It is impossible and impracticable to separate health problems from their environmental causes. Thus, a quick glance at the present world distribution of famine and of severe and chronic malnutrition reveals a concentration in the tropics and subtropics. Undoubtedly, negative factors exist in tropical regions that make it more difficult for man to attain an adequate level of nutrition and development.

Figure 1 illustrates that deficiencies in both provision of food and environmental sanitation constitutes the primary factors in the causation of malnutrition. The role of infection has been given increasing emphasis in recent times, because a close examination of food balance sheets, family dietary histories, and individual records of food intake by small children do not consistently reveal a limitation in food availability.

The ways in which infection affects the nutrition of the host are summarized in Table 1. Among all the mechanisms, reduction of food intake and stress-induced nutrient wastage, as outlined in Table 2, seem to be the most important consequences of the infection in rural villages. The mother often lacks the knowledge and resources to rehydrate the child, particularly when he has diarrhea, or to provide an adequate diet during convalescence. Another important adverse effect of infection is calorie restriction and inadequate management of illness, which are often mediated by cultural beliefs and taboos.

Scientists and field workers have long suspected that malnutrition influences the immune response. Although it has been difficult to document, it is now known that certain components of the immune response are altered in severe and moderate malnutrition. It is worth noting that infection by itself may suppress some manifestations of the immune response.

Long-term prospective field studies conducted in poor rural communities demonstrated that malnutrition usually results from the combined actions of deficient diets and infections. Such interactions interfere with nutrition and growth from the moment of conception; in preindus-
trial societies, the ratio of small-for-gestational age to premature infants ranges from 4:1 to 2:1, indicating the preponderance of intrauterine malnutrition\(^{(7)}\), it appears that fetal malnutrition results not only from inadequate maternal diet during pregnancy, but also from a history of malnutrition and infection in the mother during her own childhood and adolescence(s). Thus, supplementary feeding during pregnancy improves fetal growth, although the main determinants of fetal malnutrition are short maternal height, conception at an early age, and short birth intervals.

Low birth weight infants are often victims of early post-natal malnutrition, particularly of the marasmic type, and low birth weight is also one of the determinants of deficient growth and development later in life. However, postnatal malnutrition develops primarily as a result of poor child-rearing and hygienic practices, inadequate nourishment, and recurrent infection.

Recent evidence from community studies incriminates infection as a more important contributing factor than food availability in the genesis of malnutrition. Thus, malnutrition is commonly observed in homes where food supply does not appear to be limited. Detailed analysis of individual child histories often indicates that infection is the cause of significant caloric restriction because it is customary to feed the sick child watery gruels\(^{(3)}\). During convalescence, the mother does not always feed the child properly, partly because anorexia persists, and partly because she does not know how to care for the child recovering from illness. In such instances, an adequate food supply may be available in the home, but the child does not receive his share.

During the first year of life, respiratory infections and diarrhea) diseases are the most common illnesses. While diarrhea, respiratory infections and the common communicable diseases of childhood (measles, whooping cough, and chicken pox) predominate during the second year. All of these have marked deleterious effects on host nutrition\(^{(9)}\).

Control and prevention of malnutrition cannot be discussed without considering the whole community's health and development. Table 4 outlines interventions that must be affected under any political system if nutrition and health are to be promoted, particularly among poor populations. Thae interventions are difficult to implement in most countries for lack of political decisions, limitations in human and material resources, and insufficient technological knowledge to implement mea-
sures where most needed. Table 5 describes general goals that must be fulfilled if the objective is to attain an adequate nutritional status for most of the population. In the past, individual actions have been implemented independently, often with beneficial outcomes; however, most scientists would agree that the holistic approach is the sensible means to reach the desired objectives. As table 6 illustrates, the interaction of two or more measures aimed at the correction of malnutrition and infection results in a greater beneficial effect than either intervention alone ($t^0$). However, independent programs such as food fortification, immunization, and treatment of intestinal parasites have positive effects on nutritional status.

Oral rehydration of children with diarrhea is potentially one of the most important interventions in public health\(^{(11)}\). Field studies supported by the World Health Organization indicate that it can be easily carried out by non-medical persons at a low cost and with dramatic results, as illustrated in Table 7. Children rehydrated by mouth were healthier and had better appetites than those who did not receive oral fluids. Furthermore, weight gains of orally rehydrated children were significantly greater than in those who did not receive oral therapy. In fact, rehydrated children exhibited weight increments comparable to those of well-nourished European children of the same age \(^{(12)}\).

It is difficult for countries in transition to diminish malnutrition and infant mortality with the resources available at present. Health planners and field workers meet with frustration when the appropriate resources to correct or solve a specific problem are not available. It seems evident that the application of existing knowledge and the accumulation of new knowledge hinge on a change in political and academic attitudes toward the kind of research needed, now commonly described as "health services research" (Table 8). This endeavor calls for a re-definition of specific problems, the establishment of priorities, the identification of measures to be applied, and the development of methods suitable for complete implementation where it is most needed.

