Child and Maternal Health Services in Rural India
The Narangwal Experiment
Volume I
Integrated Nutrition and Health Care
Arnfried A. Kielmann and Associates
Child and Maternal Health Services in Rural India

The Narangwal Experiment

Carl E. Taylor and Rashid Faruqee
Research Coordinators

A WORLD BANK RESEARCH PUBLICATION
The two volumes of this study are books I have long been wait-
ing for: waiting to find corroboration or refutation of what
initially may have been no more than hunches or surmises, born
of valid observation but not subjected to any rigorous statis-
tical analysis. My generation was brought up in an age when
quantitative analysis had not yet developed into the modern
technology of intervention that it is today. It is true, of
course, that this technology may often lead one astray by
forcing upon one what will be no more than spurious refine-
ments that the multitude of individual responses, which depend
so much on exogenous factors, will bear. Nevertheless, one
feels fortified when one’s subjective hunches are supported by
objective statistical analysis. When they are not, one is
still loth to shed one’s hunches but gives more serious thought
to doubts. And doubts are far more important than certitudes.

In the late 1950s through the early 1970s, the certitudes
of many national policies to improve the well-being of people
in the developing countries were almost exclusively the estab-
lishment of family planning services, the development of con-
traceptives, and the extension of family planning communica-
tion. Reduction of fertility, it was argued, was a straight-
forward function of these services: they alone would deliver
the goods. International advice and aid bore down on national
doubts, and anyone who pleaded that mortality (especially in-
fant and child mortality), or the state of nutrition, or the
low levels of literacy and women's participation in economically productive activity was a far more obdurate enemy than high fertility was shunned like a pariah.

Policy prescriptions and action programs that relied almost exclusively on these assumptions—in whose aid, again, many statistical correlations were invoked—did not, however, work the way they were expected to. Already in the 1950s the United Nations had convened a distinguished interdisciplinary group of scholars who foretold why they would not [(United Nations, The Determinants and Consequences of Population Trends, Report no. ST/SOA/Ser. A/17 (New York, 1953, revised 1973)]. C. Chandrasekharan also had produced the Mysore study, which identified many determinants and imponderables and the cunning ways in which they interact to affect fertility behavior [C. Chandrasekharan, "The Mysore Population Study: A Cooperative Project of the United Nations and the Government of India," Population Studies, no. 34 (1961); also United Nations report no. ST/SOA/Ser. A/34 (1961)].

Some of these determinants had been spelled out by critics of Malthus as early as the second quarter of the nineteenth century when, as a result of social, cultural, and economic factors, natural fertility in Europe had already declined to levels lower than in developing countries a century later. Socialist thought in the last quarter of that century hinted that education, health (particularly reduction of infant, child, and maternal mortality), women's liberation and work outside the home, equity, and income were the chief determinants of a woman's right and decision to have the number of children she desired. The development of contraceptives and family planning communication came more or less after the other determinants had begun to work in Europe. But these interrelations and historical paths were ignored for the developing countries in the haste to achieve quick results that kept eluding their sponsors despite the pressures already mentioned.
Against this faith in the primacy of contraceptive supply and services together with family planning communication that prevailed throughout the 1960s and well into the 1970s, small groups of men and women persisted in investigating more comprehensive approaches to the complex problem of child and maternal health in the developing world. For India, the Khanna study [J. B. Wyon and J. E. Gordon, The Khanna Study—Population Problems in the Rural Punjab (Cambridge, Mass.: Harvard University Press, 1971)] yielded important and complex relationships, as did Project Poshak [T. Gopaldas, Project Poshak, 2 vols. (New Delhi: CARE-India, 1975)] and several of the evaluation exercises conducted by the Planning Commission of India, which ultimately led to substantial attitudinal and policy changes from the period of the Fifth Five Year Plan onward. A series of interim research conclusions emerging from the Narangwal Project, which had its origin as early as 1955 in the Narangwal Rural Health Teaching Centre (it became the Narangwal Rural Health Research Centre in 1961), have whetted the appetite for the full account these volumes provide.

The chief value of these books to me lies in their statistical rigor, complexity, and rectitude bordering on welcome understatement and a disinclination to attempt blanket answers. The conclusions they contain cannot, of course, be the last word on policy issues or on the understanding of subtle interrelationships. Rather, the principal virtue of the books rests in the way the authors have questioned assumptions that need investigation because they are so firmly embedded in faith and honest endeavor.

There were difficulties in the way of continuing the Narangwal Experiment, but these were quite unconnected with the objectives, content, and worth of the Experiment. The way in which the Experiment was conducted and analyzed must not suffer obloquy, and surely not for the wrong reasons. I did
in which the Experiment was conducted and analyzed must not suffer obloquy, and surely not for the wrong reasons. I did not have then, nor do I have now, any misgivings about the solid worth of the Experiment and the messages it had begun to convey as long ago as 1968-69, to which the books bear ample testimony. And for this I must compliment the authors for their devotion, persistence, and rectitude. These volumes are indispensable to those who, like them, hustle while they wait, work with faith yet are visited by doubt, and look for rigor and comprehensiveness in research design and methodology.

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New Delhi
December 1983
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Preface

The origins of the Narangwal Nutrition Project derived from several sources. The Narangwal Rural Health Research Centre was established in 1961 at the request of the Minister of Health, Government of India. Through the years the work depended heavily on the direct involvement of a series of health ministers, health secretaries, directors general of the Indian Council of Medical Research (ICMR), and other officials to whom we express our gratitude. All policy decisions and issues of governmental liaison were channeled through ICMR. In the Narangwal annual conferences about sixty of the leading administrative and academic decision-makers met and lived in tents in the village for three to four days. Research data were presented as raw tables for interpretation, guidance was received for future research directions, and there was gratifyingly rapid feedback on implementation of findings in governmental programs. The decision to undertake this action research project grew out of these conferences. The first several projects at Narangwal had demonstrated some of the problems in the rural orientation of physicians, the functional organization of primary health centers, and the gaps in rural health care. It became evident that it was time to do practical field research to find solutions to the problems that had been identified.

Two primary problems of rural health in India were selected for intensive, prospective, longitudinal field experimentation. Parallel projects were organized on ‘The Integration of Family
Planning and Health Services" and "The Interactions between Infections and Malnutrition in Weaning-age Children." Different packages of services were provided, according to a systematic research design, in clusters of villages in three community development blocks in Ludhiana District, Punjab.

The first grant for the nutrition project was arranged by Dr. Patwardhan, who was then Director of Nutrition for the World Health Organization (WHO) in Geneva. Because of our involvement in preparing the basic WHO monograph on malnutrition and infections (WHO Monograph no. 57, 1968; see chapter 1, note 3), and because of the inconclusive results from the only previous comprehensive field trial of these interactions [at the Institute for Nutrition in Central America and Panama (INCAP) in Guatemala; see chapter 1, note 2], he suggested a long-term study at Narangwal. Other grants were obtained from the U.S. National Institutes of Health (NIH), ICMR, the U.S. Agency for International Development (AID), and several foundations, and supplies were provided by Church World Service and CARE.

The main collaborating institutions in addition to ICMR were the Ludhiana Christian Medical College, the All-India Institute of Medical Sciences, and the Chandigarh Post-graduate Medical Institute. These institutions provided continuing consultation and technical support, especially in doing the more complex laboratory work. The combined staff of the various Narangwal projects eventually totaled about 150 Indian scientists and other personnel. In addition there were an average of two expatriates, who were faculty members from The Johns Hopkins University and came from six different countries, working at any one time at Narangwal. Everyone lived in simple village houses, which were adapted to healthful living as part of the project's demonstration effort.

The field activities were totally dependent on close collaboration with health officials at provincial and district levels. Their guidance and field involvement were crucial to whatever success was achieved. This included their making arrangements
for us to work in the study villages that were assigned to the project for provision of the types of health care indicated in the experimental design.

The World Bank supported the Narangwal research with funds and technical participation. The Bank has always stressed the need for economic growth and improvement of economic management. But beginning in the 1970s, as part of a growing worldwide recognition that economic growth was not reaching the poor, the Bank began to emphasize direct measures to alleviate poverty, both in its lending program and in its research and policy analysis. Nutrition drew special attention because inadequate nutrition—or malnutrition—is often the direct result of poverty. It was recognized that "in the developing societies, malnutrition plays a part in substantial numbers of deaths, and inadequate diet and related illness interfere with the learning ability, capacity to work, behavior, and well-being of large segments of the population [Alan Berg, *Malnourished People: A Policy Overview*, Poverty and Basic Needs Series (Washington, D.C.: The World Bank, 1981), p. 1].

Since most malnutrition is caused either by shortages of food or by inadequate purchasing power of the poor, the Bank in its work has been stressing economic growth, especially agricultural growth and rural development. But it has now been recognized that for most of the world's malnourished the economic growth process is too slow to improve these nutritional conditions. Hence, there is a need for direct programs to improve nutrition. Among such direct programs, the Bank developed multi-sectoral nutrition projects. The most promising vehicle for nutrition interests was provided by health programs. In 1980, the Bank published a Health Sector Policy Paper [Frederick Golladay, coordinating author, *Health* (Washington, D.C.: The World Bank, 1980)] endorsing direct lending in the health sector. It also appeared plausible that a primary health care system could help in improving nutrition. The interaction of malnutrition and infection seemed to have a far more serious effect on
individuals than the combined effect of the two conditions working independently. Thus, the effects of nutrition actions and health programs undertaken simultaneously would be greater than the sum of their effects on the same population if the actions were undertaken separately. Is this true in a project experience? More important, is integration of nutrition and health services an efficient way of using limited resources? To answer these operationally relevant questions, the Bank welcomed the opportunity to work with the Department of International Health of The Johns Hopkins University to analyze data from the Narangwal field experiment. To complete this analysis, many in the Bank helped—Timothy King and Ravi Gulhati gave especially valuable advice and support to the researchers. Martha List of Johns Hopkins helped with typing the monograph.

For those of us who were privileged to be part of the Narangwal experiment, it seems inadequate to attempt to record what we learned in reports and publications. There was a depth and continuity in the experience of our sharing with village communities their search for a better quality of life that goes beyond means of formal reporting. The members of the staff came to feel very close to our village hosts, and our deepest gratitude and affection must be expressed to the wonderful people of our experimental villages. Their hospitality was unmatched as we became more and more conscious of their increasingly effective drive to develop and to find solutions to their own problems. This research effort became, we hope, a part of that process.

CARL E. TAYLOR

RASHID FARUQEE

Research Coordinators
The Narangwal Nutrition Project Team

This volume is based on experience gained in the Narangwal Nutrition Project between 1965 and 1973. The following personnel were actively involved in the field or analytical aspects (or both) of the studies reported in this volume. (Dates are for field activities in the Punjab.)

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William A. Reinke (1965-73)*

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Cecile DeSweemer (1968-70)*
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Elsie Ferguson (1969-70)*
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Kalyandrug Sivaram (1970-73)*
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A. Douglas Robertson

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N. Sengupta Kielmann (1970-73)
Bimla D. Arora (1972-73)

The important contributions of the many family health workers, field investigators, statistical staff, administrators, and support staff are also gratefully acknowledged.

* Personnel with significant field responsibilities in the parallel Population Project or Functional Analysis Project.
## Definitions

### PROJECT TERMS

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<tr>
<td>ANM</td>
<td>Auxiliary nurse midwife</td>
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<tr>
<td>CHW</td>
<td>Community health worker</td>
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<tr>
<td>CONT-N</td>
<td>Control--nutrition project (designates villages not receiving nutrition, health, or integrated services)</td>
</tr>
<tr>
<td>CONT-P</td>
<td>Control--population project (designates villages not receiving family planning, health, or integrated services in parallel population project)</td>
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<tr>
<td>FHW</td>
<td>Family health worker</td>
</tr>
<tr>
<td>FPCC</td>
<td>Family planning and child health care services, including nutrition care (designates villages receiving such care in population project; same as NUTHC in nutrition project)</td>
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<tr>
<td>FPED</td>
<td>Family planning and education (designates villages receiving such services in population project)</td>
</tr>
<tr>
<td>FPWS</td>
<td>Family planning and women's health services (designates villages receiving such services in population project)</td>
</tr>
<tr>
<td>FPWSCC</td>
<td>Family planning, women's health services, and child health care services, including nutrition care (designates villages receiving such integrated services in population project; also called NUTHC-P in nutrition project)</td>
</tr>
<tr>
<td>HC</td>
<td>Health care (designates villages receiving such services, which included infection control)</td>
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<td>Definition</td>
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<tr>
<td>ICDS</td>
<td>Integrated Child Development Scheme</td>
</tr>
<tr>
<td>NUT</td>
<td>Nutrition care (designates villages receiving such services)</td>
</tr>
<tr>
<td>NUTHC</td>
<td>Nutrition and health care (designates villages receiving such integrated services)</td>
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<tr>
<td>PHN</td>
<td>Public health nurse</td>
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**TECHNICAL AND INDIAN TERMS**

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<td>ANOVA</td>
<td>Analysis of variance</td>
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<tr>
<td>chowkidar</td>
<td>Village watchman responsible for reporting births and deaths under government's vital statistics system</td>
</tr>
<tr>
<td>dai</td>
<td>Traditional village midwife or birth attendant</td>
</tr>
<tr>
<td>Jat</td>
<td>High-caste, land-owning farmers of the Sikh region</td>
</tr>
<tr>
<td>kharif</td>
<td>Fall harvest (predominantly of maize, with some rice and cash crops)</td>
</tr>
<tr>
<td>neonatal</td>
<td>Refers to the first month of life</td>
</tr>
<tr>
<td>panchayat</td>
<td>Elected village council</td>
</tr>
<tr>
<td>parchawan</td>
<td>&quot;Shadow of a spirit&quot; (in local belief, the casting of a shadow by an &quot;impure&quot; person that is thought to cause illness)</td>
</tr>
<tr>
<td>patti</td>
<td>Village faction or clan</td>
</tr>
<tr>
<td>PCM</td>
<td>Protein-calorie malnutrition</td>
</tr>
<tr>
<td>perinatal</td>
<td>Refers to the period from the seventh month of pregnancy to the first seven days of life</td>
</tr>
<tr>
<td>postneonatal</td>
<td>Refers to the second through twelfth months of life</td>
</tr>
<tr>
<td>prenatal</td>
<td>Refers to the period from conception to birth</td>
</tr>
<tr>
<td>rabi</td>
<td>May-June harvest (predominantly) of wheat</td>
</tr>
<tr>
<td>Ramdasia</td>
<td>Low-caste, non-Jat, landless agricultural workers of the Sikh religion; referred to in the population study as &quot;scheduled Sikh&quot;</td>
</tr>
</tbody>
</table>
DEFINITIONS

SD Standard deviation
SE Standard error
SEM Standard error of mean
siyana Faith-healer
sokha "Drying up" (local term for marasmus)
TKO "Technical knock-out" (for statistical purposes, designates a child in the NUT, HC, or CONT-N villages who, having received needed emergency nutrition or health care, was then eligible for full treatment even though the services needed were not provided in that experimental group)

INSTITUTIONS

AID U.S. Agency for International Development
FAO Food and Agriculture Organization of the United Nations
ICMR Indian Council of Medical Research
NIH U.S. National Institutes of Health
NIHFW Indian National Institute of Health and Family Welfare
NRC National Research Council, U.S. National Academy of Sciences
WHO World Health Organization
Part One
The Narangwal Nutrition Experiment
Chapter 1
Background and Summary of Findings

Carl E. Taylor, Arnfried A. Kielmann, Cecile DeSweemer, and Dov Chernichovsky

The distribution of childhood malnutrition and infection around the world reflects local patterns of poverty. The moral and political justifications for equity in meeting basic human needs include growing awareness of the continuing flagrant neglect of many of the world's children. National and international policy is beginning to be influenced by the pragmatic realization that optimum development of children represents any society's greatest resource for the future. The research reported here provides hope that direct, practical, and affordable measures are available that could correct most of the existing inequities in the health and nutritional care of children.

THE SOCIAL BURDEN OF MALNUTRITION AND INFECTION

As many as 25 percent of the children in some developing countries die before they reach the age of 5. The social costs of childhood malnutrition and infections show up not only as high death rates but even more as long-term deficits in those children who survive. Children in developing countries may have an average of up to 160 days of illness each year, with 3 to 4 episodes of diarrhea and 4 to 5 illness due to severe respiratory infections. Nutritional deficits and associated lack of stimulation in early life interfere with both physical and mental growth. As a consequence, the potential reduction in productivity and physical output throughout
adult life represents a major limitation on human resources, as has been shown by studies such as those of Basta in Indonesia and Viteri in Guatemala.\textsuperscript{7,8}

The two-way interactions between socioeconomic development and health status include the multiple effects of child mortality on population growth. People improve the care and condition of their children as soon as socioeconomic conditions permit, and this leads to a reduction in childhood mortality. The most rapid population growth has resulted from imbalance in birth and death rates during periods when mortality declined spontaneously and moderately but fertility remained high. This imbalance is maintained for protracted periods when the poor do not receive equitable coverage by health care and other social services, even though the affluent segments of society may enjoy rapid economic development. In contrast, recent experience in an increasing number of developing countries suggests that promoting mortality decline among the poor as part of overall social development creates conditions that offer the best chance of bringing fertility down to levels consistent with optimum population growth.\textsuperscript{9} This in turn should increase the potential of socioeconomic development.

Some efforts have been made to quantify investment in children in economic terms.\textsuperscript{10} Child death in developing countries is, however, so ubiquitous that it seems to be taken for granted by parents who act as though having children entails essentially no cost. Another mouth to feed is not considered a major concern in comparison with the potential of adding another family member who might become economically productive. We know little about the emotional investment and sense of loss when a child dies. Under conditions of high mortality this may be accepted as a part of life beyond the parents' control, but important changes in attitude occur when people begin to feel that they can gain control over their own and their children's future. Although it is harder to measure, the noneconomic benefits of reducing child death rates probably include a
reduction in fatalistic attitudes as awareness emerges that both parents and children have increased years of healthy life to look forward to.

Background Information on Synergism between Malnutrition and Infection

Throughout history around the world, the leading cause of death, disease, and retarded growth and development in children has been the synergism between nutritional deficiencies and common childhood infections. Delayed recognition of this relationship resulted from the tendency of research workers to seek single causes to explain complex interactions and to base scientific advance on increasingly narrow analytic definitions of problems. In the past two decades major advances in understanding of the interactions between malnutrition and infections emerged from a synthesis of several different channels of investigation. The underlying biologic principles have now been sufficiently clarified to provide a better basis for policy formulation and for action in control programs.

For many years nutrition research workers reported problems that arose when infections intervened in nutritional studies and considered it a nuisance that laboratory animals with carefully nurtured nutritional deficiencies died from intercurrent infections. Recognition of the frequency and importance of the phenomenon led to realization that many infections could be controlled by providing better nutrition. Infection control then became one of the justifications for nutrition programs.

Similarly, scientists studying infections found that their results were seriously compromised by what was happening to patients or laboratory animals nutritionally, and conversely that infections often precipitated malnutrition. The recognition emerged that, unless nutritional status was controlled in experiments, the manifestations of infections were likely to be confounded. The care of diseases such as typhoid and tuberculosis was revolutionized when it was found that any kind of
fever caused massive protein loss and that maintaining nutritional status was essential for good care. It was also recognized that infections frequently precipitated malnutrition in children; for instance, epidemics of kwashiorkor followed epidemics of measles. Progressive accumulation of such observations led to claims among infection control specialists that a primary justification for their programs was to prevent malnutrition. The complex ecology of the interactions between malnutrition and infections has been reviewed by Scrimshaw, Taylor, and Gordon; Burgess and Dean; Taylor and DeSweemer; and Taylor, Kielmann, and DeSweemer.

It is now known that the common infections precipitate malnutrition, which in turn reduces resistance; this facilitates further infections, which again lead to increased nutritional deficit. If the sequence moves rapidly the patient dies, although neither malnutrition nor the infections by themselves would have caused death. When the sequence proceeds at a slower pace the combination is the major cause of the chronic growth deficit, physical and perhaps mental, that affects many millions of deprived children in the world. These problems are most prevalent in developing countries where most of the world's children live.

The gradually increasing awareness of interactions between infections and malnutrition has been accompanied by a great deal of research on possible mechanisms. Both antibody and cell-mediated immune responses, as the major protections against infection, are seriously compromised by protein-calorie malnutrition and by specific deficiencies that have selective effects on particular immune mechanisms. A wide range of natural barriers that provide natural resistance to infections—such as the integrity of the skin and mucous membranes, the normal physiology of the bowel—are also selectively modified by specific nutritional deficiencies.

Conversely, particular infections and the related response mechanisms of the body have been found to cause deterioration
in nutritional status in diverse ways. Most marked are direct increases in calorie consumption and the tissue-destroying catabolic effects of fever with protein loss. A complex chain of hormonal stress-related mechanisms causes direct interference with cell-building anabolic activity. Intracellular infections destroy or coopt the functions of cells. Other more general mechanisms are equally important; for instance, fever may cause loss of appetite, and diarrhea may interfere with absorption of nutrients from the intestines. These effects are aggravated in many societies by social taboos that impose restricted diets during fever or diarrhea.

Nutritional demands are highest in early childhood during rapid growth. The birth weight of a normal infant doubles in six months, triples in one year, and quadruples in two years. Good nutrition is well maintained by breast-feeding during the first four to six months. In many developing countries breast-feeding continues into the second year, generally with inadequate supplementation, and then the child usually goes directly to an adult diet without appropriate transitional weaning foods.

Infectious diseases are relatively uncommon during breast-feeding while the child is protected by passively acquired maternal antibodies and minimal exposure to infections. As the baby becomes more mobile, direct exposure increases, and as supplementary foods replace breast-feeding the prevalence of infections can become extremely high during the second half of the first year and the second year. As immunity develops, the prevalence of infections then progressively declines.21

The period of high nutritional demand coincides with the time of most frequent infections. Infections increase nutritional requirements, and the malnutrition predisposes to infections.

The problems of the first several years may be compounded if the baby does not get a good start at birth. The newborn may suffer from prenatally acquired infections.22 Low birth weight
and inadequate nutritional reserves from a malnourished mother can be equally serious. Children born with a decisive handicap in nutrition or infection have special difficulty in catching up to their genetic growth potential on a food intake that is marginal. In rural Guatemala most deaths in the first year of life were in children with low birth weight.\textsuperscript{23}

Combinations of interactions frequently occur in well-defined patterns under natural conditions. An acute childhood disease (such as measles or whooping cough) in well-nourished children causes minimal and temporary disability; but in children with borderline malnutrition similar infections may precipitate kwashiorkor\textsuperscript{24} or the acute manifestation of specific deficiencies such as blindness from avitaminosis A.\textsuperscript{25} The relatively large caloric and nutrient requirements needed to recover from specific illnesses are considerably more than what is usually available to children in developing countries.\textsuperscript{26}

In spite of these clear-cut relationships, research and the organization of programs to control these two major problems have almost always been separated. The Narangwal nutrition study summarized here is a major step forward in moving from the new understanding about synergism between malnutrition and infections to practical policy and programs.

PRIOR FIELD TRIALS

Most child nutrition programs currently place major emphasis either on nutritional rehabilitation centers, which treat children severely ill with marasmus and kwashiorkor, or on mass programs for feeding school children. Rehabilitation programs tend to be so expensive that there is increasing doubt about their cost effectiveness. In 1966, McLaren in Beirut demonstrated that it took four months of care at a cost of at least US$1,000 to rehabilitate one marasmic child; one-third of these children died within six months.\textsuperscript{27} Since then, other demonstrations have shown that rehabilitation centers can provide services at costs that range from less than US$50 to
several hundred dollars depending on whether day care or inpatient facilities and services were used. In spite of efforts to use the centers for nutrition education, an essentially curative approach for children who are brought for care at late stages of nutritional deterioration clearly is not a means of meeting mass need. The second alternative is mass feeding programs which usually focus on school children. These have the limitation that they do not usually reach the preschool children who are in greatest need or the poorest children who do not go to school.

Ways must be found to recognize and treat malnutrition early and as near to the home as possible. It is especially important to change basic patterns of child care in the home through nutrition education, ensuring the availability of food, personal hygiene, and general health education. Since synergism between malnutrition and infections is more important than either of these conditions alone, they both need to be studied and cared for together.

Between 1955 and 1960 the first major epidemiological study of the interrelation between malnutrition and infections was carried out as an ancillary study of the Khanna Population Project in the Punjab (India), only 35 kilometers from Narangwal. A detailed longitudinal survey of numbers and causes of death showed an age-specific death rate for children less than 1 year old of 156 infant deaths per 1,000 live births. The neonatal death rate was 74, and the postneonatal death rate 82, per 1,000 live births. For children one to four years old, the mortality rate was 27 per 1,000 population in that age group. During the second year of life mortality remained very high, with 72 deaths per 1,000 population in that age group.

Weanling diarrhea was identified as the major cause of death in children, and the general pattern of its interaction with marasmus was defined. Mortality rates varied considerably by season with overall crude death rates; they were highest in May and June (21.1 per 1,000 population) and lowest dur-
ing the winter months (14.5 per 1,000 population). The causes of childhood deaths varied with the seasons. In general, deaths from diarrheal diseases predominated in May, June, October, and November, and deaths from pneumonia in December, January, and February. The Khanna data showed that child mortality from infectious diseases was highest for all age groups up to five years when it was associated with malnutrition.

In 1959 the first major field study to try to modify experimentally the variables influencing the interactions between malnutrition and infection was organized in the Guatemalan highlands. The research design provided for comparisons between three villages with differing service inputs. Nutritional supplements for all children were provided in one village; medical care by a doctor and a fairly complete health team and improved water supply and a latrine program were provided in the second village. The third village was a control. Over a five-year period growth, morbidity, and nutritional status of all the children in these village communities were observed. The study contributed numerous valuable discoveries regarding the ecology, extent, nature, and manifestations of malnutrition and infectious disease in rural Guatemalan preschool child populations. The specific contributions relating to interventions can be summarized as follows.

In the village with nutrition supplementation, infant mortality declined more than expected on the basis of trend lines established over the five years preceding introduction of services. Neither of the other villages (the one with medical care and environmental sanitation and the control village) showed a greater than expected decline in infant mortality. Mortality in children 1 - 4 years old was reduced in all three villages, with the largest decrease occurring in the village with nutrition supplementation, the next largest in the village with medical treatment and sanitation control, and the least in the control village.

Children in the village with nutrition supplementation
showed a statistically insignificant, although consistent, improvement in linear growth and weight gain compared with those in the village with medical treatment and sanitation and in the control village. There was no apparent effect on morbidity experience other than an inverse relationship between feeding-center attendance and morbidity experience in the feeding center village. The village with medical treatment experienced the highest morbidity, 4.4 illnesses per year, while the control and nutrition-supplementation villages had relatively low rates, 2.0 and 2.4 illnesses per child per year respectively. However, these results were markedly influenced by a diarrheal disease epidemic that twice during the five years struck the medical-treatment village but not the other villages. Results were also difficult to interpret because there was only one village in each experimental group, and the villages were not precisely matched. Differential reporting may also have influenced the morbidity results, since it was demonstrated at Narangwal that more illness tends to be reported where treatment is provided.

Although results from this Guatemalan experiment clearly indicated some beneficial effects, especially from the child feeding program, the relative contribution of curative, preventive, and nutritional services to child health and their optimal mix in an integrated program remained unclear.

PURPOSES UNDERLYING THE RESEARCH

The general policy issue underlying the Narangwal study was to determine whether there is a synergism in programs to control malnutrition and infections similar to the known synergism between these problems. Specifically, we planned to measure the relative strength and dynamics of both sets of interactions as programs were developed to meet the most evident needs.

The more specific policy questions that led to this study were:
Can nutrition interventions reduce the incidence, duration, and impact of infections in addition to having a direct effect on nutritional status?

Can infection control improve nutritional status in addition to having a direct effect on morbidity and mortality?

Is there a synergism in program effects so that a combined program of nutrition and infection control will have greater impact in cost effectiveness than would be expected from each program alone?

Can better field programs be developed to combine the most cost-effective malnutrition and infection control measures so that they can be implemented within the personnel and financial constraints of developing countries?

The ultimate practical purpose is to improve knowledge and methods that can be applied in programs to improve the health and nutritional status of the millions of children who have been underserved.

The Narangwal Setting

The Nutrition Project was one of a number of studies carried out at the Narangwal Rural Health Research Center located in Ludhiana District, Punjab, India. This center was a research, training, and demonstration area developed collaboratively by the Indian Council of Medical Research (ICMR), the Punjab Health Directorate, the All-India Institute of Medicine, and other academic and research institutions in India. Funding for this research was obtained from the ICMR, World Health Organization (WHO), U.S. National Institutes of Health (NIH), the U.S. Agency for International Development (AID), and several foundations and private donors.

The first project at Narangwal was started in 1961 jointly with the Ludhiana Christian Medical College and six other Indian medical colleges to study the rural orientation of interns and physicians, and a book, Doctors for the Villages was pro-
duced. Subsequent projects included a study of primary health centers, which also produced a book, *Functional Analysis of Health Needs and Resources*, and studies of beliefs and practices of village people in relation to diet and disease. A major field study on the integration of health and family planning services was conducted in parallel with this nutrition project, and results are being analyzed. During the fieldwork phase of the health and family planning project and the nutrition project there were more than 150 project staff—including family health workers, public health nurses, physicians, statisticians, social scientists, and field investigators—working together on the projects. All of these were Indian except for an average of two Johns Hopkins faculty members, who over the years of the research came from six countries. About one-third of these project staff members worked primarily on the nutrition study. All personnel lived in village homes near the project headquarters except for the family health workers, who resided in their study villages. These accommodations were made hygienically safe by simple improvements. There were tremendous advantages in sharing the lives of the village people, both in gaining their acceptance and in improving the staff's understanding of village life. The total population covered in the parallel nutrition and population projects was about 35,000 people, who lived in twenty-six villages distributed in clusters as experimental groups within three community development blocks of Ludhiana District (containing about 300,000 population; see figure 1-2).

The research project headquarters in Narangwal village was located in village houses that were converted to provide office space for investigators, statistical staff, supervisors, and administrators; for storage of records, research forms, drugs, supplies, and equipment; for a library, classrooms, a field laboratory, and a workshop supporting the renovation and maintenance of village housing for clinics and residents; and for maintaining equipment and vehicles.
The ten study villages in the nutrition project were selected in clusters of two to three villages scattered around two community development blocks. During their selection, particular efforts were made to get reasonable comparability between the different groups of villages in terms of major sociocultural and economic indicators described in chapter 2. An effort was also made to maintain sufficient separation between village clusters to minimize communication among villagers about differences in service packages. To avoid the problem that arose in the Guatemalan study when outbreaks of diarrhea seriously affected intervillage comparisons, we decided to include at least two villages in each experimental or control group. An important part of the selection process was to assess the potential level of cooperation in each village and to negotiate with the villagers until they were willing to accept whatever combination of service interventions was assigned to their village according to the research design. In this negotiation it was made clear that there would be no compulsion for families to cooperate with the particular set of services that would be provided in their village. All village leaders, however, agreed without reservation to help persuade all families to participate in all of the survey and measurement activities that were necessary for this to be an effective research enterprise.

During June 1967, prior to the start of the experimental service programs, a preliminary anthropometric survey of 391 children 0-5 years old was carried out in our study villages. Sixty-two percent of children 7-12 months old and 82 percent of children 13-24 months old fell below the Harvard standard third percentile for weight. Overall, almost 50 percent of children 0-5 years old fell below the third percentile of the Harvard weight-for-age standard. On clinical examination 24 percent of children had growth retardation in height, 18 percent had reduced subcutaneous fat, 13 percent had reduced muscle mass and 2 percent were severely marasmic. These data suffer the bias
of a point prevalence survey in that they indicate the nutritional status at one point in time, which happened to be the most difficult time for children (during the hot and dry harvesting season from mid-April through June, when morbidity and mortality are highest).

Neuman and others also reported the results of a pilot longitudinal morbidity study in Narangwal villages in 1967. The study showed a high load of infectious diseases in children, which included respiratory illness, diarrhea, and eye infections averaging 4.0, 2.7, and 1.2 episodes per child per year, respectively.

The nutrition villages received the following service packages: nutrition care (NUT); health care mainly concentrating on infection control (HC); integrated services for both (NUTHC). The control village for the nutrition project was designated CONT-N. Figure 1-1 shows the experimental design of both the nutrition and population projects. The study population in the ten villages at any point in time averaged about 1,000 children up to 3 years of age with each experimental group having an average of 200-300 children 0 to 3 years of age. The map included here shows the location of these villages along with the study villages of the parallel population project.

THE PUNJABI SETTING

Narangwal and the study villages are in Ludhiana District in the heart of the predominantly agricultural Punjab in northwest India, an area that benefited dramatically from the "green revolution" immediately before and during the project. About 80 percent of the land is under irrigation from canals and tubewells. The combination of abundant water, fertile soil, rapid introduction of high-yield hybrid wheat strains and other improved crop varieties, intensive use of fertilizer, selective mechanization and implementation of modern farming techniques, together with the assertive character of the Punjabi popula-
Figure 1-1. Distribution of Villages According to the Experimental Design of Both Nutrition and Population Studies, Narangwal Project

<table>
<thead>
<tr>
<th>No nutrition</th>
<th>Nutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>No health care</td>
<td></td>
</tr>
<tr>
<td>CONT-N</td>
<td>MUN</td>
</tr>
<tr>
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<td>Kaind</td>
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<tr>
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<tr>
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<td>Kishanpura</td>
</tr>
</tbody>
</table>

No women's services | Women's services

--- Nutrition project design.
--- Population project design.
CONT-N Control—nutrition project.
CONT-P Control—population project.
FPCC Family planning and child care.
FPED Family planning and education.
FPWS Family planning and women's services.
FPWSCC Family planning, women's services, and child care.
HC Health care.
MUN Nutrition care.
NUTHC Nutrition and health care (integrated services).
NUTHC-P Nutrition and health care (integrated services)—population project.
tion, has led to phenomenal economic progress. The per capita income was approximately US$150 (during the period of the study, the average exchange rate was approximately Rs7.5 = US$1). This compared with approximately US$90 per capita for the rest of India. According to the 1971 census, Punjab had a population of 13.4 million, with 67 percent living in rural areas, and the high population density of 1,976 persons per square kilometer. According to a 1968 sample registration survey, 13 percent of the population was less than 5 years old. Sixty percent of the population are Sikhs and the rest are Hindu (38 percent), Christian (1.2 percent), and Muslim (0.8 percent). The largest proportion of Sikhs are Jats of the warrior (Kshatrya) caste.

The Punjabis are probably the best nourished of India's population groups. Their diet--based mainly on wheat, milk, and dal (pulse)--is good. Two main crops are grown yearly: the rabi harvest in May and June, which is primarily winter wheat, and the kharif harvest in the fall, which produces a wide range of products including corn (maize), millet, pulses, cotton, peanuts, and rice. In both seasons a large amount of fodder is grown for milk buffalos and draught animals.

Dramatic improvements have occurred in many areas of life. Education has spread so rapidly that every village has a primary school. Secondary schools are within cycling distance. Some villages, including Narangwal with 1,800 population, have degree colleges. Probably more than 70 percent of children are now in school. In 1969 approximately 75 percent of women and 54 percent of males age 15 or older were illiterate. The rapid generational change is indicated, however, by the finding in the same year that, of persons 5-15 years old, only 45 percent of females and 37 percent of males are illiterate.

Transport has also improved; villages are now linked by paved roads instead of by mud tracks for oxcarts as formerly. Buses run regularly along numerous routes from Ludhiana. Increasingly, village streets are paved, and the perpetual mud-
holes from village drainage are disappearing. Basic sanitation has changed for the better. According to our socio-economic survey, 80 percent of homes now have reasonably safe handpumps in the courtyard, albeit for convenience and time saving rather than for health reasons. Change is not complete, since latrines are still rare and flies swarm as always. But housing is improving as an early response to local affluence.

One of the key questions in this study has been, "Why is there so much malnutrition in an area with an abundant food surplus?" Punjabis have the reputation of being the tallest, strongest, and hardest working of India's many cultural groups. The "typical" well-nourished Punjabi is the Jat farmer who owns and farms his own land. Even among Jat farmers the nutritional status of adults does not always predict the nutrition of their children. About one-third of the villagers are from the lower castes who work mainly as farm laborers, and the prevalence of malnutrition among their children is particularly high.

PLANNING THE EXPERIMENT

From 1969 through May 1973 the Narangwal Rural Health Research Centre conducted this field experiment in ten villages. Prior preparatory work started in 1967 and lasting for almost two years included: preliminary surveys of anthropometric status and morbidity; selection of study villages; standardizing methods for data collection and health services; training staff; and, most important, developing good cooperative relationships with the local populations. The data collected from 1969 to 1973 reflect a relatively stable field activity and are the basis for this analysis.

As indicated above, this was a period of extremely rapid socioeconomic development in the Punjab, and an important question is whether this changing environment influenced our research findings, their general applicability, and their meaning for practical health programs in India. The research design was structured so that intervillage differences would provide
valid comparisons. Dramatic economic and social changes were evident in all the villages, and therefore the demonstration of significant differences between groups should have even greater scientific validity because they were demonstrable even in the presence of general economic development. Interactions and causal relationships can be interpreted within the experimental design because most nonprogram variables were controlled for.

We recognized from the beginning that this research would not provide final answers of what could be implemented directly in all parts of India because economic levels, cultures, and local ecologies varied greatly nationwide. These research findings need to be adapted and applied in demonstration projects under different conditions and within the constraints of available services in each part of the country. Appropriate combinations of services can then be evolved to fit local situations.

The relevant question, then, is whether the measures that were found to be effective as experimental inputs in our research design would be effective only in situations with rapid general development. This query can be answered only by research under other appropriate situations. Since the rural areas of most developing countries are entering periods of rapid development such as has occurred in the Punjab, although perhaps less dramatically, we feel that the Narangwal findings will have most meaning for areas experiencing such developmental change. Our intuition suggests, however, that it may be possible to demonstrate significant effects even more dramatically in less developed areas because the nutrition and infection problems are greater. A real challenge in such situations is to see if an integrated package of child health care, maternal health care, nutrition, and family planning can become an effective force in the process of development.

To conduct studies on these complex and basic questions, there was need for a reorientation of research thinking. Experiments on synergism in laboratories have been done by intro-
ducing an agent and a particular deficiency and observing effects directly. Once the basic biological relationships have been worked out in laboratory studies, the crucial question remains, "How do these findings apply to humans?" Some evidence on specific interactions between malnutrition and infections has been obtained from clinical observations of patients who are already sick. But to investigate these interactions epidemiologically is substantially more complicated. The usual epidemiological field study falls methodologically short because it tends to focus on single problems, even though these may be viewed in the total ecology of the community. The need here was to observe multiple health problems simultaneously.

The only ethical way of studying these problems in human populations is to find groups with a high prevalence of both malnutrition and common infections and then to observe what happens when there is selective reduction of each type of condition. The research design should permit measurement of all parameters in the interaction as particular conditions are eliminated or reduced. This means that controlled studies of comparable population groups have to be structured so that each group will receive a different service input. Through open discussion these decisions have to be agreed on by the population studied. Local officials also have to agree that this kind of selective intervention is ethically justified. In chapter 2 some ways that were developed to monitor these ethical concerns in the Narangwal case are described.

Because we were primarily interested in services to control the overall effects of malnutrition on the one hand and infections on the other, it was essential that the research design combine interventions against each grouping of conditions into simple service packages. The data gathering had to have a sufficiently sound epidemiological base so that we could also sort out the specific effects of individual interventions within the broad service groups.

The most important ethical aspect of designing this ex-
periment was recognition that the pure research objectives had to be kept in balance with the parallel set of service objectives that are specified in chapter 2. While getting basic scientific information on particular interactions we insisted that anything we did should have immediate applicability and should contribute to the health care of the village children being studied. No intervention would be tried that could not conceivably be fitted into eventual application in rural health services in India.

With these limitations, developing a tight experimental design presented problems. Most fundamental was insistence on a high level of quality control in data collection. Even if we could not control all intervention variables, we should at least know what was going on in our villages. Therefore, the largest proportion of project costs went into well-organized data collection. Prior methodological experience in the Khanna and Guatemala studies was very helpful, especially in selecting variables to be measured.\textsuperscript{39, 40}

Similarly, intervention packages had to be developed. In the usual experiment, a basic dogma is that the intervention being tested must be kept uniform throughout the study. We could not do this because our best judgement at the beginning of the study about what would be the best intervention package was within a few months often shown to be wrong. There was no point in holding rigidly to a pattern of work when straightforward field experience showed that there was a better way of doing the same thing. From the beginning, therefore, we defined broadly the interventions that were to be tried in each package of services, but within that grouping we deliberately set out to develop improvements in service routines. This progressive refinement of services throughout the experimental period represented a parallel research effort in which systematic rapid feedback of results led to a deliberate effort to keep all field workers and scientists intimately involved in the search for innovations and practical improvements. As new
measures were evolved, we tried to implement them rapidly. The excitement of the field work was largely due to this dynamic process. However, the continuous evolution of services made the eventual analytical task much more complex.

In the analysis, we then had to sort out the interrelationships between the complex interacting variables relating to nutritional status, morbidity, and mortality. We hypothesized that, in addition to their individual direct effects, poor nutrition would adversely affect morbidity, high morbidity would decrease nutritional level, and poor nutrition and high morbidity together would act synergistically in raising child mortality. In addition, we were able to include measures that could presumably serve as indicators of maternal influences (birth weight, maternal height) and socioeconomic status, (that is, caste affiliation, landholdings, parental occupation, income, education). The outcome indicators were child nutritional status and growth, morbidity experience, psychomotor development, and mortality. It was postulated that socioeconomic status affects child growth, child development, and morbidity mainly through three intermediate variables: availability and quality of mother care, quality and quantity of diet, and housing and environmental conditions.

Finally, a statement needs to be made about the process by which research findings can be implemented in national programs. It has become fashionable to discount field research projects, such as the Narangwal experiment, because of a blanket indictment that they lack replicability. The word "replicability" is fundamentally the wrong word to use for the process of moving from projects to general implementation because it implies reproducing a precise copy of the pattern developed in the initial project, which should never be the objective. This continuing complaint requires a statement about the role and relevance of health services research. After discussing two concerns about field research, we will present some thoughts about the process of moving from research to implementation.
The first concern is the greater cost of a field research project compared with normal costs in government services. Because of this concern, what happens is that massive investments in primary health care are producing less than expected results because relatively small amounts are not spent to test under field conditions what can be done about improving effectiveness, efficiency and equity; what are the influences of specific local constraints; and what adaptations might be needed under different circumstances. This project was started at a time when theoretical understanding of synergism had been developed in laboratory and clinical research, but the dynamics of the interactions were not understood under the normal living conditions of everyday life in developing countries. An analogy seems relevant to illustrate the need to answer basic questions about the implementation process. No one would expect an immunologist to undertake to develop a vaccine with the constraint that all research be done within the limits of costs and facilities that would eventually be needed to produce and administer the eventual national immunization programs. Special research investments are needed to define the basic mechanisms of biologic interactions and the very expensive testing through phase 1, 2, and 3 trials prior to general implementation. The research on synergism reported here dealt with scientific issues far more complex than developing a new vaccine, with more variables to be tested simultaneously. Methods were used from biological sciences, behavioral sciences, economics, systems analysis, and health services research in general. Using only methods and resources available in national services would have precluded testing new improvements or measuring changes as they occurred.

A second concern is the direct influence of research on replicability. We decided that, rather than discounting or apologizing for the "halo effect" (through which research improves motivation and the quality of services), we would deliberately promote a research attitude in the entire staff.
The underlying Narangwal research philosophy was to get everyone on the staff involved in asking research questions and suggesting possible innovative approaches. This included getting village people to help us think through ways of improving services. Many of the most practical innovations came from family health workers or village people, very often at the biweekly training days when everyone shared problems and solutions. Visitors talked about the "Narangwal spirit" and asked whether ordinary service programs can generate equivalent enthusiasm and caring. The obvious fact is that the greatest need in most national health systems is improvement in the quality of caring so that health workers devote sufficient attention to daily activities to produce impact and community satisfaction. This kind of concern cannot be legislated; it can be promoted slightly by material incentives, moderately by good educational preparation, but ultimately it cannot be taught—it has to be caught. A contagion of caring comes from exposing students and field workers to role models who practice in their daily tasks the innumerable small details and willingness to put the people's needs ahead of their own convenience that makes the greatest difference in quality of service. Administrators should encourage exposure to role models who have these characteristics. Classes of students and continuing education workshops for field workers should have the chance to work in demonstration projects that have a high quality of care. Only when workers see that new patterns of behavior and relationships are possible will new attitudes of caring permeate the health system.

For eventual implementation nationally, it was recognized from the beginning that the basic research questions and practical interventions we were testing would have to be further tested in demonstration projects to adapt findings to local conditions in the various parts of India. We had planned to apply streamlined and simplified methods in a full community development block in the poorest area we could find. Interven-
tions and field methods were tested only if they showed promise for eventual implementation, but we would never have been able to develop the simplified package of services that evolved without the basic research approach.

Since Narangwal, it has been most gratifying that such an implementation process has been generated spontaneously with numerous field projects in all parts of India applying the basic principles that guided the Narangwal effort. Two ICMR conferences revealed the spread of the ideas and the demonstration of their feasibility. Out of the almost 100 field projects now in India, only a few such as Jamkhed and Poshak include the gathering of systematic data that permit evaluation. The rest are providing excellent services, but reports are anecdotal. Large-scale implementation is also occurring in projects such as the Integrated Child Development Scheme (ICDS) which is steadily expanding to a national program. The Community Health Workers (CHWs) Scheme also has made a good start, and evaluation shows that village people were satisfied with even the initial efforts of CHWs. In reports of national planning committees, in training manuals, in speeches by politicians, and in the day-to-day work of health administrators and Primary Health Center staff—the Narangwal research results are part of the primary health care movement that is influencing the total health care system of India and of many other developing countries.

SUMMARY OF NARANGWAL RESULTS

In chapters 4–9 detailed data are presented documenting the conclusions summarized in this section and described further in chapter 3. The ways that these findings can be applied in practical programs are outlined in chapter 9.

Growth and Development (Chapters 4, 5, and 6)

Nutrition care alone (NUT) or in combination with health care (NUTHC) significantly improved both weight and height of
study children beyond 17 months of age. At 36 months, children from NUT or NUTHC villages weighed on the average 560 grams more, and were 1.3 centimeters taller, than children in control (CONT-N) villages. Children in health care (HC) villages had mean weights and heights intermediate between those in NUT and CONT-N villages. Among the many socioeconomic and demographic variables tested, sex and caste were shown to have especially pronounced independent and additive effects, which averaged 0.6 to 0.75 kilograms for weight and about 2 centimeters for height. A male, high-caste child from a NUT or NUTHC village, therefore, averaged about 2 kilograms more in weight and 6 centimeters more in height at 36 months of age than a female, low-caste child from a CONT-N village. Beyond 13 months of age, the proportion of underweight children (arbitrarily defined as being below 70 percent of the Harvard weight median) in NUT or NUTHC villages was consistently lower than in other villages. The difference between the proportion of underweight children in NUT or NUTHC and CONT-N villages was not impressive for high-caste boys. Yet this difference was highly significant for low-caste children, especially for females, and this suggests that children whose undernutrition had resulted primarily from minimal care and poverty profited most from the program. Breast-feeding was prolonged by about five months as a result of special educational efforts in NUT or NUTHC villages.

As far as we have been able to determine, this project was the first to show in a controlled experiment significant differences in average growth of all children in communities receiving specified nutritional and health inputs. Although much epidemiological and program evaluation data supports the assumptions on which most health and nutritional programs proceed, most controlled experiments in total village populations have been disappointing. Control groups have tended to improve along with experimental groups perhaps because, as control children were being weighed and measured, mothers spontaneously provided the extra nutrition care needed. In Narangwal we were
able to demonstrate statistically significant differences between control and experimental groups by careful quality control of data and systematic program inputs.

Results from regression analyses on a subsample of 180 children on whom exact dietary measurements were obtained showed a strong relationship between dietary intake and achieved anthropometric status. Conversely, the amount of food consumed was associated with achieved growth and socioeconomic status.

Psychomotor tests showed significant synergistic effects in that the combined care (NUTHC) villages showed higher scores than either of the other two experimental groups, whose scores were in turn higher than those of the control groups. Psychomotor development was found to be directly affected by past nutritional status, and to a lesser extent by present nutritional status and by past morbidity.

Morbidity (Chapter 7)

Health care (HC or NUTHC) villages exhibited a significant reduction in the average duration of infectious disease episodes compared with villages without health care (NUT or CONT-N villages). Each episode of diarrheal disease was reduced on the average by 2 days, lower respiratory tract infections by 1.5 days, fever by 1 day, cough by 2.5 days, and skin infections by 1.5 days in comparison with villages without health care. The only condition for which the combination of nutrition and health care exerted a larger effect than health care alone was eye infections. The mean duration for eye infections in NUTHC villages was 6.3 days compared with 7.1 in HC, 8 days in NUT, and 8.3 days in CONT-N villages.

Mortality (Chapter 7)

Perinatal mortality was significantly reduced in NUT and NUTHC villages (31 deaths per 1,000 live and stillbirths) compared with HC villages (45 per 1,000 live and stillbirths) or
BACKGROUND AND SUMMARY OF FINDINGS

CONT-N villages (57 per 1,000 live and stillbirths). This decline in mortality probably resulted mainly from supplementation of all mothers with iron and folic acid. We are not able, however, to distinguish this effect from the effect of providing food from the feeding center during pregnancy to mothers judged by the family health workers (FHWs) to be nutritionally at risk.

Neonatal and postneonatal mortality, and mortality in children 1-2 years old were significantly reduced by one-third to one-half in villages where infectious disease control services (HC or NUTHC) were provided as compared with CONT-N villages. Nutrition care (NUT) produced an intermediate effect in children under 1 year of age and an equivalent effect on mortality among children 1-2 years old. In four villages of the population project that received comprehensive child care (FPWSCC: family planning, women's services, and child care services) active surveillance for illness in the course of home visiting was only one-eighth as frequent, and early treatment for illnesses presumably was therefore less intensive than in infectious disease control (HC and NUTHC) villages. From these less intensive activities, no effect on mortality in children below 1 year of age was detected, but beyond 1 year of age mortality improvement was similar to that in HC, NUT, or NUTHC villages.

A concentrated effort focusing on analysis of program effects, with rapid feedback to change service delivery, sharply reduced mortality rates from the two main causes of death. In 1971, 44 percent of deaths in children between 8 days and 3 years old were caused by diarrhea and dehydration and 22 percent by lower respiratory tract infection, mainly pneumonia. A complete revision of standing orders and retraining in the recognition, management, and follow-up of the two conditions resulted in delegation of increased responsibility for treatment (oral rehydration and penicillin injection) to the FHW. Mortality from the two conditions dropped by 50 percent over the
succeeding 17 months. Mortality rates from other causes remained unchanged during this interval.

**Input Services, Costs, and Cost Effectiveness (Chapters 8 and 9)**

Detailed measurement of input services demonstrated clear differences between experimental groups in use of staff time, service contacts, and costs. The largest amount of service time and service contacts provided per child were in NUTHC villages. However, the costs per service contact, either curative or preventive, were very similar in all experimental groups. The NUT villages were the most costly per child primarily because of the higher average number of child feedings provided per child under 3 years old. Costs in the NUTHC villages for combined nutrition and health care were about US$21 per year per child under 3 years old, or less than US$2 per capita of the total population. The average cost per service contact of US$0.20 was about equal to the cost per patient visit in government primary health centers in Punjab in 1969. Costs per child feeding per session averaged about US$0.04. (There were two feeding sessions per day, making the cost per day US$0.08.) Because project services partially replaced use of private and government services, the combined health care and nutrition program increased overall health care expenditures in NUTHC villages by only 40 percent above expenditures for private and government care in control villages.

Cost-effectiveness calculations in comparing study and control figures were based on deaths averted. "Prenatal child care" costs for each perinatal death averted were lowest in NUT villages (US$7.75). The lowest cost per infant death averted (US$25) was in the HC villages. The HC villages also produced the lowest costs per death averted in children 1-3 years old (US$31). Costs per day of illness averted in children under 1 year old were US$0.40 in HC villages and US$0.56 in NUTHC villages. Similar calculations for children 1-3 years old were US$0.35 and US$0.39, respectively. Nutrition costs per addi-
tional centimeter of growth attained by 3 years of age were US$26 in NUTHC and US$30 in NUT villages.

Synergism between Nutrition and Health Care Programs

A major objective of this research was to test whether synergism could be demonstrated between programs to provide nutrition and health care. In the research design a major issue was whether the NUTHC group of villages should receive an overall input that was quantitatively equivalent to, although qualitatively different from, that received by the other (NUT and HC) groups, or whether the inputs for each component of services should be added. In the latter instance we would have had about twice as much input into combined services, since the NUTHC group of villages would receive as much nutrition input as NUT villages and as much health care as HC villages. This would have provided our best chance to measure synergism in that we could have measured whether each component of services produced a quantitatively greater impact when they were combined. We decided, however, that we were interested in a more practical question from the point of view of administrators responsible for services: assuming that the overall input in the three packages of services were approximately equalized, what would be the most cost-effective package of services?

Quantifying cost was manageable, but the unsolved methodological problem was to find a common means of measurement for the two sets of benefits, nutrition and health care.

A clear-cut synergism was demonstrated that could not be reduced to a simple mathematical calculation. NUTHC produced almost as much nutritional impact on growth and development as NUT, and also almost as much impact on morbidity and mortality as HC for only slightly more time input than either of the separate inputs alone. The fact that NUTHC did not produce a greater impact than either HC on illness or NUT on growth and development has to be related to the reality that workers in these villages were providing both sets of services and thus
could spend less time on each. The design, therefore, permitted us to demonstrate a synergism in cost-effectiveness rather than a synergism in overall impact.

NOTES TO CHAPTER 1


BACKGROUND AND SUMMARY OF FINDINGS

12. Scrimshaw, Taylor, and Gordon, (1968); see 3 above.


16. Scrimshaw, Taylor, and Gordon, (1959); see 11 above.

17. Scrimshaw, Taylor, and Gordon, (1968); see 3 above.


20. Taylor, Kielmann, and DeSweemer (1978); see 13 above.

21. Mata, Urrutia, and Lechtig (1971); see 4 above.

22. Ibid.


24. Morley, (1965); see 15 above.


29. Scrimshaw, Taylor, and Gordon (1968); see 3 above.

30. Neumann, C. G.; Shanker, H., and Uberoi, I. S. "Nutri-

31. Scrimshaw, Behar, Guzman, and Gordon (1967); see 2 above.

32. Ibid.


37. Neumann, Shanker, and Uberoi (1969); see 30 above.

38. Ibid.


40. Scrimshaw, Behar, Guzman, and Gordon, (1967); see 2 above.


Chapter 2
Research Objectives, Design, and Methodology

Cecile DeSweemer, Arnfried A. Kielmann, Robert L. Parker, and Carl E. Taylor

Field research can never be entirely quantitative. Measurements of complex phenomena within a population group must rely also on qualitative information. The cultural social and economic milieu of the study villages, the rationale behind the research design, the selection of specific service interventions, and the motivations and objectives of the research team all were important in decisions about the research and in interpretation of the results.

GOALS AND OBJECTIVES

The research plans grew out of earlier experience in the Khanna1 and Guatemalan2 studies. The underlying goal was to contribute directly to rural health programs in developing countries. The research included both basic and applied research goals. The basic research goal was to study the dynamics of interactions between undernutrition and infectious disease. The more applied goal was to determine the relative impact on the health of rural children of alternative interventions that were technically and financially feasible within the constraints of health services in India and other developing countries. Both goals are described in more detail below.

Basic research objectives:
- To measure the extent to which health care, mainly focused on infectious disease control, influenced morbidity
prevalence, mortality, and nutrition status

- To determine the effects of nutrition care -- consisting of nutrition education, surveillance and selective supplementation -- on child growth and development, mortality, and infectious disease experience
- To determine the effects of combined nutrition care and health care on the same indicators of child health
- To determine the influence of selected socioeconomic and demographic factors on each of these interactions.

Applied research objectives:
- To develop practical field procedures for implementing service programs that are effective and feasible, within the cost and administrative constraints of rural health services, for
  - Selected nutrition care measures
  - Selected infection control and health care measures
  - The optimal functional combination of both nutrition care and health care measures
  - The population characteristics, such as age of child, that determine when each component of the integrated care package can be most effectively and efficiently introduced.

The achievement of these multiple objectives in one project was complex. There was need to maintain data quality within a research design providing measurable inputs (services provided), outputs (services used), and outcomes (impact attributable to services) so as to analyze the relative cost and effectiveness of specific interventions. At the same time, we concentrated on using low-cost methods and intermediate technology in providing health and nutrition care and in documenting the management procedures. The results reflect what could be implemented eventually in a national program given a favorable political environment. Furthermore, since this kind of action research had only rarely been attempted, there were numerous methodological problems that had to be worked out in an
incremental way, with experience gained at early stages of the
gained at early stages of the project used to modify field pro-
cedures. Extremely delicate ethical issues had to be resolved in
maintaining the controlled experimental design.

RESEARCH DESIGN

The research design of the nutrition project as seen in
chapter 1, figure 1-1, included the following experimental
groups: nutrition care (NUT), health care (HC), nutrition and
health care (NUTHC), and a control group (CONT-N) for the nutri-
tion project. In addition, we also included some data from a
parallel population project at Narangwal, in particular from
an experimental group receiving nutrition and health care for
children plus women's services (FPWSCC, or NUTHC-P) and from
the population project control group (CONT-P). Family planning
was provided in NUTHC and NUTHC-P villages. The nutrition inter-
ventions were nutrition surveillance, education, and selective
supplementation. Health care interventions were infectious dis-
ease surveillance, early treatment, immunizations, and education
for preventive measures. Integrated care was a combination of
both types of services. No effort was made to provide exact
replication of both sets of inputs; instead, a major objective
was to develop functional integration of both nutrition and
health services. Because we were concerned especially about the
applicability of our results in general service programs, each
program package was designed for independent implementation. In
each group of villages the service packages differed qualita-
tively in the internal balance of how the various components were
put together. An effort to equalize overall quantitative inputs
in each village was made in the general service load assignments
of female health visitors who were trained by the project and
designated family health workers (FHWs). Precise measurements of
time spent in specific activities were made so as to provide com-
parative analyses of actual work distribution.

In all four groups of villages in the nutrition project
the measured outcome variables were physical growth, morbidity, and mortality of children from birth to 36 months. The study universe consisted of an average mid-year population of approximately 1,000 children below 3 years of age who were permanently living in the ten selected villages or who had resided there for at least six months. After the design stabilized, three villages (Mansuran, Rattan, and Saya), with an average total population of children 0-3 years old of about 450, constituted the combined care group (NUTHC). Three villages (Kaind, Bool, and Gurum) with a total of about 230 children formed the nutrition care group (NUT). Two villages (Rattowal and Tugal) with a child population of about 230 constituted the health care group (HC). Two villages (Jand and Ghuman) with a child population of about 190 were the control villages (CONT-N). In the last year Ghuman was dropped from the study because an increasing number of its residents found employment at a nearby airfield, and this led to a dramatic improvement in their socioeconomic status and access to medical facilities. (See the map in chapter 1 for physical locations.)

To have a larger population base for control vital rates, we included both birth and death rate statistics from four control villages (Leel, Rajgarh, Dangon, and Nangal Kalan) from the parallel Narangwal study on population dynamics, which was conducted in other clusters of villages (CONT-P). Children in control villages of the nutrition project received minimal symptomatic and emergency care; in the control villages of the population project they received no curative or health promoting services from project personnel. We were also able to measure the effects of less frequent and intensive health and nutrition surveillance on mortality and growth by including relevant information from four child and women's service villages (Ballowal, Chaminda, Dhaipe, and Dolan Kalan) of the parallel population project (NUTHC-P).

Children from the ten nutrition study villages also formed a population pool from which samples of children were drawn for
a number of ancillary studies that were carried out during the project.

CHARACTERISTICS OF EXPERIMENTAL GROUPS

A conscious effort was made to select villages that would provide relative comparability in major socioeconomic characteristics between experimental groups. Other selection criteria included year-round accessibility to jeep travel. A great deal of negotiation with village leaders was required to get their consent and cooperation in becoming part of the experiment. A special criterion for control villages was that they should have good access to a government primary health center and other sources of health care and not be left completely without care. In spite of these efforts to ensure similarity among experimental groups, the inherent variation among villages produced important differences between experimental groups. Table 2-1 summarizes selected characteristics for all the experimental groups included in the subsequent analyses. Many of the analyses attempted to adjust for these differences by controlling for variations in caste distributions and other socioeconomic variables. Caste was strongly associated with health outcome measures and also was highly correlated with other socioeconomic characteristics.

Table 2-1 shows that the CONT-N villages had higher socioeconomic status than the other villages. Conversely, by many indices the combined NUTHC villages were the most deprived of the study villages. Thus, project interventions had to overcome significant initial differentials in key descriptive indicators. This would suggest that the findings of positive impact are even more significant than if the descriptive information had shown the villages to be more nearly similar.

Important differences in the CONT-N villages included a lower male to female sex ratio (103 compared with close to 120 in other villages) due, no doubt, to the fact that more of the men from the control villages worked in the cities or were in
Table 2-1. Selected Demographic, Socioeconomic, and Other Characteristics of the Experimental Groups of Villages, 1971

<table>
<thead>
<tr>
<th></th>
<th>Nutrition Project</th>
<th></th>
<th>Population Project</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NUTHC</td>
<td>NUT</td>
<td>HC</td>
<td>CONT-N</td>
</tr>
<tr>
<td>No. of villages</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Census populationa</td>
<td>4,623</td>
<td>2,646</td>
<td>2,613</td>
<td>2,120</td>
</tr>
<tr>
<td>Under 3 years (percent)</td>
<td>9.1</td>
<td>8.2</td>
<td>8.3</td>
<td>8.3</td>
</tr>
<tr>
<td>Married women</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-49 Years (percent)</td>
<td>17.5</td>
<td>16.4</td>
<td>16.0</td>
<td>18.5</td>
</tr>
<tr>
<td>Sex ratio (MF x 100)</td>
<td>117</td>
<td>118</td>
<td>121</td>
<td>103</td>
</tr>
<tr>
<td>Caste groups (percent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jat</td>
<td>40.8</td>
<td>56.3</td>
<td>55.0</td>
<td>50.1</td>
</tr>
<tr>
<td>Ramdasia</td>
<td>39.2</td>
<td>25.9</td>
<td>29.6</td>
<td>30.2</td>
</tr>
<tr>
<td>Others</td>
<td>20.0</td>
<td>17.8</td>
<td>15.4</td>
<td>19.7</td>
</tr>
<tr>
<td>Literate (percent)</td>
<td>34.0</td>
<td>31.5</td>
<td>40.8</td>
<td>45.5</td>
</tr>
<tr>
<td>Occupation of head</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of household (percent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer</td>
<td>33.6</td>
<td>48.8</td>
<td>42.5</td>
<td>47.4</td>
</tr>
<tr>
<td>Laborer</td>
<td>35.7</td>
<td>22.8</td>
<td>34.1</td>
<td>17.3</td>
</tr>
<tr>
<td>Other</td>
<td>30.7</td>
<td>28.4</td>
<td>23.4</td>
<td>35.3</td>
</tr>
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</table>
### Housing (percent)

<table>
<thead>
<tr>
<th></th>
<th>All mud</th>
<th>20.9</th>
<th>33.2</th>
<th>14.3</th>
<th>31.2</th>
<th>33.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Courtyard handpump</td>
<td>93.3</td>
<td>90.0</td>
<td>85.9</td>
<td>95.2</td>
<td>88.9</td>
<td>85.0</td>
</tr>
<tr>
<td>Lane drains</td>
<td>55.4</td>
<td>39.9</td>
<td>69.7</td>
<td>53.9</td>
<td>44.2</td>
<td>38.8</td>
</tr>
<tr>
<td>Electrified</td>
<td>42.8</td>
<td>46.1</td>
<td>32.1</td>
<td>24.3</td>
<td>42.2</td>
<td>28.6</td>
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</table>

### Farming

<table>
<thead>
<tr>
<th></th>
<th>Median land acreage&lt;sup&gt;b&lt;/sup&gt;</th>
<th>5.0</th>
<th>6.4</th>
<th>4.8</th>
<th>4.9</th>
<th>5.7</th>
<th>7.8</th>
</tr>
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<tbody>
<tr>
<td>Tractor users (percent)</td>
<td>17.7</td>
<td>26.5</td>
<td>18.3</td>
<td>19.9</td>
<td>8.2</td>
<td>22.8</td>
<td></td>
</tr>
<tr>
<td>Tubewell owners (percent)</td>
<td>21.3</td>
<td>36.9</td>
<td>28.2</td>
<td>30.8</td>
<td>27.2</td>
<td>33.3</td>
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### Household annual income and possessions (US$)

<table>
<thead>
<tr>
<th></th>
<th>Median total income</th>
<th>323</th>
<th>344</th>
<th>276</th>
<th>306</th>
<th>292</th>
<th>289</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median nonland income</td>
<td>162</td>
<td>178</td>
<td>145</td>
<td>187</td>
<td>77</td>
<td>75</td>
<td></td>
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<tr>
<td>Median value of possessions</td>
<td>508</td>
<td>679</td>
<td>586</td>
<td>560</td>
<td>521</td>
<td>572</td>
<td></td>
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</table>

### Accessibility (km)<sup>c</sup>

<table>
<thead>
<tr>
<th></th>
<th>To project center</th>
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<th>10</th>
<th>16</th>
<th>12</th>
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<th>n.a.</th>
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<td>To closest other facility</td>
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<td>To market town</td>
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<td>To city (Ludhiana)</td>
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</tbody>
</table>

CONT-N Control, nutrition project; CONT-P control—population project; HC health care; NUT nutrition care; NUTHC nutrition and health care (integrated) — nutrition project; NUTHC-P nutrition and health care (integrated) — population project; n.a. not available.

a. Individuals (primarily women and children) identified through provision of services and by means of other surveys, but not enumerated in the census, would increase the total population by about 5 percent in each experimental group.

b. Median of households owning land.

c. Mean distance in kilometers weighted by village population.
the armed forces. These villages have the highest median non-
farm income and highest percent of nonfarmer, nonlabor occupa-
tions. The literacy rate (46 percent), type of housing, and
availability of water were all best in CONT-N villages. Elec-
trification was, however, lower in these villages because one
control village had not been reached by the rural electrifica-
tion program at the time of the socioeconomic survey.

Conversely, important differences indicating lower socio-
-economic status were found in the other villages. The NUTHC
villages had the smallest percentages of Jat (high-caste farm-
ers) and the largest percentages of low-caste groups. These
villages along with NUTHC-P villages also had the highest pro-
portion of children under 3 years in the population, primarily
because lower-caste families have higher ratios of children to
adults. There was a smaller proportion of farmers (landowners)
in the NUTHC group, and this also was related to the caste dis-
tribution. Both NUTHC and NUTHC-P had the least agricultural
mechanization, as indicated by use of tractors and ownership of
tubewells.

In summary, these differences and others shown in table
2-1 should be kept in mind when interpreting the results of ex-
perimental group comparisons. If we had been able to select
villages with identical characteristics, it is possible that
even greater differences in the effects of health and nutrition
services would have been demonstrated between study villages
and controls. Similarly, the combined health and nutrition
villages may have shown even greater effects when compared with
villages receiving only health care or nutrition services.

METHODS OF DATA COLLECTION

Formal data collection within the experimental design
started only after a prolonged tooling-up period in which phy-
sicians and public health nurses developed and refined test in-
struments. It was also necessary to develop methods of train-
ing the FHWs, who not only provided services but also gathered
research data in longitudinal and cross-sectional surveys.

Longitudinal Surveys

Each FHW was responsible for collecting data on morbidity, anthropometry, diets, vital statistics (births and deaths), and fertility. The morbidity survey was conducted weekly for each child up to 3 years of age in every village (including the control villages) of the nutrition project. Based on the mother's recall, a detailed record was obtained of both the incidence and the duration of all illnesses during the preceding six days as well as the day of interview. Local terms were used in a standardized format to define illnesses according to a list of forty-four clinical signs and symptoms. This history was supplemented by a physical examination, which obviously had to be limited to the day of the visit. For children who had been outside the village for more than fourteen days, recall data were collected for the preceding two weeks.

Anthropometric measurements (weight, height, and, from 1971 on, head circumference) were recorded in the ten villages of the basic nutrition project and in the four child service (NUTHC-P) villages of the population study. These measurements were made at intervals conforming to the decelerating rate of growth of children over the first 3 years of life so that in each time period there would be an expected average weight increment of 250 grams. Measurements were scheduled once every month for the first 9 months of age, once every two months between 9 and 21 months, and once every three months between 21 and 36 months. Measurements were taken on the day of the month corresponding to the birthday, plus or minus five days.

Initially, the FHWs in nutrition care villages gathered simplified recall data for a dietary survey that was developed to monitor feeding and weaning patterns and to provide feedback for individual and group nutrition education. Later the survey was expanded to all villages to measure and compare specific program effects relating to breast-feeding and weaning-feeding
patterns. This dietary survey was taken once every three months.

On a subsample of 170 children a detailed dietary survey was carried out to determine both qualitative and quantitative nutrient intakes in our study population. The methodology employed was actual observation and weighing of all food items consumed over a period of three consecutive days.  

Vital statistics information was collected in three ways: by the FHW in the course of her regular activities; by special vital statistics investigators, who collected information from a group of eight to ten selected informants in each village once every two weeks; and by the village watchman (chowkidar), who is the government's source of vital statistics information from rural areas. Vital events were recorded as they occurred, with separate forms for births and deaths being turned in monthly to the Narangwal data pool.

A fertility survey every two months served to identify pregnancies early in order to start prenatal care, to prepare for the impending arrival of a newborn to be included in the study, and to establish menstrual patterns in a normal population of village women. This information also helped in the very difficult task of getting precise numbers of live births and stillbirths and of detecting early child mortality. Most of our problems in getting valid vital statistics arose because local cultural practices dictated that mothers go to their parental homes in another village for their first two or three births. This meant that for about one-third of the births mothers were absent from the village for several months before and after delivery. The fertility form was designed to monitor pregnancy status and menstrual patterns of all married women 15-49 years old. In addition, it recorded the expected date of delivery, dates of prenatal administration of tetanus toxoid in HC and NUTHC villages, iron and folic acid supplements in NUT and NUTHC villages, information on the date of delivery, outcome of pregnancy, birth weight, and nature and dates of post-
nata care.

For every child attending village subcenter clinics, which were held five afternoons a week, a clinic record was maintained on which the FHW, the public health nurse, or the physician recorded the history, management, outcome, and follow-up of specific episodes of illness. These records were subjected to a detailed analysis of services.

Essentially, the same personnel simultaneously ensured the quality control of research data and supervised service delivery at the subcenter. The supervisory staff of physicians and public health nurses carried out routine checking of service records and scrutinized research records for completeness of recording, internal consistency, and comparability with other records. In addition, a specially trained FHW repeated a spot-checking assessment of a randomly picked subsample from the morbidity history and physical examination data one day after the regular FHW visited homes; this special FHW made her rounds about once every ten to twenty-one days in every village. An additional quality-control mechanism at the Narangwal Research Center consisted of a monthly scrutiny of the number and completeness of morbidity, feeding center, and vital statistics records. These were compared with monthly food and drug requisitions submitted by the FHW.

Cross-sectional Surveys

Cross-sectional surveys were conducted at approximately two-year intervals. Special teams of Punjabi investigators, most with a master's degree in social sciences, covered all study villages. They collected data on all households to establish population baselines and intermediate results. Principal surveys included census, recensus, socioeconomic status, pregnancy history, beliefs about child survival, anthropometry, dietary intake, and biochemical indices. The census records and pregnancy histories also contributed information on births and deaths.
CONTENT AND METHODOLOGY OF SERVICES DELIVERED

The services were flexibly adapted and improved as research information was analyzed and deficiencies were identified. The goals were to develop service packages for health care delivery that were sensitive to the needs of a rural Indian preschool population and realistic with respect to the manpower and budgetary constraints prevailing in the country. At the same time, we were constantly testing new approaches that might have the potential of increasing program effectiveness.

The experimental design imposed the need to develop packages of field-tested and carefully selected activities that fell within the competence of auxiliary workers and that could be adapted to national programs. Keeping in mind the present distribution of health manpower and facilities in India and in most of the developing countries of the world, we developed services according to the following basic principles:

- Maximum delegation of responsibility to auxiliaries with the minimum training consistent with good care
- Primary health care provided as far as possible at the periphery
- Good communication and medical back-up from the center
- Emphasis on preventive measures applied to the total population
- Early diagnosis and treatment to prevent disease progression in individuals
- Home contacts in approximately equal balance with clinic contacts
- Regularity and consistency in logistic support using simplified and appropriate methods
- A pervasive system of supportive supervision providing interactions among all members of the health team.

Rather than waiting for parents to seek crisis care, both nutrition and health care approaches relied on surveillance techniques to identify problems early. Most service activities were based on early diagnosis, prompt intervention, and stan-
Since FHWs had to provide health services as well as maintain research activities, each was assigned responsibility for 75-95 children under 3 years of age in the NUTHC villages and 90-120 children in other villages.

**Nutrition Care Villages**

NUT services consisted of surveillance, selective food supplementation, and nutrition education. The intensive surveillance system was based on regular measurement of weight and height. Participation of malnourished children in the food supplementation program, though voluntary, was encouraged mainly through social pressure in the community. When the feeding program began, supplementation was limited to severely malnourished children below 60 percent of the Harvard median weight-for-age standard. Within a few months, as conditions improved, we included all malnourished children below 70 percent of the Harvard standard. In the last two and a half years of the project, any child in the village was encouraged to attend, but special attention was still focused on those showing a weight deficit. Twice daily, FHWs or feeding-center attendants prepared and distributed food supplements consisting of calorie-fortified milk in the mid-morning and porridge made from crushed wheat, milk powder, raw sugar, and oil in the mid-afternoon. Standard servings of the daily supplement, if taken on both occasions, provided approximately 400 calories and 11 grams of protein. Although children were allowed to eat as much as they wanted, few were able to consume more than one serving at a feeding session. Parents were also actively encouraged to provide increased amounts of food at home. Because the servings at the center were outside normal meal times, it was hoped that this would discourage substitution.

When children dropped below 70 percent of the Harvard median weight-for-age standard, a special effort was made to encourage their regular attendance at the feeding station. This
was sometimes difficult to achieve because most of the malnourished children came from the lower socioeconomic class and their families found it difficult to bring them. Specifically, their parents and older siblings often had to work all day in the fields of landowners and did not have time to bring small children to the center. This occurred most often during the harvest, when infants and toddlers were left in the care of siblings only slightly older than themselves or, at best, with an old and usually ill relative. Under these circumstances nutrition center attendants delivered food directly to homes and supervised the feeding.

Nutrition education programs concentrated on encouraging late weaning (beyond 18 months) and consistent supplementation starting at 4-6 months of age. During the diet history, every three months the FHW learned about the diet provided, tried to correct practices found to be faulty, and reinforced the need for breast-feeding and good feeding habits. Nutrition education classes for groups of mothers and dais (traditional village midwives) were occasionally held. These meetings were organized mainly for mothers of malnourished children.

Health Care Villages

For children up to 3 years old the HC service package developed included curative and preventive care for common illnesses (especially infections), immunizations, and education to improve general hygiene. The main emphasis was on surveillance for early diagnosis and treatment. Cases were identified either through home visits or in village clinics. Home visits were made in the mornings and clinics in the village subcenter were held in the afternoon five days a week. Emergencies were seen in the home or clinic at any time. For children through 14 years of age, curative services were available on demand.

During the weekly morbidity survey, children with any kind of illness or injury were treated in the home or were referred to afternoon clinics, if necessary, for a more intensive work-
up. Children who became ill between home visits were brought by a parent or sibling to the afternoon clinic. A physician visited once a week in all HC and NUTHC villages and every three weeks in the NUT and CONT-N villages to see only those patients who had been screened and referred by the FHW. The physician also made follow-up visits to patients previously seen by him, and met with village leaders to discuss new programs or community problems. For emergencies, FHWs could summon a physician from the Narangwal Center at any time, usually sending a note by a family member on a bicycle.

In all villages of the project, smallpox vaccination continued to be provided by the government health services. In addition, the FHW routinely gave primary vaccinations to all children missed by the government vaccinator and eventually to infants born between vaccination rounds in HC or NUTHC villages. She also gave diphtheria-pertussis-tetanus (DPT) immunizations to preschool children and tetanus immunizations to prenatal mothers. BCG, for tuberculosis, and measles immunization were provided on a campaign basis because of the necessity for refrigeration of both vaccines and because the relatively small number of children to be vaccinated in a village made the use of standard BCG ampoules containing 50 doses uneconomical. In NUT and CONT-N villages only a small minority of the children were reached by government programs for vaccinations other than smallpox, except that in the last year of the project two NUT villages were included in a governmental BCG program.

**Integrated Care Villages**

The NUTHC villages received both the nutrition and health care inputs. These services were, however, carefully integrated. Home visits were scheduled to take care of multiple activities simultaneously, and clinic visits were scheduled to promote efficient coverage and reduce waiting time for family members. A deliberate effort was made to link activities so as to mutually reinforce acceptance and learning of simple preven-
OBJECTIVES, DESIGN, AND METHODOLOGY

tive measures.

Control Villages

In the CONT-N villages, no services other than symptomatic care on demand were provided. Symptomatic care was limited to aspirin, gentian violet, and boroglycerin.

The prospect of collecting data on sick children who might have died if no care were provided raised serious ethical issues that led to a compromise arrangement. In the NUT, HC, or CONT-N groups of villages, if in the opinion of two physicians (one if it was an acute medical emergency) a child would either die or suffer permanent loss of sight if therapy were not instituted, then full treatment (either medical, nutritional, or both) was provided on an emergency basis. Such a child was then statistically tagged as a "technical knock-out" (TKO) and, from then on was eligible for full treatment. At the time of analysis these cases were handled separately in calculating "fatalities."

PERSONNEL

The physicians shared responsibility for the overall running of the project. They served as medical consultants to whom both the FHW and public health nurse (PHN) referred those children who required specialized or emergency care as indicated in standing orders.

The Physician

The physicians were actively involved in the writing of standing orders and manuals, and assisted the PHNs in the preparation and implementation of training programs. A special responsibility of the physicians was to determine as accurately as possible the cause of each child death in study villages. As soon as possible after the death, the physician questioned family members, the FHW, and relevant private practitioners and hospital personnel about the terminal illness. All available
records such as growth charts and morbidity and clinic records were reviewed, and a provisional cause of death was established. Subsequently, the physician presented his findings from this "verbal autopsy" at a staff conference, and a "most likely" cause of death was agreed upon.

The Nutritionist

Although her qualifications and experience were in biochemistry and research on growth and development, the nutritionist was mainly responsible for central administration and supervision of the food supplementation program. She also planned and implemented more specialized nutrition research activities and laboratory work for several ancillary studies.

The Social Scientist

Leadership for project planning and implementation was shared by a group of project social scientists. They were responsible for negotiations with the villages and for action programs requiring community participation. They maintained a community profile and helped with community diagnoses and in the planning of community action. It was necessary that they develop a whole new philosophy of being part of the health care team rather than individual research scientists. For instance, they were to respond to an outbreak of rumors in the same way our epidemiologist physicians responded to an epidemic. On an emergency basis they mounted a diagnostic field investigation and appropriate countermeasures. They also supervised the team collecting periodic survey information on census, socioeconomic factors, and attitudes and beliefs.

The Public Health Nurse

The FHWs' direct supervisors were the PHNs. The PHN played a major role in the proper functioning of both day-to-day services and research activities. She was responsible both for supervising FHWs, served as consultant, teacher, and a member
of the primary health care team, and was also responsible for quality control of the data collected by FHWs. She formed the main link in integrating research activities at Narangwal with the village subcenters. She was actively involved in the designing, pretesting, and revising of both service and research records and had primary responsibility for planning the ongoing auxiliary training program. A very important function of the PHN was the elaboration and coordination of village work schedules and the preparation and revision of the content and methodology of standing orders and work manuals.

The Family Health Worker

Throughout the project the theme was publicly pronounced and frequently reiterated that the FHWs were the most important members of the health team. The family health workers in the nutrition project all had previous training as lady health visitors. In government services, lady health visitors are primarily used to supervise auxiliary nurse midwives (ANMs), who work in subcenters of both urban and rural primary health centers. The curriculum for training FHWs provided experience in home visiting as well as the preventive and curative aspects of child and maternal care. The basic education of FHWs was two and a half years in addition to high school.

FHWs were selected by the usual practice in India of advertising in local newspapers that a specified number of positions were available for graduates of schools for lady health visitors. Preliminary screening criteria for applicants included academic performance and references. Candidates invited for interview were given a variety of tests for practical performance and a "nonverbal logic test" (Ravens Matrix Test). They had to be able (or willing to learn) to ride a bicycle and live by themselves in a village. We especially tried to assess their attitude toward village people through nonformal tests such as role playing as a measure of adaptability to village life.
Following their selection, FHWs went through an intensive orientation and training period to acquaint them with the specific service and research requirements of the project. At the outset, the FHWs underwent 18 weeks of training at the Narangwal Center. As the project progressed, the preservice training period was shortened to six weeks in all, without apparent loss in learning technical skills as well as ways of working with village people. A particularly effective pattern was established of one week in Narangwal followed by two weeks mostly spent in the field living with an experienced FHW and her supervisor, followed by three weeks spent alternately in the field and at the Narangwal Center. From the beginning it was recognized that the most important training would be on-the-job under the guidance of the PHN and physician.

During the first week of the preservice training the main emphasis was on telling the FHW what her work was going to be and helping her to become familiar with the aims and objectives of the research. Her specific duties were systematically explained both in relation to the kind of services she would provide and the survey data she would collect. In learning home visiting techniques she was trained in approaching and establishing rapport with village women, asking questions appropriately, and listening to and recording women's responses.

Starting in the second and extending through the third week, the new FHW repeatedly spent several days at a time with an experienced FHW at one of the established village subcenters to observe day-to-day functioning of routine service delivery and data collection activities and to become familiar with specific child care and family care services as well as with the necessary administrative work. This alternated with periods back at the Narangwal Center at which times she had a chance to get her questions answered and get theoretical training. More important, this period gave the FHW an intensive exposure to what had been learned in the project about personal ways of adapting to village life. The fourth and sixth weeks were
again spent living with an experienced FHW in a village sub-center to get practical experience. The fifth week was spent in Narangwal to review basic knowledge and skills relating to child care, nutrition, and family planning. This alternating process of exposure to practical experience and theoretical training provided the trainee with opportunities to get practical questions answered as they came up, and learning was greatly accelerated. Following completion of the six weeks of preservice training, new recruits were sent to work first at one of the larger villages, where two FHWs were normally stationed, so that they could get support as needed.

Two of the more experienced FHW's were assigned as "releevers" with temporary responsibility for a village during absences of the worker normally responsible for that village. Experience was essential for such a position since the FHW had to perform in any of the four input cells and had to be familiar not only with each of the specific work routines but also with the geographic arrangements of all villages.

Initially every week, and later every fourteen days, FHWs from all villages come to the Narangwal Center for a full day of formal training sessions. These trips also served administrative purposes ranging from getting their pay to picking up their quota of medications and food supplies. During these training sessions, their basic knowledge and techniques were reviewed and upgraded, and specific case presentations were analyzed in detail by the peer group. Especially useful were discussions in which they presented problems they had encountered in daily routines, and the whole group jointly worked out appropriate solutions.

This pattern of continuing education was an extremely efficient way of augmenting knowledge and skills in direct relation to specific problems emerging from daily work. The bi-weekly training days also proved to be an extremely important means for maintaining morale. It was the best time for the professional staff to learn from the day-to-day experiences of
FHWs as they shared their insights and understanding of village problems. During discussions, one would frequently hear, "I had that problem and this is how I solved it." Or, a lengthy discussion on how the problem might be solved would lead to various FHWs' trying out different ideas and receiving feedback in an evolutionary, problem-solving approach.

Special topics for training discussions included preparations for nonroutine programs such as immunization campaigns, organization of day care centers during harvest, methods for special cross-sectional surveys, and recognition and management of high risk diseases. For instance, prior to the onset of the diarrheal season the signs and symptoms of dehydration, various methods of rehydration emphasizing especially the oral route, and the importance of close supervision and prompt referral of critically ill children were reviewed. Similarly, before the cold season, special attention was given to reviewing signs for recognizing lower respiratory tract infections and the treatment and assessment of the progress of pneumonia. Teaching methods included informal lectures, discussions, group workshops, case presentations, and role playing.

During the second part of the project, in addition to the training days at the Narangwal Center, every other week a three- to four-hour conference was held in one of the villages of each study group. These reviews of progress involved the physician, the PHN, FHWs from other villages of that group, and, in nutrition supplementation villages, the nutritionist. Village visits rotated so that each was covered every four to six weeks. During this conference, a random sample of service and research records was examined and criticized. The FHWs also brought up special problems and solicited help, especially from other FHWs.

Throughout the project, salaries of FHWs were kept at par with those for similar workers employed by the Indian Council of Medical Research (ICMR). Especially during later years, this level was below that paid by the State of Punjab to lady
health visitors.

Feeding-Center Attendants

Our main use of community health workers was in NUT villages, where local women were trained to serve as feeding-center attendants. Selection was carried out with the participation of panchayat (village council) leaders. Care was taken to determine that those selected were acceptable to all segments of the village. The most important requirement was that the attendant be willing to work intensively with low-caste people. They became extremely capable in handling the multiple responsibilities associated with preparing and distributing food and in providing follow-up for children identified as being in special need.

A second program was to work with and train village dais (indigenous midwives), but, despite excellent results with some dais, our coverage never became sufficiently great to have a systematic impact.

STANDARD OPERATING PROCEDURES

The basic daily work routine was similar in all villages and consisted of home visiting during early morning hours, a one- to two-hour lunch break around noon, work in the subcenter until late afternoon, and then more home visiting in the early evening. During the morning home visits, most of the ongoing longitudinal survey data were collected. Evening home visits were for follow-up visits, home treatment, immunizations, and the completion of unfinished surveys. At the subcenter daily clinics were held, routine anthropometric measurements were taken, and day-to-day administrative chores were performed. In control villages the FHW understandably spent considerably less time in the clinic. In villages receiving nutrition services, the FHW was responsible for the supervision of feeding-center attendants and the proper functioning of the feeding center.

Once a week a PHN visited each FHW and spent at least half
a day in each village to check and discuss all aspects of the work. These visits served both as informal training sessions and as problem-solving opportunities. Supervision was supportive and educational rather than punitive.

The many sociological and cultural problems in each village included complaints arising from competition between village factions, cultural resistance to services offered for the first time, dissatisfaction of family members with the behavior of the FHW and vice versa, and rumors and misunderstandings in our relations with traditional practitioners. Such problems were first handled by the FHW; if she was unsuccessful, she would ask the PHN for help; if the PHN also met with little success, the physician tried to work out a solution; finally, if all else failed, a project social scientist was called in.

VILLAGE PARTICIPATION AND INTERACTIONS

A sincere effort was made not to interfere with established village routines, beliefs, and practices. Where local traditions were contrary to our program purposes and efforts, we patiently tried to educate the individuals or communities involved, first to create awareness of a problem and then to get their cooperation in finding a solution. In our relations with indigenous practitioners and dais, we developed a focused methodology of classifying their practices according to whether the effects were favorable, neutral, or dangerous. We then concentrated our educational efforts on trying to modify what was dangerous and supporting the rest of their work. Some treatments prescribed by indigenous practitioners produced effects opposite to our treatment. For example, in diarrheal disease it was traditional in families to withhold food and fluids, thus precipitating dehydration and malnutrition. Traditional treatment also included giving herbal powders, some of which increased stool frequency to get rid of the "poison."

Resistance to our services was mainly among some families who did not want to have babies weighed. Specifically, there
was a strongly held general belief that marasmus (known locally as sokha which means "drying up") was caused either by "evil eye" or by parchawan ("shadow of a spirit"). Comments about a child being well-nourished were believed to produce envy among spirits and neighbors, and the resultant evil eye would make the child wither. Parchawan is the casting of a shadow, however fleeting or casual, on the child by any "impure" person. Mothers with marasmic children, a marasmic child, and even menstruating women were among those who might cause parchawan. Because these beliefs were firmly held, we took great precaution not to make public remarks praising a child and commenting favorably about the child's being healthy. Care about such cultural considerations permitted good coverage of growth surveillance. In addition, the custom of having mothers go to their parental home for the births of the first several children also made it difficult to get birth weights and weights of children up to 1 month old.

COMMUNITY PARTICIPATION

A general objective was to promote direct participation of village communities in service activities and to help the communities learn how to solve their own health problems. We were totally dependent on village cooperation, and much time was spent in negotiations with panchayat members. Throughout the program, villagers assisted in the organization and execution of all major activities such as vaccination campaigns and community education. They provided buildings for the village sub-centers and feeding centers.

We observed early in the study that a disproportionately large number of children became malnourished and ill during or at the end of the main harvest in May and June. At this time most villagers, and especially lower-caste women, were in the fields all day working extremely hard to bring in the wheat harvest. If their children were able to walk, they were taken along or were left in the care of a slightly older sibling or
an elderly or sick relative; occasionally they were left in the home alone. In addition to receiving little care, the baby had to adjust to temperatures often between 40° and 47°C (110° and 118°F) for as long as ten to fourteen days at a stretch. Most children lost considerable weight. If they became ill with diarrheal disease or fever, they rapidly became dehydrated and required emergency care. A demonstration day care center was organized and first run by FHWs in one of the smaller villages. Because everyone agreed that this had worked well, the next year we suggested that the village provide food, furniture and recreational equipment, and payment in the form of a special allocation of wheat from the harvest for two locally recruited mothers to look after the children, cook, and generally assist the FHW. Satisfaction was so great that the program was later expanded to other villages.

Similarly, another almost accidental event led to a worthwhile general pattern. In mid-1971 we temporarily ran out of wheat in four of the feeding centers. Volunteers from the village panchayat went from house to house and collected enough wheat from landholding farmers to last until the end of the year. This suggested that it would be a reasonable general principle to have the panchayat collect grain from the farmers at harvest time and store it for use as needed. Again in mid-1972 when we temporarily ran out of powdered milk, community leaders in two villages were sufficiently concerned to collect pledges for enough fresh milk to keep the program going until a new stock arrived.

POSSIBILITIES FOR WIDER PROGRAM APPLICATION

The reason for this detailed presentation of the service patterns developed at Narangwal is to help future implementation of primary health care in general governmental programs. Specific activities obviously need to be adapted to local conditions, even for the various parts of India.

The most complete exposition of the actual work routines
is found in the two manuals that were published from Narangwal. The *Child Health Care in Rural Areas* manual\(^4\) presents a detailed statement of each of the activities that were found to be useful. Similarly, the *Manual for Child Nutrition in Rural India*\(^5\) gives a straightforward and simple description and justification of the nutrition components of the work. Both are widely available in India as training and reference manuals for auxiliaries and as home treatment reference books for middle-class mothers. From this experience we are convinced that the only right way to write a manual is during a field project on the basis of practical measures that evolve locally from day-to-day work in village homes and subcenters.

Finally, before the definitive research data are presented in chapters 4-9, we would like to stress that Narangwal-type services are eminently feasible technically and financially and can be readily adapted to other situations. We never expected administrators, even in the Punjab, to implement totally what was learned at Narangwal. The final cost-effectiveness calculations provide a sort of cafeteria choice of interventions, each with an approximate price tag. Administrators can select from these and adapt a combination or program mix that is most appropriate to each local setting and to local political and economic conditions.

**NOTES TO CHAPTER 2**


3. A detailed description of the dietary survey techniques and their validation and of ensuring results is given in Chapter 5.

4. Narangwal Rural Health Research Centre *Child Health Care in Rural Areas: A Manual for Auxiliary Nurse Midwives*. New Delhi:
Current worldwide concern for basic human needs and social justice leads naturally to higher priority for primary health care.\textsuperscript{1,2} Inequities that result in differential access to services require direct measures designed to meet the main health problems of those who have been deprived of entry into an appropriate health care system. The most important contribution of the Narangwal research is the hope it offers that access to health services can efficiently and effectively be extended to the poor. The types of services that were developed eliminated most of the prior inequities in access to care for the children in greatest need.

The practical interventions tested in this research are especially relevant to world needs because about half of the child mortality and much of the growth retardation in developing countries appears to be caused by synergism between malnutrition and common infections.\textsuperscript{3} Programs to reduce such synergistic interactions would profoundly improve health status among the children of the poor. Our research refined understanding of the dynamics of the interacting variables that produce such synergism in human populations. More important, we have demonstrated ways in which nutrition and infection control can be combined to produce a synergism of health programs to compensate for the synergism of health problems. In the past, improvement in the health and nutritional
status of children occurred spontaneously as a result of general socioeconomic development. It is not necessary now to wait for general development, since measures are available that contribute directly to improving the quality of children's lives. The process of implementing national programs obviously has to start with political commitment among national leaders. Decisions that lead to successful programs, however, require assurance that there is a technological and organizational framework that can be applied within the constraints of the financial and manpower resources available in any country. A selective approach is needed in health planning to put together appropriate combinations of interventions that will produce the greatest health and nutrition improvement at the least cost. Careful adaptation of findings from this and similar research to the particular conditions of each country can provide such a technology and framework.

POLICY CONCERNS RELATING TO EQUITY IN DISTRIBUTION AND INTEGRATION OF SERVICES

This project made no effort to study the broad policy questions -- such as food production, pricing policy, marketing, and distribution -- that have been the focus of most nutrition reports. Similarly, we have not been specifically concerned with the focus of most demographic research, which looks at macro-level population and program data in terms of general sociocultural and economic factors, or of most health policy research, which studies specific factors related to disease.

Contribution to General Socioeconomic Development

Even though these issues have not been the primary concern of this research, we recognize their importance in interpreting our results. The rapid improvement in food production and economic level in the Punjab obviously influenced our findings. We started with the situation as we found it in
Punjab villages and obtained considerable information about the socioeconomic status of households. In the analysis these were considered background variables and not variables that might be directly manipulated. Our primary care program showed the people that change was possible and thus contributed to general attitudes conducive to development in these villages.

The situation in the Punjab challenges many current preconceptions about nutrition programs. The fact that 25 to 35 percent of children at various seasons were malnourished in spite of considerable food surpluses meant that just providing more food would not be useful. Since there was abundant food available in these Punjabi villages, the nutritional problems would not be alleviated by increasing production at the macro level. It was clear that the usual types of feeding programs would be irrelevant because they tend not to be used by the most needy children, who are too poor to go to school or are unable to get to local feeding centers. In addition to the direct health and nutrition services that were provided, solutions were sought through two types of social mechanisms.

First were measures to meet the obvious need for more equitable distribution. Many findings from this research demonstrate that malnutrition and poor health occurred mainly in socially and economically deprived families. Mechanisms at the community level to ensure equity in distribution had to be developed specifically to focus nutrition and health care on high-risk children. We disagree with the idealistic mythology that seems to assume that communities will automatically take care of their problems if just given resources. The reality is that turning development activities over to communities as presently structured may simply strengthen local exploiters who are in positions of authority because they have most successfully gained control of community resources. These leaders have to be educated to see that it is in their own best interest to ensure the development of the poor.
One of the most important changes that occurs in the development process is when people begin to recognize that shared progress for the community as a whole is possible and that benefits for those who have will be jeopardized by continued deprivation of those who do not have. Cooperation becomes possible when the community orientation is turned away from a "zero-sum" view of the future that leads people in traditional communities to consider any benefit for one family to be at the expense of their neighbors. Surveillance activities showed where the real problems were and focused on mechanisms to encourage local leaders to understand that the whole community would benefit if better care reached everyone, with special attention given to those in greatest need. Although not focusing generally on community development, this project showed that integrated child care services can provide almost total coverage and can stimulate the enthusiastic and continuing support of the village leadership in promoting equity.

The second mechanism that produced a broad social impact was our deliberate educational effort to change family lifestyles and patterns of raising children. For instance, there was a strong belief in the supernatural causation of severe marasmus, and when a siyana or faith-healer pronounced a child to have sokha, or "drying up," it was equivalent to an inevitable prognosis of death. A dramatic recovery as a result of intensive nutritional support produced major changes in people's view of the future, fatalism, and the potential for change, especially if it were carried out right in the home. Our main educational effort was through intensive one-to-one, service-based teaching of mothers. The quality of mother-care is the most powerful force influencing the growth and survival of children. It is mothers, not doctors, who are the most important health care personnel around the world. The high prevalence of childhood malnutrition in the food-surplus Punjabi villages was due mostly to poor feeding practices and the
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metabolic drain of common recurrent infections. The most important long-term effect of the Narangwal nutrition project in these villages will probably be what was done to change the general patterns of child care in the homes through the personalized educational approach in daily relations with family health workers.

A New Definition of Program Synergism

Demonstration of synergism in public health programs requires a conceptualization distinctly different from synergism as defined in laboratory or clinical research, in which the combined effect of two factors can be shown to be measurably greater than the sum of their separate effects. If one were measuring synergism between malnutrition and infection in a laboratory experiment, the usual procedure would be to produce a full-scale nutritional deficiency and a significant infection in laboratory animals. Control groups would be needed to provide comparison not only with normal animals but also with groups with each condition alone. Impact would be measured by a single outcome indicator such as mortality. Similarly, synergism between two clinical treatments would usually be measured by full doses of each therapy on single outcome indicators.

In planning this research it became evident that to measure program synergism we would have to change radically the conceptual approach. In the first place, it did not make sense to introduce full programs for nutrition and infection control simultaneously into the combined care (NUTHC) villages. For practical purposes in eventual program implementation we needed to know what happened when the two services were truly integrated, not merely juxtaposed. The issue was not to measure the impact of two workers, one for nutrition and one for health, in the same village but rather whether a single worker doing both nutrition and infection control could produce greater impact than a worker who did only nutrition or only
health services. The actual input into the NUTHC villages was carefully measured by work-sampling techniques and was shown to be only slightly more than the input into each of the single service (NUT and HC) villages.

A second major difference was that we were less interested in whether the combined approach had a synergistic impact on a single outcome indicator (that is, growth, mortality, or morbidity) than we were in trying to judge the total impact on multiple indicators. When synergism was demonstrated for a single indicator, it showed that the effect was strong indeed because it had been achieved with only a partial input of either service. In actual fact, much more nutrition input went into NUT, and more infection control effort went into HC, than was provided for each service in NUTHC. Except for a few outcome indicators such as psychomotor development, mortality in children 1-7 days old, and duration of eye infections, combined services were usually not even additive in producing a greater impact on any parameter measured than was produced by a single service alone.

We knew that some indicators would respond primarily to nutritional inputs and others primarily to infection control inputs. The most important synergism in program terms, therefore, would be if we could show that for a total combined input essentially equivalent to each of the separate inputs we could get the multiple benefits of the nutrition program plus the benefits of infection control. To estimate overall impact on health it is necessary, however, to speak in qualitative terms because we have found no way of quantifying the equivalence of deaths to days of illness and to growth measurements. The final results were clear in that the combined services did in fact produce almost as much impact on mortality and morbidity as health care alone and also almost as much effect on growth and development as nutrition alone. The total effect on health was therefore greater than either of the separate services, and this combined impact is clear-cut evidence of
synergism, even though it cannot be reduced to a single set of numbers.

A third consideration is important in making judgments about whether the usual definition of program synergism might in fact be found under other conditions more often than the few instances in which we were able to demonstrate it. By all socioeconomic and health indicators, the combined care villages had the worst initial health status, nutritional levels, and socioeconomic and environmental conditions. Since final comparisons were made between service and control groups at the end of the project, we did not show as much impact as probably would have been evident if we had attempted to quantify relative improvement.

Advantages of Integrated Services

At least five potential benefits of integrated services have been identified.

1. The first is the program synergism discussed above. Integration was justified in terms of efficient use of resources because the combined cost of nutrition and infection control program components in NUTHC villages was less than the sum of individual costs in NUT and HC. This includes important savings in the use of transport, facilities, drugs, and supplies that have to be duplicated if programs are run separately.

2. Integration also produces greater organizational efficiency. The greatest shortage in most countries is of skilled mid-level management personnel. In the past, the best managers have typically been drawn to the more glamorous categorical programs, which have had international support and opportunity for international fellowships and travel. Basic health services, into which the categorical programs are eventually supposed to integrate, have tended to remain undeveloped, and the "territorial imperative" of protecting the area to which they have become accustomed makes it natural for
leaders of categorical programs to attempt to show that the
good of attention to their area of interest would suffer if
it were turned over to integrated services.

Once integration is carried out, the savings in numbers
of people employed will be primarily at the periphery. How-
ever, there are invariably problems in providing adequate
supervision to ensure attention to activities that have been
taken over from the separate categorical services. The most
peripheral workers should provide integrated services, and so
should their direct supervisors. Since much of the program at
Narangwal depended on home visiting, efficiency was greatly
increased by scheduling activities so that one visit could be
used to carry out several functions. Standard rosters were
developed to facilitate such scheduling and supervision.

At the next level in the health hierarchy there should be
specialists responsible for the highest-priority activities.
They should have responsibility for surveillance in their area
of interest and ensure that appropriately focused effort is
mobilized when previous achievements are being eroded.

The greatest problem in this process is that integrated
workers are usually overloaded. Since it is obviously impos-
sible for them to do everything in their job description, they
spend as much time as possible in the activities that produce
the greatest community response and personal gratification.
These activities invariably are in acute clinical care, and
this leads to a gravitational pull away from preventive and
surveillance activities. Integration does not mean that work-
ers should be expected to do everything in a vague and uncoor-
dinated way, but that a limited set of tasks should be defined
to attack the highest-priority problems. As was demonstrated
clearly at Narangwal, three approaches are necessary to ensure
balanced attention to priority activities: first, a clear un-
derstanding of what the priorities are, preferably with full
participation in their definition by the community; second,
reducing the size of the population to be covered as the num-
ber of activities in integrated services is increased; third, a tight system of surveillance, accountability, and supervision to ensure that a reasonable work load is carried out systematically.

3. The project also demonstrated the possibility of more efficient use of training resources in preparing peripheral primary care workers for a redefined set of responsibilities. It was possible to train family health workers (FHWs) to carry out the whole range of combined activities with little more training than for a more limited range of tasks. Our experience in other situations suggests that it is probably harder to retrain a single-purpose worker to become a multipurpose worker than it is to train workers from the beginning to perform integrated tasks. It is possible for training to be added to incrementally as work responsibility expands, but for such a system to succeed it must be planned from the beginning so that workers are prepared psychologically to accept wider responsibilities.

4. The fourth reason for integration is that the long-range rapport and acceptance needed for effective community participation can be achieved most permanently through programs that address multiple concerns. Since health and nutrition are both important in the minds of the people, the combined services generated greater social support. High demand for immediate care increased the acceptability of other activities about which people were ambivalent. One of the reasons for the remarkably high level of cooperation with health surveillance, preventive activities, and family planning in the parallel population project was that village people trusted FHWs completely because of rapport created through curative work.

5. Finally, quality of work obviously depends on worker satisfaction, and this was greater with a balanced mix of health activities, including direct patient responsibility. When we first started field activities we were aware that the
sheer numbers of ill children, the concerns of parents, and 
the status attached to successful healers might influence FHWs 
to pay attention primarily to curative work and to neglect 
noncurative activities. To forestall such a situation, pre-
ventive and surveillance tasks were emphasized in the contin-
uing education program, in village meetings, during supervi-
sory visits, and especially through a record system that in-
cluded appropriate reminders of scheduled tasks. Through 
careful training, supervision, and recognition for achievement 
in high-priority areas, FHWs accepted the need for such activ-
ities as organizing immunization rounds, establishing the 
practice of oral rehydration at home for diarrhea, educating 
mothers to prolong breast-feeding, and collecting routine sur-
veillance data. They did, however, express continuing reluc-
tance to work in either of the two control villages, where 
their tasks were limited essentially to data collection and 
to the simplest symptomatic care.

APPLICATIONS OF RESEARCH FINDINGS

The two major purposes of this project, as outlined in 
chapter 2, were to answer specific research questions and to 
define pragmatic field interventions to be implemented in reg-
ular government programs. In chapter 1 the detailed quanti-
tative findings relating to the first set of specific research 
objectives were summarized. This section presents some prac-
tical applications of these research findings that are based 
on experiences in developing the service packages used in ex-
perimental groups of villages. These program effects are 
presented according to types of services provided.

Prenatal and Perinatal Child Care

A cost-effective means of reducing mortality of babies 
at minimal cost in our study population was prenatal care with 
nutritional education and supplementation for pregnant mothers. 
The FHWs provided health and nutrition advice and iron and
folic acid for all women from the time that pregnancy was diagnosed. In addition, caloric supplementation was given to selected poor mothers in clear nutritional need. These relatively simple interventions had a dramatic overall effect because of the high prevalence of nutritional anemia in women and children and the low average birth weights (below 2,500 grams) in this population.

Almost as dramatic a means of reducing mortality at low cost was the control of neonatal tetanus. In the Khanna study in nearby villages ten years earlier, this complication from poor care of the umbilical stump at the time of delivery was the fourth most common cause of death overall. Our activities concentrated on two approaches. An immediate impact was achieved when women were immunized with tetanus toxoid to provide their babies with protective antibodies. We have evidence that immunizing all village women of reproductive age with a single dose of a new tetanus toxoid results in antibody responses that should provide adequate protection to their off-spring.

A somewhat slower approach was to train dais (indigenous midwives) to use aseptic techniques in cutting, tying, and dressing the umbilical stump. Education of dais also included improving obstetrical care during delivery to protect the baby as well as the mother from unnecessary trauma, a major cause of perinatal deaths. A program to develop good surveillance techniques for identification and early referral of mothers at risk was a part of the parallel population program. Surveillance techniques involving both dais and FHWs were being progressively improved but required much time and patience.

Medical Treatment and Infectious Disease Control
Components of Child Care

The most straightforward approach to prevention of infections is immunization. An effective immunization program for the common childhood diseases was established, but none of

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these conditions became sufficiently prevalent during the study period to show measurable impact.

Another approach to the prevention of infections is sanitation. We did not include such activities in this study. Punjabi villages already had a handpump in almost every home -- for convenience rather than for health reasons. There was no simple way to further improve water supplies significantly. Many years of health work in Punjabi villages had convinced us that achieving utilization of latrines and improving general hygiene would require a long-term effort. The only such activity that we promoted in this project was education about cleanliness in child care. In a general health care program, sanitation activities should obviously have a prominent place.

The most effective infection control measure in this project was a continuing program for morbidity surveillance that provided early diagnosis and treatment of common infections. The conditions of greatest concern were common diseases such as simple diarrhea, respiratory infections, and skin and eye infections. The first two are the major killers in village children in combination with malnutrition, and the last has been a significant cause of blindness. We did not expect to reduce incidence of these common infections except through general education about hygienic practices. However, a major finding of this study was the demonstration that efficient surveillance, early diagnosis, and simple treatment by auxiliaries sharply reduced both mortality and the duration of morbidity. The FHWs independently diagnosed and treated over 90 percent of health problems. Their effectiveness depended largely on a regular system of supportive supervision with weekly visits by a physician and a public health nurse. Special emphasis was placed on training sessions every two weeks in which field and supervisory staff worked out problems together, reviewed skills, and developed new competence.

Establishing simple methods for controlling major disease problems does not happen automatically, as we learned in the
special activities to reduce mortality from diarrhea and pneumonia, which are described in chapter 9. At the start we had to work within the official policy that the best care would be provided by referring acutely ill children to the doctor in the health center rather than by having auxiliaries treat such children immediately at home. Systematic efforts to change practices started midway through the project after careful monitoring of the causes of mortality identified diarrhea and pneumonia as still being responsible for 60 percent of child deaths. In group discussions practical measures for shifting care to the home were worked out. FHWs were intensively trained and supervised to carry out these measures and experienced a great sense of satisfaction in being able to initiate effective treatment themselves.

The simple measure that proved most effective in controlling diarrhea mortality was early and consistent oral rehydration in the home. The biggest problem in getting this accepted was that it seemed too simple both to our physicians and to FHWs. They had been trained to assume that the right way to treat rehydration was to refer patients to a health center for intravenous rehydration. A cultural constraint that added to the difficulty was the common tradition that all fluids were to be withheld when diarrhea occurred because it was correctly observed that one way of stopping diarrhea was to let the baby become dehydrated. One experience that helped in changing these attitudes was that, as part of the concentrated training effort, FHWs were encouraged to stay in the homes giving oral rehydration for however long it took to demonstrate that, even though the diarrhea was continuing, babies were improving. As a result of this kind of special attention, mothers learned to start oral rehydration on their own even before notifying the FHW. We closed the special rehydration unit we had opened in the health center because the few cases that needed intravenous fluids could be handled by the regular health center staff and facilities.
The problem with lower respiratory infections and pneumonia was basically similar, since analysis of time sequences showed that the main need was for immediate treatment. In this instance, however, it had been assumed that giving a penicillin injection before the patient had been seen by a doctor was beyond the capability of the FHW. We got official permission to test as a research question whether the hazards from prompt treatment would not be less than from continuing to leave cases untreated. New standing orders were formulated permitting FHWs to initiate penicillin treatment with arrangements for physician referral thereafter. The FHWs became remarkably adept at diagnosing pneumonia, relying mostly on the baby's patterns of respiration and fever. Under our supervisory system they did not overuse the treatment and tended to be more conservative than physicians in their use of penicillin.

A final practical lesson relates to the intensity of morbidity surveillance at different ages. The maximum drop in infant mortality occurred in villages where FHWs visited every infant approximately every week. At this age illness had to be monitored frequently to get care started promptly. By contrast, the frequency of monitoring used in comprehensive child care (FPWSCC) villages of the parallel population project (one home visit every one to three months, depending on age of child) proved less effective in reducing infant deaths. This longer interval was, however, fully effective in reducing mortality in children 1-3 years old. Since it will usually be difficult in developing countries to set up a system where health workers can make weekly home visits to all children, attention should be given to training village volunteers and mothers to carry out the simple type of illness monitoring needed to screen infants for serious illness. In a long-term program they could initiate simple care such as oral rehydration and bring the child to a subcenter when illness is more severe. The surveillance procedures were found to have a powerful educational impact and could be readily included in
Nutritional Components of Child Care

As with morbidity, the central activity in the nutrition program was systematic surveillance to monitor nutritional status. Worldwide experience with road-to-health cards for recording weight gain has been reinforced by experience at Narangwal, which shows that it is possible to help mothers learn that a child with faltering growth is a sick child. Growth monitoring therefore served both as an educational device and as the principal entry point for active nutrition supplementation.

At the start of the project we decided against trying to provide supplementation to all children in the villages. It was obvious that mere provision of food was not needed because we were in a food-surplus area. However, one-fourth to one-third of children were malnourished. An analysis of risk factors showed underlying inter- and intra-familial maldistribution related to measurable socioeconomic variables. The surveillance methods made it possible to focus nutrition care on children with incipient nutritional deficiency. In many nutrition programs great amounts of money and effort go into feeding well-nourished children while those in nutritional need remain unattended. The expense of monitoring weight and height can be easily justified because this makes possible the great savings that occur when food supplements do not get diverted to those who are not in need. The long-term objective should be to start a continuing educational process so that mothers and community members would themselves learn to make consistent use of relatively simple surveillance measures such as the regular weighing of children.

In most developing countries, just as important as providing food supplies is the need for a major effort to help mothers learn how to make better use of food. Much of the childhood malnutrition could be ameliorated by nutrients that
are already available in the village. The nutrition education activities that had the most positive effect seemed to result from person-to-person contact with FHWs. This occurred most naturally when FHWs and mothers were working together on a problem such as adapting the content of weaning foods to sharp seasonal shifts in availability in homes.

A detailed dietary analysis was done on a sample of children to provide information on the nutritional benefits that can be expected from different dietary intakes. Levels of dietary intake were defined, below which optimal growth did not occur in children. These levels were higher than Food and Agriculture Organization (FAO) and other current standards, presumably because the high prevalence of infectious diseases produced increased demand for nutrients.

As with rehydration for diarrhea and penicillin treatment for pneumonia, the definitive change in nutritional care of marasmus occurred as a result of progressive shifting of activities from the health center to the village feeding center and to the home. When the project started we established a nutritional rehabilitation unit at the Narangwal teaching health center that was specially staffed to provide intensive care for extremely marasmic children (below 50 percent of the Harvard weight-for-age standard and not improving with home treatment). The multicausal background included illness, poor weaning practices, or parental neglect because of large families or because parents were busy during harvest season. We eventually found that children who had become marasmic were rehabilitated most effectively by adjusting conditions in their homes or by arranging for regular attendance at a nearby village feeding center staffed by village women. This avoided the anxiety, fear, time loss, and cost associated with hospitalization at the nutritional rehabilitation center. As with the rehydration center, we were very soon able to close the nutritional rehabilitation unit because it was no longer needed after the full village program was effectively imple-
mented, and the only children who remained under 50 percent of the Harvard weight-for-age standard were high-parity female children whose mothers were unable to provide adequate attention.

One of the most positive achievements of nutrition education was prolongation of breast-feeding. Average duration of breast-feeding in NUT and NUTHC villages was extended by five months, from the age of 15 months to 20 months. A somewhat complex educational message had to be transmitted -- to start supplementation with weaning foods at the fourth to sixth month but then to continue breast-feeding as long as possible because this maintains protein content in the child's diet.

In educating mothers about weaning foods we faced the usual problem that families in developing countries customarily wean children directly on adult diets. An infant would normally be handed a piece of chappati (unleavened coarse wheat bread) to chew on. A major reason for this practice is the lack of fuel and time to make special preparations just for children. Therefore, simple methods of preparation needed to be developed, such as not putting spices in the dal (lentils) until some had been taken out to be added to the child's weaning food of wheat gruel. Such procedures obviously need to be adapted to local situations and the seasonal availability of foods.

PRACTICAL EVOLUTION OF PROGRAM PACKAGES

In addition to the results relating to specific research objectives summarized in chapter 1, this project had a parallel set of objectives for practical program development. To have discrete program packages that would serve as the experimental inputs into the cells of the research design, it was necessary to develop optimal sets of activities under field conditions. Each set of activities was designed to make the maximum impact through particular combinations of health care and nutrition intervention. Integration should be much more
than a simple juxtaposition of activities. Great effort went into working out the integrated combinations of services that were not only most efficient but provided services to those at highest risk. Through getting involvement of all field staff in identifying problems early, and through rapid feedback to work out solutions together, we learned a great deal about how a practical program can be implemented. The conclusions described in this section are based more on field experience than detailed analysis of data.

Balancing Epidemiologically Determined Need against Community Demand

Local services must evolve from sound epidemiological understanding of local patterns of illness. Too many services are planned centrally without flexibility to adjust to local conditions. As indicated repeatedly in this report, we found it especially important to set up a series of surveillance systems with simple indices and with rapid feedback for program improvement. To be effective, a health care program should be dynamic in shifting from one priority need to the next as conditions improve. To have such an adaptive approach, staff need to develop the capacity at the local level to use simple epidemiologic methods to make a community diagnosis. Such capacity should include the capacity to define local causal factors and to identify the most cost-effective interventions under local conditions. Balanced against this epidemiologically determined definition of need, there should be a parallel process of responding to community demand. Developing community capacity to express demand, especially among the poorest people in greatest need, may be difficult. By responding to their immediate concerns, often for curative care, it is usually possible to generate interest and cooperation in collaborative efforts to define underlying but difficult to articulate concerns. The people will then be more likely to help in getting continuing information for epidemiological
analysis and for the initiation of appropriate preventive activities.

Grouping Interventions According to Functions Rather Than Disciplines

Development of service packages involves selection of interventions that are focused on local priority problems, adapted to cultural constraints and convenience of the people, and grouped so as to encourage program implementation. In most health programs grouping of activities follows the disciplines of the specialists involved. For instance, nutrition activities are developed in accordance with what nutrition experts feel comfortable in doing; medical care has to fit doctors' preconceptions derived from hospital practices. Immunization programs should not automatically be grouped together for the convenience of infection control specialists, but should be included in primary care packages according to the convenience of families. Vaccines may differ greatly in target ages, routes of administration, location of service, and cold chain requirements to maintain refrigeration, and their administration should be grouped with whatever other activity has similar requirements.

We found that the appropriate approach is to start by conceptualizing the functions to be performed. The grouping of about a half dozen of the highest-priority interventions should be clustered according to the convenience of patients and where the functions can be best performed. For example, activities that require surveillance through home visiting can be worked out to fit together whether they relate to nutrition, infection control, or treatment. Similarly, functional categories such as clinic care, education, mass immunization campaigns, and supportive activities should be integrated mainly according to what makes sense to patients.
Selection of Auxiliaries

A complex but important principle relates to selection of the auxiliary workers who will provide most of the primary health care. It is essential to fit into whatever national manpower pattern has been established in order to facilitate training, licensure, and subsequent job openings. At Narangwal during the period of the research, the peripheral workers we retained as FHWs had to have a high performance level because of the research needs of the data collection. We decided on lady health visitors and auxiliary nurse midwives because they were already serving as regular staff in primary health centers and subcenters and were available. We retrained them to fit their new roles in the project. Part-time community workers were used mainly in nutrition activities. We encountered serious resistance to sending FHWs to work in their home villages because the strong factions (pattis) in North Indian villages make it very difficult for workers to cross faction lines in their own villages. In North Indian villages, one option that may have to be considered in implementing a community health worker (CHW) program is to have a part-time CHW for each of the two or three factions in a village.

As a follow-up of the Narangwal experience, we showed in the Companiganj Project in Noakhali District, Bangladesh, that a much simpler service program could effectively use CHWs as the principal providers of care. These village women were often illiterate but still extremely capable. Similar results with CHWs have more recently been achieved by several demonstration projects in India such as at Jamkhed, Kasa, Mandwa/Uran, and Vadu.

Supportive Supervision and In-service Education

Especially important for morale was a systematic approach to combining supervision with in-service education. This required intensive reorientation of physicians and public health nurses (PHNs) to accept a new kind of supervisory role. Doc-
tors had to learn that when they went as consultants to a village subcenter they were not to take over and subordinate the FHW into serving as an assistant. Instead they were expected to work through the FHW and support and strengthen her. The frequently reiterated slogan was that after a supervisory visit three things should happen: the capability, self-confidence, and prestige of the FHW should be greater than before.

For in-service education of FHWs we depended mainly on a general training day every two weeks when all staff were brought together to review problems and search for solutions. The FHWs told us what was or was not working, and together we developed better approaches. Sessions were organized around problems staff were currently experiencing in the field. Those of us who were supposedly running the project learned as much as the FHWs.

Size of Population to Be Covered

We learned a great deal about what is a reasonable population load for a primary care auxiliary to cover. Although these services concentrated only on children, it seems possible to extrapolate our carefully recorded experience to what would be a reasonable overall work load in government services. Numbers will obviously have to be adjusted according to whether or not village homes are conveniently clustered for easy visiting, as they were in the Punjab. A greater dispersion of population will obviously make it necessary to reduce numbers in the coverage load and to consider using more part-time workers from the community.

Our FHWs were able to provide comprehensive care for an average of about 100 children. Because at least half of their activities were devoted to research functions, they probably could have cared for about 200 children under 3 years of age in a purely service setting. Since child care is one of the largest components of total primary care, we estimate from this experience that an auxiliary could provide total coverage
for a population of about 2,000 under conditions as in the Punjab. This could be increased to the current goal of national health services in India -- one multipurpose worker for 5,000 population -- by making much more use of CHWs and eliminating some components of the services.

Use of Other Sources of Care

When effective new services were introduced into study villages, it was shown that they rapidly became accepted and heavily utilized by the community. In comparison with control villages, the number of ill children going untreated in study villages was reduced from 60 percent to less than 20 percent. The use of other sources of care was diminished but continued at significant levels in all villages. The fact that there was a persistent trust in local practitioners, whether qualified or unqualified, supports the usefulness of programs to upgrade the competence of all rural health practitioners as an adjunct to well-organized village-level services staffed by auxiliary workers. The need for selective retraining of rural practitioners has been documented in a recent report. A review of mortality data in the Narangwal area revealed that the majority of deaths due to dehydration associated with diarrhea was in children who received inappropriate treatment from both unlicensed and licensed private practitioners.

As mentioned earlier, even in villages in which FHWs were active, the use of other sources of care continued, and expenditures on them were far from negligible. Accordingly, we met with local indigenous practitioners individually and on occasion brought groups of practitioners to the project headquarters to explain what we were doing, to get their cooperation, and to try to neutralize the negative rumors about project services that were occasionally started. We tried to work even more closely with dais, to make them feel that they were members of the health team, but only about half of the dais chose to cooperate. In a separate project we conducted de-
tailed studies of their practice patterns and classified their activities according to whether they were beneficial, neutral, or harmful. We then began to develop methods to teach them to change those activities that were harmful.

Costs

In absolute terms, the costs of providing nutrition and health services to children under 3 years of age in the Narangwal nutrition project were about Rs150 (US$19.5) per child or Rs14 (US$1.8) per capita of the total village population per year (about Rs7 or US$0.90 per capita if government economies of scale could be realized). Since the costs per service contact were quite similar to government primary health center costs per contact, the difference in total costs between Narangwal services and current government services was due to the much greater frequency of contacts in the Narangwal project. Differences in mortality and health indicators amply demonstrated the effectiveness of the intensive Narangwal services in comparison with control villages, which had access only to private and government services. However, considerations of equity as well as political and economic realities would seem to dictate spreading currently available government health resources over total populations rather than concentrating on particular villages in intensive areas as was the current policy in the Punjab. Since there is a threshold beyond which spreading the coverage of services would seriously compromise effectiveness, rational health planning has to address the inevitable balance between equitable coverage and significant impact of services.

For eventual implementation of mass child health and nutrition programs, it would seem appropriate to explore alternatives to past national plans that promised free medical care to all but actually reached only a fraction of the population. An example of such an alternative that might produce maximum effects on child health would be to have communities pay more
of the costs of medical care. The primary health centers could then focus their limited funds on preventive services, surveillance, and early definitive treatment. The primarily symptomatic curative services that people are already paying for privately might be provided on a prepayment or insurance basis.

As mentioned above, the most important and feasible saving in personnel costs would be to train village people to take more responsibility for their own health care. Especially in surveillance, many of the tasks are relatively simple and repetitive. For example, weighing of infants and children on a routine basis could be handled by village volunteers. Similarly, simple morbidity surveillance could become a community responsibility.

Community Participation

Although it was not a major research objective, the Nar-angwal study produced some information about ways to promote community participation. In WHO terminology, "primary health care" differs from "basic health services" in that it not only builds up the peripheral components of the health system but also includes a major emphasis on promoting community participation and the involvement of other development sectors such as education, agriculture and so forth.

Primary health care includes all activities at the interface between the community and the health system. In this research we concentrated mainly on the health system at subcenter level, but we also gained some practical experience in promoting community involvement. For instance, there was little problem in getting villages to provide buildings for subcenters. Usually a part of a home was adapted for the purpose, and this proved highly acceptable culturally. This suggests that the current emphasis of international agencies on building facilities is misplaced. Putting money into new buildings that are more elaborate than village homes carries
the implication for community workers that their most important work will be in the subcenter rather than in the home and community. In the Punjab ecology, home visiting proved especially effective in reducing infant mortality. A high level of motivation and felt need seemed to be necessary to get mothers to leave home with their children; the preventive and educational activities that seemed to have the greatest health impact therefore had to be taken to village homes on a frequent and continuing basis. It was evident that the most effective way to discourage the FHWs from walking village streets and visiting the homes of the poor was to provide them with an excuse to sit behind a desk in a comfortable building filling out forms. It is our impression that this tendency will be true in most rural services in developing countries.

Another activity for which it was relatively easy to get community participation was in providing food for the feeding centers. Providing food proved to be the single most expensive part of the combined services. Again, food has been a favorite item for international assistance. We became concerned about the tendency to create dependency on outside food resources and in the latter part of the project began to explore the possibilities of developing among landholding farmers an awareness of their responsibility to help meet the needs of the landless. The most tangible evidence of community participation occurred when feeding-center supplies were delayed and community leaders went around at harvest time to get donations of food from farmers for the supplementation program. This was relatively easy in the food-surplus Punjab, where it became a matter of community pride. Our experience suggests, however, that much more could be done even in poorer communities. An approach that has worked in projects such as at Jamkhed in South India\(^1\) is to get the village to put aside land on which villagers cooperatively grow food to provide nutrition supplements for those in greater need.

Along with promoting community participation it is also
important to get individual families to take pride in and responsibility for maintaining adequate levels of nutrition in their children. In cases of malnutrition, individualized nutrition education to families focused on getting them to provide the necessary weaning foods so that their children would return to expected nutrition levels. The whole concept of surveillance of weight-for-age is built on the principle that making parents conscious of patterns of growth will help them to identify faltering of growth as an illness and will encourage them to take early and appropriate nutritional action.

A third instructive experience in community involvement was the development of day care centers. The finding that much of the child mortality was concentrated during the harvest season in May and June led to careful definition of the specific causes. The principal cause of death was severe dehydration resulting from a combination of high prevalence of diarrhea, extremely hot weather, and greatly reduced parental care because everyone was busy with harvest activities. These problems were most severe among the poorest agricultural laborers, whose greatest priority had to be concentrated on long hours of work to get the year's supply of food. Setting up day care centers generated cooperation in providing facilities, equipment and volunteer labor. It was apparent, however, that the organization of these activities and the process of making them useful for nutrition education depended largely on considerable effort by the FHW assigned to a village and other project staff.

We found that services provided through a well-organized, cost-effective integrated program of auxiliary-based services are feasible and greatly improved coverage and equity. It is not sufficient, however. Self-help within the family, committed community participation, effective involvement of indigenous health care providers, and intersectoral cooperation are also important.
Relation to Population Growth

Prospects for long-term development in a country depend on maintaining a balance between the number of people and resources. The interactions between mortality and fertility are two-way. Family planning is clearly one of the most important and readily available health measures both for mothers and children. In fact, after all the efforts reported here, about 15 percent of children continued to be malnourished in these villages, mostly female children with high-parity mothers. Our impression is that malnutrition in these villages will be eliminated only when family planning is widely practiced.

Conversely, it is increasingly evident that improved child health can have both direct service and indirect motivational effects on increasing family planning practice. One of the most important elements in this motivational change seems to be that improved health and expectation of longer life for children can have a powerful influence on parents' views of the future. This in turn may affect their attitudes to change, progress and hard work. A parallel population study at Narangwal explored in depth the interrelated ways in which health services improved family planning. Among the health measures, the reciprocal relationships between family planning and child care emerged as an important factor that strengthens the practical significance of the research reported in this volume.

PROCESS OF MOVING FROM FIELD RESEARCH TO PROGRAM IMPLEMENTATION

The Narangwal experience has contributed to an understanding of how health services research can directly influence program planning and implementation. The evolution of new patterns of integrated nutrition, health, and family planning services has become such an urgent need for developing countries that rapid progress toward effective implementation has high priority. Most countries are moving ahead with im-
plementing what is known now, and that is appropriate because implementation of current knowledge should never be postponed while waiting for more research. There is nothing so wasteful, however, as a mass program, designed on the basis of experience elsewhere, that does not fit local conditions. Trial and error is a useful approach for minor incremental change but usually not for large-scale innovations. We devoted great effort to maintaining constant communication with health administrators at central and state levels and were greatly encouraged by their openness to trying new ideas and to adapting findings for rapid feedback to general services. Conferences at Narangwal became popular among administrators and academic leaders because these professionals enjoyed living for three days in tents and having a chance to review tables of recently collected data, to give advice on interpretations, and to make suggestions for modifications in approach. We showed that good field research can facilitate acceptance by health professionals and the public of innovations for general implementation.

A spectrum of project types is required in a country such as India. A few centers are needed where detailed health services research of the type undertaken at Narangwal is carried out. Basic problems can be studied, but findings from such research need to be adapted in demonstration projects suited to different local conditions and working arrangements where inputs should be close to anticipated program costs in general services. These demonstration projects can be used as training bases for preparing field workers as part of phased implementation in general services. It is possible to convince health workers through field visits and workshops that the new approaches are feasible and within their capability. Repeatedly at Narangwal visitors to the project left saying something to this effect: "The greatest thing I have learned is I can do what I have been doing, differently."
PROSPECTS FOR FUTURE PROGRAMS

The ultimate message of the Narangwal nutrition project is one of hope. We have shown that simple methods of infection control can reduce the duration of infectious disease morbidity, dramatically lower mortality in infants and children 1-3 years old, and produce moderate increases in growth and development for a total child population living under normal village conditions. We have also shown that highly focused nutrition care will significantly increase growth and psychomotor indices and reduce mortality in children 1-3 years old. Perinatal mortality was reduced by improved prenatal care, supplementation with iron and folic acid for mothers and with calories for those at greatest risk, health and nutrition education, appropriate umbilical cord care, and tetanus toxoid immunizations.

Integration of services improved effectiveness and efficiency. It produced all of the benefits of the two single-purpose programs but for much less than their combined costs. Multiple additional reasons for integrating services included worker productivity, public rapport, long-range organizational effectiveness and educational simplicity. In designing these programs, it became clear that professionals should give up their habit of structuring field activities categorically according to their own disciplinary orientation. Instead, functional packages need to be developed that address a limited number of high-priority problems, that fit the cultural sense and convenience of villagers, and that promote the efficiency of workers at the interface between the community and the health system.

All of these benefits in child health were achieved by simple and inexpensive methods, with over 90 percent of the care being provided by village-based FHWs. The total cost for comprehensive nutrition and child care was less than US$2 per capita (total population) per year.

These activities were structured to ensure equitable
coverage of the poorest and most needy segments of the village populations. A significant potential emerged for continuing involvement of the village people, especially mothers, in solving their own problems.

To apply these findings to local situations in other places will require careful field adaptation through demonstration projects. This research provides a practical basis for a combined approach to counteract the synergism between malnutrition and infections. Improving the mortality, morbidity, growth, and development of children can be a tangible and rapidly implementable component of a general development process designed to promote directly a better quality of life for village people. The research findings show that, technically and practically, these improvements are feasible and within the cost range of local support. Field methods for implementation also were worked out. The challenge now is to proceed with general implementation. This requires political and administrative courage to make the organizational and management changes needed.

NOTES TO CHAPTER 3


13. Arole and Arole (1975); see 8 above.

Part Two

The Detailed Findings
Chapter 4
Impact on Child Growth, Nutrition, and Psychomotor Development


Simplistic notions that improving nutrition requires only making more food available must be given up in the light of increasing evidence from this research and similar studies. In the dramatically food-surplus villages of the Narangwal study, the high prevalence of childhood malnutrition was related to many other variables. The strong distributional effect that led to maximum prevalence of malnutrition among low-caste and female babies was related not so much to the availability of food as it was to feeding practices, mother's time and understanding of child care, the number of children in the family, and -- in support of the main hypothesis tested in this research -- the type and frequency of infections. The important pragmatic contribution of this research is to demonstrate that relatively simple and cost-effective measures can directly correct these problems without waiting for spontaneous social change as part of general economic development.

PHYSICAL GROWTH

Growth was monitored through regular anthropometric measurements of all children in the study villages. From October 1969 until May 1973, 15,365 measurements were made at prescribed protocol ages (monthly up to 9 months of age, every two months between 9-21 months, and every three months between 21-36 months).
Statistically significant associations between achieved weights and heights and a number of socioeconomic, demographic, and research input variables were found by simple correlations. To determine more accurately the relative strength of relationships, multiple linear regression analyses relating weight or height to various sets of variables were performed for fourteen protocol ages: birth, 1, 5, 9, 13, 15, 17, 19, 21, 24, 27, 30, 33, and 36 months. The variables used for these regressions were sex, caste, experimental group, season and year of measurement, number and sex of living siblings, and maternal age. Tables 4-1 and 4-2 show the significance and direction of relationships of socioeconomic, demographic, and experimental variables as they affect weight and height. Significance tests indicate the factors that have explanatory importance.

The most consistently significant differences were found for sex, caste, and season. The number of siblings and maternal age showed a somewhat weaker but generally significant pattern. Sex and caste showed some interaction with intervention effects, as described below. Brief descriptions of the influence of season, family composition, and maternal age on growth are presented first.

Season had a distinct and statistically significant ($p < .001$) effect on mean weight at most ages. Weights recorded in the wet (July-September) and hot (April-June) seasons were consistently lower than those recorded in either the mild (October, November, and March) or cold (December-February) seasons.

As expected, the number of siblings alive when a child was born had a less significant ($p < .05$) influence upon weight and height after adjusting for maternal age, sex, caste, service group, season and year of observation. Five categories of family composition by number of siblings were considered: (A) 0-1 males, 0-1 females; (B) 2+ males, 0-1 females; (C) 0-1 males, 2+ females; (D) 2+ males, 2+ females;
and (E) unknown. Those coded as unknown family composition were probably almost all first births, although this could not be verified because of the way family composition had been coded. The percentage distribution of children who fell into these five sibling classifications was 45, 18, 18, 11, and 8 percent, respectively. For every age group those with two or more male siblings, regardless of the number of female siblings, had both lower average weights (mean = 0.28 kg) and lower average heights (mean = 0.9 cm) than those with fewer male siblings. Children with two or more female siblings and two or more male siblings showed somewhat greater differences, with a mean weight difference of about 0.29 kg and a mean height difference 1.2 cm less than those with only one or no living brothers. These differences in nutritional status are certainly related to the strong preference for males and to the cultural practice that older siblings take precedence.

Maternal age at the time of the child's birth influenced both weight and height, but the direction of the effect was opposite to that of parity. Four age categories were considered: less than 26 years, 26-33 years, more than 33 years, and a fourth representing unknown age. Maternal age of more than 33 years had a significant positive effect in producing greater growth, and the greatest deficit was in children of very young mothers. This effect probably reflects physiological differences as well as relative skill in child rearing.

EFFECTS OF NUTRITION AND HEALTH CARE ON GROWTH

As far as we have been able to determine, this research is the first field study that has shown a statistically significant difference in growth of children in natural populations as a result of specific nutrition and health interventions in comparison with control groups. In other research projects where similar observations have been attempted, either the interventions did not have the expected effect or the controls also improved because of the special attention given to regular
<table>
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<td>795</td>
<td>725</td>
<td>758</td>
<td>762</td>
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<td>.15</td>
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<td>.34</td>
<td>.31</td>
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<td>SE (kg)</td>
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<td>0.52</td>
<td>0.67</td>
<td>0.84</td>
<td>0.95</td>
<td>0.94</td>
<td>0.98</td>
<td>1.01</td>
<td>0.99</td>
<td>0.99</td>
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</table>

s p < .10; o p < .05; oo p < .01; ooo p < .001.

a. Degree of freedom.
b. Family composition classified as: A = 0-1 male siblings, 0-1 female siblings; B = 2+ male siblings, 0-1 female siblings; C = 0-1 male siblings, 2+ female siblings; D = 2+ male siblings, 2+ female siblings; E = unknown.
<table>
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<th>33</th>
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<th>Direction of significant effects</th>
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<td>M &gt; F</td>
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<td>ooo</td>
<td>ooo</td>
<td>ooo</td>
<td>High &gt; Middle &gt; Low</td>
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<tr>
<td>Family composition&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>o</td>
<td>o</td>
<td>o</td>
<td>E, C &gt; A &gt; B, D&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
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<td>o</td>
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<td></td>
<td>Old &gt; Middle, Young</td>
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<td>o</td>
<td>o</td>
<td>o</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>All other ages: NUT, NUTHC &gt; CONT-N</td>
</tr>
<tr>
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<td>oo</td>
<td>ooo</td>
<td>ooo</td>
<td>o</td>
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<td>Cold &gt; Mild &gt; Hot &gt; Wet</td>
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<td>Ages 27-33: 70 &gt; 71 &gt; 72-73 &gt; 68-69</td>
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<td>603</td>
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<tr>
<td>SE (kg)</td>
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<td>1.12</td>
<td>1.18</td>
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<sup>c</sup> Maternal age classified as: 33+ y = old; 26-33 y = middle; < 26 y = young.
Table 4-2. Direction and Statistical Significance of Socioeconomic, Demographic, and Experimental Effects upon Height at Ages 0-36 Months

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<tr>
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<td>593</td>
<td>590</td>
<td>621</td>
<td>638</td>
<td>613</td>
<td>616</td>
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<tr>
<td>R&lt;sup&gt;2&lt;/sup&gt;</td>
<td>.26</td>
<td>.25</td>
<td>.32</td>
<td>.27</td>
<td>.29</td>
<td>.27</td>
<td>.27</td>
<td>.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SE (cm)</td>
<td>2.52</td>
<td>2.66</td>
<td>2.58</td>
<td>2.78</td>
<td>2.84</td>
<td>2.99</td>
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Note: Footnotes same as table 4-1.
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<tr>
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<td>000</td>
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<td>E, C &gt; A &gt; B, D&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>00</td>
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<td>000</td>
<td>000</td>
<td>000</td>
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</tr>
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<td>s</td>
<td>oo</td>
<td>s</td>
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<td>(Not consistent)</td>
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<td>Year</td>
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<td>68/69 &gt; 70 &gt; 72/73 &gt; 71</td>
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<td>559</td>
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<td>SE (cm)</td>
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</table>
measurements. It has been difficult to portray the composite results of the impact of interventions in any simple set of curves; therefore, two sets are presented with somewhat increasing complexity but greater specificity in demonstrating differences. Since growth rates vary markedly at different ages, simple growth curves mask some important differences.

Figures 4-1 and 4-2 show mean growth in each of the experimental groups as a percentage of the median Harvard standard at each age from 0 to 36 months. (In principle, it would have been more appropriate to present the data in percentile or probability format relative to the Harvard standard. Since coefficients of variation were essentially constant at all ages, however, the "percent of Harvard standard" measure is equivalent and is considered to be of more practical relevance.) This presentation gives the most accurate picture of where these children were in relation to an internationally recognized index of where they might have been. For comparability, the curves have been adjusted for very unequal caste distribution and slightly unequal sex distribution in the various groups of villages.

From birth to approximately 13 months of age, children living in the control villages (CONT-N) tended to have higher weight-for-age than children in villages receiving nutrition (NUT), medical services (HC), or both (NUTHC). Their height-for-age, however, was similar to children in service villages. This initial advantage was probably related to the fact that socioeconomic conditions were somewhat better in control villages, making the later shift even more significant. After 13 months of age, however, the greater growth in NUT and NUTHC villages is evident. All weights in experimental groups suggest some catching up, but they never reached 80 percent relative to the Harvard standards. The controls show no sign of catching up and seem to have stabilized around 75 percent. Among the experimental groups NUT and NUTHC, both start improvement at about 15-17 months of age, but in health care
Figure 4-1. Mean Weight, Relative to Harvard Standard, at Ages 0-36 Months by Experimental Group, Adjusted for Caste and Sex

Input services
- Nutrition care (NUT).
- Nutrition and health care (NUTHC).
- Health care (HC).
- Control (CONT-N).
Figure 4-2. *Mean Height, Relative to Harvard Standard, at Ages 0-36 Months by Experimental Group, Adjusted for Caste and Sex*

- Input services:
  - Nutrition care (Nut).
  - Nutrition and health care (NutHC).
  - Health care (HC).
  - Control (Cont-N).

-aged graph showing the percentage of Harvard standard height over months of age.
(HC) villages the catch-up growth is most pronounced after 24 months. In comparison, the height curves show a consistent decline compared with the Harvard standard for the control groups between 0-24 months, with stabilization around 90 percent after that. In the experimental groups the children started with a slight disadvantage compared with the controls, but the relative rate of decline from the Harvard standard was less, and the curves leveled off around 19 months of age at about 92 percent. Height, therefore, did not show the catch-up observed with weight.

The next two sets of curves (Figures 4-3 and 4-4) concentrate on differences among experimental groups, using the control group data as a zero baseline for comparison and expressing differences in physical units (kilograms or centimeters). The fluctuations shown are somewhat exaggerated compared with figures 4-1 and 4-2 because of variation in the control curves.

Figure 4-3 indicates that from age 15 months the villages with nutrition intervention maintained a weight advantage of 0.3-0.4 kg over control villages; the advantage seems to have increased to 0.5 kg by 36 months. The HC effect was less pronounced and seemed to occur only after the second year of life. For each age group, \( t \) values were calculated, and differences in nutrition intervention villages were significant from 15 months onward \( (t \approx 2; \ p < .05) \). For HC the \( t \) values were positive after 21 months of age but did not reach statistical significance.

A similar improvement in height is shown in figure 4-4, with NUT intervention having produced an average increase of two cm in children over 21 months of age. Again, a smaller but still positive effect was produced by HC, with differences being somewhat less than two cm after 24 months of age. The apparent reduction in observed differences after 30 months (see figure 4-2) was in reality due to a modest improvement in the control group, which also began to show some catch-up narrowing the gap relative to other experimental groups. The
Figure 4-3. Effects of Input Services on Weight at Ages 0–36 Months, Experimental Groups Compared with Controls, Adjusted for Sex, Birth Order, Mother’s Age, Caste, Year, and Season of Observation

---

Input services
- Nutrition care (NUT).
- Nutrition and health care (NUTHC).
- Health care (HC).

Zero baseline Control (CONT-N).
Figure 4-4. Effects of Input Services on Height at Ages 0-36 Months, Experimental Groups Compared with Controls, Adjusted for Sex, Birth Order, Mother's Age, Caste, Year, and Season of Observation.
differences in NUT and NUTHC villages were significant after 21 months of age and became more so, reaching $t = 3, p < .05$. For HC the $t$ values became significant at 24 and 30 months of age) $t = 2, p < .05$).

Because of the persistence of observed effects over a range of ages, their composite significance is clearly greater than that exhibited at any particular age. Some caution in interpretation is required, however, because of the lack of independence in the sequential observations; individual children were included several times in the analysis of different ages because the observations were longitudinal. The seriousness of nonindependence can be judged in two ways. First, within any experimental group the striking difference between the effects at earlier and later ages suggests that the effects were genuine. If the persistence of effects in the third year of life were due only to repeated observations on the same children, the effects should have been similar at earlier ages. Second, the impact of nonindependence can be judged by comparing variation among children at a given age with the variation of estimated effects by experimental group between ages after the $t$-values had stabilized. Such a comparison reveals that variation between ages in a specific experimental group was about 70 percent of the expected variation assuming statistical independence. Thus, while the effect of repeated observations on the same children is important enough to require that the conclusions be somewhat guarded, that effect is not large enough to negate the composite comparisons over all ages from 15 to 36 months. In judging the improvements that occurred, it is important also to recall the disadvantageous situation of children in the experimental groups in the first year of life.

Table 4-3 shows the result of the six possible pairwise comparisons. It is clear that nutrition is the key discriminator among experimental groups. The difference between NUT and NUTHC is nonsignificant, and these two groups are clearly
set apart from the other two. Thus, we may rank the groups in terms of statistical significance, with NUT and NUTHC showing the best nutrition, CONT-N at the bottom, and HC in the middle. In the case of weight, HC is closer to CONT-N; in the case of height, HC is closer to NUT and NUTHC. These conclusions are weakened by the assumption of independence of observations at different ages. But they do not take into account the slight upward trend of weight observations relative to CONT-N, which is evident in tables 4-1 and 4-2 and in figures 4-1 to 4-4.

Table 4-3. Comparison of Experimental Groups, under the Assumption of Independent Samples, Adjusted for Sex, Birth Order, Mother’s Age, Caste, Year, and Season of Observation

<table>
<thead>
<tr>
<th>Comparison</th>
<th>df</th>
<th>Weight t</th>
<th>p</th>
<th>Height t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUT &gt; NUTHC</td>
<td>16</td>
<td>0.67</td>
<td>.256</td>
<td>0.45</td>
<td>.329</td>
</tr>
<tr>
<td>NUT &gt; HC</td>
<td>16</td>
<td>3.73</td>
<td>.001</td>
<td>1.84</td>
<td>.042</td>
</tr>
<tr>
<td>NUTHC &gt; HC</td>
<td>16</td>
<td>3.08</td>
<td>.004</td>
<td>1.39</td>
<td>.092</td>
</tr>
<tr>
<td>NUT &gt; CONT-N</td>
<td>8</td>
<td>7.86</td>
<td>.000</td>
<td>5.91</td>
<td>...</td>
</tr>
<tr>
<td>NUTHC &gt; CONT-N</td>
<td>8</td>
<td>6.87</td>
<td>.000</td>
<td>5.27</td>
<td>...</td>
</tr>
<tr>
<td>HC &gt; CONT-N</td>
<td>8</td>
<td>2.39</td>
<td>.022</td>
<td>3.31</td>
<td>.005</td>
</tr>
</tbody>
</table>

... Zero or negligible.

Another way of analyzing the effects of nutrition care is to determine the proportion of children who were malnourished, defined as falling below 70 percent of the Harvard weight median. Up to the age of 11 months, villages with nutrition intervention had as many or more children below that level as control villages (figure 4-5). By age 11 months this proportion had reached 25-30 percent. After 1 year of age children in villages with nutrition intervention (NUT and NUTHC) had significantly fewer measurements below 70 percent of the Harvard median, while in villages without nutrition services the proportion stayed about the same. In villages with nutrition services the proportion of malnourished children continued to decline from above 25 percent to about 15
Figure 4-5. Proportion of Children below 70 Percent of the Harvard Weight-for-Age Median by Age and Input Services, Adjusted for Sex, Caste, and Size of Service Group

With nutrition supplementation (NUT, NUTHC).

Without nutrition supplementation (HC, CONT-N).

Percentage of children below 70 percent of Harvard weight-for-age median

Age (months)

1 6 11 17 21 27 33 36

p: n.s. n.s. n.s. <.05 <.05 <.05 <.05 <.05

n.s. Not significant.
percent. The latter were mostly moderately malnourished children between 65-70 percent of weight-for-age, but there also remained a few severely malnourished females, low-caste children in high-parity families.

SOCIOECONOMIC AND DEMOGRAPHIC EFFECTS ON GROWTH
AND THEIR INTERACTION WITH SERVICES

A series of preliminary analyses showed close correlation among the various indicators of socioeconomic status, including indices of income. It was evident that the most useful general index reflecting socioeconomic status was caste. For high-caste groups (mainly Jat farmers), incomes and possessions were considerably higher than those of a middle-caste group consisting of Hindus of nonscheduled castes (mainly merchants, priests, and civil servants) and non-Jat Sikhs (mainly artisans). These in turn had better economic status than low-caste groups (mainly scheduled Hindus and Sikhs, including agricultural laborers, leather workers, and the like) who mostly worked for Jats.

Sex and caste each had a highly significant ($p < .001$) effect upon weight and height beyond 17 months of age (figures 4-6 and 4-7). At various ages males were from 0.6 to 1.0 kg heavier and from 0.5 to 2.8 cm taller than females, with the largest differences occurring between 5 and 17 months of age. Beyond the age of 1 year, high-caste (Jat) children were approximately 0.8 kg heavier and 2.0 cm taller than low-caste averages. Middle-caste averages were about 0.6 kg and 1.5 cm higher than low-caste averages.

Interactions between experimental groups and sex or caste were generally not significant. A significant interaction between caste and type of intervention occurred at the age of 13 to 15 months, when nutritional services had a greater impact upon the height of high- and middle-caste children than on those of low-caste children. This contrasts with the observation that around the age of 33 months all types of services
Figure 4-6. Mean Weight at 17 Months by Caste and Sex, Adjusted for Input Service Group, Birth Order, Mother’s Age, Year, and Season of Observation
Figure 4-7. Mean Height at 17 Months by Caste and Sex, Adjusted for Input Service Group, Birth Order, Mother’s Age, Year, and Season of Observation
Figure 4-8. Mean Hemoglobin Level by Age Group and Input Service
(mean ± 1 standard error of mean, SEM)

With nutrition supplementation (NUT, NUTHC).
Without nutrition supplementation (CONT, HC).

a. Gm percent = gram percent (grams per 100 grams of blood); the normal range is 10–15 gm percent.
showed a greater proportional effect on the average weight and height of low-caste children compared with other castes. Although these differences may be due to variation in utilization by the various caste groups, the overall comparison probably indicates that it took longer for the program to produce an effect on the nutrition of a low-caste child than on a high-caste child, but that eventually special benefit for the most needy was achieved.

HEMOGLOBIN LEVELS

Hemoglobin levels were determined in cross-sectional surveys. The last survey involved almost 80 percent of all children under three years of age in the study population and was carried out in the spring of 1971. No age or experimental group reached an average level of 10 gm percent (grams per 100 grams of blood), which is considered the borderline for anemia (the normal range is 10-15 gm percent) (figure 4-8). Results showed that children living in NUT and NUTHC villages, where iron and folic acid were provided to all children identified as having low hemoglobin levels, had significantly higher hemoglobin levels at all ages above six months than children in HC or CONT-N villages.

AGE AT WEANING

One of the main functions of the quarterly dietary survey of all mothers with children under 3 years old was to provide nutrition education, especially in relation to the time of weaning. At first, the survey was administered in NUT and NUTHC villages only. An extremely important component of the health education of mothers was to encourage prolongation of breast-feeding. The records from the dietary survey showed that the duration of breast-feeding in NUT and NUTHC villages was significantly (p < .01) prolonged by an average of 5.2 months, from 15.3 months to 20.5 months between 1969 and 1970 (figure 4-9).
Figure 4-9. Age at Weaning in Nutrition-supplemented Villages, 1968-69 and 1970
(mean ± 1 SEM)
PSYCHOMOTOR DEVELOPMENT

A special psychomotor development test was developed by adapting items relating to four psychomotor domains (gross motor, fine motor, language, and social integration). After standardization, this test was administered to a sample of 479 study children. To select the sample for the test, children from study villages were stratified according to age and caste groups and then randomly selected. Objectives of the study were to determine whether child nutritional levels, family socioeconomic status, and demographic variables were related to motor and cognitive development. A psychomotor index was separately determined for each of the four domains, and an aggregate score for the four domains was also calculated. For the analysis, the raw score achieved in each of the four domains and the aggregate score were divided by the median scores of all Narangwal children of comparable age who were tested. Multiple linear regression models, with the five indices as dependent variables, were used to determine relationships and to adjust for confounding variables.

In general, all five psychomotor indices were positively and significantly related to past and present nutritional status. In addition, large variations in nutritional status over the first 18 months of life were associated with low indices of psychomotor development.

More significantly, birth weight and mean weight-for-age over the first 9 months of life had a significant and positive effect on psychomotor development. However, the importance of birth weight and nutritional status over the first 9 months of life progressively decreased with increasing age of the child, and this suggests that subsequent nutritional intakes compensated for low initial levels of nutrition. Deficits in psychomotor development related to poor nutritional status in life did not seem to be as permanent in this population as has been suggested in other studies.

The relationship between psychomotor development and
early and subsequent nutritional status is shown in Table 4-4. Children were separated into high and low nutritional status groups in two age periods. In the Narangwal study population, the median for children under 9 months old was generally 85 percent of the Harvard median, and the median for children between 10-18 months old was 75 percent of the Harvard standard. Using these median levels as criteria in Table 4-4, children are grouped according to whether they were consistently in the lower or upper groups or had shifted one way or the other. The mean scores for each of the five psychomotor indices were

Table 4-4. Means and Frequencies of Psychomotor Indices (Gross Motor, Fine Motor, Communicative, Social, Total) by Mean Weight-for-Age, Months 0-9, and by Mean Weight-for-Age, Months 10-18

<table>
<thead>
<tr>
<th>Mean weight-for-age, months 0-9</th>
<th>Mean weight-for-age, months 10-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>75%</td>
<td>75+%</td>
</tr>
<tr>
<td>Mean index N</td>
<td>Mean index N</td>
</tr>
<tr>
<td>GM 92.5</td>
<td>140</td>
</tr>
<tr>
<td>FM 93.5</td>
<td>139</td>
</tr>
<tr>
<td>85%</td>
<td>COM 93.0</td>
</tr>
<tr>
<td>SOC 89.6</td>
<td>140</td>
</tr>
<tr>
<td>TOT 93.2</td>
<td>139</td>
</tr>
<tr>
<td>GM 94.9</td>
<td>21</td>
</tr>
<tr>
<td>FM 96.2</td>
<td>21</td>
</tr>
<tr>
<td>85+%</td>
<td>COM 96.9</td>
</tr>
<tr>
<td>SOC 93.1</td>
<td>21</td>
</tr>
<tr>
<td>TOT 96.2</td>
<td>20</td>
</tr>
<tr>
<td>GM 92.8</td>
<td>161</td>
</tr>
<tr>
<td>FM 93.8</td>
<td>160</td>
</tr>
<tr>
<td>All</td>
<td>COM 93.5</td>
</tr>
<tr>
<td>SOC 90.0</td>
<td>161</td>
</tr>
<tr>
<td>TOT 93.6</td>
<td>159</td>
</tr>
</tbody>
</table>

GM = gross motor; FM = fine motor; COM = communicative; SOC = social; TOT = total.
a. The cut-off points for the two different age groups (0-9 months and 10-18 months) approximately correspond to the median levels of weight-for-age for these age groups.
compared among the various nutritional groups. The similarity of the psychomotor score means in the two cells for "high" weight-for-age at 10-18 months (101.9 and 101.1) is striking and suggests that good psychomotor development can ultimately be achieved regardless of nutritional status in the first 9 months of life. This same finding was seen in stepwise five psychomotor indices were compared among the various nutritional groups. The similarity of the psychomotor score means in the two cells for "high" weight-for-age at 10-18 months (101.9 and 101.1) is striking and suggests that good psychomotor development can ultimately be achieved regardless of nutritional status in the first 9 months of life. This same finding was seen in stepwise regression analyses, in which mean weight-for-age for children 0-9 months old was a very significant predictor by itself, but became nonsignificant when mean weight-for-age for the 10-18 month interval was introduced into the model.

A regression was done to evaluate program effects in the various village groups while controlling for the effect of socioeconomic, demographic, and morbidity variables. For gross motor, fine motor, and total indices, the effect of NUTHC was significant and generally exceeded the summed separate effects of NUT and HC, and this suggests program synergism on psychomotor development. No other separate effects reached significance. For the total index, a child in NUTHC scored on average 5.22 percentage points more than a child in control villages. For all five indices, except social, NUTHC scored highest, with NUT second. The results for the total psychomotor index are shown graphically in figure 4-10.

PRACTICAL SIGNIFICANCE OF INTERACTIONS

Our analyses of child growth showed an almost equal effect on body weight and height of caste, sex, and the direct effects of nutrition services. That these effects seemed to be additive supports the importance of promoting both the
Figure 4-10. Means and SEMs of "Total" Psychomotor Index by Experimental Group, Adjusted for Socioeconomic, Demographic, and Morbidity Variables

- CONT-N: difference between CONT-N and NUT = 2.9; t = 1.37; p = n.s.
- NUTHC: difference between CONT-N and NUTHC = 5.2; t = 2.22; p < .05.
- HC: difference between CONT-N and HC = 0; t = 0; p = n.s.
provision of direct services to improve nutrition and medical care and general socioeconomic development.

Our results did not show the direct synergism in program effects that the hypotheses had set out to measure. The NUTHC villages had slightly but consistently lower growth curves than the NUT villages. This was presumably related to the fact that FHWs in nutrition villages could concentrate more on nutrition activities, as evidenced by the greater attendance the NUT villages achieved at feeding centers. Yet both NUTHC and NUT groups showed clearly superior growth and development. HC villages showed intermediate levels between NUT and CONT-N villages, presumably because of the protective effect on nutritional status of reduced duration of infections.

The number of live siblings, especially more than two living male siblings, had a significant effect on levels of nutrition and growth (weight and height). The effect of birth order on nutritional status had been demonstrated earlier by Gopalan,\(^5\) who showed that children of fourth or higher order had a 61 percent prevalence of protein calorie malnutrition compared with 39 percent for those of the first through third birth order. These findings showing the direct effect of family size on child development confirm the importance of family planning as part of comprehensive care. Furthermore, a fluctuating percentage (15 to approximately 25 percent depending on season, sex, and caste) of children remained undernourished (arbitrarily defined as below 70 percent of the Harvard median in two consecutive months), even though they were covered by our nutrition services. The observation that most of these children were moderately malnourished (65-70 percent of median), low-caste girls born into high-parity families who continued to have the most severe nutritional deficits suggests that further progress in combating malnutrition could be greatly facilitated if families only had the number of children they could support.

Service inputs had no significant effect on average
weight before 15 months of age, and on height before 17 months of age. The delayed impact of the feeding program may be partly related to the fact that feeding center utilization by undernourished children between 6 and 12 months of age tended to be low, averaging 22 percent (utilization rates are based on the total feedings received by children in the target group as a percent of expected feedings -- 2 feedings per day per child -- for malnourished children). According to a longitudinal survey of feeding center attendance over the last two and one-half years of the project, utilization rose to 42 percent and 40 percent in the second and third years of life, respectively. The fairly low utilization under one year of age may be due to the combined influence of a number of factors. One reason is that a deliberate effort was made to encourage families to provide their own weaning food at home because we did not want to create undue dependency on the feeding centers. Second, in this culture supplementation of children under 1 year old is discouraged. Third, malnutrition in children under 1 year old tends to be moderate and does not usually seem alarming to the untrained eye. Overall, Ramdasia (low-caste) children attended feeding centers slightly more consistently (41 percent) than did Jat (high-caste) children (30 percent).

In addition to evidence that care given to a total child community can improve average growth patterns, we also have data on whether taller and heavier children were also better off in other indices of health. In chapter 7 data are presented showing that the level of nutrition was closely related to the child's relative risk of dying. Another analysis also showed a significant relationship between nutritional status and morbidity. A separate investigation showed that weight-for-age less than 70 percent of the Harvard standard was associated with a significant decrease in nonspecific immune capacity.

Psychomotor development was also greater with improved
nutrition. We found, however, that nutritional deficiency in the range commonly encountered in a rural, ambulatory child community seemed not to be associated with permanent psychomotor impairment. The children's psychomotor development seemed to catch up if nutritional levels improved before the age of 18 months. It would seem, therefore, that better growth patterns contribute to improving immunity, morbidity, mortality, and psychomotor development.

SUMMARY

- Three variables had major additive effect in improving growth: nutrition intervention, caste, and sex. Each variable produced increases of 0.3 to 1.0 kg and 1.4 to 2.8 cm in average weight and height. A high-caste male from a NUT or NUTHC village, therefore, averaged 2.5 kg more in weight and 6.0 cm more in height at 36 months than a low-caste female from a CONT-N village.

- Nutrition intervention can significantly increase the weight and height of total populations of children. As far as we can determine, this is the first controlled experiment of total child populations under natural conditions where this has been demonstrated.

- Health care in HC villages also produced a significant improvement in weight and height of children that was intermediate between that of NUT and NUTHC and CONT-N villages.

- Combined nutrition and health care, NUTHC, produced growth essentially equivalent to nutrition care alone, but no true synergism of program effects on growth was observed. Combined service did, however, show a synergistic effect on psychomotor development.

- After a family had two male children, additional siblings averaged 0.3 kg less in weight and 0.9 cm less in height than siblings of earlier birth order.
Average growth in weight and height increased with maternal age, suggesting that "maternal depletion" is no serious problem in the average Punjabi woman.

Nutrition supplementation including iron and folic acid raised mean hemoglobin levels for all age groups above six months of age by an average of 1 gram percent.

Psychomotor performance was influenced more by nutritional status at 10-18 months than at 0-9 months and was also influenced by the amount of fluctuation in nutritional status in the child's past.

The practical package of nutrition care that evolved in this project was based on surveillance through regular weighing and measuring of all children. Concentrated efforts were focused on children showing no increments in growth, with primary emphasis on nutrition education of the mother. In addition, children who were underweight were provided food supplements twice a day at village feeding centers, and about 40 percent of such children participated in this program.

Breast-feeding was prolonged by an average of five months through simple but intensive nutrition education related to a dietary survey at three-month intervals.

All services were provided very effectively by family health workers, FHWs (retrained lady health visitors), and by village feeding-center attendants.

In spite of the intensive nutrition program, there remained a "hard core" group (15-25 percent) of relatively malnourished children, which included mainly low-caste girls born to high-parity mothers. To get further reduction in the levels of malnutrition, it seemed apparent that more effective family planning practice and general socioeconomic development would be necessary.
NOTES TO CHAPTER 4


7. Kielmann and Curcido, (1979); see 1 above.
Chapter 5
Indicators of Nutritional Risk

Cecile DeSweemer, Arnfried A. Kielmann, and Robert L. Parker

The preceding chapter documented the overall nutritional status of children in Narangwal study villages and the impact that health care and nutrition supplementation programs had on the growth and development of these children. This chapter brings together in one place data on a series of factors that were closely monitored for each child: increments in weights and heights over time, morbidity rates, dietary intake, and clinical signs of nutrition. The data were from the individual records of each child that were used to guide the delivery of care. This analysis at an aggregate level validates the pragmatic, case-by-case approach used in the field and from this practical experience draws conclusions that have relevance to other programs concerned about the adequacy of nutritional intake in children.

The anthropometric data presented in this chapter are from a subanalysis of incremental growth of children in all experimental groups. When supplemented by clinical observations and age-specific morbidity data, these analyses provide indications of the timing of nutrition and health deficits. Finally, both qualitative program-related dietary data and quantitative food-intake studies gave us an unusual opportunity to relate dietary patterns with levels of nutrition and morbidity. These analyses can be used to judge the appropriateness of the various international standards for dietary
Chapter 4 described the methodology of the longitudinal anthropometric survey of study children under the age of 3 years. Anthropometric measurements were used to identify high-risk children in need of nutrition care and to monitor the effectiveness of that care.

The discussion thus far has focused on measures of attained weight-for-age, height-for-age, and weight-for-height. Incremental weight gain is potentially a more sensitive anthropometric indicator of the dynamics of concurrent nutritional stress. Inadequate weight gain or actual loss may provide an early warning of risk, even if achieved weight has not yet fallen below "normal" levels. In this chapter therefore, we further explore the definition and identification of high risk as measured by incremental growth.

On intuitive clinical grounds, our services established the rule that any child with no weight gain over two consecutive routine measurement periods (in contrast to an expected gain of at least 250 grams), or a weight loss over one such period, should be considered as showing signs of nutritional stress, even if the child maintained a "good" attained weight-for-age. A more analytical investigation of risk follows, based upon incremental growth data for all children observed between September 1968 and June 1970. With this definition of high-risk groups, we can judge the validity of the intuitive rule for detection of individual high-risk cases. The analysis first compares Narangwal results with an external (Harvard) standard. We then proceed to an internal comparison among Narangwal subgroups, based mainly on caste, sex, and age.

Figure 5-1 shows that the average weight gain of Narangwal children fell short of the Harvard standard from the first 3 months of life and that the gap widened thereafter to the age of 9 months. After 1 year of age the weight gain of
Figure 5-1. Average Three-month Weight Gain of Narangwal and Harvard Children
Narangwal children was virtually constant, whereas the Harvard standard continued to decline—with the result that by the age of 2 years and above, average weight gain in the two groups was similar. The early plateau reached at Narangwal is probably due to the combination of selective loss of high-risk children through death and, more important, the "catch-up" of survivors through nutrition care.

Internal differences in weight gain among Narangwal children by age, sex, and caste were investigated through analysis of variance (ANOVA) and multiple regression analysis. In undertaking these analyses it was recognized that distortions could occur because of the multiple measurements obtained per child. Since the number of observations per child was not entirely uniform, and the sequential measurements were possibly correlated, a few exceptional children could unduly influence the statistical significance of the results. Thus, for example, a few children of a particular sex and caste who consistently exhibited low weight gain over an extended period of time could both exaggerate real sex-caste differences and produce an underestimation of sampling error as a basis for testing the significance of observed differences.

Preliminary analysis of the data showed this concern to be largely unfounded. (In the analysis of variance based upon monthly averages within the 9-21 month age group, for example, the residual variance was found to be 36.68, compared with a pooled variance of individuals within caste-sex-month of age equal to 40.47; clearly, the ratio $F \frac{417}{424} = \frac{40.47}{36.68} = 1.10$ is nonsignificant.) This permitted further statistical analysis to proceed with confidence. ANOVA was considered preferable because of its capability for detecting interactions. The analysis was complicated, however, by unevenness in the number of observations per cell. The analysis was limited, therefore, to averages at ages 1-30 months, where all cell averages were made up of at least 30 observations. Multiple regression analysis was also conducted to confirm the
Table 5-1. Comparative Analysis of Weight Increments by Age, Sex, and Caste

<table>
<thead>
<tr>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg.</td>
<td>SD</td>
<td>Jat</td>
<td>Ramdasia</td>
</tr>
<tr>
<td>0-3</td>
<td>2,342</td>
<td>499</td>
<td>+0.18</td>
<td>-0.36</td>
</tr>
<tr>
<td>3-6</td>
<td>1,946</td>
<td>529</td>
<td>-1.05</td>
<td>-1.22</td>
</tr>
<tr>
<td>6-9</td>
<td>1,396</td>
<td>435</td>
<td>-1.48</td>
<td>-1.69</td>
</tr>
<tr>
<td>9-12</td>
<td>978</td>
<td>395</td>
<td>-1.18</td>
<td>-1.00</td>
</tr>
<tr>
<td>12-18</td>
<td>1,334</td>
<td>482</td>
<td>-0.48</td>
<td>-0.29</td>
</tr>
<tr>
<td>18-24</td>
<td>1,119</td>
<td>467</td>
<td>-0.21</td>
<td>-0.21</td>
</tr>
<tr>
<td>24-30</td>
<td>1,034</td>
<td>486</td>
<td>-0.11</td>
<td>+0.22</td>
</tr>
<tr>
<td>30-36</td>
<td>1,047</td>
<td>447</td>
<td>-0.15</td>
<td>-0.17</td>
</tr>
</tbody>
</table>
ANOVA investigation of averages. The two approaches did produce similar findings, although ANOVA results tended to be somewhat more clear-cut and significant.

Furthermore, because of the changing periodicity of scheduled measurement by age, separate regression and variance analyses were conducted for ages 0-9 months, 9-21 months, 21-36 months. Under the age of 9 months, month of age was of greatest significance in ANOVA ($p < .001$), and the main effects of both caste and sex were important ($p < .01$). No interactions were found. None of the factors were significant in the analysis of 9-21 month ages, and only caste was of some consequence ($p < .05$) at ages 21-30 months.

Having identified the importance of both sex and caste at some ages, we examined sex-caste groupings by age in relation to the Harvard standard. The basis for comparison was the number of standard deviations (SDs) between the Harvard and Narangwal averages. During the 6-9 month age period, for example, the average weight gain for Ramdasia females was 2.15 SDs below the Harvard average. Assuming a normal distribution, therefore, the average Ramdasia female at this age was at the second percentile of the Harvard distribution; that is, 98 percent of the Harvard children exceeded the average weight gain of Ramdasia females. The assumption of normality is questionable, but the results, shown in table 5-1 and figure 5-2 are useful for comparative purposes.

The most striking finding is the growth deficit of Narangwal children during the first year of life, especially during the age period of 6-9 months. The deficit is greater for Ramdasias. It begins earlier and is more severe for females; in fact, the growth of Jat males during the first three months of life met or exceeded the Harvard standard. Ramdasia females, in contrast, were at a severe disadvantage throughout the first year of life. Thereafter, they matched or exceeded the growth of Jat males. After age 2 years they outperformed the Harvard children. Of interest is that Harvard females
Figure 5-2. Narangwal Average Weight Gain by Age, Sex, and Caste Compared with Harvard Standard
(measured in standard deviations, SDS)

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramdasia</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Age (months)
also did slightly better than males during the third year of life.

The above analyses have shown that group differences in average growth deficits are real. The findings suggest risk differentials but are not definitive in themselves. They are more meaningful, however, when coupled with earlier findings showing that Narangwal children with zero or negative increments at any age under 21 months had significantly higher levels of future morbidity, especially gastrointestinal, than others exhibiting more normal growth patterns.\(^1\) We proceed, therefore, to an estimation of numbers of children under nutritional stress in different age groups by estimating the percent with negative or zero increments. The estimates that follow are conservative in that they do not account directly for dietary intake or morbidity.

Figure 5-3 shows zero weight gain in relation to the 25th and 5th percentiles of weight increment distributions by age for the main caste and sex groups. Weight increments during routine scheduled periods of measurement are expressed on the vertical axis as kilograms of gain over a standardized six-month period. Increments are plotted on the horizontal axis against the month that opened the scheduled period.

At least 5 percent, and sometimes up to 25 percent, of children 5-24 months old had no weight gain. After 24 months there seems to be an improvement, and weight loss before the age of 5 months is rare. Ramdasias and females had a higher proportion of negative values, more pronounced weight losses, and longer age spans with substantial deficits. The proportion of children 4-21 months old with no weight gain exceeds 5 percent in all sex-caste groups. From about 6-21 months of age, the proportion of female children with weight loss is close to 25 percent, while for males it hovers around 20 percent. The 5th percentile is most negative between 8-11 months of age.

Analyses of average and negative weight gain have pro-
Figure 5-3. Weight Increments between Routine Scheduled Measurements Standardized to Six-month Period, Punjabi Children in Fifteen Villages, Anthropometric Survey (September 1968–June 1970)
duced similar findings. Both gave evidence of nutritional stress at earlier ages than had been suspected from the clinical survey or from analysis of achieved weight. Characteristics of low caste and female sex appear to be risk factors during the first two years of life. All sex-caste groups were found to be at special risk of nutritional stress from 4-6 months of age to the end of infancy. The findings raise questions about the universal sufficiency of breast-feeding in children 4-6 months old in this population (perhaps as a result of "opportunity feeding," as opposed to "demand feeding"), constraints on quantity of milk production due to mother's nutritional status, and especially the heavy morbidity load that also became evident at 4-6 months of age (see chapter 7).

The indicators of incremental growth used in this project to detect high-risk individuals should probably be revised. Up to 9 months of age, lack of growth, over a period of one month, should be recognized to be an indication of high risk. From 9-21 months of age, absence of weight gain over two months should trigger concern over nutritional stress. After 21 months of age, weight increments are probably not very useful as risk indicators.

CHILD FEEDING PRACTICES

Two dietary surveys were done that provide information helpful in making judgments about the adequacy of feeding practices by age. One was a longitudinal survey in which qualitative dietary intake of all study children was obtained every four months by the family health worker (FHW). The other was a cross-sectional observational sample survey that obtained detailed and quantitative information on actual food intake and used specially trained investigators.

Longitudinal Data about Weaning Practices

The qualitative dietary survey was especially designed to
Table 5-2. Average Age When Weaning Was Completed, by Caste (months)

<table>
<thead>
<tr>
<th></th>
<th>1968-69</th>
<th></th>
<th></th>
<th>1970</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jat</td>
<td>Ramdasia</td>
<td>Other</td>
<td>Total</td>
<td>Jat</td>
<td>Ramdasia</td>
</tr>
<tr>
<td>Number of children</td>
<td>66</td>
<td>49</td>
<td>26</td>
<td>141</td>
<td>72</td>
<td>74</td>
</tr>
<tr>
<td>Average age</td>
<td>14.4</td>
<td>16.5</td>
<td>15.1</td>
<td>15.2</td>
<td>19.6</td>
<td>21.7</td>
</tr>
</tbody>
</table>
be used by the FHW to make judgments about the appropriateness of the diet the child was receiving so that the FHW could provide nutrition education. We also used the survey to make qualitative assessments of average nutritional intake of the various groups of children. Two kinds of advice were given to mothers. The first was to postpone complete weaning until after the age of 18 months. The second was to introduce supplementary semisolids between 4-6 months because this had been identified as the age when a significant number of children in our population developed caloric deficits if kept only on breast-feeding. Dietary survey visits were made in all villages receiving nutritional supplements.

Weaning is a phased process, with one definite date being the age at which weaning is completed. Analyses were carried out on 321 children who were recorded as fully weaned by May 1970. The average weaning age in months was determined for children weaned before project services were well established (1968-69) and after (1970). Table 5-2 summarizes the average age at weaning for these two time periods by caste. The average age at weaning was 15.2 months in 1968-69 and 20.4 months in 1970. Ramdasias tended to wean their children about two months later than Jat Sikhs or other castes, but in both castes the increase in duration of breast-feeding was the same. Analysis by sex showed similar ages at weaning for male and female children except among Jat Sikhs, who tended to wean females on the average two months earlier than males. There was no special practice of excessively early weaning found in any caste, sex, or treatment group.

"Other" milk (mainly buffalo milk, but including some cow's milk) was a high-prestige food for children after 6 months, but it was rarely given in significant amounts. Of 884 children included in the analysis of the dietary survey by 1970, 747 were said to have received other milk as a part of their regular diet, in most cases as a supplement to breast-feeding. The exact month at which other milk was
Table 5-3. Age at Start of "Other" Milk by Caste and Sex (months)

<table>
<thead>
<tr>
<th>Caste</th>
<th>Sex</th>
<th>Number of children</th>
<th>Mean (months)</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jat</td>
<td>Male</td>
<td>192</td>
<td>7.4</td>
<td>24.5</td>
</tr>
<tr>
<td>Ramdasia</td>
<td>Male</td>
<td>157</td>
<td>7.8</td>
<td>38.9</td>
</tr>
<tr>
<td>Other</td>
<td>Male</td>
<td>86</td>
<td>8.1</td>
<td>44.3</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>237</td>
<td>8.0</td>
<td>39.3</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>198</td>
<td>7.3</td>
<td>26.5</td>
</tr>
</tbody>
</table>

started was specified in 57 percent of the records. Further analysis is based on these more complete records. The average age when other milk was started was 7.7 months. The distribution by caste and sex showed little variation across the various subgroups (table 5-3). The variances were very large, however, indicating a wide spread.

For further definition of the weaning process and dietary adequacy we recorded nutritional intake qualitatively according to whether the child was receiving milk only (this could be breast milk, other milk, or both), milk and other foods, or other food only. "Milk only" given to children over 6 months of age might indicate caloric deficiency in our population. "Other food only" might result in protein deficiency with or without a deficit in calories. Out of 1,437 survey visits to children 7 months of age and over, 307 or 21.5 percent were to children receiving milk only. This is an estimate of the extent to which we failed to introduce early supplements. The ages most affected are between 7-15 months -- 284 children out of 683, or 41 percent. Even at 16-18 months of age nearly 5 percent were still on a milk-only diet. However, in 745 visits to children over 16 months of age, only 12 or 1.6 percent received "other food only." Thus, over 93 percent of these children were on a potentially adequate combination of milk and other foods, though the quantity may or may not have been adequate.

Cross-sectional Dietary Sample Survey

Between 1971 and 1973 detailed quantitative data were collected
on food intake in our study population. Because of the unreliability of methods using recall of dietary intake, particularly in small children, it became necessary to use direct observation and weighing techniques. Since it is difficult to measure the intake of breast-fed children, especially at night when babies sleep with their mothers, the decision was made to limit the survey to a random sample of partially and fully weaned children. "Partially weaned" was defined as taking only occasional breast-feeding during the day, but breast-feeding at night.

**Sampling.** The total child population between 6 months and 3 years of age from six villages of the Narangwal nutrition study was screened for weaned or partially weaned children. Through random sampling, an approximately equal proportion of children from each caste group and sex was selected for inclusion in the survey.

Investigators contacted the families and made a definitive list of eligible children based on the selection criteria that parents had no objections to the investigator's continuing presence in the house during the survey and that the children were free from current illness. One hundred sixty-nine children were included in the study, with no parents refusing to participate. Only 9 children were partially weaned, and 160 were fully weaned. The sampling technique introduced a number of constraints:

- Only conclusions about the dietary intake of weaned children that were not currently ill are possible.
- The weaned population tends to be older, which gives them a greater likelihood of a dietary intake with a lower proportion of high-quality protein.

**Methods of Observation and Weighing.** On the morning of each observation day the investigator arrived at the house before the child's first meal and weighed the child. During the course of the day, all food items were weighed to the
nearest gram on a beam balance scale. Wasted or leftover food was subtracted. The investigator remained at the house until the child went to bed in the evening. All 169 children were observed for at least one full day. Of these, 50 children were randomly selected for a further two-day observation in order to have a built-in test of reliability.

All food intake was analyzed according to a previously derived recipe composition table based on observations in similar families. Nutrient content was calculated using Indian Council of Medical Research (ICMR) food tables. Protein intakes were adjusted for protein quality by using factors reflecting the source of protein at various age groups: below 18 months of age a factor of 0.9; at or above 18 months a factor of 0.7.

Results. Eighty-six (51 percent) of the children in the final sample were Jat, 72 (43 percent) were Ramdasia, and 11 (6 percent) belonged to other caste groups. Eighty-three (49 percent) were male, 86 (51 percent) were female. Fourteen (8 percent) were between 6 and 12 months of age, 17 (10 percent) between 12 and 18 months, 41 (24 percent) between 18 and 24 months, 44 (26 percent) between 2 and 2 1/2 years, and 53 (31 percent) between 2 1/2 and 3 years of age. The age distribution of the children selected clearly reflects a sampling bias in favor of older children because of the requirement of partial or completed weaning. Mean family incomes ranged from Rs220 to Rs700 per month (Rs7.5 = US$1.0). Thirty-six percent of the families were land-owning farmers; 28 percent were landless laborers; the rest of the families were either employed or were practicing independent skills as tailors, blacksmiths, shopkeepers, and so forth.

Twenty-nine percent of the children in the sample were below 70 percent of the Harvard weight standard, 26 percent were between 70-80 percent of the Harvard standard, and 45 percent were at or above 80 percent. By comparison, 20 percent of all Narangwal children between 6-36 months of age were
below 70 percent of the Harvard weight median, 35 percent were between 70 percent and 80 percent, and 44 percent were at or above 80 percent of the standard. This shows that the children under 70 percent of the median are overrepresented and that children between 70-80 percent median are underrepresented.

In tables 5-4 and 5-5 dietary intakes by age groups are shown. Overall mean calorie intake (table 5-4) was 1,080. Mean intake below 1 year of age was 674 calories, and between 1 and 3 years of age it was 1,173. Both intakes are lower than the average energy requirements proposed as standards by the National Research Council (NRC) of the U.S. National Academy of Sciences, the Food and Agricultural Organization (FAO) of the United Nations, or by the ICMR (figure 5-4). That we saw so much malnutrition indicates that our findings support the higher standards for energy requirements.

Mean protein intakes (table 5-4) were 15.6 grams between 6 and 12 months of age and 22.0 grams between 1 and 3 years of age. According to the NRC recommendations these intakes were not adequate (87 percent and 96 percent, respectively), whereas according to FAO guidelines these intakes exceeded the recommended minimum by about 10 percent. Since the protein "standards" represent a minimum safe level and not an average requirement, it is important to look at the distribution of intake. Over 50 percent of weaned children in the study had an intake below the safe protein level judged by NRC requirements, whereas about 35 percent were below FAO minimum levels for children under 12 months old and over 18 months old. That about one-third of the children had depressed immune capacity, with associated increased risk of mortality has been reported elsewhere. We think, therefore, that the FAO and ICMR levels may be low (figure 5-4).

Average calcium intakes (see table 5-5) were highly adequate according to both NRC and FAO recommendations in all age groups. Average vitamin A intakes (table 5-5) were only
Table 5-4. Observed Calorie and Protein Intakes of Rural Punjabi Children by Age, Compared with Daily Allowances Recommended by NRC and FAO

<table>
<thead>
<tr>
<th>Months</th>
<th>Number</th>
<th>Calories</th>
<th>SD</th>
<th>% Standard</th>
<th>NRC</th>
<th>FAO</th>
<th>Grams</th>
<th>SD</th>
<th>% Standard</th>
<th>NRC</th>
<th>FAOd</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-11.9</td>
<td>14</td>
<td>673.6</td>
<td>305.6</td>
<td>69.3</td>
<td>82.0</td>
<td></td>
<td>15.6</td>
<td>8.8</td>
<td>86.7</td>
<td>111.4</td>
<td></td>
</tr>
<tr>
<td>12-17.9</td>
<td>17</td>
<td>1,113.1</td>
<td>324.0</td>
<td>85.0</td>
<td>81.8</td>
<td></td>
<td>27.9</td>
<td>9.0</td>
<td>121.3</td>
<td>174.4</td>
<td></td>
</tr>
<tr>
<td>18-23.9</td>
<td>41</td>
<td>1,106.6</td>
<td>396.9</td>
<td>85.1</td>
<td>81.3</td>
<td></td>
<td>21.9</td>
<td>7.4</td>
<td>95.2</td>
<td>136.9</td>
<td></td>
</tr>
<tr>
<td>24-29.9</td>
<td>44</td>
<td>1,059.2</td>
<td>401.0</td>
<td>81.5</td>
<td>78.0</td>
<td></td>
<td>20.4</td>
<td>8.7</td>
<td>88.7</td>
<td>127.5</td>
<td></td>
</tr>
<tr>
<td>30+</td>
<td>53</td>
<td>1,171.6</td>
<td>434.9</td>
<td>90.1</td>
<td>86.5</td>
<td></td>
<td>21.5</td>
<td>9.9</td>
<td>93.5</td>
<td>134.4</td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>169</td>
<td>1,079.5</td>
<td>413.8</td>
<td>83.0</td>
<td>79.4</td>
<td></td>
<td>21.5</td>
<td>9.2</td>
<td>95.2</td>
<td>135.8</td>
<td></td>
</tr>
</tbody>
</table>

NRC  National Research Council (U.S. National Academy of Sciences), 1973 standards.
FAO  Food and Agriculture Organization of the United Nations, 1974 standards.
a. Adjusted for protein quality by factors 0.9 from 6 months to 17.9 months, 0.7 from 18 months and above.
b. Energy standard represents average requirement.
c. Protein standard represents minimum safe level.
d. Adjusted to Narangwal median weights.
Table 5-5. Calcium, Iron, and Vitamin A Intakes of Rural Punjabi Children by Age, Compared with Daily Allowances Recommended by NRC and FAO

<table>
<thead>
<tr>
<th>Age group (months)</th>
<th>Number</th>
<th>Calcium</th>
<th>% Standard</th>
<th>Iron</th>
<th>% Standard</th>
<th>Vitamin A</th>
<th>% Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Observed</td>
<td>Mg</td>
<td>SD</td>
<td>NRC</td>
<td>FAO</td>
<td>Observed</td>
</tr>
<tr>
<td>6-11.9</td>
<td>14</td>
<td>766.7</td>
<td>497.4</td>
<td>142.0</td>
<td>139.4</td>
<td>2.7</td>
<td>2.6</td>
</tr>
<tr>
<td>12-17.9</td>
<td>17</td>
<td>1,248.5</td>
<td>633.5</td>
<td>156.0</td>
<td>277.3</td>
<td>9.3</td>
<td>6.4</td>
</tr>
<tr>
<td>18-23.9</td>
<td>41</td>
<td>1,011.5</td>
<td>556.1</td>
<td>126.4</td>
<td>224.7</td>
<td>10.3</td>
<td>5.6</td>
</tr>
<tr>
<td>24-29.9</td>
<td>44</td>
<td>878.8</td>
<td>570.9</td>
<td>109.8</td>
<td>195.3</td>
<td>10.2</td>
<td>6.3</td>
</tr>
<tr>
<td>30+</td>
<td>53</td>
<td>1,028.2</td>
<td>128.5</td>
<td>128.5</td>
<td>228.5</td>
<td>14.5</td>
<td>11.7</td>
</tr>
<tr>
<td>All</td>
<td>169</td>
<td>985.7</td>
<td>842.9</td>
<td>126.6</td>
<td>215</td>
<td>10.9</td>
<td>8.6</td>
</tr>
</tbody>
</table>

Note: See table 5-4 for standards for other intakes.

a. Adjusted to Narangwal median weights  
b. International units
Figure 5-4. Daily Intakes of Rural Punjabi Children Compared with Daily Allowances Recommended by ICMR, FAO/WHO, and NRC

- ICMR (Indian Council of Medical Research), 1968.
- FAO/WHO (Food and Agriculture Organization/World Health Organization), 1974, adapted to Narangwal median weight.

Daily Narangwal intakes, proteins adjusted for protein quality.
about half of those recommended by NRC, yet more than adequate (128 percent compared with FAO standards). Signs of vitamin A deficiency are extremely rare in these villages, and this suggests that intakes, although low according to NRC recommendations, were adequate in protecting against clinical vitamin A deficiency.

Iron intakes (table 5-5) were low -- especially in the 6-12 month age group (18 percent of NRC and about 35 percent of ICMR and FAO recommendations). Beyond the first year of life they averaged 13.3 milligrams, which is low according to ICMR and NRC standards (80-90 percent of recommended intakes), but well above recommendations according to FAO (177 percent). The frequency of anemia in these age groups seems to confirm that ICMR and NRC standards are relevant for this population.

These diet data confirm the anthropometric results showing that energy deficiency in these children is common in the weaning period. On the average, calcium intake seems satisfactory, but iron is deficient up to the age of 30 months. Vitamin A intakes fall between the two norms but were probably adequate, since few clinical indications of deficiency were found.

Such comparisons of averages are unsatisfactory for decisions on service delivery strategies because the analyses are not based precisely on which children had deficient intakes at particular ages and what their immune responses were. The analyses do point to the type of nutrition advice or supplementation that may be necessary, and the general relevance of the various standards that are being used for policy decisions.

Caste proved to have the clearest association with nutritional status. Table 5-6 shows daily protein and energy intakes for the two major caste groups, Jats (high caste) and Ramdasias (low caste). The difference between castes in mean calorie intake for weaned children below 1 year of age is statistically not significant, probably because of the small sample. At all other age groups, daily average calorie intakes
Table 5-6. Observed Calorie and Protein Intakes of Rural Punjabi Children by Age and Caste Compared with Daily Allowances Recommended by NRC and FAO

<table>
<thead>
<tr>
<th>Age group (months)</th>
<th>Caste</th>
<th>Number</th>
<th>Observed Energy</th>
<th>% Standard&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Observed Protein&lt;sup&gt;a&lt;/sup&gt;</th>
<th>% Standard&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Calories</td>
<td>SD</td>
<td>Grams</td>
<td>SD</td>
</tr>
<tr>
<td>6-11.9</td>
<td>Jat</td>
<td>9</td>
<td>612.3</td>
<td>288.5</td>
<td>13.3</td>
<td>8.4</td>
</tr>
<tr>
<td></td>
<td>Ramdasia</td>
<td>4</td>
<td>772.7</td>
<td>387.8</td>
<td>19.8</td>
<td>10.5</td>
</tr>
<tr>
<td>12-17.9</td>
<td>Jat</td>
<td>9</td>
<td>1,113.0</td>
<td>267.7</td>
<td>35.9</td>
<td>7.7</td>
</tr>
<tr>
<td></td>
<td>Ramdasia</td>
<td>8</td>
<td>862.0</td>
<td>149.4</td>
<td>18.9</td>
<td>3.9</td>
</tr>
<tr>
<td>18-23.9</td>
<td>Jat</td>
<td>20</td>
<td>1,235.0</td>
<td>255.5</td>
<td>25.3</td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td>Ramdasia</td>
<td>20</td>
<td>977.4</td>
<td>480.9</td>
<td>18.3</td>
<td>7.7</td>
</tr>
<tr>
<td>24-29.9</td>
<td>Jat</td>
<td>25</td>
<td>1,164.2</td>
<td>404.4</td>
<td>23.3</td>
<td>9.7</td>
</tr>
<tr>
<td></td>
<td>Ramdasia</td>
<td>14</td>
<td>960.2</td>
<td>399.1</td>
<td>17.6</td>
<td>5.0</td>
</tr>
<tr>
<td>30+</td>
<td>Jat</td>
<td>23</td>
<td>1,341.6</td>
<td>519.9</td>
<td>27.0</td>
<td>11.2</td>
</tr>
<tr>
<td></td>
<td>Ramdasia</td>
<td>26</td>
<td>999.2</td>
<td>285.2</td>
<td>16.7</td>
<td>6.7</td>
</tr>
<tr>
<td>All</td>
<td>Jat</td>
<td>86</td>
<td>1,165.1</td>
<td>433.1</td>
<td>25.0</td>
<td>10.4</td>
</tr>
<tr>
<td></td>
<td>Ramdasia</td>
<td>72</td>
<td>957.7</td>
<td>363.3</td>
<td>17.7</td>
<td>6.7</td>
</tr>
</tbody>
</table>

<sup>a</sup> Adjusted for protein quality by factors 0.9 from 6 months to 17.9 months, 0.7 from 18 months and above.
<sup>b</sup> Energy standard represents average requirement.
<sup>c</sup> Protein standard represents minimum safe level.
<sup>d</sup> Adjusted to Narangwal median weights.
of Ramdasia children are significantly lower than those of Jat children. Mean intake between 1 and 3 years of age for Jats was 1,230 calories (96 percent of NRC average requirement) compared with only 969 calories for Ramdasias (74 percent of NRC average requirement).

The difference in protein intake between Ramdasia and Jat infants between 6 months and 1 year was also not significant statistically. After 1 year of age, Ramdasia intakes were consistently (and significantly, \( p < .05 \)) lower than those of Jat children. The protein intake of Ramdasias (1-3 years old) averaged 17.6 grams, which was 77 percent of NRC, but 110 percent of the FAO, minimum safe level. Calcium intakes in Jats were uniformly high throughout all ages, mainly because of consumption of buffalo and cow milk. For Ramdasias, calcium intakes were adequate up to 1 1/2 years of age, but they became inadequate at higher ages according to NRC standards (79 percent of the recommended), while according to FAO guidelines they continued to be highly adequate (140 percent of recommended). Iron intakes were similar for both groups -- low (73 percent) by NRC recommendations and high (157 percent) on the FAO scale. Vitamin A intakes of Ramdasia children were, on the average, only 60 percent of those of Jat children. Neither of the two received adequate intakes according to NRC guidelines -- 68 percent for Jat, 40 percent for Ramdasia, but, according to FAO tables, both had adequate intakes (Jat 160 percent, Ramdasia 94 percent).

Straightforward comparisons of the average intakes among weaned children of different castes show that Ramdasias have a 15 to 20 percent lower calorie intake than Jats. An even wider difference in the protein intake of the two groups was evident from 12 months of age onward (23 to 47 percent difference). This difference in nutritional intake between castes therefore is probably a major cause of the difference in growth patterns in a synergistic relationship, with the greater morbidity occurring among low-caste children.
Female children consistently received less food than male children. At all ages in comparison with males, females received 86 percent as many calories, 84 percent as much protein, 69 percent as much calcium, 88 percent as much iron, and 78 percent as much vitamin A. According to both NRC and FAO guidelines, caloric intakes of both male and female children were below recommended levels (88 percent and 77 percent, respectively, of FAO standards). For female children, only calcium intakes reached adequate levels (105 percent of NRC recommendation). For males, calcium and protein seemed adequate, but vitamin A and iron inadequate. The low intakes of girls reflect the low social priority accorded female children and suggest that restricted intake is a major contributor to their deficient growth.

Figure 5-4 portrays in a summary fashion the clearest representation of the interrelationships between dietary intakes of calories, protein, calcium, and iron in comparison with recommended allowances. In addition to NRC and FAO recommendations, those of the ICMR are included. The data are shown for the ages of 6-12 months and for 1-3 years. The graphs show that the daily calorie intake of children fell short of all recommended levels, both between 6 and 12 months and between 1 and 3 years of age. Protein and calcium intakes were adequate or higher than the recommended allowances. Iron intake below 1 year of age was much lower than recommended. However, from the age of 1-3 years, although iron intake was higher than in infants, it was still below ICMR and NRC recommendations.

CLINICAL OBSERVATIONS

Baseline clinical observations done in the study area in 1967 had shown convincingly that a significant proportion of the childhood population under 40 months of age had signs of protein-calorie malnutrition (PCM). Although clinical measures of nutritional status are generally not sensitive to
moderate undernutrition, they do pick up overt signs of specific deficiencies and provide qualitative evidence for the relative deficit of calories and protein; that is, the identification of overt cases of marasmus or kwashiorkor. In July 1970, clinical assessment of children from birth to 60 months of age was carried out in another cross-sectional survey designed to detect nutritionally significant symptoms within the study population. This survey covered 2,046 (93 percent) of the estimated 2,200 children up to 5 years of age resident in our villages. The sex distribution of those surveyed (54.2 percent males) approximates very closely the sex distribution (53 percent males) in the target population.

To minimize the usual problems of standardization, all observations were made by only two physicians working together, with positive or doubtful signs being shared in an effort to maintain interpersonal comparability. Because of the well-known tendency to adapt to the "norm" of a community, both observers tried to maintain a consistent pattern of evaluation. In addition, both had been working in these villages for more than two years, so that they had already made their adjustment to local "norms." They also knew the type of service available in each village and had already seen and treated the severe cases of malnutrition. Because of this chance for bias in judging the nutritional status of children, in accordance with the services available to them, this presentation has been limited to findings by sex, caste, and age across all villages.

We have not shown signs that occurred with frequencies of less than 1 percent. All suspected or confirmed signs of vitamin deficiencies fell into this category.

A child was classified as "marasmus" when it had little or no subcutaneous fat and had wrinkled skin over the buttocks. A child was judged "undernourished" when it seemed thin, was obviously stunted, had obvious hair changes such as dyspigmentation, or had a combination of these symptoms.
Table 5-7. Clinical Impressions of Nutritional Status of Rural Punjabi Children by Sex or Caste, July 1970

<table>
<thead>
<tr>
<th>Care</th>
<th>Marasmus</th>
<th>Undernourished$^a$</th>
<th>Subtotal</th>
<th>Normal</th>
<th>Total (Number)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
<td>Percent</td>
<td>Number Percent</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>19</td>
<td>1.7</td>
<td>149</td>
<td>13.4</td>
<td>168</td>
</tr>
<tr>
<td>Female</td>
<td>23</td>
<td>2.5</td>
<td>210</td>
<td>22.7</td>
<td>223</td>
</tr>
<tr>
<td>No information</td>
<td>...</td>
<td>...</td>
<td>2</td>
<td>14.4</td>
<td>2</td>
</tr>
<tr>
<td>Caste</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jat</td>
<td>7</td>
<td>0.8</td>
<td>116</td>
<td>14.1</td>
<td>123</td>
</tr>
<tr>
<td>Ramdasia</td>
<td>25</td>
<td>3.7</td>
<td>140</td>
<td>21.1</td>
<td>165</td>
</tr>
<tr>
<td>Others</td>
<td>7</td>
<td>1.9</td>
<td>63</td>
<td>17.2</td>
<td>70</td>
</tr>
<tr>
<td>No information</td>
<td>3</td>
<td>1.4</td>
<td>42</td>
<td>20.3</td>
<td>45</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td>2.1</td>
<td>361</td>
<td>16.5</td>
<td>403</td>
</tr>
</tbody>
</table>

Zero or negligible.

$^a$. This represents mild-moderate protein-calorie malnutrition (PCM) including nutritional dwarfing, pre-kwashiorkor.
These "undernourished" children were considered to have mild-to-moderate PCM. No children were found to have edema, puffiness, or other signs of kwashiorkor or pre-kwashiorkor. Table 5-7 shows that females suffered more PCM and that Ramdasias were worse off than either of the other castes. The age distributions (table 5-8) showed a general prevalence of PCM of about 20 percent, reaching more than 30 percent between the ages of 8 and 22 months.

Marked dyspigmentation and yellowing of the hair is extremely common in Punjabi children and might represent a specific amino-acid deficiency due to marginal protein intake in the presence of caloric deficiency. It is probably not simply due to exposure to the sun, because when a child is placed on an adequate feeding program there is a clear-cut flag sign as the normally pigmented hair grows out. Hair abnormalities were found in 37.1 percent of children, appearing from the age of 2 months onward and rising to 51 percent at 8 months of age. Because Sikhs do not cut their hair, discoloration of hair tips could be seen beyond the age of 5 years as a visible "scar."

The clinical nutrition survey confirmed that deficiencies were mainly caloric; that extreme undernutrition shown by marasmus was relatively rare; and that mild-to-moderate PCM affected a large proportion of children. This survey supported the conclusion that in this population females, low-caste children, and all children between 8 and 22 months of age are at special risk of PCM. It gave credence to the program at Narangwal designed to concentrate nutrition surveillance, education, and supplementation on children under 3 years old, with those under 2 years old receiving highest priority.

SUMMARY

Data presented in this chapter are consistent with the following sequence in the evolution of synergism. Essentially all children are breast-fed and do well for about 4 months.
Table 5-8. Clinical Impressions of Nutritional Status of Rural Punjabi Children by Age, July 1970

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>Marasmus</th>
<th></th>
<th>Undernourished&lt;sup&gt;a&lt;/sup&gt;</th>
<th></th>
<th>Subtotal</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total (Number)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
<td></td>
</tr>
<tr>
<td>0-1.4</td>
<td></td>
<td></td>
<td>2</td>
<td>8.6</td>
<td>2</td>
<td>8.6</td>
<td>21</td>
<td>91.4</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>1.5-2.4</td>
<td>1</td>
<td>3.2</td>
<td>7</td>
<td>22.6</td>
<td>8</td>
<td>25.8</td>
<td>23</td>
<td>74.2</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>2.5-5.4</td>
<td>1</td>
<td>1.2</td>
<td>7</td>
<td>8.8</td>
<td>8</td>
<td>10.0</td>
<td>72</td>
<td>90.0</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>5.5-8.4</td>
<td>2</td>
<td>1.9</td>
<td>17</td>
<td>16.2</td>
<td>19</td>
<td>18.1</td>
<td>86</td>
<td>81.9</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>8.5-11.9</td>
<td>7</td>
<td>4.7</td>
<td>40</td>
<td>26.8</td>
<td>47</td>
<td>31.5</td>
<td>102</td>
<td>69.5</td>
<td>149</td>
<td></td>
</tr>
<tr>
<td>12.0-17.9</td>
<td>7</td>
<td>4.0</td>
<td>60</td>
<td>33.9</td>
<td>67</td>
<td>37.9</td>
<td>110</td>
<td>69.1</td>
<td>177</td>
<td></td>
</tr>
<tr>
<td>18.0-22.4</td>
<td>9</td>
<td>5.8</td>
<td>63</td>
<td>40.9</td>
<td>72</td>
<td>46.1</td>
<td>82</td>
<td>53.9</td>
<td>154</td>
<td></td>
</tr>
<tr>
<td>22.5-49.4</td>
<td>10</td>
<td>1.1</td>
<td>135</td>
<td>15.5</td>
<td>145</td>
<td>16.6</td>
<td>726</td>
<td>83.4</td>
<td>871</td>
<td></td>
</tr>
<tr>
<td>49.5-60</td>
<td>5</td>
<td>1.1</td>
<td>30</td>
<td>6.5</td>
<td>35</td>
<td>7.6</td>
<td>421</td>
<td>92.4</td>
<td>456</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td>2.1</td>
<td>361</td>
<td>17.6</td>
<td>403</td>
<td>19.7</td>
<td>1,643</td>
<td>80.3</td>
<td>2,046</td>
<td></td>
</tr>
</tbody>
</table>

... Zero or negligible.

<sup>a</sup> This represents mild-moderate PCM including nutritional dwarfing, pre-kwashiorkor.
Then two types of findings appear. Average growth increments drop significantly below the Harvard standards. As shown in chapter 7, a high rate of morbidity is evident at 4 months of age, and seasonal patterns of prevalence suggest that diarrheas may be associated especially with the timing of greatest nutritional stress. The fact that breast-feeding does not prove adequate to maintain growth increments up to 6 months of age is undoubtedly influenced strongly by the heavy infection load. At least two mechanisms for this can be readily identified. First is the cultural taboo against feeding sick children, which includes breast-feeding. The second is the direct nutritional drain caused by infections, which is aggravated by the lack of compensatory feeding.

Synergism can probably also be initiated by specific dietary deficits, and in Narangwal children the most obvious was iron deficiency. Anemia is a major problem, and a gross deficit in intakes was clearly demonstrated in the dietary survey. Iron deficiency has been shown in other studies to cause a distinct reduction in resistance to infections.

Another important causal factor in starting the synergistic process is the shift in breast-feeding from demand-feeding to opportunity-feeding that occurs when mothers become very busy during the harvest season. This is compounded by environmental stress from the extreme heat in May and June at the time of harvest.

International standards for dietary intake have been based mainly on clinical studies in well-nourished populations in developed countries. There have been few field studies of children living under natural conditions in developing countries that have permitted detailed analysis of the relation between dietary intake and developmental parameters. The Narangwal findings contribute to current discussions in which the need for clarification is indicated by the widely ranging differences in the various international standards -- especially those of the FAO and the NRC. The ICMR standards tend
to fall in between the others.

The results of the dietary survey suggest strongly that the average consumption of calories was insufficient for all children under 1 year of age in the study population. Moreover, for Ramdasias this deficiency continued up to the age of 36 months. The intake of these children was distinctly lower than the norms established in all international standards.

There is also clear-cut evidence of iron deficiency, especially in children under 1 year old. At other ages the average iron intake is below NRC and ICMR standards and above FAO standards. Elsewhere it has been shown that high rates of anemia prevail up to the age of 2. This suggests that the FAO standard for iron intake is probably inappropriate for children in the Punjab environment.

Similar impressions can be applied to the standards for vitamin A intake and protein intake. We found no clinical evidence of vitamin A deficiency, since intakes were adequate by FAO standards but only half of NRC standards, the results support the former standards.

For protein, however, we feel that, even though no clinical kwashiorkor was found, evidence of protein lack was suggested by other findings such as changes in hair color. In addition, more than a third of the children had depressed immune capacity associated with increased mortality risk. We feel, therefore, that the current FAO minimum level of intake is probably low. Our general impression is that, because of the high infectious disease burden and climatic stress, intakes judged adequate by U.S. or European standards may be inadequate in a developing country.

Intakes were grossly different between castes and sexes, but no caste-sex grouping seems entirely free of deficiency. Intake also varied widely between individuals.

The concordance between the different methods of judging nutritional status used at Narangwal suggests that our service delivery methods were appropriate in emphasizing simple growth
surveillance and efforts to provide intensive nutrition supplementation for children with faltering growth. Periodic hemoglobin checks by a laboratory technician were also important to detect children with iron deficiencies. It is somewhat difficult to judge the sensitivity or specificity of the process of detecting those children in need of nutrition supplements based on weight-for-age achieved as well as on weight increments. It would seem that the specificity was quite good; judged from the fact that children below 70 percent of weight-for-age or with two unsatisfactory increments seemed to respond well to nutritional follow-up. The sensitivity is more difficult to judge, since considerable malnutrition and morbidity continued to appear in this population. The results suggest that the nutritional advice and the supplements provided were focusing on the correct deficiencies: calories, iron, and the marginality of protein. The improvements in resulting growth indicate that we were beginning to meet the important nutritional needs of these children, but that even more intensive efforts were still needed.

NOTES TO CHAPTER 5


Chapter 6
Correlates of Preschool Child Growth
in Rural Punjab

Dov Chernichovsky, Nandita S. Kielmann,
Arnfried A. Kielmann, and William A. Reinke

The purpose of this analysis is to relate the influence of the quality and quantity of diet, the quality of maternal care, and general environmental conditions to child growth as measured by weight and height. In this chapter we attempt to isolate statistically the effect of children's diets on their growth and to relate this dietary intake to the family’s economic status.

This discussion is based on a subsample of 173 children 1-36 months old on whom detailed dietary intake data were obtained. The discussion falls into two parts. First, we introduce the conceptual framework drawn from Chernichovsky and Coate that is used to analyze the data. Second, in the empirical discussion, we introduce the data and the estimation procedure and report our results. Finally, we summarize our conclusions.

CONCEPTUAL FRAMEWORK

The purpose of this section is to formalize the interdependence among children’s growth, health, and diet (figure 6-1). From a behavioral viewpoint it is assumed that, although parents are constrained by genetic, biological and socioeconomic factors, they can influence the growth of their children by the choice of diet and by other inputs in their children's health: parental care, sanitary conditions, health care, and the like.
Figure 6-1. *Schematic Model for the Analysis of Narangwal Nutrition Project Data*

Genetic influences

Socioeconomic status

Dietary intake

Quality of maternal care

Housing (environmental conditions)

Nutritional status and growth

Morbidity experience

Mortality

Psychomotor development

Two-way interaction.
We begin by relating the initial diet, $D_0$, of a healthy newborn to birth weight, $BW$, which is a proxy for an infant's early appetite and muscular development, or initial health conditions, and to socioeconomic conditions, $E_0$, which determine the quality and quantity of the infant's diet, particularly when the infant is weaned and may be exposed to environmental effects. Formally,

$$D_0 = f^0 (BW, E_0). \quad (1)$$

We expect the infant's initial diet to be a positive function of these two variables.

In each subsequent period $t$ ($t = 1, \ldots, T$), the child's growth, $G_t$, is assumed to be determined by some constant genetic and parental traits, $Z$, by his diet, $D_{t-1}$, and by his health, $H_{t-1}$, in the preceding period. $H_t$ can be interpreted as an efficiency parameter affecting the body's capacity to process a given diet, in the sense that a healthy child makes better use of a given diet than a sick child. This is, formally,

$$G_t = g^t (Z, D_{t-1}, H_{t-1}). \quad (2)$$

We expect that the child's growth in each period (age) to be typical of his sex group and similar to some parental traits; for example, taller parents will have taller children. Controlling for age, sex, and parental traits, all represented by $Z$, we expect healthier children with better diets to grow better. (Parental traits, like height and weight of father and mother are not entirely genetic factors; in a more general and longer-run framework than the one described here, parents' growth and development, as their children's, reflect the parents' own socioeconomic background.)

The diet in each period after birth is a function of the child's growth, which, again, serves as a proxy for the child's
appetite, or his demand for food, and socioeconomic status. Thus,

\[ D_t = f (G_t, E_t). \]  

(3)

The child's health status is a function of his diet and other factors, such as housing and maternal care, that are inputs in good health. These other factors are, in turn, also determined by socioeconomic status, so that

\[ H_t = h (D_t, E_t). \]  

(4)

To identify statistically some key relationships with available cross-sectional data, several assumptions were necessary, some of which are explicit in relationships (1)-(4). First, birth weight was not available for all children within our project because of cultural resistance to early weighing or because about one-third of births were in the village of the mother's parents. A more sophisticated model could include birth weight as a variable that is determined by parental characteristics, especially maternal nutrition, as well as socioeconomic variables.

We also assume that some variables, such as household income and diet, are serially correlated while others, such as parents' traits and education, are constant. Furthermore, we assume that the time increments are infinitesimal.

These assumptions permit us to derive the following (reduced) relationships

\[ G = g_1 (t, Z, BW, E) \]  

(5)

and

\[ D = g_2 (t, Z, BW, E), \]  

(6)
which relate child growth to parameters that, within this partial analysis, are external to the parents' decision-making process but nevertheless influence it.

The reduced relationship (5) conceals the particular intervening mechanism, noted in equations (2)-(4), through which the household's socioeconomic status operates, whether it be diet or other inputs in child health. In particular, equations (2)-(4) specify the complex interrelatedness of the three main factors of intervention interest: diet, growth, and health. From (2) we see that growth is a function of diet and health, while in (3) we portray diet as a function of growth. Health is in turn a function of diet, as indicated in (4). Taken together, we have the following system of simultaneous equations:

\[ \hat{G} = g(t, Z, BW, D, H), \]  
\[ D = f(G, E), \]  
\[ H = f(D, E), \]

in which the circumflex (\(^\wedge\)) indicates that the variable is an outcome determined by the system of equations. In summary, diet, children's growth, and health are codetermined in the sense that they affect each other, and all are mutually determined by a set of biological, genetic, and socioeconomic variables.

EMPIRICAL ANALYSIS

The number of variables measured, and the number of observations of each, is inadequate to test fully the model represented by equations (7)-(9). Nevertheless, empirical analysis provides some useful insights, particularly with respect to (7) and (8).
Table 6-1. Means, Standard Deviations (SDs) and Numbers of Valid Observations of Variables

<table>
<thead>
<tr>
<th>Role in equations (7)-(9)</th>
<th>Number of valid observations</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>G</td>
<td>167</td>
<td>9.53</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>G</td>
<td>66</td>
<td>79.93</td>
</tr>
<tr>
<td>Calories (g)</td>
<td>D</td>
<td>173</td>
<td>1066</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>D</td>
<td>62</td>
<td>920</td>
</tr>
<tr>
<td>Diarrhea prevalence (days)</td>
<td>H</td>
<td>62</td>
<td>0.89</td>
</tr>
<tr>
<td>Age (months)</td>
<td>Z</td>
<td>167</td>
<td>24.67</td>
</tr>
<tr>
<td>Sex (male = 1)(a)</td>
<td>Z</td>
<td>167</td>
<td>0.48</td>
</tr>
<tr>
<td>Maternal height (cm)</td>
<td>Z</td>
<td>62</td>
<td>154.26</td>
</tr>
<tr>
<td>Land cultivator (Yes = 1)(a)</td>
<td>E</td>
<td>167</td>
<td>0.38</td>
</tr>
<tr>
<td>Artisan, civil servants (Yes = 1)(a)</td>
<td>E</td>
<td>167</td>
<td>0.38</td>
</tr>
<tr>
<td>Area of land cultivated (ha)</td>
<td>E</td>
<td>62</td>
<td>2.89</td>
</tr>
</tbody>
</table>

\(a\). A "dummy" variable that equals zero when the condition is not met.

The Data

Relevant available data pertain to a sample of 167 children 1-36 months old. This sample had to be substantially reduced for parts of the analysis because of a lack of key information on certain variables. Table 6-1 shows the variables available for analysis, their relationship to the conceptual model defined by equations (7)-(9), and numbers of valid observations, along with the means and standard deviations of each.

These statistics indicate that our sample is equally divided between boys and girls with an average age of two years. These children have an average weight of 9.5 kg, which compares with a weight of about 12 kg for a similar group in the United States. They have an average height of about 80 cm, which compares with about 85 cm for the United States.

Land cultivators who own their land make up 38 percent of this sample; artisans, self-employed persons, and civil servants (teachers, police, and so forth) make up 18 percent; and
the other 44 percent comprise agricultural laborers. This hierarchy of occupations presents, in a descending order, the relative economic well-being among the groups. This economic well-being is also approximated by the area of land cultivated by each household.

Children's height and weight are growth indicators, the former being a long-term indicator as opposed to the more short-term variations for weight.

Consumption levels of calories and calcium were used as proxies for the children's entire diet. Just one of these variables is used at a time because of the high correlation between them. Calcium, which approximated milk protein, appears more significant statistically in estimates that relate to height, while calories appear more significant in weight-related estimates. Occupational group and area of land cultivated serve as proxies for socioeconomic status. As is highlighted later on in this discussion, this classification between traits and economic variables may be somewhat arbitrary.

The Results

The estimated relationships, which are discussed in this subsection, represent compromises between our conceptual framework and the available data. We basically assume linear relationships between the outcome variables -- nutritional status and diet -- and the other variables. We allow for the nonlinear growth pattern of children by adding \((\text{age})^2\) to the estimated relationships. The basic conceptual deviation of our estimates from the conceptual framework is because the health indicator is treated as a variable that is not determined by the others.

The estimation procedure comprised two stages. First, we estimated relationships (5) and (6) to establish whether the household's socioeconomic status has an effect on children's growth and their diets. Second, we attempted to estimate part of the systems presented by relationships (7)-(9).
larize the effect of socioeconomic status on child growth through their diet. The results are summarized in tables 6-2 and 6-3.

With respect to the growth analysis, equation (5), the coefficients on children's age variables indicate the common nonlinear growth patterns. The coefficients on the sex variable indicate that, on the average, boys are heavier, but not necessarily taller, than girls. It is evident, however, that the sex variable loses some of its statistical significance when maternal height is introduced in the equation. The zero-order correlation between maternal height and the child being a boy is 0.31. This correlation is strangely high and apparently represents a selectivity bias. Taller mothers, who come from higher socioeconomic classes, tended to have their sons rather than daughters receive the treatment of the program. This fact is not apparent in the even age distribution in our sample of children. It may indicate, however, a bias of a small sample. While in other places the sex variable is often considered a proxy for genetic factors, this variable also represents a known behavioral discrimination against baby girls in this particular environment.

As expected, maternal height has a positive effect on child growth. Here again, while this variable approximates the effect of genetic and maternal traits, in this environment it is greatly influenced by early nutritional and socioeconomic status. Mother's height is correlated with land ownership (0.24), and with area of land cultivated (0.18). Therefore, this variable when introduced in the equation also reduced the statistical significance of the socioeconomic variables.

The effects of socioeconomic variables are of key interest. These variables are represented interchangeably by father's major occupation and by the area of land cultivated by the household. The estimated coefficients indicate that landowners, who are the highest socioeconomic class in this environment, have the heaviest and tallest children. These
children have a better nutritional status than the children of a mid-caste group (artisans, self-employed persons, and civil servants) who, in turn, are better off than agricultural laborers. Children of the mid-caste groups appear to grow better than the children of laborers; however, this particular result is not statistically significant. Substituting area of land cultivated for occupation as a proxy for family wealth (analyses 5.3 and 5.5 in tables 6-2 and 6-3) yields results that are consistent with the above findings; children whose families cultivate more land are also nutritionally better off. The estimated coefficient suggests that, around the means, a 10 percent increase in the amount of available land brings about a 0.5 percent improvement in a child's weight and a 0.3 percent improvement in his height. Alternatively, an increase of one hectare of land cultivated means, on the average, an increase of about 140 grams in the weight, and of about 1 cm in the height of a child 2 years old.

Analyses 5.4 and 5.5 in tables 6-2 and 6-3 also show that, controlling for other things, a higher prevalence of diarrhea appears to have, as expected, an adverse effect on child growth as reflected in height.

Relationships assessed in analyses 6.1-6.3 are comparable to analyses 5.1 and 5.3, with dietary factors (consumption levels of calories and calcium) replacing growth (weight) as the dependent variables. The results are also comparable, though dietary effects are not as strong as those associated with weight. In particular, older male children of landowners consume more calories than others, as might be expected.

The above results support the conclusion that socioecon-omic conditions affect children's growth and diets. They are insufficient, however, for particularizing the effect of socioeconomic conditions on growth through the diet. Analyses 6.1-6.3 may overstate the effect of socioeconomic status on the diet in the sense that heavier (and taller) children may eat better, and that some of this effect is captured by the
Table 6-2. Summary of Empirical Relationships: t-Statistics for Partial Regression Coefficients

<table>
<thead>
<tr>
<th>Analysis number</th>
<th>Ref. eq.</th>
<th>N</th>
<th>Growth (G)</th>
<th>Diet (D)</th>
<th>Health (H)</th>
<th>Diarrhea prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Weight</td>
<td>Height</td>
<td>Calories</td>
<td>Calcium</td>
</tr>
<tr>
<td>5.1</td>
<td>(5)</td>
<td>167</td>
<td>DV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>(5)</td>
<td>62</td>
<td>DV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.3</td>
<td>(5)</td>
<td>59</td>
<td>DV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4</td>
<td>(5)</td>
<td>58</td>
<td>DV</td>
<td></td>
<td></td>
<td>-1.67</td>
</tr>
<tr>
<td>5.5</td>
<td>(5)</td>
<td>57</td>
<td>DV</td>
<td></td>
<td></td>
<td>-1.61</td>
</tr>
<tr>
<td>6.1</td>
<td>(6)</td>
<td>167</td>
<td>DV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td>(6)</td>
<td>59</td>
<td>DV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3</td>
<td>(6)</td>
<td>58</td>
<td>DV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1</td>
<td>(7)</td>
<td>167</td>
<td>DV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2</td>
<td>(8)</td>
<td>167</td>
<td>5.31</td>
<td>DV</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $p < .05$; ** $p < .01$; *** $p < .001$

DV dependent variable.

Zero or negligible.
Table 6-2 (Continued)

<table>
<thead>
<tr>
<th>Genetic and parental (Z)</th>
<th>Socioeconomic (E)</th>
<th></th>
<th></th>
<th></th>
<th>Adjusted $R^2$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Age)$^2$ (boy=1)</td>
<td>Sex</td>
<td>Maternal height</td>
<td>Land cultivator</td>
<td>Civil servant</td>
<td>Area cultivated</td>
<td></td>
</tr>
<tr>
<td>4.90</td>
<td>-2.30</td>
<td>3.93</td>
<td><strong>3.56</strong></td>
<td>1.47</td>
<td>.54</td>
<td>37.2</td>
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<tr>
<td>2.31</td>
<td>-1.29</td>
<td>1.68</td>
<td><strong>2.30</strong></td>
<td>1.16</td>
<td>.47</td>
<td>8.2</td>
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<tr>
<td>1.98</td>
<td>-0.90</td>
<td>1.38</td>
<td><strong>3.04</strong></td>
<td><strong>2.00</strong></td>
<td>.49</td>
<td>10.2</td>
</tr>
<tr>
<td>2.08</td>
<td>-0.98</td>
<td>1.21</td>
<td><strong>2.10</strong></td>
<td><strong>2.86</strong></td>
<td>.48</td>
<td>8.1</td>
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<tr>
<td>1.87</td>
<td>-0.75</td>
<td>1.16</td>
<td><strong>2.49</strong></td>
<td><strong>3.22</strong></td>
<td>.50</td>
<td>10.2</td>
</tr>
<tr>
<td>2.87</td>
<td>-1.99</td>
<td>2.94</td>
<td><strong>2.73</strong></td>
<td>-1.00</td>
<td>.19</td>
<td>7.9</td>
</tr>
<tr>
<td>1.16</td>
<td>-1.28</td>
<td>2.15</td>
<td>1.26</td>
<td><strong>1.31</strong></td>
<td>.13</td>
<td>1.7</td>
</tr>
<tr>
<td>0.08</td>
<td>-0.41</td>
<td>1.51</td>
<td>...</td>
<td><strong>2.60</strong></td>
<td>.13</td>
<td>2.3</td>
</tr>
<tr>
<td>1.25</td>
<td>0.08</td>
<td>0.27</td>
<td></td>
<td></td>
<td>.59</td>
<td>45.6</td>
</tr>
<tr>
<td>1.17</td>
<td>2.50</td>
<td></td>
<td></td>
<td></td>
<td>.19</td>
<td>12.3</td>
</tr>
</tbody>
</table>
Table 6-3. Summary of Empirical Relationships: Partial Regression Coefficients

<table>
<thead>
<tr>
<th>Analysis number</th>
<th>Dependent variable</th>
<th>Growth (G)</th>
<th>Diet (D)</th>
<th>Health (H)</th>
<th>Diarrhea prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.3</td>
<td>Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4</td>
<td>Height</td>
<td></td>
<td></td>
<td></td>
<td>-1.99</td>
</tr>
<tr>
<td>5.5</td>
<td>Height</td>
<td></td>
<td></td>
<td></td>
<td>-1.84</td>
</tr>
<tr>
<td>6.1</td>
<td>Calories</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td>Calories</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3</td>
<td>Calcium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1</td>
<td>Weight</td>
<td></td>
<td></td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td>7.2</td>
<td>Calories</td>
<td></td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

... Zero or negligible.
Table 6.3 (Continued)

<table>
<thead>
<tr>
<th>Age</th>
<th>(Age)^2</th>
<th>Sex</th>
<th>Genetic and parental (Z)</th>
<th>Socioeconomic (Z)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Land Cultivated</td>
<td>Civil Servant</td>
</tr>
<tr>
<td>0.34</td>
<td>-0.003</td>
<td>0.93</td>
<td>0.95</td>
<td>.50</td>
</tr>
<tr>
<td>0.30</td>
<td>-0.003</td>
<td>0.58</td>
<td>0.81</td>
<td>.62</td>
</tr>
<tr>
<td>0.25</td>
<td>-0.002</td>
<td>0.48</td>
<td>0.14</td>
<td>0.91</td>
</tr>
<tr>
<td>1.23</td>
<td>-0.012</td>
<td>0.92</td>
<td>4.52</td>
<td>0.91</td>
</tr>
<tr>
<td>1.07</td>
<td>-0.009</td>
<td>1.78</td>
<td>1.00</td>
<td>-4.65</td>
</tr>
<tr>
<td>50</td>
<td>-1.2</td>
<td>257</td>
<td>180</td>
<td>-80</td>
</tr>
<tr>
<td>5</td>
<td>0.6</td>
<td>255</td>
<td>31</td>
<td>291</td>
</tr>
<tr>
<td>0.11</td>
<td>0.0001</td>
<td>0.17</td>
<td>89</td>
<td>929</td>
</tr>
<tr>
<td>78</td>
<td>-212</td>
<td>1.79</td>
<td>121</td>
<td></td>
</tr>
</tbody>
</table>
socioeconomic variables. Stated differently, analyses 5.1-5.5 showed an association between growth and socioeconomic factors. Since only the latter are included in analyses 6.1-6.3, they may indirectly express the effects of growth on dietary consumption.

To overcome these problems to some extent, we estimated the simultaneous equations reported in analyses 7.1 and 7.2. These equations correspond to relationships (7) and (8) in the conceptual framework that presumes that nutritional status measured by weight, for example, and by the diet, measured by consumption of calories, are codetermined. Children who eat more are heavier, and heavier children tend to eat more.

This relationship is confirmed. Of special interest to us are the estimates in analysis 7.2. They indicate that for their weight (and age and sex), as determined by all other variables, children of landowners do not appear to get more calories than children of agricultural workers; although positive, the relevant coefficient is not significant statistically in our estimates. (It is most likely that with a bigger sample we could achieve superior statistical estimates, showing that children of landlords consume more calories than other groups). This suggests that, when two children of equal weight and other measured characteristics are observed, those of landowners have a diet similar to the diet of those of agricultural workers, at least as far as calories are concerned.

For equal weight and other measurable characteristics, however, children of the mid-caste group (artisans, self-employed persons, and civil servants) get fewer calories. Since we know from earlier estimates that these children grow at least as well as those of agricultural laborers, the results imply that children of the mid-caste groups can grow as well as other children but with a smaller diet. Alternatively, children of parents involved in agricultural activities
incur some loss of the diet they consume. This suggests that the lower frequency of infections or lower levels of activity may contribute to the growth of children of the mid-caste group. These mid-caste children also had the lowest infant mortality of any caste group (see chapter 7). These factors may be related to better housing and sanitary conditions and childbearing practices. This conclusion, which agrees with our field experience and underlies our conceptual framework, cannot be strictly tested with our data.

SUMMARY

While the available data do not permit a full exploration of the conceptual framework we postulate, the results show a clear link between the socioeconomic environment of preschool children and their nutritional status.

On the one hand, children of landowners grow better and have better diets than children of artisans, self-employed persons, civil servants, and agricultural laborers. On the other hand, children of the mid-caste group appear able to achieve higher growth levels with smaller diets than those of children of parents in agricultural occupations. This suggests that artisans (carpenters, masons), self-employed persons (shopkeepers, goldsmiths), and civil servants (teachers, policemen, and so forth) may maintain better sanitary conditions than do members of other primarily agricultural occupations; thus, their children may incur less of a loss in the diet consumed due to infection. This conclusion is supported by other data on the adverse effect of diarrhea on child growth.

NOTE TO CHAPTER 6

Chapter 7
Analysis of Morbidity and Mortality

Arnfried A. Kielmann, Cecile DeSweemer, Robert L. Parker, and Carl E. Taylor

A critical analysis of the interrelationships between morbidity and nutritional status was an especially important part of this research, especially since such observations have only rarely been attempted under field conditions. The amount of work that went into collecting morbidity information overshadowed all other field activities of the Nutrition Project. At the start, great effort was put into standardizing observations through setting clear diagnostic criteria and through using symptom categories that seemed to fit local concepts of illness, special training of family health workers (FHWs), and tight supervision.

PATTERNS OF MORBIDITY

A measurement process was developed to record both incidence and duration of illness. Once a week, mothers reported whether any of forty-four symptoms had occurred in children under 3 years old, and these daily records were supplemented by physical examinations conducted by FHWs on their weekly visit. Duration of a recorded illness episode proved to have many fewer measurement problems and was considerably less subject to underreporting than was incidence. This was fortunate because our initial analysis had led us to the hypothesis that the program would have greater impact on duration than on incidence of illness. It was presumed that in the village environment children would be exposed to infections at a continu-
timings high rate. We did not expect that incidence would be greatly influenced by most of our health interventions -- except immunizations to prevent specific infections, none of which became epidemic during the period of the study, and nutritional status, which would probably influence the ratio of clinical to subclinical infections. Improvement of water supply and environment was not included in our interventions because most homes already had adequate handpumps and because other changes would have taken too long to implement.

As expected, we showed that our program of surveillance for early detection and treatment to control infections and improve nutrition reduced the duration and severity, but not the incidence, of infections. In fact, the morbidity levels were especially difficult to interpret because the reported level of incidence was directly correlated with the type of care provided and the frequency of contacts for therapeutic or preventive services. Not only were FHWs more likely to find illness when they were able to do something about it, but also mothers were more likely to report illness if care was being provided. Multiple and complex efforts were made to correct for these fundamental inaccuracies in disease reporting. We had to conclude, however, that incidence results based on mothers' reports must always be intrinsically unreliable in comparisons between experimental and control groups. The only use we could make of incidence data, therefore, was to aggregate information from all groups to get a reasonable definition of overall patterns of illness that showed the expected seasonal and ecologic variations.

Underreporting seemed most pronounced for minor illnesses. This observation is supported by the finding that incidence of severe infections, such as lower respiratory tract infection (pneumonia), was similar in all experimental groups. To eliminate the probable bias in data on duration of minor illnesses, we limited analysis to eight symptoms out of the forty-four. The eight that seemed least ambiguous and best reported were:
cough; diarrhea; eye infections; fever; pneumonia (lower respiratory tract infections); two kinds of skin infection, pustular rash and skin ulcers; and vomiting. The special reasons for retaining these symptoms were: diarrhea, vomiting, and pneumonia together accounted for more than 60 percent of deaths in preschool children in this area; eye infections, fever, cough, and diarrhea are all highly prevalent and easily recognized in the preschool population, and skin and eye infections were considered good indicators of hygiene and the quality of child care in the home.

Total Morbidity and Seasonal Patterns

A subsample of morbidity data was analyzed covering all villages from July 1968 to October 1971. The general morbidity load in this population of children is shown in table 7-1. The last column indicates the number of days in a year that the average child had each symptom. The total illness burden is indicated by a cumulative number of illness days that averages out to 1.1 symptoms each day. Nasal discharge was most common and was present one day out of four in each child. Cough was present one day out of seven, diarrhea one day out of twelve, eye infections one day out of fourteen, and fever one day out of twenty-three. A complex series of skin lesions are also common, starting with papules from heat rash or insect bites and proceeding to furuncles, pustules, and impetigo.

The age distribution is rather uniform for the various infections as shown in figures 7-1 and 7-2. Even though most pediatrics texts say that children are protected from infection until the age of about 6 months, this was clearly not the pattern in these children. Infections peaked between 4 and 6 months of age for all infections, and this indicates the rapidly increasing exposure of children in a village environment as the child becomes mobile.

Seasonal patterns of infection showed tremendous variation, as indicated in figure 7-3. Respiratory complaints were
Table 7-1. Common Symptoms Ranked by Their Prevalence, Expressed as Average Proportion of Observed Days and as Symptom Days per Child per Year, Morbidity Survey (All Villages, July 1968 - September 1971)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Prevalence</th>
<th>Symptom days/child/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasal discharge</td>
<td>.255</td>
<td>93</td>
</tr>
<tr>
<td>Cough</td>
<td>.139</td>
<td>51</td>
</tr>
<tr>
<td>Papulea</td>
<td>.085</td>
<td>31</td>
</tr>
<tr>
<td>Abnormal frequency of stools</td>
<td>.081</td>
<td>30</td>
</tr>
<tr>
<td>Abnormal consistency of stools</td>
<td>.078</td>
<td>28</td>
</tr>
<tr>
<td>Purulent discharge of eye</td>
<td>.070</td>
<td>26</td>
</tr>
<tr>
<td>Crusts</td>
<td>.058</td>
<td>21</td>
</tr>
<tr>
<td>Furuncle</td>
<td>.046</td>
<td>17</td>
</tr>
<tr>
<td>Fever</td>
<td>.043</td>
<td>16</td>
</tr>
<tr>
<td>Pink eye</td>
<td>.040</td>
<td>15</td>
</tr>
<tr>
<td>Ulcer of the skin</td>
<td>.022</td>
<td>8</td>
</tr>
<tr>
<td>Sore tongue</td>
<td>.021</td>
<td>8</td>
</tr>
<tr>
<td>Edema</td>
<td>.021</td>
<td>8</td>
</tr>
<tr>
<td>Pustule</td>
<td>.019</td>
<td>7</td>
</tr>
<tr>
<td>Scales</td>
<td>.018</td>
<td>7</td>
</tr>
<tr>
<td>Ear discharge</td>
<td>.016</td>
<td>6</td>
</tr>
<tr>
<td>Cracked skin and furrow</td>
<td>.014</td>
<td>5</td>
</tr>
<tr>
<td>Croup</td>
<td>.009</td>
<td>3</td>
</tr>
<tr>
<td>Vomiting</td>
<td>.008</td>
<td>3</td>
</tr>
<tr>
<td>Vesicles</td>
<td>.008</td>
<td>3</td>
</tr>
<tr>
<td>Whoop</td>
<td>.007</td>
<td>2</td>
</tr>
<tr>
<td>Paroxysmal cough</td>
<td>.005</td>
<td>2</td>
</tr>
<tr>
<td>Exanthema</td>
<td>.005</td>
<td>2</td>
</tr>
<tr>
<td>Blister</td>
<td>.004</td>
<td>1</td>
</tr>
<tr>
<td>Vesicular lesions of stomach</td>
<td>.004</td>
<td>1</td>
</tr>
<tr>
<td>Ulceration in mouth</td>
<td>.004</td>
<td>1</td>
</tr>
<tr>
<td>Sore throat</td>
<td>.004</td>
<td>1</td>
</tr>
<tr>
<td>Blood in stools</td>
<td>.003</td>
<td>1</td>
</tr>
<tr>
<td>Bulkiness of stools</td>
<td>.001</td>
<td>less than 1</td>
</tr>
<tr>
<td>Angular cheilosis</td>
<td>.001</td>
<td>less than 1</td>
</tr>
<tr>
<td>Stye</td>
<td>.001</td>
<td>less than 1</td>
</tr>
<tr>
<td>Rapid respirationc</td>
<td>.001</td>
<td>less than 1</td>
</tr>
<tr>
<td>Flaring of nostrils</td>
<td>.001</td>
<td>less than 1</td>
</tr>
<tr>
<td>Retraction of chest wall</td>
<td>.001</td>
<td>less than 1</td>
</tr>
<tr>
<td>Anorexia</td>
<td>.001</td>
<td>less than 1</td>
</tr>
<tr>
<td>Blepharitis</td>
<td>.001</td>
<td>less than 1</td>
</tr>
<tr>
<td>Other eye symptoms</td>
<td>.001</td>
<td>less than 1</td>
</tr>
<tr>
<td>Thrush</td>
<td>.001</td>
<td>less than 1</td>
</tr>
</tbody>
</table>

Note: Average number of symptoms per day was 1.10  
a. Heat rashes often starting pustules, furuncles or impetigo.  
b. Mostly due to impetigo.  
c. In about half the cases combined with flaring of nostrils, retraction of the chest wall, or both.
Figure 7-1. *Selected Morbidity Incidence by Age Group*

Figure 7-2. *Selected Morbidity Prevalence by Age Group*
Figure 7-3. Selected Morbidity Incidence by Season

- Diarrhea
- Fever
- Cough
- Eye discharge
- Pneumonia

Incidence (episodes per 1,000 days of observation)
Figure 7-4. Illness Days per Ten Observed Days by Sex-Caste and Quarter: Gastrointestinal Symptoms, Morbidity Survey (All Villages, July 1968–September 1971)
highest in winter months. Diarrhea was most frequent in the hot, dry months from April to June. This is both the time when dehydration is most rapidly aggravated by the climate and the preharvest period when food shortages are greatest. The opportunities for synergism are especially evident for the diarrheas because of this congruence in timing. Eye infections also are most common in the hot, dry season from April to October and are least common in January-March, but they did not show as much seasonal fluctuation as diarrheas. Skin infections reached their highest level in July-September, the hot, moist period of the monsoons, and were least frequent in January to March.

Although seasonal patterns for most infections were consistent from year to year, there were some exceptions. Detailed data on the sequence of infections over the whole period of three years showed some variations in prevalence. The diarrhea peak was diffuse in 1968 but sharp in 1969 and 1970 (figure 7-4). Eye infections normally were high from April to October, but the summer peak in 1969 was much lower than in other years (figure 7-5).

Caste and sex differentials are also shown in that epidemics of eye infections were largely among low-caste children. Similarly, figure 7-6 shows that nasal discharge was most common among low-caste children.

Differences in Morbidity between Experimental Groups

The results of program interventions on the duration of the symptoms are shown in figure 7-7. Mean symptom duration was statistically adjusted for unequal age and caste distributions in each group as well as for differences in the number of observations at various seasons. Disease episodes were shorter in duration in villages where health care services were provided (NUTHC or HC) than in villages without such services (NUT and CONT-N). Differences were statistically significant (p < .02) for diarrhea, fever, cough, and eye infection.
Figure 7-5. Illness Days per Ten Observed Days by Sex-Caste and Quarter: Eye Symptoms, Morbidity Survey (All Villages, July 1968-September 1971)
Figure 7-6. Illness Days per Ten Observed Days by Sex-Caste and Quarter: Nasal Discharge, Morbidity Survey (All Villages, July 1968–September 1971)
Figure 7-7. Morbidity Duration by Experimental Group

- Cough ($\bar{X} = 9.6$)
- Ulcer ($\bar{X} = 8.8$)
- Pustule ($\bar{X} = 7.7$)
- Eye infection ($\bar{X} = 7.4$)
- Diarrhea ($\bar{X} = 5.5$)
- Vomiting ($\bar{X} = 3.8$)
- Pneumonia ($\bar{X} = 3.6$)
- Fever ($\bar{X} = 3.3$)
Nutrition care by itself had an intermediate effect on duration. Children in control villages, on the average, had disease episodes of longer duration for all but two conditions (skin ulcers and pneumonia) than did children in any of the other villages. For these two conditions, children in control villages who were ill may have been taken to local private practitioners or to the government health center more promptly.

In comparisons between the two groups of villages that received health care, the only condition in which combined health and nutrition care (NUTHC) seemed to reduce duration significantly more than health care alone (HC), was with eye + infection. This indicated a greater combined effect than was shown in nutrition (NUT) or HC alone. Even though it was only in eye infections that an increased program effect was shown, this does not prove that there was no synergistic impact on other infections because in NUTHC villages it was necessary to overcome the significantly worse health and socioeconomic conditions that had been found in the baseline survey.

OVERALL MORTALITY

During the four years 1970-73, a total of 376 deaths in children up to 3 years of age and 137 stillbirths occurred in the eighteen study and control villages included in the mortality analysis (these figures include eight villages from the parallel population study). A life-table analysis starting with 1,000 live births showed that 41 would have died during the first seven days of life, 17 between the eighth and thirtieth days, and 44 between the first and twelfth months of life. Between the first and second year of life, 17 more died; between the second and third year, 5 died; between the third and fourth year, 4 died; and between the fourth and fifth year, 3 children died. The death rate in the first year was about twenty times higher than in the third year, and in the second year of life it was about three times higher than in the third year. This decrease in risk of death per 1,000
Figure 7-8. Risk of Death, per 1,000 Child Months of Exposure, by Age Group
child months of exposure is shown graphically in figure 7-8.

Deaths by Sex and Caste

In this study the generally observed excess of male deaths in children was found only in perinatal mortality rates. For stillbirths and perinatal deaths, males made up 61 and 58 percent of total deaths, respectively. After the first seven days of life, females suffered higher mortality. Male deaths were 47 percent of total neonatal deaths, 41 percent of total post-neonatal deaths, and 37 percent of total mortality in children 1-3 years old. For the total period from 0-3 years of age, male deaths formed 41 percent of the total mortality. The higher female mortality reflects local social values in preference for sons.

Mortality of children depends largely on socioeconomic factors, and caste was an especially important indicator in these villages. Mortality experience during the first year of life was higher for both Jat and Ramdasia castes (102 and 116 per 1,000 live births, respectively) than for a third group made up of a mixed population mostly of artisans, some Hindu merchants, and a few Muslims (67 per 1,000 live births; table 7-2). This was due to lower perinatal and neonatal death rates in this third group. Postneonatal death rates from 1-12 months of age were essentially equivalent in all three caste groups and ranged between 39 and 48 per 1,000 live births. Between 1 and 3 years of age, however, Ramdasia children had three times the death rate of Jat children (18 versus 6 per 1,000). Children 1-3 years old belonging to the mixed caste group had an intermediate mortality rate (13 per 1,000). These caste differentials were probably due both to socioeconomic status and to differences in living patterns and care provided to children.

Effects of Health and Nutrition Care on Mortality

Figures 7-9 through 7-14 summarize mortality in the first
Table 7-2. Child Mortality Rates by Caste in Eighteen Villages, 1970-73

<table>
<thead>
<tr>
<th>Caste group</th>
<th>Perinatal (1)</th>
<th>Neonatal (2)</th>
<th>Postneonatal (3)</th>
<th>Infant (4)</th>
<th>1-2.9 Years (5)</th>
<th>0-2.9 Years (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jat (mostly landholding families)</td>
<td>86</td>
<td>63</td>
<td>39</td>
<td>102</td>
<td>6</td>
<td>107</td>
</tr>
<tr>
<td>Ramdasia (mostly agricultural</td>
<td>87</td>
<td>68</td>
<td>48</td>
<td>106</td>
<td>18</td>
<td>122</td>
</tr>
<tr>
<td>families)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other castes (artisans, Hindu</td>
<td>57</td>
<td>25</td>
<td>42</td>
<td>67</td>
<td>13</td>
<td>79</td>
</tr>
<tr>
<td>merchants, etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Defined as number of stillbirths and deaths in the first seven days per 1,000 live and stillbirths.
(2) Defined as number of deaths in the first month of life (excluding stillbirth) per 1,000 live births.
(3) Defined as the number of deaths between 1-11 months of age per 1,000 live births.
(4) Defined as the number of deaths between birth and 12 months of age per 1,000 live births.
(5) Defined as the number of deaths between 1-3 years of age per 1,000 children in this age group.
(6) Defined as the number of deaths between birth and 3 years of age per 1,000 live births.
Figure 7-9. Mortality Rate of Infants 1–7 Days Old by Input Service Group, 1970–73

- CONT-N.
- NUT.
- NUTHC.
- EHC.
- NUTHC-P (parallel population study, where less intense child health services were provided).
Figure 7-10. *Perinatal Mortality Rate by Input Service Group, 1970-73*

[Bar chart showing perinatal mortality rate by input service group, 1970-73.]

Legend:
- CONT-N.
- NUT.
- NUTHC.
- HC.
- NUTHC-P (parallel population study, where less intense child health services were provided).
Figure 7-11. **Neonatal Mortality Rate by Input Service Group, 1970–73**

- CONT-N.
- NUT.
- NUTHC.
- HC.
- NUTHC-P (parallel population study, where less intense child health services were provided).
Figure 7-12. *Postneonatal Mortality Rate by Input Service Group, 1970–73*

- CONT-N.
- NUT.
- NUTHC.
- INC.
- NUTHC-P (parallel population study, where less intense child health services were provided).
Figure 7-13. Infant Mortality Rate by Input Service Group, 1970-73

Deaths per 1,000 live births

- CONT-N.
- NUT.
- NUTHC.
- HC.
- NUTHC-P (parallel population study, where less intense child health services were provided).
Figure 7-14. Mortality Rate of Children 1–3 Years Old by Input Service Group, 1970–73

(cont.)

NUT. (parallel population study, where less intense child health services were provided).
three years of life for experimental and control villages and include data from the parallel population study -- four comprehensive care villages (NUTHC-P) and four control villages (CONT-P). In the NUTHC-P villages morbidity surveillance for early diagnosis and treatment was carried out with only one-eighth the frequency of villages in the nutrition project. Data from both sets of control villages were combined for this analysis.

Mortality rates of children under 3 years of age in villages with project services were consistently lower than in control villages. Reductions were greatest in the experimental villages of the nutrition study proper and less marked in the child care villages of the population project. This holds true for still-birth rates and mortality in any age group under 3 years.

Stillbirth rates were lower in all service villages than in controls. The difference between the stillbirth rates of all service villages combined and control villages was statistically significant ($p < .05$). Stillbirth rates were lowest in NUT villages (24.9 per 1,000 live and stillbirths), a figure less than half the rate in control villages (57.4 per 1,000). The difference was statistically significant ($p < .025$). The next lowest stillbirth rate was in NUTHC villages (36.8 per 1,000), and in the remaining two groups of villages it was 43.8 per 1,000 (NUTHC-P) and 44.6 per 1,000 (HC).

Mortality in the first seven days was lowest in NUTHC villages (28 per 1,000 live births), intermediate in HC and in NUT villages (37 per 1,000 live births), and high in NUTHC-P villages (45 per 1,000 live births) and control villages (52.1 per 1,000 live births). This is one of the few instances, but an extremely important one, in which a distinct synergistic program effect was found, with maximum impact appearing in the combined care group of villages. The difference in mortality in children 1-7 days old between the three service groups of the nutrition study and the control group of villages was...
statistically highly significant ($p < .005$) (figure 7-9).

The effects of service inputs on total perinatal mortality (obtained by adding stillbirths to deaths in the first seven days) are shown graphically in figure 7-10. The greatest impact again was in NUT and NUTHC villages, with HC and NUTHC-P being intermediate and control villages having the highest rates. We feel that the nutritional impact was due to reduction in maternal and child anemia and protein-calorie malnutrition, due to our "prenatal child care," which included regular iron and folic acid to mothers and nutritional supplementation for malnourished mothers. The impact on infections was probably due to tetanus toxoid and general improvement in child care practices. The fact that a distinct synergistic effect was observed in the first seven days is probably related to the specific nature and effectiveness of the interventions used.

Neonatal mortality rates (deaths in the first month excluding stillbirths) were reduced equally in all input villages of the nutrition study in comparison with control villages, as shown in figure 7-11. This decline was statistically highly significant ($p < .005$). Villages receiving less intensive combined care in the population study had an intermediate reduction of mortality. We felt this effect was due to the same factors that influenced perinatal mortality.

In the postneonatal period, mortality rates in villages of the nutrition project were most influenced by the provision of health care services -- HC 23.3 and NUTHC 35.2 per 1,000 live births compared with control villages or villages with nutrition care only, about 50 per 1,000 live births -- as shown in figure 7-12. The differences between postneonatal mortality rates in villages receiving care and control villages was statistically significant ($p < .05$). Postneonatal death rates in the less intensive combined care villages of the population study showed no change compared with control levels. We feel that the lack of impact of nutrition care on
postneonatal rates may be due to the fact that most babies' nutritional needs were essentially satisfied by breast-feeding up to 6 months of age, and nutritional deficiencies would have tended to have a cumulative impact between 6-12 months of age. A direct nutritional influence of services on survival would have become evident in the second year of life.

The infant mortality rate (obtained by adding neonatal and postneonatal rates) was lowest in the HC villages (70 per 1,000 live births), and second in the NUTHC villages (81 per 1,000 live births), and third in the NUT villages (97 per 1,000 live births). In the population study villages receiving less intensive child care (NUTHC-P) it was 118 per 1,000 live births, and in the control (CONT-N and CONT-P) villages it was 128 per 1,000 live births (figure 7-13). The difference in infant mortality rates between the three nutrition project service groups combined and the control group of villages is statistically significant (p < .025).

As shown in figure 7-14, in the second and third years of life children from service input villages also had lower death rates than those in control villages (p < .025). Mortality rates were lowest in the combined care villages (NUTHC-P) of the population project (7 per 1,000 population) intermediate in other service villages of the nutrition study (10 to 13 per 1,000 population), and highest in the control group villages (19 per 1,000 population). The differences between experimental groups did not reach statistical significance because of the relatively small number of deaths that occurred in this age group.

Causes and Circumstances of Deaths

Two hundred forty-three deaths were analyzed in the Narangwal study for causes and events leading to death. Of these, 124 were perinatal deaths, of which about half were stillbirths, and 117 occurred between the eighth day and fifth year of life. It should be noted that proportionately the
control villages contributed more heavily to the total number of cases than the experimental villages. As described in chapter 2, detailed "verbal autopsy" was done, based on specially collected detailed history and all available records, and a presumptive diagnosis of the cause of death was arrived at by consensus among staff physicians. These decisions relied mainly on clinical judgment and, because we realized that this might underestimate the role of malnutrition and prematurity as contributory causes, we ran another parallel death analysis using a more statistical approach, which is reported later in this chapter. The verbal autopsy used the following definitions for prematurity and malnutrition:

- Prematurity -- birthweight of less than 2,000 grams. Prematurity was assigned as primary cause only if no other, more likely cause was found.
- Malnutrition -- less than 70 percent weight-for-age. Malnutrition was only assigned as primary cause when no other was apparent. Malnutrition was shown as a contributory cause for all deaths when the child was less than 60 percent of weight-for-age and also for those between 70-60 percent of weight-for-age in which clinical judgments determined that malnutrition was a contributory cause.

Table 7-3 shows that for deaths during the first seven days of life prematurity (32 percent), intrauterine asphyxia (19 percent), and birth trauma (18 percent) were the major causes of death. Twenty deaths were clearly related to poor delivery practices or poor child care: 9 of the 24 deaths from intrauterine asphyxia were associated with intramuscular injection of pitocin during labor by indigenous practitioners; 11 (8 among premature deliveries, 3 among healthy full-term babies) deaths resulted from accidental aspiration while the infants were being force-fed by spoon during the first days of life.

In infants 8-28 days old, gastroenteritis, diarrhea, and
Table 7-3. Causes of 124 Deaths during the First 7 Days of Life in Narangwal Study Villages

<table>
<thead>
<tr>
<th>Cause</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prematurity</td>
<td>40</td>
<td>32.2</td>
</tr>
<tr>
<td>Intrauterine asphyxia</td>
<td>24</td>
<td>19.4</td>
</tr>
<tr>
<td>Birth trauma</td>
<td>22</td>
<td>17.7</td>
</tr>
<tr>
<td>Congenital anomalies</td>
<td>8</td>
<td>6.5</td>
</tr>
<tr>
<td>Tetanus neonatorum</td>
<td>4</td>
<td>3.2</td>
</tr>
<tr>
<td>Other neonatal infections</td>
<td>3</td>
<td>2.4</td>
</tr>
<tr>
<td>Other causes</td>
<td>8</td>
<td>6.5</td>
</tr>
<tr>
<td>Unknown</td>
<td>15</td>
<td>12.1</td>
</tr>
<tr>
<td>All</td>
<td>124</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Dehydration were the principal causes of death and accounted for almost a quarter of all deaths; these causes were followed by prematurity (21 percent), septicemia (17 percent), tetanus neonatorum (10 percent), lower respiratory tract infection (7 percent), and congenital anomalies (7 percent).

Between 1-12 months of age the primary causes of death were gastroenteritis, diarrhea, and dehydration (40 percent); lower respiratory tract infection (30 percent); and malnutrition (6 percent). Three deaths, including two from diarrhea and dehydration, were attributed to inadequate health care.

Table 7-4 summarizes the causes of all the 117 deaths in children from 8 days to 5 years old. Gastroenteritis, diarrhea, or both were the primary cause of 43 (37 percent) and the contributing cause in 4 (3.4 percent) deaths; lower respiratory tract infection as a primary cause accounted for 20 (17 percent) deaths and was a contributory cause in 17 (14.5 percent); prematurity was the primary cause of death in 7 (6 percent) and a contributory cause in 4 (3.4 percent); septicemia was the cause of 5 (4 percent) deaths and contributed to 3 (2.6 percent) deaths; all other causes were primary in 22 (19 percent) and contributory in 23 (20 percent) of the child deaths. For 12 (10 percent) deaths the cause of death remained unknown.
Table 7-4. Primary and Contributory Causes of Death in Children 8 Days to 5 Years Old, 1970-73

<table>
<thead>
<tr>
<th>Cause</th>
<th>Primary cause</th>
<th></th>
<th>Contributing cause</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
<td>Percent</td>
</tr>
<tr>
<td>Gastroenteritis, diarrhea, dehydration</td>
<td>43</td>
<td>36.8</td>
<td>4</td>
<td>3.4</td>
</tr>
<tr>
<td>Lower respiratory tract infection</td>
<td>20</td>
<td>17.1</td>
<td>5</td>
<td>4.3</td>
</tr>
<tr>
<td>Malnutritiona</td>
<td>8</td>
<td>6.8</td>
<td>17</td>
<td>14.5</td>
</tr>
<tr>
<td>Prematurity</td>
<td>7</td>
<td>6.0</td>
<td>4</td>
<td>3.4</td>
</tr>
<tr>
<td>Septicemia</td>
<td>5</td>
<td>4.3</td>
<td>3</td>
<td>2.6</td>
</tr>
<tr>
<td>Tetanus neonatorum</td>
<td>3</td>
<td>2.6</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Congenital anomalies</td>
<td>3</td>
<td>2.6</td>
<td>3</td>
<td>7.6</td>
</tr>
<tr>
<td>Other gastrointestinal diseases</td>
<td>20</td>
<td>3.4</td>
<td>19</td>
<td>...</td>
</tr>
<tr>
<td>Accident (and external causes)</td>
<td>4</td>
<td>3.4</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>Other/miscellaneous</td>
<td>8</td>
<td>6.8</td>
<td>19</td>
<td>16.2</td>
</tr>
<tr>
<td>Unknown</td>
<td>12</td>
<td>10.3</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>All</td>
<td>117</td>
<td>100.0</td>
<td>56</td>
<td>47.9</td>
</tr>
</tbody>
</table>

Zero or negligible.

a. As defined in the text.

Seasonal variations were especially important between 1 and 5 years of age. Deaths from diarrhea and dehydration or nutritional deficiency diseases were highest from April through August (the hot season), when the combined rate for these conditions averaged 11.0 deaths per 10,000 child months of exposure in children 8 days to 5 years old. Death from these conditions was lowest from November through February, with 6.0 deaths per 10,000 child months of exposure, and intermediate during the mild season (March, September and October), when they averaged 9.5 deaths per 10,000 child months of exposure. Deaths from lower respiratory tract infection, fever or septicemia (or both) were high during the cold (November through February) months, with 5.5 deaths per 10,000 child months of exposure; intermediate (4.5 per 10,000 child months of exposure) during the mild months; and low (3.5 per 10,000 child months of exposure) from April through August. Seasonal differences by age group showed that neonatal mortality was
high during July through October (rainy season), that mortality for children 1-11 months old peaked between May and June (harvest - hot season), and that for children 12-36 months old deaths occurred most often from March through April (preharvest - hot season with low food availability).

When mothers of the children who died between 8 days and 5 years of age were asked for their opinion of the cause of death, 97 out of 117 mentioned a specific cause. Of these, 74 (64 percent) made the same diagnosis that was made by project physicians through the verbal autopsy. Supernatural reasons were given as cause of death for 21 (18.3 percent).

Among these same 117 deaths, it was found that the proportion who had previously had a sibling die was significantly higher (45 percent) than for the general child population (22 percent) enrolled in the nutrition study.

Birth order and mortality seem most clearly associated at seventh and higher birth order. The birth orders of dead children were as follows: 21 percent were first children, 16 percent second, 14 percent third, 14 percent fourth, 8 percent fifth, 9 percent sixth, and 20 percent seventh or higher in birth order. The proportion of children seventh or higher in birth order was, however, almost two times greater among dead children than among the total child population (19.7 percent versus 10.4 percent).

A simple indicator of family access to care and availability of services was whether any medical care from any source was provided for children during the illness from which they died. There was information on the timing of such care in 95 of the deaths. (Sudden deaths or children from whom the time of care was not specified were excluded). Fifty-eight percent of the children received care within 24 hours after their parents realized they were ill. Seventy-seven percent received care within three days of the onset of their illness (including those receiving care in the first 24 hours), 17 percent had some form of care only after they had been ill
three or more days, and 6 percent never received care. If
sudden deaths such as accidents are included in the analysis,
those never receiving care would rise to 18 percent. Twenty-
four out of 50 female children (48 percent) received care in
the first 24 hours of their terminal illness in comparison
with 29 out of 45 male children (64 percent) who received
early care.

Among 312 deaths in high-caste (Jat) families, 21 (68
percent) of children received care within 24 hours of the on-
set of illness. This contrasts with 22 of 45 (49 percent) in
low-caste (Ramdasia) families and 12 of 19 (63 percent) among
other castes. Caste differences in seeking early care were
found equally in villages where project services were and were
not available. This clearly demonstrates the persistent so-
cial, cultural, and economic barriers to timely use of ser-
vices even when they were directly available in the village.
The problem emerged most acutely in the time demands on the
low-caste mother for long hours of work in the fields at har-
vest time, when economic survival of the family often seemed
to take precedence over seeking care for a sick child.

Obtaining health care for children who died was also
strongly associated with the age and nutritional status of the
child. For children who died at 1 month of age or less, only
about half received care, but 87 percent of children 1-11
months of age and about 80 percent over 1 year old obtained
medical help. Fifty-nine percent of severely malnourished
children (less than 50 percent of the Harvard weight median)
who died received treatment compared with 86 percent of chil-
dren who were above 50 percent of the Harvard median (p < .025).
This suggests that the poor and low-caste families with the
most malnutrition were also making the least use of available
services.

As a potential influence on motivation for family plan-
ning, there is interest in whether parents deliberately re-
place children who die. In the course of verbal autopsies,
parents were asked whether they intended to have another child. Ninety-five percent of mothers who had no or only one living child said they intended to have another child, compared with 54 percent of those who had two to three living children and 11 percent who had four or more living children. None of the mothers who had three or more living sons said they intended to have another child. No association was found between positive responses and the sex, age, or nutritional status of the deceased child, or the socioeconomic variables relating to the family. In this population there was strong motivation for child replacement in families with few sons, but this diminished greatly as the number of sons satisfied local norms.

**Nutritional Status and Child Mortality**

The nutritional status immediately prior to death was known for 95 of the 117 "verbal autopsy" children under 3 years of age. Twenty (21.1 percent) were at or above 80 percent of the Harvard weight median; fifteen (16.8 percent) were between 80 percent and 70 percent of the Harvard median; 19 (20 percent) were between 60 and 70 percent of the Harvard median, and 41 (43.3 percent) were below 60 percent of the Harvard median. This compares with an average distribution among all Narangwal study children of 44 percent at or above 80 percent; 37 percent between 80 and 70 percent; 15 percent between 60 and 70 percent; and 4 percent who were below 60 percent of the Harvard weight median. This clearly demonstrates that the risk of dying increases sharply under 70 percent of weight-for-age and is particularly pronounced under 60 percent. Of the 41 children who were below 60 percent of the Harvard weight median and died, 31 (76 percent) were female. By contrast, of the 20 children whose nutritional status at death was 80 percent or higher, 11 (55 percent) were male (table 7-5).

At low levels of nutrition (below 60 percent of the Harvard weight median), diarrhea and dehydration proved to be
Table 7-5. Nutritional Status at Death, by Sex of Dead Child

<table>
<thead>
<tr>
<th>Sex</th>
<th>&lt; 60</th>
<th>60-69</th>
<th>70-79</th>
<th>80+</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>Male</td>
<td>10</td>
<td>24.4</td>
<td>6</td>
<td>31.6</td>
<td>6</td>
</tr>
<tr>
<td>Female</td>
<td>31</td>
<td>75.6</td>
<td>13</td>
<td>68.4</td>
<td>9</td>
</tr>
<tr>
<td>All</td>
<td>41</td>
<td>100.0</td>
<td>19</td>
<td>100.0</td>
<td>15</td>
</tr>
</tbody>
</table>

Note: The test for linear trend in the proportion of male/female deaths with increasing nutritional status was statistically significant (p < .025).
approximately 1.7 times more frequent as a cause of death than in better-nourished children (Fisher's exact test; \( p = .14 \)). This difference, although not statistically significant, is similar to findings in other areas² and would suggest that there is a specific synergism of diarrhea with the type of marasmus that represents the main nutritional problem in the Punjab. By contrast, among children at or above 70 percent of the Harvard weight median, lower respiratory tract infection as a cause of death was 3.7 times more frequent than among malnourished children, a finding that is difficult to explain without more definitive data (Fisher's exact test; \( p = .05 \)).

To assess quantitatively how much undernutrition contributed to other causes of death, we calculated the relative risk of death at various levels of nutrition for all the children in the nutrition project. For these risk calculations we had data on almost 3,000 children. To reduce the bias introduced by including children who had low weights because of the disease from which they died, we averaged the nutritional level over several months prior to death. Specifically, the longitudinal anthropometric record of each Narangwal study child under observation between January 1970 and December 1973 was divided into individual child-month records according to age and weight-for-age. The three age groups were 1-5.9 months, 6-11.9 months, and 12-34.9 months. Four nutritional classifications were used: below 60 percent, 60-69 percent, 70-79 percent, and 80 percent or more of weight-for-age. For those who died between 1-2 months of age, weight at or near birth was used. Child months for all children were then aggregated according to age and nutritional groups. The probability or the risk of death for each age and nutritional group was determined by dividing the number of deaths in each of the possible twelve cells (four nutrition and three age groups) by the number of child months in each cell. Out of a total of 109 deaths in children 1-36 months of age covered by the anthropometric survey, 73 (66 percent) qualified for inclusion.
Because some deaths were obviously missing from the numerators as well as the denominators, the risk is probably underestimated.

Table 7-6 shows the estimated risk of death from the three age intervals by nutritional category. Within each age interval the probability of death appears to decrease exponentially with every ten percentage points of increase in nutritional status. For children under 70 percent of weight-for-age, the risk of death seems uniformly high over the different ages under consideration. For children between 70-79 percent of weight-for-age, risks are higher at the earlier ages compared with ages 1-3 years. For over 80 percent weight-for-age, risks are uniformly low. Table 7-6 by itself does not permit drawing any conclusions on long-term risks of dying. But we can get a rough estimate by considering two hypothetical children at the extremes of the nutritional spectrum. If a child stays under 60 percent of weight-for-age from birth to 36 months of age and we assign it arbitrarily the average risk for that weight group for each age, its chances of survival to 36 months would be 77 percent. If a child stays over 80 percent of weight-for-age throughout the first 36 months and we assign it the average risk for that weight group, its chance of survival would be 98 percent.

Table 7-6. Risk of Death at Various Nutritional Levels and Age Intervals

<table>
<thead>
<tr>
<th>Age interval (months)</th>
<th>Item</th>
<th>Nutritional status (percent of Harvard weight)</th>
<th>&lt;60</th>
<th>60-69</th>
<th>70-79</th>
<th>80+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-5.9</td>
<td>Deaths</td>
<td></td>
<td>3</td>
<td>5</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Child months</td>
<td></td>
<td>205</td>
<td>527</td>
<td>1,215</td>
<td>5,276</td>
</tr>
<tr>
<td></td>
<td>Risk&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>.073</td>
<td>.047</td>
<td>.037</td>
<td>.007</td>
</tr>
<tr>
<td></td>
<td>Deaths</td>
<td></td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>6-11.9</td>
<td>Child months</td>
<td></td>
<td>466</td>
<td>1,386</td>
<td>2,797</td>
<td>4,720</td>
</tr>
<tr>
<td></td>
<td>Risk&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>.103</td>
<td>.030</td>
<td>.013</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td>Deaths</td>
<td></td>
<td>4</td>
<td>12</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>12-35.9</td>
<td>Child months</td>
<td></td>
<td>1,472</td>
<td>6,646</td>
<td>13,046</td>
<td>10,479</td>
</tr>
<tr>
<td></td>
<td>Risk&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>.065</td>
<td>.043</td>
<td>.007</td>
<td>.009</td>
</tr>
</tbody>
</table>

<sup>a</sup> Probability of death per child in age interval.
When one compares this with the real overall death rates, it is clear that the risk of death in each weight category has been underestimated, as mentioned above. Moreover, assigning these hypothetical children the average risk at each age ignores the fact that long periods of undernutrition may carry excess risk—or, on the reverse, rapid declines rather than stable undernutrition may carry excess risk. However, the estimated differential risk in different weight groups does give a first approximation of the real differentials.

Birth weights were available for 99 children who died. Of these 38, (38 percent) had a birth weight below 2,500 grams. This compares with 207 children with a birth weight below 2,500 grams (24 percent) from a sample of 859 children from the general child population of the study villages (p < .01).

PRACTICAL PROGRAM IMPLICATIONS

The disease burden that children bear is staggering even in what has been considered the relatively "healthy environment" of the Punjab. At the time of this project, malaria had not yet reappeared, there were relatively few intestinal parasitic infections, and levels of child and adult nutrition were among the best in India. Yet our prevalence figures indicate that children were ill 11 percent of the time with respiratory tract infections, 6 percent of the time with diarrheal disease, 6 percent of the time with eye infections, and 4 percent of the time with fever. Prevalence of infectious diseases tended to be highest when the child was nutritionally most vulnerable—between 7 and 15 months of age, during the period when breast-feeding alone is insufficient. This congruence in timing between nutritional vulnerability and morbidity prevalence is made more serious because the two are causally related. In a subgroup of the study population, Kielmann and others showed that several indices of immune capacity were significantly reduced in subclinical undernutrition. Kielmann also showed that as mild an "infectious" illness as immunization with live
agents caused a significant decrease in weight. The findings from the present study confirm and expand on earlier clinical analyses from these data on the reciprocal effects of undernutrition on morbidity and of morbidity on growth. Finally, we have demonstrated that health care significantly contributed to reduction in the prevalence of illness through a decrease in disease duration, a finding that is supported by detailed analysis of service inputs (see chapter 9).

The general effect of socioeconomic development is indicated by comparison of child mortality rates recorded in the Khanna study (undertaken 35 kilometers from Narangwal) between 1957-59 with those from control villages of this project between 1970-73. A dramatic fall in death rates was most evident in the 1-3 year age group (from 48 in the Khanna project to 19 per 1,000 population in Narangwal controls) and in the postneonatal period (from 83 at Khanna to 53 per 1,000 live births in Narangwal controls). The period from 1957-59 to 1970-73 spans the agricultural green revolution, which produced a dramatic improvement in the socioeconomic conditions in the average Punjabi home. The fall in child mortality during this time, when accessibility and availability of government health services improved only slightly, seems to reflect an improvement in the quality of life -- especially in better nutrition, sanitation, education, economic status, and private medical care.

Differences in mortality rates among the three caste groups continued to reflect socioeconomic influences on nutritional and health status. All caste groups showed essentially equivalent improvement in mortality from the various service inputs. Preventive services were provided about equally to all groups. In chapter 4 it was shown that Ramdasia children, especially females, consistently had lower weight and height than other caste groups. They lived in more crowded and less sanitary houses, and had less access to private medical care facilities. Previously, we demonstrated that among Ramdasias
birth weights averaged 120 grams lower (2,700 grams) than Jat birth weights (2,820 grams), and that mean maternal height of Ramdasia mothers was 2.2 centimeters less than that of Jat mothers.\(^7\)

It was sobering to note that more than 60 percent of deaths in children between 0-5 years of age resulted from diarrheal disease and lower respiratory tract infections, conditions that are readily amenable to treatment. Gopalan had earlier shown that these two conditions may account for more than 20 percent of preschool child mortality in India as a whole.\(^8\)

Of special importance from the detailed analysis of causes of death was the finding that 19 percent of perinatal deaths and 6 percent of deaths in older children were iatrogenic or related to inappropriate medical practices. These included pitocin injections by traditional practitioners during labor, forced feeding of newborns, under- or overhydration, and failure to provide tetanus immunization to mothers.

For rural Punjab we have identified the following "high-risk" factors conducive to child mortality, in relative order of importance:

- Age under 2 years
- Prior low nutritional status
- Low birth weight
- Low caste
- Female sex
- A history of previous sibling deaths in the family
- Higher than sixth birth order

If health service resources are scarce, as they are in most developing countries, identification of risk factors and focusing of care on those most at risk in an intensive service program would seem to make more sense than providing "diluted" services to all preschool children. Under the resource constraints of the Punjab, intensive maternal and child health services should, therefore, be concentrated on children below
2 years old and especially on those whose weight has dropped below a locally determined threshold of definition of malnutrition.

An especially dramatic relationship was the sharp increase in relative risk of death with every ten percentage points' decline in nutritional status as shown by weight-for-age below 80 percent of the Harvard weight standard. These results indicate the importance of nutritional status in mediating other high-risk factors.

Several of the risk factors that are usually considered to be biologically determined were accentuated in their effects by social or cultural practices. Most apparent was the finding that mothers of children who died before 6 months of age or of children who were severely malnourished at death had sought treatment later in the course of illness than they did for children who were older or better nourished. The greater risk of dying of female children, and their overall lower nutritional status, was clearly associated with differential care related to the cultural preference for males.

Climate and seasonal change represents another external risk. Higher mortality occurred during the harvest season (April and May), when climatic conditions are especially severe and child care is left to older siblings because all adults are extremely busy. This seasonal difference in care resulted in sharp increases in malnutrition during a time when food should have been amply available. We demonstrated that a practical solution to these problems was to set up day care centers during harvest as a base for focused health education and care provided by village women.

An important differential finding was that the frequency of surveillance contacts needed to produce a change in mortality appeared to vary at different age groups. In the four villages of the population project, there was a sharp contrast between the consistently higher mortality experience during the first year of life and a dramatic reduction in mortality
during the ages 1-3 years. In the four villages of the population project the child care services were similar in content to those in the NUTHC villages, but the frequency of home visiting (once every two months) was only one-eighth of the frequency in NUTHC villages (once a week). The infant mortality of the population villages was consistently higher than in NUTHC villages, but the mortality in children 1-3 years old was somewhat better. This suggests that early detection of potentially serious conditions, followed by ready treatment as a part of frequent home visiting, was especially important in reducing infant deaths. Yet ready availability and accessibility of primary care in the village clinic, at the initiative of the parents, worked sufficiently well to reduce mortality in children 1 to 3 years old. This difference in the impact of intensive health surveillance between those below and above 1 year of age may also be related to the distribution of age-specific causes of death (that is, lower respiratory tract infection in younger children, compared with diarrhea and malnutrition in older children). The response may also be because older children have greater resistance to infections and mothers and family members are better able to recognize and seek treatment for severe illness.

It is probable that a weekly health check of children 1 year old by a health worker would not normally be affordable in a poor community except when done as part of a research project. However, mothers or lay (community) volunteers could easily be taught the essentials of health surveillance -- especially the danger signs and symptoms of common conditions such as pneumonia or diarrhea, as well as what to do if these signs were found. Had the nutrition study continued, greater utilization of lay personnel in surveillance for the "first-line" management of common child health problems would have been the next logical extension of our applied research program.
SUMMARY

In the interaction of nutrition and infections at various ages, the nutritional impact on perinatal mortality was greater than the effect of infection control. Prenatal services included regular administration of iron and folic acid to mothers, nutrition and health education, and food supplements provided to "needy" mothers at their request or when the FHW saw evidence of maternal malnutrition. During the postneonatal period, health care -- either with or without nutrition care -- clearly was more important than nutrition care alone. This is not surprising; most child deaths in this age group result from conditions that require fast curative interventions, (that is, pneumonia, septicemia, gastroenteritis). While premature infants or those who become malnourished in the course of the first year of life undoubtedly run a higher mortality risk from these diseases, the nutrition service components (supplementation and education) were less effective at this age than above 1 year of age. In addition, our services succeeded in prolonging breast-feeding so that most infants in this area were not fully weaned until well into the second year of life. In the second and third years of life, nutrition and health care (and their combination), in both the nutrition and population villages had significant impact on child deaths. Our findings on child morbidity and mortality are given in more detail in the following.

- Improvement in morbidity was manifested mainly in a 20 percent reduction in the average duration of episodes of illness (eight symptoms) in villages receiving health care. Significant changes were recorded in the mean duration of an average episode of cough (reduction of three days), fever (reduction of one day), diarrhea (reduction of one day), and eye infections (reductions of one day).

- An example of program synergism in which a combination of nutrition care and health care produced a greater effect than health care or nutrition care alone was found
in eye infections, for which a further reduction in duration of about one day was demonstrated.

- Compared with mortality in the third year of life, death rates were twenty times higher in the first year and three times higher in the second year of life.
- Males had higher stillbirth and perinatal mortality rates. After the first year of life, female mortality was greater, with male to female mortality ratios of 0.9 for neonatal mortality, 0.7 for postneonatal mortality, and 0.6 for mortality in children 1 to 3 years old.
- Causes of death from 1-7 days of age were ranked as follows: prematurity, intrauterine asphyxia, birth trauma, congenital anomalies, and tetanus neonatorum. Cause of death from 8 days to 5 years of age had the following ranking: diarrhea with dehydration, lower respiratory tract infections, marasmus, prematurity, septicemia, tetanus neonatorum, accidents, and congenital malformations.

Program interventions had varied effects on mortality depending on age:

- Nutrition care reduced perinatal mortality (stillbirths and mortality in infants 1-7 days old) by 40-50 percent, probably mainly as a result of prenatal supplementation with folic acid, iron, and calories.
- Medical care (health education and tetanus toxoid to mothers) reduced perinatal mortality by about 20 percent. A synergistic effect was observed in reducing mortality in children 1-7 days old.
- Neonatal mortality was reduced by about 40 percent in all groups of villages where either nutrition care or medical care was provided.
- Postneonatal mortality was reduced by half in health care (HC or NUTHC) villages but by only 7 percent in nutrition care (NUT) villages. Since nutritional inputs became effective mainly after 6 months of age, most of the reduction in mortality in nutri-
tion villages would have been concentrated during the later months of the first year.

-- Infant mortality rates were reduced by about 40 percent in both groups of villages receiving medical care (HC and NUTHC) and by 25 percent in villages receiving only nutrition care (NUT).

-- Mortality of children 1-3 years old was reduced by about 40 percent in all villages receiving services.

Primary health care delivered by FHWs provided an effective approach to the control of illnesses of children in Punjab villages. Not only did FHWs effectively care for about 90 percent of illnesses and appropriately refer the remaining 10 percent, but there are also reasons to think that the care they provided for infants was better than would have been provided by having an equivalent number of doctors available at health centers. The greatest impact on health status of children under 1 year old seems to have been related to the frequency of contact through weekly morbidity surveillance and prompt treatment. It is unlikely that doctors would have done this kind of home visiting. These intensive contacts produced maximum impact on duration of episodes of infection and on infant mortality. There seemed to have been little impact on mortality under 1 year of age from less intensive morbidity surveillance provided every two months in villages of the population project. If doctors had been readily available within the village, this presumably would have required parents to take initiative in seeking care, and this initiative was not demonstrated for younger or malnourished children.

For general coverage, it will be necessary to increase parent initiative. Greater impact on infant mortality would be achieved if sufficient attention were paid to parent education so that they could manage surveillance activities themselves, but this will probably take per-
sistent effort. A modification of this approach will probably be necessary if the population covered by an auxiliary nurse midwife (ANM) is set at 5,000, as projected in present government plans. Surveillance would then have to be carried out by community health workers. By contrast, mortality in children 1 to 3 years old dropped just as dramatically in villages that received surveillance visits every two months as in villages that received weekly home visits. Therefore, intensive surveillance might profitably be limited to children under 1 year of age, where it is most effective and needed.

NOTES TO CHAPTER 7


Chapter 8
Information Monitoring and Feedback for Service Modifications

Arnfried A. Kielmann, Colin McCord, Senyukta R. Vohra, Robert L. Parker, and Carl E. Taylor

An important contribution of the Narangwal Nutrition Project was to develop a systematic procedure for monitoring key indices so as to encourage rapid feedback and prompt change of field procedures. As mentioned in earlier chapters, an evolutionary approach to defining input services was part of the design of the project. We decided that we would not try to maintain a fixed set of inputs during the whole time of the experiment because we really did not know at the beginning what methods would work best. If field experience showed that we could improve on a field procedure, it would have been unethical to continue to use the original approach.

All the field methods evolved progressively from experience throughout the project. To illustrate this process, this chapter presents findings from a particular period (1971 through 1973) when it was possible to delineate clearly a series of steps that had dramatic program effect. These findings are presented to encourage those who are working in demonstration projects or in routine services to use similar simple methods to improve their own services.

The situational analysis described here resulted from a special study of the causes of child death. Even though mortality had considerably improved, in 1971 there were still high death rates from specific causes -- particularly diarrhea, pneumonia, and tetanus. Changes in service procedures subsequently led in one year to a 50 percent reduction in the death
rate from diarrhea and to a 45 percent reduction in the death rate from pneumonia, despite the fact that severe weather conditions seemed to have increased the incidence of both conditions. In addition, adequate tetanus toxoid immunization of 87 percent of women of reproductive age was achieved, and neonatal tetanus was essentially eliminated in health care (HC and NUTHC) groups.

The simple system that was developed to monitor the effectiveness of project services and to provide rapid feedback included the following procedures:

- A simple method for rapidly reporting deaths of children under three in village homes.
- A method to determine the most probable cause of death.
- Biweekly meetings of supervisors and field staff at which reported deaths, changes in morbidity patterns, and other selected topics were discussed and service records reviewed; during this period the practice was started of holding these meetings in the village subcenters.
- Revision of standing orders and other procedures based on the results of these discussions.
- Retraining of the staff in regular, biweekly, in-service training sessions.
- Maintaining high-priority files for the follow-up of children at increased risk of illness or death because of anemia, tuberculosis, malnutrition, etc.

These procedures represent the practical application of a management information system model consisting of an interrelated set of activities involving problem definition, causality analysis, information dissemination, procedure revision, staff retraining, and follow-up. They were independent of the more detailed research data that were also being collected and would take years to analyze. Of the three selected health problems, diarrhea and pneumonia improved dramatically in response to surveillance and early treatment, and neonatal tetanus improved because of immunization procedures.
ANALYSIS OF CAUSES OF DEATH

In community-based health care, it is often difficult to get precise information on causes of death because deaths usually occur at home and, frequently, among those who have made least use of the services. Although a considerable improvement in child mortality had occurred, in 1971 a system was started to accelerate the reporting of deaths from the villages so that a project pediatrician could visit the family promptly to conduct a "verbal autopsy." In a high proportion of cases a cause of death could be ascribed with considerable confidence.

Diarrhea was responsible for 44 percent of deaths in children under 3 years old, and pneumonia for 22 percent. Neonatal tetanus caused 19 percent of deaths in children under 1 month of age. It was apparent that the procedures introduced at the start of the program for managing or preventing these conditions were either no longer being adequately implemented or were not making the desired impact. Reemphasis of the importance of these conditions to the staff and revision of the procedures for managing these diseases were followed by intensive programs of inservice training and supervision as described in detail below.

SITUATIONAL ANALYSIS OF DIARRHEA AND PNEUMONIA

A high-priority item for discussion in the biweekly village staff conferences was the high proportion of deaths due to diarrhea. The original treatment guidelines had presented diarrhea as an important disease problem, but not as the most important cause of child death. Review of more than six months' individual case records followed by discussions with staff and village people revealed that oral fluid treatment was not well accepted or used consistently by village mothers and was considered second-rate care by family health workers (FHWs) for a complex set of reasons. In the local culture there was a traditional reluctance to give fluids to a child with diarrhea, partly because of the valid observation that
giving fluids, especially milk, caused a prompt increase in diarrhea or that, conversely, an effective way of stopping diarrhea was to induce dehydration. Most FHWs believed antibiotics and parenteral fluids at the primary health center were superior forms of treatment because they fit the image that in-patient care is good-quality care.

Criteria for differentiating between serious and minor diarrheal diseases in the standing orders failed to distinguish sufficiently the importance of the simplest home methods for maintaining hydration in the very large number of insignificant cases. The care recommended for children with clinical signs of severe dehydration did not adequately emphasize the importance of oral rehydration but stressed the importance of referring such children to a physician for parenteral fluid therapy. It was found that many children died at home of dehydration, which developed after they had been seen by the FHW because parents were unwilling or unable to go to the health center. Others died without ever being seen. Little progress was being made in increasing the use of oral fluid treatment in the home.

Pneumonia, the second most important cause of child death, seemed at first to be a simpler problem. Standing orders called for the use of sulfonamides for cough with fever, but if difficult breathing was also observed no treatment in the village was advised, and all children were to be referred promptly for physician care. Criteria for recognizing serious cases of pneumonia with respiratory distress had been developed but were not being used effectively by the FHWs. Most villages were 4 to 10 kilometers from project headquarters, but two were more than 14 kilometers distant. A note requesting an emergency visit by a project physician usually was hand-carried to Narangwal by a family member riding a bicycle. Treatment delays of hours, occasionally days, were common.

Reevaluation of the management of these conditions was initiated as a result of discussions among the supervisory
staff about the causes of mortality. Standing orders for both
diarrhea and pneumonia were revised:
- To shift responsibility for treatment as much as possible to village-level workers, since the emergency referral system imposed insuperable logistic problems for conditions that were common and required a rapid response
- To establish clear guidelines for differentiating between serious and minor illness
- To conduct intensive retraining of all workers
- To reinforce procedures for regular follow-up of these potentially life-threatening illnesses.

Subsequent discussions with village workers and mothers confirmed the practicality and acceptability of these decisions and led to many refinements and additions. For diarrhea, it became clear that the only feasible approach was to go even farther than first anticipated and to shift responsibility for oral rehydration as much as possible to mothers. The volume of cases was so great that it was impractical for village workers to care for every case. The incidence of diarrhea was sufficiently high so that most mothers had to deal with several episodes of diarrhea each year in their children under 3 years of age. Intensive training and demonstration given to mothers became a routine part of diarrhea care.

Eighteen months after the revised procedures for training mothers to provide oral fluid therapy were implemented, workers reported that most mothers had started treatment before the child was seen by project staff on weekly morbidity visits. The special parenteral rehydration unit that had been set up for project patients at the nearby health center was no longer needed, since the very few severe dehydration cases could be handled by regular health center staff.

Similarly, in the staff conferences detailed discussion of the pneumonia problem led to a special training program to help FHWs diagnose pneumonia. A presumptive diagnosis was made if there was a combination of fever and respiratory dis-
tress with drawing in of the spaces between the ribs and flaring of the nasal openings. FHWs became expert in making appropriate clinical judgments and were remarkably conservative and accurate in their diagnoses. On the basis of these signs, they were authorized to give a penicillin injection and then to refer the patient to a project pediatrician.

Revision of standing orders for diarrhea and pneumonia involved changes in diagnostic criteria (signs and symptoms) and in the treatment. The final set of standing orders for both conditions resulted from several months of field trial and revision.

Categories of Treatment Procedures for Diarrhea

For diarrhea in the absence of any of the diagnostic criteria listed in table 8-1, the treatment procedure was:  

- Explain need for fluid replacement and preparation of "home diarrhea mixture" (6 teaspoons of sugar and 1 level teaspoon of salt per liter of water) to mother. Mother to administer at least 1 liter of fluid per 24 hours and to continue child's regular caloric intake. Instruct mother to return to village clinic next day if diarrhea persists. Revisit child within one week.

If any of the "one plus" criteria were present, the treatment procedure was:

- Prepare 1 liter of "home diarrhea mixture" and start giving it to child. When child is taking fluids, show mother how to give it and how to prepare more. Advise continuous fluid intake: 2-3 liters per 24-hour period. If child is on milk supplement, ask mother to stop milk for 24 hours but to continue all other foods. If child is exclusively breast-fed, skip one feeding. Treat fever and blood or mucous in stool, if present, according to standing orders. Revisit home within 12 hours.

If any of the "two plus" (more severe) criteria were present, the treatment procedure was:
Table 8-1. Diagnostic Criteria for Categorizing the Severity of Diarrhea

<table>
<thead>
<tr>
<th>Item</th>
<th>Findings</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>History</td>
<td>Six or more stools per 24 hours</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Vomiting</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Fever</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Blood and mucus in stool</td>
<td>+</td>
</tr>
<tr>
<td>Special characteristics</td>
<td>Less than 1 year of age</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Less than 70 percent of Harvard weight-for-age median</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Consumption of less than 500 cc of sugar, salt, and water mixture during 12 hours (only on revisit after 12 hours)</td>
<td>+</td>
</tr>
<tr>
<td>Physical examination</td>
<td>Temperature (rectal) 100°F or higher</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Signs of dehydration</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Temperature (rectal) 103°F or higher</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Weight loss (detected at revisit)</td>
<td>++</td>
</tr>
</tbody>
</table>

++ Greater severity of diagnostic finding.

- Prepare "project diarrhea mixture" (from a diarrhea mixture concentrate prepared in the project pharmacy, which contained sodium and potassium chloride—no sodium bicarbonate; sugar from the home supply was added). Start giving it to child. Send message to physician for immediate consultation. Remain with child giving fluids until physician arrives.

Diagnostic Criteria and Treatment Procedures for Pneumonia or Lower Respiratory Tract Infection

Presence of either of the following combinations was considered adequate reason for PHWs in the village to start penicillin treatment:

- Cough and fever with temperature (rectal) of 102°F or higher
- Cough with labored respiration -- that is, flaring of the nasal openings, drawing in of the spaces between the ribs.
Pencillin treatment began with an immediate injection of crystalline rapid-acting penicillin and benzathine (long-acting) penicillin to get both immediate and long-lasting effects (dose varied according to age of child), followed by:

- If no improvement in clinical signs within 4-6 hours, repeat crystalline penicillin injection and refer immediately.
- If improvement, refer to next clinic visit of doctor.

Training Program

A practical in-service training program for all health workers resident in study villages was instituted. Training over a three-month period was conducted in the village by the physician and public health nurse (PHN) in the course of their supervisory activities and at formal training sessions at the project headquarters at fortnightly intervals. Recognition, management, and referral of patients with diarrheal disease and lower respiratory tract infection was explained and demonstrated at these sessions, and the newly revised standing orders were discussed. Recent case histories were reviewed with respect to management and outcome. Following this training period, a village conference was held in each group of our villages every two weeks. At these village conferences a rough estimate of the incidence of both conditions was made by having FHWs relate their clinical experience over the preceding two weeks. Service and research records were examined for compliance with standing orders, and the practicality of these orders was discussed. Children currently under treatment were visited in their homes when a visit could serve an educational purpose, (for example, demonstration of signs of dehydration). Deaths among children in each group of four villages over the preceding two months were reviewed and analyzed for cause, events leading to death, treatment, and avoidability. Discussion of problems observed and results eventually led to further modifications in the standing orders. For instance, a
single injection of a mixture of benzathine penicillin and crystalline penicillin replaced daily procaine (intermediate-duration) penicillin when the resident health workers pointed out that mothers frequently did not return with their children for repeated injections.

In 1971 diarrheal disease accounted for 20 deaths, pneumonia for 10 deaths in children 8 days to 3 years old, giving a cause-specific mortality rate of 14.1 per 1,000 child years of exposure for diarrhea and 7.1 per 1,000 for pneumonia. Over the next 17 months after implementation of the revised standing orders and up to the end of the project, 15 deaths from acute diarrheal disease and 8 deaths from lower respiratory tract infection occurred, giving diarrhea-and pneumonia-specific mortality rates of 7.3 and 3.9 respectively, per 1,000 child years of exposure — about one-half of the rates in 1971 (figure 8-1). The difference in diarrhea and pneumonia deaths between the two time periods is statistically significant (p < .02). This decline in mortality had not resulted from a decrease in the incidence of the two conditions. If anything, incidence increased — both because of better diagnosis and because of particularly harsh weather conditions. Mortality from other causes had already dropped and did not change further between the two time periods; it was 10.6 in 1971 and 10.7 per 1,000 child years of exposure in 1972-1973.

No allergic reactions, abscesses, or other complications from penicillin injections were observed in the more than 200 children treated for pneumonia by FHWs.

ANALYSIS OF NEONATAL TETANUS

In contrast to diarrhea and pneumonia, neonatal tetanus is a disease in which a program of surveillance and treatment would be essentially meaningless, since treatment is extremely expensive and seldom effective. Yet, there were two effective approaches to prevention that seemed worth applying to the total population because the disease was so common in the Punjab
Figure 8-1. Deaths from Diarrhea, Pneumonia, and All Other Causes, per 1,000 Child Years of Exposure, in Rural Punjabi Children 8 Days to 3 Years Old (January 1971–May 1973)
(fourth cause of death overall in the Khanna study, sixth cause of death among children in our study). One method was to educate and work with the dais (indigenous midwives) to improve the quality of care of the umbilical stump after the baby was born. This was a major emphasis in villages where the FHW-dai relationship was good. Although a great effort was made to get total coverage with prenatal care, the training of the dais depended on their willingness to cooperate.

The second approach was to immunize mothers so that antibodies would be transmitted to the fetus during pregnancy. This approach was incorporated into routine antenatal care from the beginning of the project.

Following a review of tetanus deaths by project staff, two modifications in the tetanus immunization program were suggested:

- To immunize systematically all women in the reproductive age group irrespective of their current fertility status instead of only immunizing antenatal women
- To use a tetanus toxoid vaccine requiring fewer injections to achieve immunity.

A field study, which has been reported in detail elsewhere, was designed to test these program modifications. Fortunately, a new commercial vaccine had become available that featured a higher concentration of calcium phosphate-absorbed toxoid (IPAD-T, Institute Pasteur, Garches, France) than in the standard vaccine.

In the first part of the field study, a sample of 159 women between 15 and 44 years of age were randomly given either standard tetanus toxoid or IPAD-T followed with serial tests of antibody levels in their blood. Results indicate that a single injection with IPAD-T raised the levels of circulating antibodies by approximately the same amount as three injections of the standard tetanus toxoid. We are not aware of any deaths from neonatal tetanus in infants whose mothers had completed a full course of three injections with standard
toxoid. We therefore assume that one injection of IPAD-T was equally effective.

In the second part of the study, we were able to immunize 1,583 (87 percent) out of 1,820 women with one injection of IPAD-T in the course of a single routinely scheduled immunization round and we saw no further cases of tetanus in these experimental groups.

SUMMARY

The procedures developed to manage diarrhea, pneumonia, and neonatal tetanus in this project can be adapted to the many villages of the world where these problems are also the principal causes of death. Introducing and implementing new standing orders does not require setting up a research project but could be done in any service with systematic mechanisms for reviewing field procedures. In our case, complete reporting of mortality and morbidity made it possible to document the effectiveness of these procedures, but detailed mortality and morbidity rates are not necessary for defining local problems and setting up active in-service training and supervisory activities. In fact, precise data did not become available until long after the special review process was completed.

Other health service programs could similarly focus on reducing child deaths by establishing a simple monitoring system for deaths, reviewing their importance and vulnerability to intervention under local conditions, and then developing or modifying field services. Other relevant information -- such as relative disease incidence, adequacy of response to treatment, and unusual complications -- can be derived from service records or can be elicited impressionistically during discussions with staff.

The principle of establishing ongoing evaluation of service activities with immediate feedback into in-service training is based on the reality that standing orders, supervisory procedures, and training programs prepared at the start of a
new program or developed at any point along the way cannot be expected to be either completely relevant or effective. Identification and correction of problems requires both continuing evaluation of program effectiveness and a procedure to communicate this information to supervisors, village workers, and the community. Involvement of all levels of workers in analysis of problems was an essential element in the success of this program. The system of review was a learning process for all members of the staff and, ultimately, for the community. The importance of community involvement was demonstrated most effectively in teaching mothers to take responsibility for starting oral rehydration immediately at the onset of significant diarrhea in their children. For primary care workers, in-service training of this sort is probably more important than their original training. Frequent conferences based on service records, especially if conducted at the place of service delivery, are an important element in providing the kind of supportive supervision that tangibly improves the quality of peripheral health services.

NOTES TO CHAPTER 8


2. Ibid.


Chapter 9
Evaluation of Program Utilization
and Cost Effectiveness

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As the services of the Narangwal Nutrition Project were being
developed, it became evident that this long-term research under
field conditions provided a unique opportunity to incorporate
a systematic approach to relating health needs to health ser-
vices and community resources. We needed to measure systemati-
cally health inputs, the output of services, and outcomes in
terms of changes in health and nutrition status. In many
health services research projects, inputs are assumed to be
simply the number of personnel or the money and facilities al-
located, but this gives no direct measure of what actually
happened. Detailed information about specific inputs and the
participation of staff in various activities would greatly
improve our understanding of the dynamics, cost, and effec-
tiveness of the interventions used to influence mortality,
morbidity, and growth and development. There were obvious
variations in work loads of family health workers (FHWs) be-
cause of differences in the service packages in the four exper-
imental groups of villages. Quantitative measurements of ser-
vice inputs and activities were, therefore, included as an in-
tegral part of the data gathering. Selection of measurement
methods relied heavily on experience gained in the functional
analysis of government health services conducted at Narangwal
and other sites.¹

The use of functional analysis methods to quantify in-
terventions in the nutrition project yielded the following
benefits:

- A fundamental approach of the project was to develop the best package of services to be applied in each experimental group rather than to hold rigidly to predetermined patterns of work. At first this process of developing better methods depended on empirical observations and intuitive assessment of service activities. As the more obvious improvements were made, further refinement of services required measurement methods, such as functional analysis, that were more precise and immediately relevant for rapid feedback to improve services.

- By documenting the activities, efforts, and costs required in the delivery of services, it became possible to plan practical adaptation of the Narangwal service patterns to other situations by using quantitative estimates of required inputs.

- By relating input data to specific functional components of services, the functional analysis provided information about the cost of each service component so that administrators and health planners who were designing new nutrition and child health programs could use the Narangwal experience as a guide in estimating relative costs of different services.

- At the Narangwal Rural Health Research Center the development of service activities was intimately intertwined with multiple research, training, and demonstration activities. Detailed measurements of input and activity data helped separate out from research and training activities most of the effort and costs that could be ascribed to actual services. For example, surveillance activities were important not only for gathering some of our most significant research data but were also a key element in maintaining effective services. Functional analysis provided a more rational basis for recommendations about service packages, recommendations that would
be relevant as replication was carried out in purely service settings. Rather than the rather crude approach of simply subtracting costs in control villages from in service villages, we tried to estimate more accurately the proportion of each activity that could be classified as research. A systematic review was conducted by the health professionals involved in field work on an item by item basis, and the proportion that was primarily research was estimated by consensus. By this procedure some of the costs in control villages were allocated to service because such costs would have been important in surveillance, early detection, and treatment under normal service conditions.

Finally, these data provided variables that could be used for input-output analyses such as cost-effectiveness calculations and regression equations designed to establish the relative cost or importance of specific service components in producing desired outcomes.

METHODS

To generate the service input information presented in this chapter, data were collected in all project villages by a separate evaluation team. Field methods from our functional analysis research\(^2\) were adapted as follows:

- Work sampling produced detailed information on the time spent by project staff in providing specific services in study villages. Observers followed all service staff on at least twenty-four different days sampled throughout one full year of the project (1971), recording the functions and activities performed at every two-minute interval during the observation day.
- Information was abstracted from individual service records for all years of the project (1969-73). These data consisted of a description and count of all project services that were received by each study child.
Information on feeding center utilization by children in the study villages was obtained from three sources: (1) counts of all visits to the feeding centers by any child receiving supplements; (2) detailed record of the supplementation received by children under 3 years of age who were below 70 percent of the Harvard standard weight median or who had been below that standard during the preceding two months; and (3) records of food supplied to the feeding centers that were used as a means to verify the visit counts.

A sample household survey was carried out in all study villages during the final year of the project (1973). Two hundred households were randomly selected in each experimental group to yield a sample of approximately 40 percent of all households. This survey provided an estimate of the use and cost of services other than those available within the project (for example, use of private practitioners or government services).

Detailed accounts were maintained of all costs related to the provision of services for each year of the project. These costs were allocated to specific activities and services mainly according to work-sampling information using methods established in the previous functional analysis project.

RESULTS

The results of the functional analysis are given in this section for time spent in direct services, service content, use of other (nonproject) services, costs, effects of services on health indicators, and cost effectiveness.

Time Inputs

The average amount of time spent in direct services by project staff with each child under 3 years of age is summarized in figure 9-1. This varied from an average of about...
Figure 9-1. *Average Staff Time Spent Weekly in Direct Services per Child under 3 Years Old in Each Experimental Group, 1971*

Nutrition services.

Pregnancy survey and prenatal "child services."

Services to well children.

Services to ill children.

Note: Staff did not include village attendants.
7 minutes per child per week in the villages receiving nutritional supplementation and health care services (NUTHC) to less than 5 minutes per child in control villages (CONT-N). The latter amount of time consisted primarily of surveillance visits as part of longitudinal surveys. Contacts with ill children (identification of ill children in the home, treatment in the home when appropriate, and clinic visits) averaged 4.2 minutes per child per week in NUTHC villages; 3.3 minutes in villages receiving only nutritional supplementation (NUT); 3.5 minutes in villages receiving only health care (HC); and 2.5 minutes in control (CONT-N) villages. These time differences probably are related to (1) variations in number of ill children identified per visit; (2) provision of specific treatments in NUTHC and HC villages in contrast to symptomatic medications in NUT and CONT-N villages; (3) time available per home visit (especially in NUTHC villages, where the ratio of children per FHW was purposely adjusted down to compensate for the FHW's combined health and nutrition responsibility), and (4) rapport of the worker with the family. All these factors would tend to make time spent in NUTHC villages on ill children greater than in the two single-service groups and definitely more than in the controls. It should be recalled that in NUT and CONT-N villages collection of detailed morbidity data was carried out just as in HC villages, and FHWs had a few purely symptomatic drugs they could use to maintain rapport. If a life-threatening condition was identified in NUT and CONT-N villages, a "technical knockout" (TKO) was declared, and full-scale treatment efforts were initiated. When NUT villages are compared with HC villages, the time spent with ill children over and above the time spent for surveillance was almost identical and this seems to indicate that providing definitive treatment to sick children in HC villages did not differ very much from the time required to give them symptomatic treatment in NUT villages. (This finding is supported by the similar number of treatment contacts in these two sets of
Figure 9-2. Average Annual Service Contacts per Child under 3 Years Old in Each Experimental Group, 1970–73

- Preventive and surveillance only.
- Treatment contacts for illness.

a. 1973 contacts adjusted to annual rates.
villages identified in the service record analysis.)

Almost no variation was observed in the time spent per well child in the following activities: morbidity survey and monitoring of weight in all villages, giving immunizations, health and nutrition education, and "prenatal child care" in the appropriate service villages. Time with well children averaged 1.6 minutes per child per week in all villages except HC, where it was 1.4 minutes. Visits to eligible women (married and 15-49 years of age) every two months to identify pregnancies early and institute simple antenatal care ("prenatal child care"), required only from 0.5 to 0.8 minutes per week per child (or 0.3 to 0.5 minutes per week per eligible woman).

Over 95 percent of the staff time input was for the work of the FHW assigned to each village. The one exception to this was in NUT and NUTHC villages, where village women were employed as "feeding-center attendants" to provide most of the direct services to children receiving food supplements. As seen in figure 9-1, nutrition contact by staff other than the village attendants averaged only 0.2 to 0.3 minutes per week per child under 3 years old.

If we assume that the time in the control group was mainly for surveillance activities and that these same activities were also carried out in the experimental groups, we can conclude that surveillance took over two-thirds of the service time per child. The justification is that surveillance greatly increased the efficiency of services actually provided and ensured that they reached those in most need.

Finally, since the average times include all children under 3 years old, whether they actually received services or not, these figures should not be interpreted to reflect the real time inputs provided any individual child receiving care.

Service Contacts

Figure 9-2 summarizes the average annual number of services received by each child in the various experimental
The variation between years was not as great as the differences between experimental groups. Theoretically, each child should have received at least one contact per week according to the study design. In NUTHC villages, the average number of contacts was 50 to 60 per child per year, close to the target level of 52. Over 90 percent of children under 3 years of age received at least one visit for curative or preventive services during any given year. The control villages consistently had the fewest contacts per child, reflecting the difficulties of maintaining rapport in villages where no services were provided.

No significant differences were noted in use of curative services by caste or other socioeconomic characteristics. However, project-initiated surveillance services were significantly higher among lower-caste children, demonstrating the built-in responsiveness of services to the greater health needs of this group of children.

The majority of contacts involved only surveillance or preventive services and ranged from 23 to 36 per child per year. Contacts for treatment of illnesses (alone or combined with surveillance) averaged between 21 and 28 per year per child in the NUTHC villages but were minimal and predominantly symptomatic in control villages. As with time allocated to care of ill children, treatment contacts in NUT villages were limited to minimal symptomatic care, but because of special efforts made by FHWs in NUT villages, their visits were almost identical in number to definitive treatment contacts in HC villages.

In NUT and NUTHC villages, nutritional supplementation was provided systematically to children who were identified by anthropometric surveillance as being underweight or faltering in their growth and, after 1970, to other children who chose to come to the feeding centers. By dividing the annual number of supplemental feedings by the number of children from 6 months to 3 years of age, we obtained the average annual number of
feedings per child. The figures were 255 in NUTHC villages and 370 in NUT villages — about 35 percent and 50 percent, respectively, of the potential feedings of 730 per year if all children had attended the feeding centers twice every day during the study. Since some pregnant women and children over three also received supplemental feedings, the actual average feedings per child under 3 years of age would be slightly lower. Although a special effort was made to maintain regular attendance by those who were below 70 percent of the Harvard weight-for-age median, actual attendance figures for children between 1 and 3 years of age and below 70 percent of the Harvard weight-for-age standard showed that they received about 40 percent of the potentially available feedings. Reasons for not receiving the full complement of feedings included resistance by higher-caste mothers to bringing their children to the center, lack of concern by mothers of unwanted female infants, lack of time among mothers who had to work in the fields, and periods of time when children left the village with their mothers to visit maternal grandparents. Attempts to improve coverage included having feeding-center attendants take food to the homes of the most seriously malnourished, but this obviously could only reach a few of the nonattenders on any given day. Our experience demonstrates the problems of trying to maintain total coverage of malnourished children in a village setting but also shows that partial attendance can achieve significant nutritional impact if adequately targeted.

Use of Other Services

Extensive use of private practitioners, both qualified and unqualified, was documented by previous surveys in the study area. Figure 9-3 shows that in control villages ill children who received treatment usually were cared for by private practitioners. In the experimental groups of villages, services provided by project personnel were used by 50-60 percent of ill children and replaced most of the use of other
Figure 9-3. Percentage of Ill Children under 3 Years Old Receiving Treatment by Source of Care, Sample Survey, All Experimental Groups, 1973

- No treatment
- Gov't
- Private
- RHRC

- Illness not treated during two-week recall period.
- Illness treated in government or other facility.
- Illness treated by private practitioner (qualified or unqualified, traditional or allopath).
- Illness treated by Narangwal staff.
sources of care. The most obvious impact was to reduce the number of ill children who went untreated, or were only treated by family members, from about 60 percent to 20 percent. In NUTHC and HC villages consultations with private practitioners were reduced to about half of the rate in NUT villages, where only symptomatic care was given, and to about one-third of the rate in control villages. The remarkably high rate of clinical contact with Narangwal staff in NUT villages was due to exceptionally good interpersonal relationships with FHWs, even though only symptomatic treatment was given. Government services, such as those provided by primary health centers, accounted for only a small part of the services used -- even in the control villages, which were closer to government primary health centers than other study villages.

Costs

The cost analysis focused exclusively on direct financial costs. No attempt was made to estimate the social cost of illness or the impact of services on such costs. In other respects the analysis included as many as possible of the components of project service costs. For example, all donated drugs, food, buildings, and land were given an estimated value based on current market prices. Capital expenditures for buildings, large equipment, small equipment, and vehicles were amortized at annual rates of 2, 5, 10, and 10 percent, respectively. These annual cost components for each of the experimental groups are compared in table 9-1. Cost related to labor (nonresearch portion of salaries) ranged from a low of 39 percent in NUT villages to 64 percent in CONT-N villages. NUTHC and HC villages were intermediate, with 45 and 58 percent respectively. By subtracting the costs of nutrition supplementation from the NUTHC costs, the residual proportion related to salaries increased to 59 percent, almost the same as in HC villages.

The supplementation program was one of the most expensive
Table 9-1. Percentage Distribution of Cost Categories in Each Experimental Group Based on Average Annual Costs for 1970-73

<table>
<thead>
<tr>
<th>Cost categories</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NUTHC</td>
</tr>
<tr>
<td>Buildings (2%)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.2</td>
</tr>
<tr>
<td>Maintenance</td>
<td>1.4</td>
</tr>
<tr>
<td>Equipment (5 or 10%)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.4</td>
</tr>
<tr>
<td>Supplies</td>
<td>6.7</td>
</tr>
<tr>
<td>Vehicles (10%)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.0</td>
</tr>
<tr>
<td>Vehicle running and maintenance</td>
<td>5.1</td>
</tr>
<tr>
<td>Food</td>
<td>25.8</td>
</tr>
<tr>
<td>Drugs</td>
<td>10.5</td>
</tr>
<tr>
<td>Referrals</td>
<td>1.8</td>
</tr>
<tr>
<td>Salaries</td>
<td>45.1</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
</tbody>
</table>

... Zero or negligible.

<sup>a</sup> Capital expenditures amortized as indicated to provide annual costs.

Components of the services, making up 45 percent and 57 percent of total costs in NUTHC and NUT villages respectively. In both of these experimental groups, expenditure on food alone was about 60 percent of the supplementation program expenditures. The amortized capital costs were only 4 to 9 percent of the total costs in any of the groups. Total costs for materials consumed annually (supplies, food, drugs, and the like) were about 56 percent in NUT, 51 percent in NUTHC, 35 percent in HC, and 26 percent in CONT-N.

Drug costs are of considerable importance in planning primary health care programs. In the two experimental groups with definitive health care services, the proportion of expenditure for drugs was 9.4 percent in HC and 10.5 percent in NUTHC. Finally, transport costs ranged from about 6 percent in the NUTHC villages to nearly 15 percent in the HC villages. When these costs are compared with the distribution of expenditures in government health centers, the major difference is that in government services salaries consume about 75 percent of all funds and that other expenditures are limited.5
Total costs for project services (excluding research and development costs) ranged from an average of Rs176 rupees (US$23); (Rs 1 = US$0.13) per child in NUT villages, to Rs58 rupees (US$7.5) in CONT-N villages (figure 9-4). Spread over the total village population, the costs to provide combined NUTHC services for children under 3 years old would be about Rs14 rupees (US$1.8) per capita (total population) per year. As with the time data, the costs in control villages could be considered the costs of surveillance, symptomatic treatment to maintain rapport, and treatment of children identified as TKOs.

If the nutrition project services were replicated as part of a government program in India, actual total costs per child should not be as high as those incurred at Narangwal because of differences in fringe benefits to workers, volume purchase of supplies, and donations of food. It was estimated that costs under a statewide government program could be reduced by as much as 50 percent.

For example, Punjabi government salaries and allowances for auxiliary nurse midwives in 1969 totaled approximately Rs350 per month. At Narangwal, base salaries for auxiliary nurse midwives (ANMs) were very similar, but the addition of free medical care, free furnished housing, uniform and bicycle allowances, and larger annual and merit increments brought salaries of experienced workers up to Rs500 to Rs600 per month. Narangwal had to purchase drugs through local retailers in the nearby city of Ludhiana. The government of Punjab receives the bulk of its drugs through a government central supply system in which drug costs are generally less than half of the costs Narangwal had to pay, even when buying in quantity. A final example would be costs associated with food supplements. If food were donated, as in Narangwal, either by local communities or outside agencies, the direct costs of the program reported here could be reduced 25 to 35 percent. (In the cost data for the nutrition project at Narangwal, the local market values of these donated foods were included in the cost account-
Figure 9-4. *Average Annual Cost per Child under 3 Years Old for Services in Each Experimental Group, 1970–73 (rupees)*

NUT: Nutrition services.
MAT: Pregnancy survey and prenatal “child services.”
WELL: Services to well children.
ILL: Services to ill children.
ing procedures.) Obviously, the efficiency of the program would almost certainly also be reduced in a widespread government replication. In any event, a statewide program with similar services would still cost over Rs75 per child per year. The equivalent per capita (total population) level of expenditure would be about Rs7 (US$1) per year. This is about three times higher than that of an average primary health center in the Punjab, which spent about Rs2 to Rs3 per capita per year in 1969. This comparison, however, is biased because it assumes that the primary health centers were in fact providing services to the total target population of about 85,000. Actually, only 10 to 20 percent of the children under 3 years old in a health center area had access to curative services and the very limited maternal and child health services provided by the primary health centers and their subcenters.

A better comparison of costs would be to use the cost per unit of service actually provided to a child. At Narangwal, total costs per contact averaged about Rs1.40, with the cost of an ill-child contact being about Rs2.50 to Rs3.70 (the few emergency illness contacts in the CONT-N villages were three times higher), and a well-child contact was Rs0.35 to Rs0.60 (table 9-2). These compare quite favorably with costs at a primary health center of Rs1.50 per patient visit and Rs0.80 for a maternal and child health contact. The observed difference in per capita cost, therefore, is due to almost total coverage of the target population and the high service utilization rates of the Narangwal nutrition project compared with primary health center populations. Service utilization in our study population was very high not only because of ready accessibility to primary care within each village, but also because of active health surveillance by FHWs. Our experience suggests that a relatively intense concentration of resources and effort may be required to produce any impact on child health and that the current dilution of effort in government services is probably below the threshold level where they can
Table 9-2. Average Cost per Service Contact or Feeding for Children under 3 Years Old in Each Experimental Group, 1970-73 (rupees, Rs)

<table>
<thead>
<tr>
<th>Type of service contact</th>
<th>NUTHC</th>
<th>NUT</th>
<th>HC</th>
<th>CONT-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ill child</td>
<td>2.48</td>
<td>3.67</td>
<td>3.07</td>
<td>10.33</td>
</tr>
<tr>
<td>Well child</td>
<td>0.52</td>
<td>0.35</td>
<td>0.59</td>
<td>0.53</td>
</tr>
<tr>
<td>All contacts</td>
<td>1.43</td>
<td>1.37</td>
<td>1.44</td>
<td>1.37</td>
</tr>
<tr>
<td>Nutrition Supplementa</td>
<td>0.33</td>
<td>0.32</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

... Zero or negligible.

a. Cost per attendance at the feeding center.

be expected to have any significant effect.

Because government services reach only 10-20 percent of children, a more complete comparison is to combine private and government health care expenditures to contrast them with project costs. This produced an entirely different picture, with total costs (excluding nutrition supplementation) in NUTHC villages now coming to only 12 percent more than in control villages (Rs 27.7 per capita versus Rs 24.6 per capita, respectively; see Table 9-3) As will be recalled, nutrition project services replaced some but not all of the existing private services (figure 9-3). Table 9-3 summarizes the total expenditures on health care in the NUTHC villages and the control villages of the nutrition and population projects (CONT-N and CONT-P) based on data from the project cost analysis, estimates of out-of-pocket expenditures from the sample household survey, and costs of government health care as determined in the functional analysis study.\(^8\) Services in the table are divided into curative, nutrition, and other (preventive, surveillance, maternal care and so forth). Data from the CONT-N villages do not include the cost of surveillance activities and emergency care, since these extra inputs were not provided in the CONT-P villages. As can be seen, the project provided
Table 9-3. Comparison of Total per Capita Health Care Expenditures in Integrated Care (NUTHC) and Control (CONT-N and -P) Villages, 1972-73

<table>
<thead>
<tr>
<th>Source and types of services</th>
<th>Expenditures (Rs)</th>
<th>NUTHC villages</th>
<th>CONT-N and -P villages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Children</td>
<td>Children</td>
<td></td>
</tr>
<tr>
<td></td>
<td>under 3 years</td>
<td>under 3 Years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>Nutrition project services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curative</td>
<td>5.4</td>
<td>2.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>n.a.</td>
</tr>
<tr>
<td>Other</td>
<td>1.3</td>
<td>1.0</td>
<td>n.a.</td>
</tr>
<tr>
<td>Nutrition</td>
<td>6.5</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Private practitioners services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curative</td>
<td>0.7</td>
<td>12.8</td>
<td>2.0</td>
</tr>
<tr>
<td>Other</td>
<td>n.a.</td>
<td>2.4</td>
<td>n.a.</td>
</tr>
<tr>
<td>Government and non-profit services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curative</td>
<td>0.3</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Other</td>
<td>0.1</td>
<td>0.7</td>
<td>0.1</td>
</tr>
<tr>
<td>All sources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curative</td>
<td>6.4</td>
<td>15.8</td>
<td>2.4</td>
</tr>
<tr>
<td>Other</td>
<td>1.4</td>
<td>4.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Subtotal</td>
<td>7.8</td>
<td>19.9</td>
<td>2.5</td>
</tr>
<tr>
<td>Nutrition</td>
<td>6.5</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rs</td>
<td>14.3</td>
<td>19.9</td>
<td>2.5</td>
</tr>
<tr>
<td>US$</td>
<td>1.9</td>
<td>2.7</td>
<td>0.3</td>
</tr>
</tbody>
</table>

n.a. Not available.

Note: Sources of data included the project cost analysis, out-of-pocket expenditures and use of different services determined during the sample household survey, and costs of government services determined in the functional analysis study (see note 1 to this chapter). The control villages in this table are from both the nutrition project (CONT-N) and the parallel population project (CONT-P). Costs associated with surveillance and treatment of emergencies in the CONT-N villages have been excluded. The latter averaged about Rs5.5 per capita in the CONT-N villages.

<sup>a</sup> Costs of services provided to children over 3 years of age and to women of child-bearing age.
some care to children over 3 years old and to women of childbearing age, but the majority of program costs were related to children under 3 years old. Expenditures for care of children under 3 years old in control villages by private practitioners were Rs2 per capita (total population), a figure three times greater than in NUTHC villages (Rs0.7), but for other individuals such expenditures for private care were almost identical in NUTHC and CONT-N villages (about Rs13 per capita). The proximity of government health centers to the control villages explains the much higher level of expenditures for these services in control villages and somewhat balances the project costs for older children and women in the NUTHC villages.

Curative service expenditures were only 9 percent more in NUTHC than in control villages, but the emphasis on prevention in our program is indicated by the finding that expenditures on other types of services were 29 percent greater than in control villages. Addition of the nutrition programs to child health care services would increase all current expenditures on health at the village level in Punjab by only about 40 percent. This conclusion is quite different from the much larger discrepancy when comparisons were made only with government expenditures.

In terms of the total economy of Punjab, the types of health programs introduced by the Narangwal project are probably within a realistic expansion of expenditures if government and community resources could be combined. Shifting some government expenditures for expensive tertiary care in urban settings to rural primary health care, having patients pay for part of their care (such as medicines), and encouraging communities to contribute food to supplementation programs in their own villages would go a long way toward providing the additional resources required for this level of expansion.
Effects of Services on Health Indicators

To sharpen the comparison of the impact of the various service packages, Pearson's product-moment correlations were carried out to measure associations between the number of service contacts provided in experimental villages, mortality rates, and mean morbidity duration of specific symptom complexes. For example, the total number of service contacts provided to children under 1 year of age in each experimental group of villages in each year was correlated with the experimental groups' infant mortality rates for these years. Since the analysis was carried out with aggregate data from each experimental group, the sample size was small. The following results must, therefore, be viewed only as indicative of the probable impact of the service packages.

Infant mortality rates were negatively correlated with the total volume of service contacts provided children under 1 year old, curative and preventive combined ($r = -0.367, p = .05$, $n = 20$; in this and subsequent findings, $n$ indicates the number of pairs of variables available for that correlation, with each pair representing data from a given experimental group in a given year). In those experimental groups and years with greater service inputs, there were fewer infant deaths. If the final year (1973) observations in the control villages are excluded from the analysis (because services and surveillance were terminated in one of the villages at the end of 1972), the association between services and the infant mortality rates was even more significant ($r = -0.561, p < .01$, $n = 19$). There was also a strong negative correlation between the number of "prenatal child care" contacts during a given year and the perinatal death rates in the following year ($r = -0.709, p < .005, n = 12$). However, service contacts with children over 1 year old were not well correlated with mortality rates of children in that age group. These findings generally support the program effects noted in chapter 7, with infant mortality rates being lowest in health care groups (NUTHC and
Perinatal death rates were also lower in all experimental groups compared with controls.

The mean duration of specific morbidity was found to be correlated negatively with the frequency of service contacts for treatment. For example, mean duration of diarrhea in children under 1 year old showed a coefficient of $-0.706 \ (p < 0.005, n = 16)$ when correlated with treatment contacts in that age group. A similar analysis among children over 1 year old showed a correlation coefficient of $-0.517 \ (p < 0.05, n = 15)$ when the final year in the control villages was excluded. The average duration of several other symptoms -- including cough, vomiting, eye and skin complaints -- also showed significant negative correlations with the volume of treatment contacts.

The only complaint that showed a significant negative correlation with the number of contacts for surveillance and preventive services was lower respiratory infection (pneumonia) in children under 1 year old ($r = -0.513, p < 0.05, n = 14$). This supports the importance of early identification and treatment of pneumonia in infants through frequent surveillance as described in chapter 8.

The effect of nutritional status on mortality was well documented in chapter 7, and its impact on morbidity has been demonstrated in an earlier analysis. We, therefore, attempted to link nutritional services measured by feeding-center attendance to mortality and morbidity levels by correlating the number of supplementary feedings provided each year in the nutrition care villages (NUTHC and NUT) with mortality rates and mean duration of specific conditions of morbidity. No associations were noted between these variables for children under 1 year old. The only significant correlations were between the mortality and morbidity of children over 1 year old and the number of feedings in the following year ($r$ ranged from $+0.8$ to $+0.9$, all significant at $p < 0.005$). This highly positive correlation probably indicated the responsiveness of the feeding programs to the fact that more children were mal-
nourished following episodes of high morbidity. No other association between the number of feedings and morbidity or mortality measures was noted except for a weak, but consistent, negative correlation between feedings in one year and mortality rates in children over 1 year old in the following year. The number of units in the analysis were too few to reach statistical significance, but the direction of the findings supports the previously identified reduction in deaths of children over 1 year old in the nutritional care villages.

Cost Effectiveness

By relating the costs of service programs in each experimental group to differences between outcome measures in each experimental group and the control group, it was possible to obtain specific cost-effectiveness ratios. Calculations of this type, however, are not straightforward. For example, the Narangwal services had a number of objectives including decreasing mortality, reducing morbidity, and improving growth and psychomotor development. All of these objectives are interrelated. Rarely does an intervention have an impact on only a single measure of effectiveness, and this makes it difficult to allocate specific portions of costs to particular measures of effectiveness. Because nutrition contributes to both improved physical growth and psychomotor development, it seemed very arbitrary to assign some of the nutrition cost to growth and some to psychomotor development. If all nutrition costs were attributed to each benefit, this would result in double counting of nutrition costs, but we could find no other way of allocating these costs. However, it was possible to separate out the costs related to reduction of mortality and morbidity by allocating a proportion of nutrition and health care costs to prevention of deaths according to age-specific mortality rates in the control villages. The balance of health care costs were attributed to morbidity reduction, the balance of nutrition costs to improvement of physical growth and
psychomotor development.

Table 9-4 shows a comparison of the impact of the different service packages on indices of effectiveness. In this table, "maximum effect" is the difference between the control village rate of a given indicator and the rate in the experimental group achieving the best results for that indicator. This level of achievement was called the "maximum observed effect" and given an index value of 100. Results in the other experimental groups were then expressed as a proportion of this index. For example, the perinatal death rate in the combined CONT-N and CONT-P villages was 104.2, while the lowest rate of 60.9 was found in NUT villages. The difference between these two rates is 43.3. This difference was given a value of 100. Similarly, the perinatal death rate in HC villages was 80.8, giving a difference of 23.4 from the controls. Dividing this difference by 43.3 and multiplying by the index of 100 gave an index value of 54 for the effectiveness of HC interventions in preventing perinatal deaths.

By indexing the results in this manner, it is possible to rapidly summarize the impact of the different intervention packages across a number of outcome measures. Thus, health care services alone (HC) stand out as having reduced infant mortality most effectively. Nutrition alone (NUT), which includes nutritional supplementation for pregnant women, was most effective in reducing perinatal mortality and increasing growth in children 0-3 years old. Maximum effectiveness was achieved by both HC and NUT in reducing mortality in children 1-3 years old. The effect on mortality and growth of the combined nutrition and health care services (NUTHC) was usually close to the performance of the more limited single-service component that excelled, demonstrating the broader impact on multiple outcomes of the combined interventions. As the best approximation of synergism between programs, NUTHC was most effective in its own right in reducing morbidity in children 0-3 years old and in improving psychomotor development.
Table 9-5 combines the effectiveness data with the costs allocated to the various measures as indicated above. Cost-effectiveness ratios are shown that assign an index of 1 to the most cost-effective packages for a particular impact. The U.S. dollar costs are given in parentheses. The relative differences in the indices are likely to hold true in similar ecological settings, but the actual costs would, of course, vary with salary levels and prices. We also strongly suspect that, in areas with food deficits and more severe malnutrition, the cost effectiveness of nutrition interventions, particularly those combined with health care, might be even more favorable.

In this table the actual differences between mortality rates in control villages and in the experimental villages were used to estimate the number of deaths that probably were prevented, or averted, by providing the specific services. These "averted deaths" then became the divisor of costs associated with mortality reduction when costs per death averted were calculated. The lowest cost-effectiveness ratios for deaths averted were US$7.75, US$9.85, and US$14.15 for "prenatal child care" costs per perinatal death averted in NUT, NUTHC, and HC experimental groups respectively. Costs per infant death averted were lowest in the HC group of villages (US$25). Using this figure as an index of 1.0, the other costs per infant death averted were 1.4 (US$36) in NUT and 1.5 (US$37) in NUTHC. As with infant deaths, the services in the HC villages were the most cost effective in averting deaths in children 1-3 years old (US$31). NUT services were more than twice as costly per child death averted (US$72), and NUTHC services were at least three times as costly (US$101).

The number of days of illness due to eight selected symptoms (see Chapter 7) were used for the morbidity indicators. Tables 9-4 and 9-5 show that only villages with health care services experienced any significant reduction in days of morbidity. For infants, the cost per day of illness averted was US$0.40 in HC villages and US$0.56 in NUTHC villages. For
Table 9-4. Comparison of the Impact of Services Provided to Different Experimental Groups on Specific Indices of Effectiveness

<table>
<thead>
<tr>
<th></th>
<th>Perinatal mortality</th>
<th>Mortality in children &lt;1 year old</th>
<th>Mortality in children 1-3 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum effect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observed(^a)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index(^b)</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>NUTHC</td>
<td>94</td>
<td>81</td>
<td>70</td>
</tr>
<tr>
<td>NUT</td>
<td>100</td>
<td>55</td>
<td>100</td>
</tr>
<tr>
<td>HC</td>
<td>54</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

... Zero or negligible.

\(^a\) Observed difference from control levels in rates or values in the most effective service package.

\(^b\) For example, if the maximum effect on perinatal mortality is a decrease of 43.3 per 1,000, then an index of 94 denotes a decrease of 43.3 per 1,000 x .94 = 40.7 per 1,000.
Table 9-4. (Continued)

<table>
<thead>
<tr>
<th>Maximum effect</th>
<th>Morbidity in children 0-3 years old</th>
<th>Growth in children 0-3 years old</th>
<th>Psychomotor scores of children 0-3 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed(^a)</td>
<td>Decrease of 22.2 days of illness per child 0-3 years old</td>
<td>Increase of 1.3 cm in height at 36 months of age</td>
<td>Increase of 5.2 percentage points by 36 months of age</td>
</tr>
<tr>
<td>Index(^b)</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>NUTHC</td>
<td>100</td>
<td>92</td>
<td>100</td>
</tr>
<tr>
<td>NUT</td>
<td>...</td>
<td>100</td>
<td>56</td>
</tr>
<tr>
<td>HC</td>
<td>94</td>
<td>15</td>
<td>...</td>
</tr>
<tr>
<td>Category</td>
<td>Perinatal</td>
<td>Infant</td>
<td>1-3 year old</td>
</tr>
<tr>
<td>----------</td>
<td>-----------</td>
<td>--------</td>
<td>--------------</td>
</tr>
<tr>
<td>I(a). Cost per death averted&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NUTHC</td>
<td>1.3 ($9.85)</td>
<td>1.5 ($37.35)</td>
<td>3.3 ($101.45)</td>
</tr>
<tr>
<td>NUT</td>
<td>1.0 ($7.75)</td>
<td>1.4 ($36.40)</td>
<td>2.3 ($71.75)</td>
</tr>
<tr>
<td>HC</td>
<td>1.8 ($14.15)</td>
<td>1.0 ($25.35)</td>
<td>1.0 ($30.65)</td>
</tr>
<tr>
<td>I(b). Cost per day of illness averted&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NUTHC</td>
<td>1.4 ($0.56)</td>
<td>1.1 ($0.39)</td>
<td></td>
</tr>
<tr>
<td>NUT</td>
<td>c</td>
<td>c</td>
<td></td>
</tr>
<tr>
<td>HC</td>
<td>1.0 ($0.40)</td>
<td>1.0 ($0.35)</td>
<td></td>
</tr>
<tr>
<td>II(a). Cost per additional cm growth at 36 months&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NUTHC</td>
<td>1.0 ($26.25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NUT</td>
<td>1.2 ($30.40)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HC</td>
<td>c</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I(b). Cost per additional percentage point increase in psychomotor development scores over the first three years of life&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NUTHC</td>
<td>1.0 ($5.05)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NUT</td>
<td>2.7 ($13.60)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HC</td>
<td>c</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Indices were created by equating lowest cost in any category to 1. Actual costs in U.S. dollars are given in parenthesis.

<sup>a</sup> Using a proportion of total program costs equal to the age-specific mortality rate.

<sup>b</sup> Using all health care costs minus costs counted under mortality.

<sup>c</sup> Small or no effects produced large or infinite cost-effectiveness ratios.

<sup>d</sup> Using all nutrition costs minus costs counted under mortality.
children 1-3 years of age, the respective costs were US$0.35 and US$0.39.

The NUTHC experimental group of villages had the best cost-effectiveness ratios for both growth indicators. Nutritional costs per additional centimeter of growth attained by 3 years of age in comparison with the control was US$26 in NUTHC and US$30 in NUT villages. Costs per percentage point of increment in psychomotor scores was US$5 for NUTHC villages and US$14 for NUT villages.

In conclusion, Table 9-5 shows that mortality in infants and children 1-3 years old is decreased with the least cost by health care alone, but perinatal mortality is lowered with the least cost through nutrition services. To decrease morbidity, health care alone is the most cost-effective approach, but increases in growth and development are obtained for the least cost through health care combined with nutrition services. Comparing tables 9-4 and 9-5, it seems that children would benefit most through the combined program, but at somewhat higher costs than shown for either NUT or HC alone.

SUMMARY

The best evidence of synergism, at least in the Punjab context, is that combined services, for only slightly more expenditure of time and money than for either one of the single intervention packages alone, achieved effects nearly equal or superior to the single interventions on all parameters of physical growth, psychomotor development, mortality, and morbidity. An important conclusion from this analysis is that questions of program synergism cannot be analyzed purely by a single-outcome measurement, as has been the case in studies of synergism among specific health problems, but must be examined by considering all possible impacts and costs. This study was not able to demonstrate substantial synergism between health care and nutrition programs purely in effectiveness or impact for most single-outcome measures. This was most likely due to
the conscious decision to keep health worker inputs relatively similar in all experimental groups. Thus, workers in NUTHC villages who had to cover both nutrition and health care tasks could not spend as much time on each type of activity as could workers in HC or NUT villages. A true test of impact synergism would have required setting worker time inputs in NUTCH villages at a level equivalent to the combined time inputs of workers in HC plus those in NUT villages. However, this would not have been in accord with our program objective of testing service packages that would eventually be relevant for general implementation in integrated government services. By allowing only moderate variations in worker inputs between experimental groups, the costs in NUTHC villages were kept close to those of HC and NUT villages. Even more important than traditional definitions of synergism is the fact that the project was able to demonstrate a synergism in program efficiency through which the combined services reached multiple impact objectives.

NOTES TO CHAPTER 9


3. Department of International Health (1976); see 1 above.

4. Ibid.

5. Ibid.

6. Ibid.

7. Ibid.

8. Ibid.

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