease that mark the passage of children through the critical first year of life.

An important contributor to high infant mortality from acute respiratory infections is low birth weight. Death rates from all causes are significantly higher for infants weighing less than 2,500 grams (5.5 pounds) at birth, who appear to be especially vulnerable to respiratory illness. Pneumonia heads the list of infectious causes of death. The link between low birth weight and early death is reflected in the elevated infant mortality rates of developing regions, where about one child in six is born underweight.
The impact of acute respiratory infections is intensified by malnutrition. In Costa Rica, children with severe protein calorie malnutrition were found to be 19 times more likely than normal children to develop pneumonia. In the Philippines, as shown in figure 4-A, mortality among children hospitalized with acute respiratory infection was far higher for malnourished children than for children of normal nutritional status.

Vitamin A deficiency, long recognized as the leading cause of blindness in childhood, may also be an important risk factor for respiratory infections. Lack of vitamin A is thought to cause physical changes in the internal linings of the lungs and digestive tract which favor bacterial infection. Figure 4-B shows the findings of recent research on this subject in Indonesia. Children with ocular symptoms of vitamin A deficiency experienced twice the rate of respiratory infection and four times the death rate of children without these symptoms. The role of vitamin A in child survival is examined further in the section on Malnutrition.

GLOBAL IMPACT ON CHILD SURVIVAL
Acute respiratory infections are by far the most common illnesses suffered by children, no matter where they live. The average child under the age of 5 experiences between 4 and 8 infections a year. These infections reportedly cause from 20 to 60 percent of visits to health services and comprise 10 to 50 percent of hospital admissions. The incidence of childhood respiratory infection is roughly the same in both developed and developing regions. This is in sharp contrast to the incidence of diarrhea disease, which is 3 to 4 times higher in developing countries.

Although there is little regional variation in overall incidence rates of acute respiratory infection, death rates are dramatically higher in developing countries. A major factor in this difference is in their higher incidence of the most severe infections, particularly the dangerous lower respiratory infections. Rates for these infections in India and Papua New Guinea are 3 to 4 times higher than U.S. rates, and in the rural highlands of Guatemala, half of 3-year-olds have at sometime suffered pneumonia. The differences are not only in terms of incidence. Case fatality rates for pneumonia, which are 4 percent in the United States, range from 5 to 20 percent in developing areas. When incidence and case fatality considerations are combined, death rates from acute respiratory infections are in some cases hundreds of times greater for children in developing countries.

THE ROAD TO HEALTH
Acute respiratory infections are now being given increasing attention by the international health community. With the exception of those for which vaccines exist, these infections have often been overshadowed in the past by other health concerns. This neglect may have stemmed from the lack of a central strategy like oral rehydration therapy, which has galvanized the fight against diarrheal disease. But growing awareness of the magnitude of the problem of acute respiratory infections and the growing number of possibilities-for their prevention and cure have stimulated new interest. Moreover, it has become increasingly apparent that the child survival revolution will not take place without successfully confronting this major cause of childhood mortality in the developing world.

Existing control technologies include immunization, drug therapy, and a variety of measures to reduce the risk from this disease group. Four of the most important respiratory infections - measles, diphtheria, pertussis, and tuberculosis - have been targeted by the Expanded Program on Immunization. Research on new vaccine treatments is ongoing. The development of vaccines against lower respiratory infections could provide a much-needed catalyst for the control effort. Drug therapy provides a potent defense against respiratory infections in developed set-
Incidence of Acute Respiratory Infection Among Children With and Without Ocular Symptoms of Vitamin A Deficiency*-Indonesia

Without ocular symptoms

With ocular symptoms

Demographic Data for Development Project

...ings, but its use poses special difficulties in many developing countries. Requirements for facilities, trained health personnel, diagnostic capabilities, and continuous drug supplies can be daunting. Most developing countries lack the resources to provide this type of curative service to more than a small segment of the population in need.

Additional measures that would aid efforts to control acute respiratory infections include promoting good nutrition, improving housing conditions, and expanding health facilities and health education. Teaching mothers and other caregivers to recognize the early stages of lower respiratory infection in areas where medical help is available could be lifesaving for many children.

Reductions in respiratory diseases accounted for a significant proportion of the mortality decline in developed countries over the last century. Much of this decline took place before the introduction of modern medical cures. Improvements in nutrition, sanitation, and housing conditions are generally given most of the credit. Similar socioeconomic improvements aided by current medical knowledge hold the promise of still more rapid declines for developing countries.
MALARIA

PROFILE
Malaria has been called "the king of diseases." The hundreds of pathogens that cause diarrhea and respiratory infections may claim more lives, but no single agent of disease can match the power of the malaria parasite to inflict suffering and death. More than half of the world's population continues to live at some risk of malaria. Only a small fraction of the estimated 200 to 400 million new cases occurring each year are ever reported.

Malaria plays a critical role in child survival: pregnant women, infants, and young children are at greatest risk of severe infection. This group is also at disproportionate risk of death. In areas where transmission is heavy, malaria may account for as many as 10 percent of all deaths before age 5. The disease also contributes to high rates of spontaneous abortion, low birth weight, and malnutrition in affected areas. Despite determined efforts to eradicate or control malaria, it remains a powerful enemy of health and survival in much of the developing world today.

Agent
The parasite responsible for malaria, a plasmodium, requires the interaction of human and mosquito to complete its life cycle, as shown in figure 5-A. Plasmodia, which reproduce inside the mosquito, are passed into the human blood stream when the mosquito bites. Once inside the human, the plasmodium passes through several stages, infecting first the liver and then the red blood cells, causing the classic pattern of chills, fever, and sweating, sometimes with delirium, that can result in death. Some forms of the malarial parasite lodge in the liver, where they retain the potential to cause recurrences of the disease throughout the lifetime of the victim. When an infected human is bitten by a mosquito, the seeds, or gametocytes, of the plasmodium in the blood pass to the insect, and the cycle begins anew.

Transmission Factors
Depending on its prevalence in an area, malarial disease is considered to be either epidemic or endemic. Epidemic malaria occurs sporadically in areas where the disease is unstable. Malaria is said to be endemic to an area if the parasite is always present in the population at some level. The extent to which conditions for transmission are met determines the extent to which malaria becomes stable, or endemic.

The level of malaria in a community is determined by a combination of environmental factors and the interactive behavior of human and mosquito. As a primary condition, the parasite requires the presence of both humans and malaria-carrying Anopheles mosquitoes in sufficient numbers to ensure continuous transmission. The mosquito population and consequent risk of disease fluctuate with seasonal patterns of temperature, humidity, and the availability of breeding sites. Warm, humid climates favor the reproduction of both the mosquito host and the parasite itself. Favorable climatic conditions also extend the mosquito's life span, thereby increasing the spread of the disease. Thus, although malaria has essentially been eradicated in Europe and the southern United States, it remains deeply entrenched in most tropical and subtropical climates where mosquitoes can live and breed year-round.

The insect's behavioral patterns play an important role in the transmission and control of malaria. There are many different species of Anopheles mosquito, each with varying patterns of breeding and feeding. Some breed in shaded areas, some in bright sunlit water; some rest on the inside
walls of houses before biting, others feed and rest outside the confines of human dwellings. Certain species feed preferentially on humans, others live off domesticated or wild animals. The risk of malaria can therefore vary greatly even within the same climate.

Malaria transmission is often increased inadvertently by human activity. Irrigation and farming practices can provide new breeding sites for mosquitoes. Human migration can introduce the parasite into previously unaffected populations or cause a resurgence of malaria in areas where control measures have lapsed. In South America's Amazon basin, for example, rapid population influx and abrupt alterations to the environment have created the conditions for endemic malaria in an area where the disease had been virtually unknown.

Host Factors

There is no complete natural immunity to malaria. Following repeated infections, it is possible for adults to develop limited resistance to the severest forms of malarial illness. Even then, malaria remains a serious disease. By some accounts, it causes more loss of healthy life in endemic areas than any other single disease.

The extent to which malaria is common or endemic to an area will determine its effect on child survival. In areas where transmission of the parasite is sporadic, malaria is rare and a sudden epidemic can affect all age groups equally. In endemic areas where transmission is continuous and malaria is entrenched, many adults develop a partial immunity to the parasite. Increasing levels of transmission
lower the average age at first infection, thereby shifting the heaviest burden of illness and death towards the youngest age group. At the highest levels, 100 percent of children suffer from malaria before age 5. Most of these children will experience their first infection in infancy.

Pregnant women are at heightened risk from malaria infection. For reasons that are not clearly understood, women lose whatever partial immunity they may have against the parasite during early pregnancy. Immunologically, they revert to the status of young children. This phenomenon is most pronounced during a first pregnancy and diminishes with each successive pregnancy. Upon the birth of the child or shortly thereafter, the women regain their ability to resist the disease. But severe malarial infections during the exposed period can cause stillbirth, fetal growth retardation, or premature delivery. Low birth weight among surviving infants greatly increases their risk of death from all causes through the first year of life (see section on Malnutrition).

The potential health gains from controlling this single disease are enormous. The direct impact of malaria on child survival is still a debated issue. Malaria accounts for 10 percent of all child deaths in highly endemic areas, but this figure does not include the silent contribution malaria makes to deaths from other causes. Figure 5-B illustrates the dramatic results of a controlled insecticide program in Kenya. Two comparable villages in a heavily infested area were selected for this study: In one village, the interior walls of die houses, where the indigenous species of mosquitoes rest before feeding, were sprayed regularly with insecticide. No spraying was done in the control villages. Over a 5-year period, general mortality in the treated village declined by half and infant mortality was reduced by 40 percent in comparison to the control village. Although the health benefits from programs of this sort have proved difficult to sustain without commensurate progress in health care services and general development, they are a clear indication of the potential of malaria control to enhance health status.

GLOBAL IMPACT ON CHILD SURVIVAL

More than half of the world’s population lives in areas where malaria is still endemic. About a fifth, largely in developed countries, live in areas where malaria has been eradicated. The credit for this achievement belongs to a combination of socioeconomic development and special programs that succeeded in arresting the transmission of malaria. Anti-malarial activities in most of the regions where malaria is endemic have significantly reduced once uncontrolled levels of transmission. Yet an important minority of the world’s population—largely located in SubSaharan Africa—continues to suffer the full effects of uncontrolled malaria. Control efforts in these areas have proved either too difficult or too costly to maintain. Active programs to fight malaria have yielded tangible gains, but they have failed to eradicate the disease from those areas where it is most deeply entrenched. Consequently, any slowdown in the battle against malaria could result in its rapid resurgence to uncontrolled levels.

Global trends in malaria, as shown in figure 5-C, reflect an unstable equilibrium. The total number of reported malaria cases declined between 1977 and 1983, with a slight upturn for the latest year reported (1984). Regional trends, however, present a pattern of mixed success. Much of the world decline comes from effective antimalarial campaigns in the Asia region. The most significant reductions occurred in India and China, which together account for 56 percent of the world population at risk.

By contrast, the malaria situation in the Americas region as a whole has steadily deteriorated during the last decade. The major negative factors underlying the rise in reported malaria cases include the introduction of malaria to newly populated areas, the increasing resistance of malaria to insecticide and drug treatment programs, and financial pressures that threaten funding for costly anti-malarial activities.

The experience of the Near East testifies to the dangers of complacency in the struggle against this disease. During the early 1970s control efforts appeared to be successfully
reining in malaria in this region. A sudden resurgence in the last half of the decade, however, dampened prospects for early eradication. Turkey provides a case in point. Anti malarial programs there had contained malaria at low levels, but the conditions for epidemic malaria persisted. When the malaria parasite was reintroduced into heavily populated areas where control measures had lapsed, the result was an explosive epidemic. The number of reported cases nearly quadrupled each year for 3 years, rising from fewer than 3,000 in 1974 to some 115,000 by 1977.

Sub Saharan Africa continues to be the primary focus of malaria in the world today. Of the 421 million inhabitants of this region, 372 million live in areas where malaria is endemic, more than half of them in hyperendemic areas where transmission is constant and intense. The quality of the malaria reporting is generally so poor that no real trends for the African region can be discerned from the information available, but there appears to have been little im-

A new and ominous development has also begun to hamper control efforts: current achievements are being challenged by the appearance of new drug-resistant strains of malaria and insecticide-resistant mosquitoes. Reports of malarial infections that do not respond to the standard chloroquine treatment are becoming increasingly widespread. Resistance to the second line of drug defense, fansidar, has been reported in South East Asia and South America. Similarly, the effectiveness of insecticides that once served as powerful weapons against malaria is being threatened by the emergence of malaria-carrying mosquitoes that have become resistant to one or more of the insecticides currently in use. Often-indiscriminate agricultural spraying practices have been implicated in this new threat to existing control activities. These drug and insecticide resistance problems make the development of new control techniques an urgent issue.
THE ROAD TO HEALTH

The key to controlling malaria lies in interrupting the interaction between human and mosquito. The two principal strategies of malaria control are 1) to target the mosquito vector of malaria and 2) to arrest the parasite cycle within humans.

Vector-control programs represent only the latest battle in the historic war against malaria. Development of powerful insecticides such as DDT was once expected to pave the way for eradication of the disease. Insecticides do in fact deserve much of the credit for reducing the worldwide toll of death and suffering attributable to malaria, but it is now clear that excessive reliance on this method of control gives limited results at best and at the same time fosters insecticide resistance.

Experience has demonstrated the greater effectiveness of balanced campaigns that combine chemical control with environmental measures to limit breeding sites and reduce human exposure. The possibilities here are vast. Environmental control strategies can be tailored to local communities and local mosquito species. And simple education for malaria prevention can tap into a powerful yet often overlooked resource: peoples’ ability to take care of themselves.

The other principal strategy against malaria consists of fighting parasitic infection. Antimalarial drugs, especially the compound chloroquine, have been the mainstay of treatment and prevention programs. The pro-vision of anti-malarials for curative purposes represents the simplest level of malaria control. This strategy, which is common in Sub-Saharan Africa, has little effect on the transmission of malaria, but does reduce mortality from severe infections. Regular periodic doses can also be used to prevent malarial infection. As with insecticides, however, the broad use of these drugs to prevent malaria represents a double-edged sword in terms of promoting the evolution of resistant strains of the parasite. Recent research has yielded a new crop of antimalarial drugs. One of these, mefloquin, has proven effective against the most dangerous form of the disease and is in the final stages of testing. The Chinese have been studying a drug called qinghaosu, which is derived from an ancient herbal remedy for malaria. Researchers hope that rational use of these new treatments can either prevent drug resistance or delay its advent.

A new, weapon against malaria may soon be added to the existing arsenal: a vaccine against the first stage of malaria infection may be available within the next decade. Primates immunized with a test vaccine have successfully resisted a direct "challenge" by the malarial parasite. Field trials are presently under way and research on vaccines for the additional stages of malaria is in progress. Questions as yet unanswered about a malaria vaccine include its cost, the duration of its protection, and whether it can be given to young children. Authorities caution against the expectation that a malaria vaccine will be the "magic bullet" that can replace other control efforts. Nonetheless, a vaccine promises to be an important addition to ongoing programs against malaria.
Malnutrition is in many respects the common denominator of the disease and deprivation processes that reduce child survival. Undernutrition affects nearly 40 percent of all children in developing countries and contributes directly or indirectly to an estimated 60 percent of all child deaths. Lack of food is only part of the problem. Disease itself is a principal agent of child malnutrition. A heavy burden of infection places a formidable strain on what may already be a precarious nutritional balance. As a result, the child is left with a nutritional debt that causes dangerous lags in growth and further vulnerability to the cycle of disease and malnutrition. Another major factor in malnutrition is human behavior. Feeding practices, for example, especially during illness, can make the difference between normal growth and malnutrition, or even between life and death.

Protein-Calorie Malnutrition

Malnutrition can result from a dietary deficiency in any or all of the three major nutrient groups: proteins, calories, and micronutrients such as vitamins and minerals. Protein-calorie malnutrition is by far the most common type of malnourishment. It occurs when a child's total protein and energy intake becomes inadequate for normal growth. A child is considered to have protein-calorie malnutrition if his weight falls below the critical level of 80 percent of the standard median weight for his age group. Below this level, the child's risk of death increases exponentially. The graph in figure 6-A shows the experience of children under age 3 in Punjab, North India. Their probability of death was found to nearly double with each 10 percent drop in weight-for-age below the 80 percent level.

The most severe levels of protein-calorie malnutrition are kwashiorkor and marasmus. Although they represent only a small part of the malnutrition picture, these extremes have become familiar to television audiences as a result of coverage of recent disasters in Africa. The flaky skin, thinning hair and swollen bellies of child victims are symptomatic of kwashiorkor. It results from a reduction in protein metabolism relative to calories that can be precipitated by a chronic dietary imbalance or a severe infection such as measles. Marasmus is characterized by a state of emaciation seen most frequently among famine victims. It occurs when protein and calories are equally and drastically deficient from the diet. Children cannot survive long in either of these states. Without improvement, death comes quickly.

Vitamin A Deficiency

Although micronutrients are only required in minute quantities, their absence from a diet can carry severe consequences. Of the many vitamins and minerals essential to a balanced diet, vitamin A, iron, and iodine play especially prominent roles in child survival. Vitamin A deficiency has long been recognized as the leading cause of childhood blindness in the world. Now, however, there is evidence that the impact of vitamin A deficiency on a child begins well before it induces blindness. Indonesian children manifesting mild symptoms of vitamin A deficiency were found to be 3 times greater risk of illness and 4 to 12 times greater risk of death than children with no outward symptoms. The presence of these mild symptoms was more closely associated with subsequent illness and death than even the presence of protein-calorie malnutrition.

Iron and Iodine Deficiencies

Iron deficiency is the leading cause of anemia, an exhausting disease that affects more than half of all children and pregnant women in the developing world.

Iodine deficiency causes goiter in adolescents and adults but is rarely seen in children. It becomes an especially
serious issue for child survival when it affects pregnant women. Children born to iodine-deficient mothers are at risk of being mentally retarded to some degree. The most serious outcome is cretinism, where the child is born deaf mute, mentally retarded, and shows abnormal motor development.

**IMPACT ON CHILD SURVIVAL**

**Low Birth Weight**

The road to health for a child begins before birth. In developing and developed countries alike, the birth weight of an infant is the most important single determinant of its chances for survival. Low birth weight infants—those who weigh less than 2,500 grams (5.5 pounds) at birth experience higher mortality from all causes through the first year of life and beyond. Figure 6-B depicts the pattern of decreasing risk with increasing birth weight. The data are drawn from births in the state of Massachusetts. While death rates for infants born in developing countries are certainly higher at all points, the dramatic rise in mortality below 2,500 grams occurs in all regions.

Of the many factors that influence the incidence of low birth weight, the most common relate to the nutritional state of the mother both before and during pregnancy. A woman's caloric needs increase during pregnancy and rise to still higher levels when she breastfeeds. For many women in areas where fertility is high, there is barely time to recover the nutritional debt from one pregnancy and breastfeeding experience before the next one begins. The problem is intensified by heavy physical workloads during pregnancy, maternal malnutrition, numerous pregnancies, and short birth intervals, all of which are important risk factors for low birth weight. Whatever the root cause, a low birth-weight infant faces an uphill battle. He is already malnourished when his life begins.

**Feeding Patterns**

The impact of nutrition on the survival of a child is generally considered in two time frames, the period of exclusive breastfeeding which optimally extends 4 to 6 months from birth, and the subsequent weaning period, when the diet of breastmilk begins to be supplemented with other foods, which extends to the end of the third year. Good nutrition during the child's first 6 months is especially critical. An infant's weight should more than double during this period; when the rate of growth is faster than at any other period in life. A child's health is particularly sensitive to interruptions in growth at this time, whether they result from inadequate nutrition or from a heavy burden of infection. Nature provides both a balanced diet and important protection from disease in the form of breastmilk, as noted in The Road to Health section, which follows. The importance of breastfeeding cannot be overemphasized. In areas where there are no viable feeding alternatives, infants who are weaned early or never breastfed at all are at significantly higher risk of illness, malnutrition, and death.

**Weaning**

Beyond the age of 6 months, breastfeeding alone will not meet the nutritional needs of a growing infant. The weaning period is a critical passage during which the child establishes greater independence from his mother. The price of that independence is greater exposure to the outside environment and its attendant agents of disease and malnutrition. His new supplemental diet introduces the child to common contaminants in food and water, and greater mobility brings him into contact with a range of new diseases carried by other children and adults. At the same time, the passive immunity inherited from his mother, which protected the child from many of these diseases in the first months of life, has begun to decline. As a result, the weaning period is marked by frequent illness. Respiratory and diarrheal diseases increase sharply. In developing countries, the major contagious diseases of childhood (e.g., measles, pertussis) also tend to converge at this time.
Nutritionally, the child switches from a diet that is biologically determined to one that is socially determined, often to his detriment. Traditional weaning diets frequently lack sufficient quantities of essential nutrients, particularly protein, vitamin A, and iron. Sometimes the problem is an absolute lack of food. More often, however, available foods that contain these elements are not considered "appropriate" for young children. Foods for young children need to have more calories per given amount, because while children's caloric needs are high, their stomachs are small. They cannot consume as much as adults, and therefore have difficulty in meeting energy needs from normal adult foods. For their part, children often have their own ideas about what is appropriate to eat. Foods high in protein and vitamin A are often excluded from weaning diets. As a result, children are at higher risk of malnutrition during the weaning period than at any other time. The regional patterns of acute protein-calorie malnutrition depicted in figure 6-C show a dramatic peak around age 1, which corresponds to the midpoint of the weaning period. Acute protein-calorie malnutrition, or wasting, is measured by the ratio of a child's weight to his or her height. Below 80 percent of the median weight for healthy children of the same height, a child is said to be acutely malnourished. This measure is considered to be a sensitive indicator of a child's immediate nutritional status and health risk. The problems of vitamin A deficiency and nutritional anemia also reach their highest levels in early childhood. The impact of poor weaning practices and heavy burdens of infection is seen in the high yearly toll of deaths in this age group.

The Disease-Malnutrition Link

The strong interaction between disease and malnutrition stems from both biological and social causes. Biologically, many diseases raise a child's metabolic rate and hence his food requirements. Certain parasitic organisms actually compete with the child for ingested food, and diarrheal diseases work to inhibit food absorption. Very often diseases occur together, posing a serious challenge to the needs of a child who may already be limited to a subsistence diet. On the individual level, the child's loss of ap-
petite is apt to further limit food intake. On a social level, when a child becomes sick, the parental response may be to stop regular feeding, which results in further deterioration of the child's nutritional status.

As disease can precipitate malnutrition, so malnutrition can complicate disease. Deprived of essential nutrients, the body loses its normal ability to resist disease. Both the severity and duration of disease have been shown to increase in moderately and severely malnourished children. Consequently, mortality from common communicable diseases is far higher among children in poor developing populations than among children who receive adequate diets.

The synergism of disease and malnutrition—the tendency of these conditions to complement and intensify each other when combined—is an important factor in child survival. At a critical level of growth retardation and disease burden, this synergism establishes a vicious cycle that culminates in death. It has been estimated that malnutrition is a contributing factor in 60 percent of all infant and child deaths in the developing world.

THE GLOBAL MAGNITUDE OF MALNUTRITION

The world has made significant progress in the battle against hunger over the last two decades. Many countries that were once periodic victims of famine have now become net food exporters. India is an example of such a country (see the section on Food Availability). This progress is reflected in a general decline in infant and child mortality during this period, but much remains to be done. In the developing world today, it is estimated that nearly 40 percent of all children under 5 suffer from acute or chronic protein-calorie malnutrition. In absolute numbers, this translates into 141 million children in 1980. Figure 6-D shows the estimated regional prevalence of this condition among children. More than one-third of African children fall below 80 percent of their expected weight-for-age, as do almost half of children in the Asian region. The estimated prevalence is lower in Latin America and the Near East at 21 and 24 percent respectively. Because of Asia's large population size and high proportions of
underweight children, some 70 percent of the world's malnourished children are found in this region.

The high global prevalence of malnutrition is especially astonishing in view of the fact that the estimates were made from data based around 1980, when the world was relatively free of famine. These children are the victims of the persistent diseases and sometimes subtle nutritional deprivation that act under "normal" conditions of poverty. Such severe and deadly forms of protein-calorie malnutrition as Liarasamus and kwashiorkor are in fact relatively rare if highly visible extremes of a much more pervasive problem.

As a closely related precursor of protein-calorie malnutrition, low birth weight follows the same geographic pattern. In figure 6-E, the regional percentage of all births under 2,500 grams (5.5 pounds) is shown for 1982. The problem is severest in Asia where an estimated 27 percent of infants born in 1982 were below this weight. In India, which accounts for more than half of births in this region, excluding China, 30 percent of newborns were critically underweight, as were fully half of infants in Bangladesh. African countries report between 10 and 20 percent underweight births, with an average of 15 percent. By contrast, fewer than 7 percent of all infants born in the United States weighed less than 2,500 grams. This tiny proportion of newborns nonetheless accounted for two-thirds of U.S. deaths in the first month of life and 20 percent of infant deaths from 28 days to the end of the first year.

Each year more than a half-million children become blind for lack of vitamin A; two-thirds die within weeks of losing their sight. Another 6 to 7 million children are believed to suffer from milder forms of vitamin A deficiency, which has been identified as a significant public health problem in 21 developing countries.

Iron deficiency anemia most often affects women of childbearing age and young children. Pregnant women are the most susceptible. Although this is true for both developed and developing countries, anemia in the developing world is 4 to 5 times more frequent. Frequent infections and deficient diets consign more than half of developing country children to the draining effects of anemia. More than 60 percent of pregnant women are affected in Asia and Africa. This reflects the greater iron requirements of women in general and especially of pregnant women, whose needs are likely to be increased in developing countries by iron-poor diets and parasitic infections.

THE ROAD TO HEALTH
The ultimate resolution of the problem of global malnutrition lies in a people's ability to feed themselves. Short-term relief efforts play a lifesaving role during extreme cycles of famine, but food scarcity issues can only be permanently resolved through long-term economic development.

In this context, however, it is important to recognize that simple measures to improve health and feeding practices can be expected to have a significant impact on malnutrition and child survival while long-term development is proceeding-

**Improved Health and Nutrition During Pregnancy**
Prevention of low birth weight is the first step on the road to health. A number of possible courses of action can reduce the risk of low birth weight. Both reducing heavy workloads during pregnancy and providing dietary supplements to women at high risk act to diminish the nutritional strains of pregnancy. The strong association between highrisk fertility and low birth weight underscores the importance of family planning in preventing low birth weight and improving maternal and child health.

**Breastfeeding**
The nutritional value, anti-infective properties, and birthspacing effects of breastfeeding make it one of the most powerful forces for enhancing child survival. Nutitionally, breastmilk provides the optimal balance and quantity of essential nutrients to infants up to 6 months of age. Even...
after supplementation with other food has begun, breastmilk can continue to be an important source of calories, protein, and micronutrients through the second year of life. Alternative feeding methods can by contrast only approximate the nutritional completeness of mothers' milk, and cannot impart the additional benefits that breastfeeding brings to both mother and child.

Breastfeeding and Disease: Breastmilk has an ideal nutritional balance and also contains anti-infective properties that help protect the child from early exposure to a disease-ridden environment. Breastmilk is sterile and passes directly from mother to child, virtually eliminating the possibility of contamination. This point is far from trivial in areas where food- and water-borne diseases are a major cause of sickness and death. Moreover, breastmilk contains maternal antibodies, enzymes, and other chemical properties that actively resist infection. Numerous studies have found that breastfed infants experience lower levels of mortality and fewer episodes of gastrointestinal and respiratory illness than infants in the same environment who are only partially breastfed or not breastfed at all. Figure 6-F shows that in rural Chile, exclusively breastfed infants experienced half the mortality of bottle-fed infants, while mortality of infants who were both breastfed and bottle-fed ranged in between. Regardless of the time period examined during the first year, mortality rates for infants who were exclusively bottle-fed were twice those of exclusively breastfed infants. The anti-infective properties of breastmilk clearly play a crucial role in enhancing child survival in a hostile disease environment.

Birth Spacing: An additional benefit of breastfeeding in the context of child survival is the important contraceptive effect it has on the mother, improving the chances of survival for both the newborn and the child that follows. Breastfeeding prolongs the anovulatory period that follows childbirth during which a woman is naturally protected against a succeeding pregnancy. The extent of contraceptive effect depends on the frequency, duration, and intensity of breastfeeding. Women who breastfeed regularly from the time of giving birth can extend this protective interval over 1 to 2 years. In many parts of the developing world, breastfeeding has a greater impact than any other contraceptive method in promoting healthful birth-spacing. The importance of birth-spacing to child survival is examined in detail in the section on high-risk fertility.

Breastfeeding Promotion

In many areas of the developing world, prolonged breastfeeding continues to be the rule. Its prevalence is generally highest in poorer, rural areas. Within the last 10 years, there has been a dramatic resurgence in rates of breastfeeding in the developed world as awareness of its natural benefits has grown. Among women in developing countries, however, the trend has been away from breastmilk, particularly in urban areas. Given the high fertility and poor health conditions that still characterize these areas, a decline in breastfeeding poses a serious threat to improvements in child survival. It is estimated, for example, that if breastfeeding patterns in Bangladesh were to fall to U.S. levels, infant mortality there would double.

The promotion of breastfeeding to counter this trend has become an important aspect of child survival programs. These generally take three forms: information and support programs in the community, training programs for health professionals, and efforts to change hospital practices to encourage new mothers to begin breastfeeding. Information programs have enlisted the support of the media and the medical profession to get the message of breastfeeding’s unique benefits across. In modern hospital settings, the decision to breastfeed is often influenced by hospital practices and the advice of health professionals in the first few days following birth. Women who are allowed to room-in with their newborns appear to be more likely to start.
breastfeeding, which both fosters intimacy between mother and child and increases the likelihood that the mother will continue to breastfeed. Figure 6-G shows the results of an intensive breastfeeding promotion program in Costa Rica. Rural hospitals that instituted a rooming-in policy witnessed a significant rise in the number of mothers breastfeeding at birth and during the child's first year. When rooming-in and other activities were undertaken to encourage breastfeeding, another hospital program recorded a 75 percent drop in neonatal mortality rates over 5 years, mostly from a decrease in diarrhea deaths.

**Improved Weaning Practices**

The promotion of careful weaning practices is another important health intervention. The extent of risk incurred in the weaning transition depends on when it begins and how abruptly it ends. Gradual weaning is safest for the child. As he grows accustomed to a supplemental diet, he still enjoys a level of disease protection from breastmilk and receives the benefits of an important source of proteins, calories, and vitamins. In fact, breastmilk may provide the major source of such essential nutrients as iron and vitamin A when they are lacking from weaning foods. In a hostile disease environment, early and abrupt weaning has serious health implications for the child. Sudden cessation of breastfeeding can occur if the child becomes sick or the mother becomes pregnant again. Deprived of a gradual transition, the child must adjust to a new diet, increased exposure to disease, and loss of immune protection all at once. The younger the child, the more dangerous such abrupt weaning becomes.

Healthy weaning means insuring that the child's new diet contains the nutrients necessary to sustain normal growth and development. Efforts to ensure healthy weaning vary from providing direct food supplements to pre-school children to simple education and the promotion of low cost, locally available weaning foods. A single vitamin A capsule costs as little as 2 cents and can protect a child against blindness and probably other illness for a full 6 months. In the case of micronutrients like iron and iodine, programs at the national level to fortify common foods sold in markets provide more comprehensive protection.
Feeding During Illness
Repeated illness need not result in serious growth lags and malnutrition. The importance of continued feeding through disease episodes must be stressed, especially when the conventional wisdom calls for withholding food. Even when feeding is continuous, a child can lose weight from serious or prolonged infection. Extra feeding is essential to fuel a child's "catch-up growth" during the recovery period.

Growth Monitoring
Growth monitoring is one of the cornerstones of global strategies to improve child survival. When periodic measurements of weight are recorded on a growth chart over time, the chart provides a progress report of a child's growth and development from birth. The "road to health" charted by the upper and lower lines in figure 6-H describes the normal range of weights for healthy children from birth to age 5. A child who enjoys steady weight gain and can stay between these lines has greatly improved his chances for survival over those of a child who slips below the lower limit into malnutrition. The chart is a sensitive indicator of pauses or lags in growth over time. Regular measurements can alert parents to the dangers of undernutrition and the need for additional feeding.
HIGH-RISK FERTILITY BEHAVIOR

PROFILE
Three aspects of childbearing have an important effect on child survival beyond the risks posed by malnutrition, infection, and lack of health care. They are the mother's age at birth, the number of children she has previously borne, and the length of time between births. Of these factors, the birth interval appears to have the greatest impact on child survival. A child who is born soon after another child, or whose birth is rapidly followed by another birth, has a much greater chance of dying. Many children are placed in double jeopardy by being born between two short intervals. Short intervals are 2 years or less, a time period that gives a mother at most little more than a year to breastfeed, to recover from the physical and nutritional strains of pregnancy and breastfeeding, and to prepare for the next child. The shorter the interval the greater the risk to the child. By the same token, when 1, 2, or 3 years are added to the interval, the child's survival chances tend to rise accordingly.
IMPACT ON CHILD SURVIVAL

Time Between Two Births

Short birth intervals are a universal health risk. Children born in quick succession are at greater risk of dying in every region of the world, in both urban and rural areas, and in countries at all levels of mortality. Moreover, close birth spacing increases mortality in families at all socioeconomic levels, even those in which the parents are wealthy and well-educated. The adverse effects of close spacing afflict children born to women of all ages, and children of all birth orders. Children of every circumstance are disadvantaged by being born less than two years apart. Sustaining a longer interval between births provides a simple preventive measure against a major hazard.

Short intervals between births affect many children. By not spacing births, a woman reduces the survival chances of both her young infant and her next child. It is common in many developing countries for women to bear children in rapid succession, and where fertility is high, most children will have both an older and a younger sibling. Figure 7-A shows regional proportions of children who are born soon after another child, and whose arrival is quickly followed by the birth of yet another child. In some countries nearly half of children are born less than 2 years after an older sibling, and one-fourth do not reach their first birthday before their mother becomes pregnant again. Many of these children find themselves in double jeopardy when they arrive between two close births. In looking at the dangers of close spacing, and the numbers of children subject to such risk, it is possible to estimate the number of deaths attributable to this cause. During 1986 approximately 2 million children under 5 will die because of hazards associated with rapid childbearing. It is estimated that, on average, 1 in 5 infant deaths could be averted by longer intervals between births.

Maternal depletion: The detrimental effect of inadequate intervals between births has a number of causes. Because women who bear children rapidly do not have adequate time to recover from the demands of a prior pregnancy and breastfeeding, they become nutritionally and physically exhausted. Maternal depletion syndrome, as this exhaustion is called, may cause the birth of premature, underweight infants and result in inadequate breastmilk, both of which are major health risks.

Premature and abrupt cessation of breastfeeding: The onset of another pregnancy soon after the birth of a child is likely to cause him to be weaned long before he should. Studies have shown that abrupt and premature cessation
of breastfeeding is a major risk to the health of young children, particularly when it coincides with a pregnancy.

**Competition:** Children close in age are placed in competition with each other for the same maternal and familial resources. Individual parental time and attention are necessarily lessened, and family resources, including food, must be stretched further. Competition for family resources appears to be more critical among 2-, 3-, and 4-year-olds than among children under two. This is seen in the fact that only beyond age 1 is excess mortality lessened when a close sibling dies.

Maternal mortality: Women who bear children in close succession are deprived of time needed to recover from the demands of pregnancy, labor, and breastfeeding. Exhaustion and higher rates of complications increase their risk of death and jeopardize the survival chances of their children.

**Related risks:** A number of factors intervene to prevent clear understanding of why a short interval between births is such an impediment to survival. For example, some households may have conditions that affect all children—a common cause that reduces their survival chances. The death of a child may spur an early new pregnancy to replace the lost child. The newly born child, arriving after a short interval, is then likely to be exposed to the same factors that killed the first child. Women who breastfeed all of their children briefly (for such reasons as disinterest or the need to work) place each child at a disadvantage, and resume ovulation sooner than those who continue to breastfeed. Brief breastfeeding duration both decreases survival chances and shortens the interval to the next conception. Although death rates are higher for children of teenage mothers, who are highly likely to have closely spaced births, high child mortality is correlated with short birth intervals in all age groups.

**Magnitude of the risk** In studies of data collected by the World Fertility Surveys (WFS), the mortality of children born at least 2 years apart is compared with that of children born in more rapid succession. In every country mortality rates are higher for children with a close prior birth; in half of the countries infant mortality rates are more than double for these children, irrespective of whether a subsequent birth follows. If births are spaced as closely as 3 births within 2 years, first-month mortality triples in more than half of the countries. The effect of a close prior birth continues beyond age 1, though with lessened severity.

When a child's birth is quickly followed by another birth, the risk of death during age 1 is often doubled, and the risk of death during ages 2, 3 and 4 often increases by 50 percent. Figure 7-B shows mortality from birth to age 5 for well-spaced children and increased mortality associated with short prior intervals, and associated with both short prior and subsequent intervals. On average, the mortality of children born soon after another child is 80 percent higher, and the mortality of children born between two short intervals more than doubles.

**Age of Mother at Birth**

Children born to mothers in either very young or very old reproductive age groups are less likely to survive. Teenage mothers are often biologically, emotionally, socially, and economically ill-prepared for childbearing. Mothers in their late 30s and 40s, especially those who began childbearing at an early age, may be less able to withstand the stresses of pregnancy, delivery, and breastfeeding. The effect of mother's age is most important during the first year of life. Beyond infancy the effect diminishes; during ages 1 to 5, levels of excess mortality decline. Figure 7-C illustrates
the generally observed relationship between mother's age and the survival of her children. Figure 7-D shows the proportion of women who bear a child as a teenager in selected countries. Although older age has been assumed to be a major determinant of child survival, some WFS data suggest that the combination of many births and too-short intervals may be the more important factor.

**Number of Children a Woman has Borne Previously**
Firstborn children and those who follow many brothers and sisters exhibit high mortality, as illustrated in figure 7-E. Compared with children born second or third, excess mortality of firstborns is acute soon afterbirth, but after age 1, firstborns are no longer at a disadvantage. Mortality of children of high birth orders is high at all ages. These children may suffer from competition from siblings. are more likely to be cared for by someone other than their mother (usually an older sister), and their births are more likely to have been considered unwanted. Though the association between high fertility and low socioeconomic status amplifies the disadvantage, being born at a high order is a mortality disadvantage at all levels of parental wealth and education.

**THE ROAD TO HEALTH**
Children who are closely spaced, have numerous siblings, or are born to mothers in the youngest and oldest childbearing ages are at a significantly increased risk of dying. Differences in risk, particularly when births are closely spaced, can be enormous. The global death toll from high risk fertility among children under age 5 probably exceed 2 million during 1986 alone.

Fertility behavior is deeply rooted in the cultural, economic, and political fabric of a nation. Changes in the number of children parents desire, and in the belief that births cannot or should not be planned, imply major changes in family relations, the status of women, expectation of life for children, and the outlook that certain aspects of life are predetermined. Contraceptive technology exists that can enable couples to effectively plan births. It is not technology that is lacking, but global access to this technology, as well as national, familial, and individual motivation to use it. Although information and education programs can encourage family planning, without effective distribution and a reliable source of supplies, efforts and enthusiasm can be undermined.

Surveys of fertility and contraceptive use in developing
## Table 7-A

### Percent of Married Women Age 15-44 Who Do Not Want to Become Pregnant and Who Know About and Use Contraception

<table>
<thead>
<tr>
<th>Region, country, and year of survey</th>
<th>Percent who do not want a birth during the next year</th>
<th>Percent who do not want any more births</th>
<th>Percent who use Traditional method</th>
<th>Percent who use Modern method</th>
<th>Percent who know Only traditional method</th>
<th>Percent who know At least one modern method</th>
<th>Percent knowing a source for any modern method</th>
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Percents not wanting a birth are adjusted to exclude the percent undecided or not stated. Traditional methods include douche, withdrawal, rhythm, abstinence, "other." Modern methods include voluntary sterilization, oral contraceptives, intrauterine devices (IUDs), condoms, injectables, and vaginal methods (spermicides, diaphragms and caps). Women knowing at least one modern method includes women who also know traditional methods.

### Notes
- only fecund married women are included + for married women aged 15-49, "use" statistics are for ever-married women, "source" statistic is for all women = percents not wanting a birth are for 1978

countries indicate that most women who want another child do not want the birth within the next year. Most women know that well-spaced children are healthier. In a WHO study of 42,000 women in Latin America, North Africa, and Asia, more than 90 percent of respondents said that short birth intervals harm child health: in Zimbabwe children born too close together are said to "burn" each other. Table 7-A shows the proportions of women who do not want a birth during the next year, who want no more births at all, and who know about and use contraception. These patterns suggest that when contraception is emphasized as a spacing tool, it may be more widely adopted.

One indicator of the unmet need for contraception is the proportion of married women of reproductive age who acknowledge not wanting a child in the immediate future yet use no form of contraception. In most countries surveyed, more than 75 percent of women did not want a birth during the next year. Nonetheless, from a fourth to in some areas nearly all of these women were using no contraceptive method whatever, abstinence-based methods included. By this indicator, the unmet need for contraception is greatest in Africa, where in most countries surveyed it exceeds 80 percent. The level of unmet need also exceeds 80 percent in Bangladesh, Nepal, and Haiti, and ranges from 24 to 71 percent in the rest of Asia and Latin America.

If a family's goal is to have as many surviving children as possible, high levels of fertility will be preferred, even though their children's survival chances are jeopardized. A terrible price is paid for this means of achieving desired family size. Yet it must be recognized that changes in goals and philosophy are required if deaths from high-risk fertility are to be significantly reduced. Healthful spacing of births and bearing children at healthful ages have such tremendous positive effects on child survival that marshalling the political and social will necessary to initiate these changes deserves the consideration of all.