Regarding malnutrition, a great deal needs to be done in relation to:

a) understanding causality (particularly the significance of social factors),
b) stimulation of "mothering" (proper child care),
c) formulation of simple weaning foods, and
d) development of systems to deliver clean water to rural areas, and to improve agriculture.
Acknowledgment: The author wishes to thank the Consejo Nacional de Investigaciones Científicas Tecnológicas (CONICIT), and the International Union of Nutrition Sciences, for the support to prepare this report.
Fig I.
Environmental determinants of malnutrition and infection, and their interaction.
Table 1. Effect of Infection in Nutrition

A. Direct

- Decreased food intake, digestion and absorption anorexia, vomiting, alteration of peristalsis
- Impaired digestion
- Nutrient depletion
- Impaired absorption

Wasting effect
- Loss of tissue (muscle, epithelia, blood)
- Loss of body nutrients
- ($\mathbb{N}$, AA, vitamins, minerals)

B. Indirect (culture-mediated)

- Decreased food intake
- Alteration of diet
- Restriction of diet
- Inappropriate treatment

Table 2 Nutrient Wastage

A. Nutrient over-utilization

- Increased expenditure of sources of energy
- Increased synthesis of cholesterol and triglycerides
- Overutilization of vitamins

B. Nutrient sequestration

- Sequestration of iron in liver
- Increased intake of zinc by hepatic cells.

C. Nutrient diversion

- Uptake of plasma AA for newly synthesized "acute reactants"
- Increased enzyme synthesis by liver
- Synthesis of foreign protein, lipids and carbohydrates (as in viral replication)

After Beisel (4)
### Table 3 Effect of Malnutrition on Immune response

<table>
<thead>
<tr>
<th>Dimensioned Immune Response</th>
<th>Reduced antibody synthesis</th>
<th>Impaired cellular immunity</th>
<th>Impaired amplification phenomena</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alteration of Natural Barriers</td>
<td>Alteration or Reduction of non-Specific Factors</td>
<td>Alteration of Endocrine Balance</td>
<td>Changes in Composition of Indigenous Flora</td>
</tr>
</tbody>
</table>

### Table 4 Interventions that will improve Nutrition and Health

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water supply and excreta control</td>
<td>Prevention of diarrhea and parasitism</td>
</tr>
<tr>
<td>Immunoprophylaxis</td>
<td>Prevention of anorexia and nutrient wastage and nutrient loss due to infectious disease</td>
</tr>
<tr>
<td>Maternal education</td>
<td>Reduction of maternal and child infection, improved child feeding, feeding in convalescence and oral rehydration</td>
</tr>
<tr>
<td>Family planning</td>
<td>Delayed conception, increased child-spacing and improved maternal and fetal nutrition</td>
</tr>
<tr>
<td>Agricultural measures</td>
<td>Increased food supply</td>
</tr>
<tr>
<td>Social legislation</td>
<td>Better distribution of resources and benefits</td>
</tr>
</tbody>
</table>
Table 5. Prevention of Maternal and Child Malnutrition in Countries in Transition

A. Promotion of optimal reproduction
   Promotion of optimal age for conception
   Increase in birth interval
   Prevention of unwanted pregnancies

B. Antenatal care
   Promotion of maternal nutrition and hygiene
   Prevention and treatment of infectious disease in the mother
   Identification of "high risk" factors
   Perinatal care

C. Care child and adolescent
   Promotion of nutrition and hygiene
   Prevention and treatment of infectious disease
   Education in health and reproduction attitudes
   Promotion of mental health and well-being

Table 6. Synergistic Effect on Child Mortality. of Feeding, Immunizations and Health Care*  

<table>
<thead>
<tr>
<th>Age, years</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None (1)</td>
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<tr>
<td></td>
<td>107</td>
</tr>
<tr>
<td>&lt;1</td>
<td>23</td>
</tr>
<tr>
<td>1 - 4</td>
<td></td>
</tr>
</tbody>
</table>

* Mortality rates per 1000
Data from Taylor & Singh (10)
Table 7. Effect of Oral Rehydration on Weight Gain

<table>
<thead>
<tr>
<th>Age in months</th>
<th>Philippines</th>
<th>Turkey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR***</td>
<td>C***</td>
</tr>
<tr>
<td>0 – 5</td>
<td>419</td>
<td>288</td>
</tr>
<tr>
<td>6 – 11</td>
<td>219</td>
<td>159</td>
</tr>
<tr>
<td>12 – 23</td>
<td>243</td>
<td>189</td>
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<td>24 – 35</td>
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<td>191</td>
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<tr>
<td>36 – 47</td>
<td>234</td>
<td>97</td>
</tr>
<tr>
<td>48 – 59</td>
<td>247</td>
<td>148</td>
</tr>
</tbody>
</table>

* 7 – month study  
** 16-month study  
*** OR = rehydration group; C = group not receiving oral rehydration  
Studies conducted by Philippino and Turkish workers, coordinated by WHO staff and consultants. Original data furnished by Dr. D. Barua, WHO, Geneva.

Table 8. Health Services Research in Developing Nations

- Definition of problems  
- Establishment of priorities  
- Identification of measures that need to be applied  
- Search for the “appropriate technology”:
  - mothering  
  - food production  
  - food supply  
  - primary health services  
  - housing  
  - education  
  - leisure  
  - other aspects of culture
References:


