Food production and nutrition
Human nutrition

The economics of malnutrition, final report, v.2

(100) Cesario, F.J.; Simon, S.R.; Kinne, I.L. (101) Battelle Memorial Inst., Columbus, Ohio

1970

Battelle

Malnutrition
Reviews
Economic analysis

PN-AAD-759

CSD-2840 GTS

14. CONTRACT NUMBER

Economic analysis

12. DESCRIPTORS

13. PROJECT NUMBER

15. TYPE OF DOCUMENT

11. PRICE OF DOCUMENT

10. CONTROL NUMBER

9. ABSTRACT

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)

7. REFERENCE ORGANIZATION NAME AND ADDRESS

6. ARC NUMBER

5. NUMBER OF PAGES

4. DOCUMENT DATE

3. AUTHOR(S)

2. TITLE AND SUBTITLE

1. SUBJECT CLASSIFICATION
THE COLUMBUS LABORATORIES of Battelle Memorial Institute comprise the original research center of an international organization devoted to research.

The Institute is frequently described as a “bridge” between science and industry — a role it has performed in more than 90 countries. As an independent research institute, it conducts research encompassing virtually all facets of science and its application. It also undertakes programs in fundamental research and education.

Battelle-Columbus — with its staff of 3,000 — serves industry and government through contract research. It pursues:

- research embracing the physical and life sciences, engineering, and selected social sciences
- design and development of materials, products, processes, and systems
- information analysis, socioeconomic and technical economic studies, and management planning research.

505 KING AVENUE • COLUMBUS, OHIO 43201
FINAL REPORT

on

THE ECONOMICS OF MALNUTRITION
VOLUME II

to

U.S. DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT

December 31, 1970

by

Frank J. Cesario, Sheldon R. Simon, and Ivan L. Kinne

BATTELLE MEMORIAL INSTITUTE
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

Battelle is not engaged in research for advertising, sales promotion, or publicity purposes, and this report may not be reproduced in full or in part for such purposes.
VOLUME II

INTRODUCTION

An important part of the project on the Economics of Malnutrition was devoted to searching the literature. The thrust of this search was twofold: (1) to discover other work that was being carried out on the economics of malnutrition and related subjects such as the economics of education, health, and welfare, and (2) to isolate those factors upon which nutritional influence is particularly significant or which act together with nutrition to influence economic development.

The important literature that deals with the first part of the search, the economics of malnutrition and related subjects, is covered in Volume I. The rest of the material is contained here in Volume II. The material in this volume is divided into two parts. The first part (Part A) contains the bibliography, with each item coded according to content, while the second part (Part B) contains the articles that were annotated during the course of the investigation.

The material in Part A is coded with numbers one to nine. Each of these numbers indicates one category of information covered by the article as follows:

1 - morbidity
2 - mortality
3 - physical development
4 - physical growth
5 - mental development
6 - mental growth
7 - behavioral development and growth
8 - economic, environmental, and cultural factors
9 - general nutrition.

These numbers appear after the first line of each bibliographical entry and are placed in one of nine columns to the right of the entry. Some entries may refer to more than one category and therefore have more than one number after them.

In addition, asterisks are placed before some entries to identify them in other ways. One asterisk before an entry indicates that the entry has been annotated in Part B, while two asterisks designates that entry as one of the presentations at an international conference on Malnutrition, Learning and Behavior held at the Massachusetts Institute of Technology from March 1 to 3, 1967, and subsequently published in 1968 by the MIT press as *Malnutrition, Learning and Behavior*, edited by Nevin S. Scrimshaw and John E. Gordon.

The annotated entries are of varying length depending on their accessibility in the literature and their pertinence with respect to the material covered in Volume I of this report. Although certain of the more classic studies have not been annotated, they are referred to in other of the studies mentioned here.

Time and money constraints prevented annotating more of the bibliographic entries, and although the choice of those included was indeed subjective, it is hoped that they illustrate some of the problems that concern the role that nutrition plays in economic development.
PART A

BIBLIOGRAPHY


Adams, Richard N., "Cultural Aspects of Infant Malnutrition and Mental Development".


Ahuja, S. P., "Some Economic Aspects of Malnutrition in India", paper presented at the meeting of the Association of Food Technologists, Eastern Regional Branch, Calcutta, India (February 1969).

Allen, Gordon, "Genetic Variation in Mental Development".


Altman, Joseph, "Effects of Early Experience on Brain Morphology".


Andriasov, A. N., and Makarychev, A. I., "The Importance of Protein Contained in Food for the Functional Condition of the Highest Sections of the Nervous System", (Review of literature) Voprosy Pitaniia, Moscow, 16, 8 (1957).


**Behar, Moises, "Prevalence of Malnutrition Among Preschool Children of Developing Countries", Malnutrition, Learning and Behavior.


**Birch, Herbert G., "Field Measurement in Nutrition, Learning, and Behavior".


**Canosa, Cipriano A., "Ecological Approach to the Problems of Malnutrition, Learning, and Behavior.


**Collier, G. H., and Squibb, R. L., "Malnutrition and the Learning Capacity of the Chicken".


**Collis, W.R.F., and Janes, Margaret, "Multifactorial Causation of Malnutrition and Retarded Growth and Development".


**Coursin, D. B., "Vitamin Deficiencies and Developing Mental Capacity".

**Cowley, J. J., "Time, Place, and Nutrition: Some Observations from Animal Studies".


**Cravioto, J., and DeliCardie, E. R., "Intersensory Development of School-Age Children".


**Dobbing, John, "Effects of Experimental Undernutrition on Development of the Nervous System".


Eichenwald, H. F., "Prenatal and Postnatal Infectious Diseases Affecting the Central Nervous System".


Frankova, S., "Influence of a Changed Dietary Pattern on the Behaviour of Rats with a Different Excitability of the Central Nervous System", Ceskoslovenska Psychologie, 10, 13 (1966).

*Frankova, S., "Nutritional and Psychological Factors in the Development of Spontaneous Behavior in the Rat".


**Guzman, Miguel A., "Impaired Physical Growth and Maturation in Malnourished Populations".**


**Hein, Alan, "Labile Sensorimotor Coordination".**

Heron, A., "The Economical Use of Scarce Higher-Level Manpower", Lusaka, Institute for Social Research, University of Zambia (1966).


**Jelliffe, D. B., and Jelliffe, E.F.P., "Field Assessment of Dietary Intake and Nutritional Status".


**Kerr, George R., and Waisman, Harry A., "A Primate Model for the Quantitative Study of Malnutrition".**


**Levine, S., "Endocrines and the Central Nervous System: Hormones in Infancy and Adult Behavior".


*Lowenstein, F., "Nutrition and Working Efficiency (With Special Reference to the Tropics)", unpublished paper.


**Monckeberg, F., "Effect of Early Marasmic Malnutrition on Subsequent Physical and Psychological Development".


Nicholson, J., Shifts in Food Consumption Patterns by Income Groups for Selected Food Items and Nutrients", AID/India Staff Research Memorandum and Accompanying Graphs (May 1969).


Nutrition Reviews, "Iron Deficiency and Growth", 24 (11) (November 1966) 34


Pollack, Herbert, "Disease as a Factor in the World Food Problem", *Institute for Defense Analysis*.


President Nixon's message to Congress, "Hunger in America", (May 1969).

President's Scientific Advisory Committee report, "The World Food Problem" (May 1967).


**Rafalski, Henryk, and Mackiewicz, Maciej, "An Epidemiological Study of Physical Growth of Children in Rural Districts of Poland".


**Richardson, Stephanie A., "The Influence of Social-Environmental and Nutritional Factors on Mental Ability".


**Robinow, Meinhard, "Field Measurement of Growth and Development".


Scrimshaw, N. S., "Nutrition and Mental Development", a speech presented at the Twenty-Fifth Anniversary Commemoration of the Nutrition Foundation, Inc. on November 17, 1966.


**Stewart, R.J.C. and Platt, B.S., "Nervous System Damage in Experimental Protein-Calorie Deficiency".**


**Stoch, M. B., and Smythe, P. M., "Undernutrition During Infancy, and Subsequent Brain Growth and Intellectual Development".**

**Strodtbeck, Fred L., "The Latent Intellective Factor in the Food Cycle".**


Stuart, H. C., and Meredith, H. V., "Use of Body Measurements in a School Health Program. Part II. Methods to be Followed in Taking and Interpreting Measurements and Norms to be Used", Amer. J. Public Health, 36, 1373 (1946).


*Third Far East Symposium on Nutrition, Manila, Philippines (February 14-21, 1967).

**Thomson, Angus M., "Historical Perspectives of Nutrition, Reproduction and Growth".


**Thorpe, William H., "The Evolutionary Stages of Learning Capacity".


United Nations, FAO, "Malnutrition and Disease", Freedom from Hunger Campaign--Basic Study #12.


U.S. House Committee on Agriculture, "Hunger Study Supplement" (June 1968).


U.S. Senate Select Committee, "Nutrition and Human Needs" (December 1968).


**Vernon, P. E., "Measurements of Learning".


Physical work tests making use of bicycle ergometry and dynamometry were performed on six groups of children and adults in Addis Ababa. It was not possible to demonstrate any definite correlation between the results of the physical work tests and the nutritional status of the subjects or the quality of the diet as measured by a 24-hour recall. In spite of often very inadequate diets, the achievements were on the whole reasonably good. The implications of these findings with respect to the definition of various types of "requirements" warrant further discussion.


Government policy makers labor under a universal malady: there is too much to be done with too few resources. The relationship of malnutrition to economic development, therefore, needs to be known. How much more productive is the properly nourished man? How much more will a man with full mental and physical capacities contribute to his society? Conversely, what are the costs to society of malnutrition in the form of medical treatment, welfare-type relief, and waste through death of those who have a limited number of productive years? What are the implications of better nutrition to family planning?

Nutrition has grown beyond its public health parenthood. It now also involves economics, agriculture, industry, education, family planning, labor, management, and marketing. To work effectively requires a different kind of experience or training, or both. This is not to suggest that the nutritionist or food scientist would not in some cases fill this role. Only that, if so, he should be able to devote full time to it and he should be appropriately equipped for it. There should be a conscious decision to prepare people for this kind of position.


Malnutrition often results from people's making poor use of the foods that are available, through ignorance or adherence to blind custom.
Education in proper diet can help to overcome this. Efficient food marketing system is important. Changes in demand may require changes in the "mix" of products commercially produced and distributed... requires not just increase in production or imports but an increase in the kinds and quantities of foods produced for commercial sale, plus expansion of marketing channels. Failure to increase commercial supplies of food leads to increases in food prices -- malnourishment for economically vulnerable groups, labor unrest, and political upsets.

Appraising food and nutrition situation: (1) estimate consumption of food, (2) convert this into intake of major nutrients, (3) compare results with standards...usually very difficult in LDC's. Can attempt to evaluate nutritional status directly: (1) analyze statistics of health and mortality, (2) have teams make detailed studies of nutritional status of sample groups, (3) correlate data with differences in food consumption among different populations...in both methods must know food consumption. Can use two methods: (1) compute averages from national aggregate data on supplies and utilization of commodities...using food balance sheets, and (2) making cross section surveys of actual food consumption of sample families.

In addition efforts must be made to increase agricultural production and improve distribution, the battle against hunger and malnutrition must take account of food habits and must include efforts to get people to want better diets and to help them improve their consumption practices. Research in these areas requires cooperation among specialists in the social sciences, education, and the medical sciences.

Call, David L., "Research Findings on the Social Consequences of Malnutrition", Cornell Agricultural Economics Staff Paper, No. 8 pp 1-20 (August, 1969)

Malnutrition and hunger in the United States is probably having its major impact on the school performance of children. The problem appears to be more closely connected to motivation and mental attitude than pure physical condition. It does not appear that this is due to any permanent reduction in mental capacity due to serious protein-calorie malnutrition (a minor problem in the U.S.). Hunger appears to be more important than malnutrition. Improved school performance would seem to be one of the major benefits to be expected from a comprehensive intervention program. For preschool children from poverty areas malnutrition is probably contributing to a higher morbidity rate.

There is little doubt that poor nutrition before and during pregnancy is one of many factors affecting birth weights. Short of actual starvation of pregnant women the relationship is complex and difficult to pinpoint. The risks associated with low birth weights of greatly increased mortality and a probability of mental damage indicate that preventive programs are needed. The relationship between the higher incidence of low birth weights in poverty areas implies deficiencies in nutrition, education, and medical care and facilities.
It is clear that past research does not provide many guidelines that would be useful in attempting to assess the social benefits in terms of physical productivity of improved nutrition of poverty or other groups.

Research is needed to examine the relationship between nutritional status of poverty groups and work performance. Work performance in terms of physical productivity is extremely difficult to measure and past attempts have limited applicability. The indirect effects of nutrition on job turnover, absenteeism, performance in training programs and job advancement may be more susceptible to isolation.


Social scientists have long used a questionnaire method to gather social and economic data. To test the usefulness of such a method in obtaining information on food habits, the replies to questionnaires used in sociological survey in an industrializing rural area in Mexico were analyzed. The findings support the hypothesis that, in the process of industrialization or urbanization, food habits or food patterns change progressively, becoming increasingly more complex and varied, and that such changes are related to other similar changes (e.g., simple to complex) in the social and economic milieu.

Where it is not essential to have quantitative information on food consumption, the questionnaire method would seem to have two special advantages over the traditional type of food consumption survey: it does not require highly trained interviewers and a much larger sample can be covered. The method permits a study of the changes in food habits which take place under the impact of such major forces of change as industrialization and urbanization. Such information is important for the nutrition educator, food planner, and others concerned with nutritional levels of populations.


The disturbing indications revealed by studies in Africa, Asia, and Latin America are that permanent damage to mental capacity may result from malnutrition during early life even though the individual may later appear to be physically normal. A vast misallocation of resources may be taking place in the developing areas of the world where malnutrition is a widespread phenomenon.

Dr. Joaquin Cravioto found that Guatemalan children who had experienced nutritional deprivation at an early age showed significantly retarded performance on tests designed to measure development of
intersensory organization among three sense systems -- touch, vision, and kinesthesia. His findings suggest, that an individual whose intersensory organization is retarded may require a longer training period in order to acquire job skills, may be less adept at manipulating industrial equipment, and may be more accident prone.

Many illnesses experienced by the world's poverty-stricken populations are a direct result of malnutrition or become considerably more frequent and severe because malnutrition has lowered resistance to infections.

In addition to the possible consequences for educational, industrial, and health programs, the effects of infant malnutrition hold more general implications for a society's vitality.

For the total population, infant nutrition is only one of a system of variables bearing upon the capacity for productive activities. The synergistic effect of malnutrition, infection, parasites, and inadequate adult-child interaction in hindering the mental development of children has been reported in detail.


Nutrition of pregnant and lactating women is seriously defective in most countries of Latin and South America, results in poor physical health among mothers, and in poor growth and development and high mortality rates among infants. Need better diets and education (resources, customs, and beliefs).


The minimal daily calorie allowances prepared by the National Research Council (NRC) and the Food and Agriculture Organization of the United Nations (FAO) have been devised to provide energy in sufficient quantities so when consumed over extended periods of time they will maintain body weight or rates of growth at levels that are helpful in promoting the well-being and health of man. Daily requirements and allowances are dependent on many variables including sex, age, environmental temperature, physical activity, relative humidity, body composition, radiation, and probably altitude. The calorie allowances are increased with an increase in body weight and are decreased with an increase in age.

The new NRC allowances in hot environments now suggest that the energy requirements are increased in man performing prescribed work and living at high environmental temperatures.
Allowances in the cold, assuming an adequately clothed individual, are not increased except to compensate for the two to five percent increase in energy expenditure due to carrying or wearing cold weather clothing.

Physical performance is dependent on many factors including good physical condition, technical skill and muscular strength to overcome a given load, motivation to perform to the best of one's ability, limitation of all the inhibiting psychological factors and above all, optimal nutrition.

Calorie restriction for short periods of time, with a subsequent decrease in body weight, in some instance, has been shown to improve performance.


Some estimates of the influence of nutritional conditions on working capacity, productivity, and economic growth are presented. Only direct observation (or experimental data) permits us to discover the relationship between nutrition and working capacity. In India and El Salvador the working capacity of the labor force is only 50 percent of the normal level. A comparison of the results for developed and underdeveloped countries shows that it is reasonable to assume that better nutrition is a determinant of higher productivity.

Production and its increments are the results of the interaction of several inputs, one of which is labor. If not all the inputs are available, then the productivity of all the others will be low. Results show that the influence of nutritional conditions on economic development is extremely important.


There is a great lack of knowledge regarding the importance of proper nutrition to specific aspects of growth and development. There are still the questions of whether it is reversible or permanent and of whether or not it alters the affected child's functional capacity. Studies are needed not only to answer such questions about nutritional effects but also to answer questions about the physical, biological, and sociocultural factors that also influence growth and development and are intimately related to nutrition.

For many years there has been controversy among biomedical scientists regarding the effects of a woman's nutritional status on the product of conception. Until the Second World War, it was generally believed the fetus was a parasite that could obtain all it needed from even a nutritionally deficient mother. Further information on the effects of maternal
nutrition on fetal development is needed to determine whether a small difference in birth weight makes a difference in the child's prenatal and postnatal development and functioning. Studies in this area are especially important since maternal malnutrition is known to be associated with increased rates of morbidity during pregnancy and of premature delivery. However, a cause-and-effect relationship between maternal malnutrition and either morbidity or prematurity has not been established.

In studies of maternal malnutrition, it is important to distinguish between an acute, sudden onset of malnutrition of a specific duration in a population -- as in a war -- and the type of chronic malnutrition that exists in developing countries. This means that where malnutrition occurs in critical periods of development, such as adolescence, future generations may be affected.

Many studies in developing countries also suggest that growth progresses satisfactorily during the first 4 to 6 months of life while the child is breast feeding and the mother's milk supply is adequate. In cases where the mother's milk is not supplemented with other foods, after 6 months the growth patterns of breast-fed children begin to diverge from the North American standards. If the supply of maternal milk is insufficient or if the mother is unable to nurse, the life of the infant is greatly jeopardized, for inadequate substitution of other food may result in serious protein malnutrition and poor hygienic conditions may result in fatal infection from contaminated, prepared formulas.

A graph shows that both weight and height for age in Guatemala fall below the Iowa standards throughout all ages, but the deficit is very small in the first few months of life. This graph brings out the marked importance of the second year of life in demonstrating growth deficits. This is the age when the classic picture of severe protein malnutrition (Kwashiorkor) frequently becomes evident.

In humans the greatest growth spurt for the brain occurs during the fetal period. By the end of the first year of life, the brain has assumed approximately 70 percent of its adult weight, and by the end of the second year its growth is almost complete. Studies of the human brain have shown a very rapid increase in DNA content toward the end of the period of gestation; the increase slows down after birth but continues until the child is 5 or 6 months of age.

The most obvious solution to the problem of malnutrition would seem to be to provide food. But this is a markedly oversimplified solution for such a complex problem. Any attack on the malnutrition problem must also include an attack on related sociocultural problems, especially the problem of psychosocial deprivation in early life.


For assessing nutritional status there is no substitute for family dietary surveys, especially when a new area is being investigated. The
minimum number of days for such a study must be a week, the normally universal period during which the cycle of the family's customary life is repeated. The most advisable method is a combination of recalling previous meals and weighing the food that is to be consumed by the family or the individual.

To assure a successful interview, the field worker should be well trained and should possess a high degree of sensibility in order to understand the person with whom she is to work. Shorter periods for dietary surveys may be used when enough information is secured from seven-day dietary studies to permit estimation of the standard deviation of the intakes.

Fresancho, Garn, and Ascoli, "Unequal Influence of Low Dietary Intakes in Skeletal Maturation During Childhood and Adolescence", in the American Journal of Clinical Nutrition, Vol. 23, No. 9 (September, 1970)

Retardation in skeletal maturation in childhood is greater than during adolescence. Postulated graded childhood retardation and lesser delay in skeletal maturation during adolescence are factors that are responsible for the small stature of Central American populations. Both sexes are equally delayed.


Since their inception, the Laboratories have felt it to be their role, first to discover the true nature of our serious nutritional problems, and then to find a means of dealing with them. Our first concern, therefore, has been the prevalent and destructive deficiency diseases associated with malnutrition.

This is probably the most important and widespread nutritional problem in India today. Research in these Laboratories has shown that locally available, relatively inexpensive vegetable foods -- can be used successfully in combating protein malnutrition, instead of the rarer and more expensive foods, meat and milk.

While there are still comparatively few studies on the specific nutrient needs of Indians, over the past few decades we have attempted to establish requirements for calories, protein, the B vitamins, vitamin C, iron, and calcium in different physiological groups. The results have been used in formulating the latest recommendations of dietary allowances for Indian subjects.

Extensive investigations on nutritional problems of pregnancy and lactation have been carried out in the past several years. Attempts have been made, not only to identify problems and to assess their magnitude, but to find the most practical approaches to their prevention and control.
Physical environment, biologic surroundings, economic circumstances, social habits, cultural taboos and customs, along with the genetic constitution and phenotypic development of the human host, all have a part in the genesis of nutritional and infectious disorders. When these two conditions exist in the same individual, they commonly interact in synergistic fashion. Malnutrition worsens infectious disease in clinical course and increases the likelihood of fatality; infection enhances nutritional disease. The organic disorder exaggerates the social situation. The problems of the developing countries are deeply affected by this cyclic maladjustment.

The plight of children in preindustrial areas, however, is the result of the everyday infections of the intestinal and respiratory tracts and of the five communicable diseases specific to early life everywhere: measles, whooping cough, rubella, mumps, chickenpox.

Many nutritional surveys in less developed countries demonstrate a general departure from optimal nutritional state in two-thirds of the child population and sometimes more. Discrepancies in height and weight for age range from 10 percent to values occasionally exceeding 40 percent. Diet is the direct source of the difficulty, yet it fails by far to explain all of the trouble.

Acute diarrheal disease in developing countries seemingly owes its importance, in clinical effect and as a cause of death, to the particular form of the disease called weanling diarrhea, a clear synergism of nutrition and infection.

Upper respiratory diseases, of the chest, multiple intestinal parasitic infections, and dermatological conditions have not been evaluated individually because in most underdeveloped areas information about their impact on persons and communities is inexact and often grossly incomplete.

Growth and development after malnutrition and disease concern primarily the population of preschool children and the extent to which their experiences will set the future nature and characteristics of their community. The question of whether or not malnutrition is also able to affect mental growth and development is past the stage of hypothesis. It clearly holds for clinical pellagra and kwashiorkor, although the extent of the damage, how persistent it is, and whether it is reversible, are questions to which the answers are still indefinite. The main and broader concern is: do lesser degrees of protein-calorie malnutrition and still other nutritional deficiencies have such a result?


A study made by Dr. Herbert Birch on a group of Mexican children hospitalized at an early age with severe malnutrition has shown that they scored lower on intelligence tests in later life than did their siblings who had not suffered from the disorders.
Dr. Birch said women who have suffered from malnutrition early in their lives have more complications and problems in child-bearing than do healthy mothers, and these complications and problems affect the health of their children.

"In this research, we are exploring hunger and malnutrition as factors which can handicap children as learners", Dr. Birch said.

"But we try to make it clear that it is not food alone or compensatory education alone which make the difference between school success and school failure for poor children", he continued. "One-shot treatments will not overcome handicaps brought on by generations of neglect. A complex and sustained attack will be required to remedy what is a complex and international problem."


India, by C. Gopalan. Preschool child centers are important and would facilitate the operation of nutrition programs. Women centers are also being created. The total health care is very important for the overall picture.

Central America, by M. Behar. Common infectious diseases are a frequent cause of death, and also an important cause of malnutrition in children living on marginal diets. Care should be used to select foods for food programs that have efficient uses. Food should be both nutritionally indicated and also fit within the dietary practices of the population, and be of the type they can acquire in the local market. Nutritional deficiencies acquire greater importance as infectious diseases are controled with dramatic advances.

Israel, P. Robinson. Considerable money is spent on health care so that there is relatively little wastage through infant and children's death and considerable savings in curative services. Pilot projects in developing countries tend to carry on without ever being implemented into full-blown projects.

East Africa, L.A. Musoko. Five percent of preschoolers suffering from severe malnutrition. Twenty-five percent were moderately undernourished. A malnutrition rehabilitation unit was established and funded by a grant from the Save-the-Children Fund in Britain.

Central Africa, D.M. Blankhart. Eighty percent of deaths of school children due to gastro-enteritis (23 percent), protein calorie malnutrition (17 percent), respiratory diseases (15 percent), measles (11 percent), smallpox (9 percent) anemia (4 percent), and tetanus (3 percent). In rural areas malaria is about 8 percent. Malnutrition, more common in rural areas, caused by imbalanced feeding. Rehabilitation centers are being established where the care of the child by improved feeding is a never-forgotten practiced life-saving lesson for the assisting mother.

West Africa, R.G. Hendrickse. After neonatal period morbidity and mortality occur principally as a result of infective disorders interacting
with malnutrition. Many non-specific infections, gastro-enteritis, and a variety of respiratory infections, measles, malaria, and tuberculosis, tetanus, whooping cough, and meningitis are also significant contributors.


The combination of poor nutrition and various social and economic dysfunctions tends to lead to the perpetuation of a disadvantaged group in the society.

The known or postulated consequences of malnutrition during the development of the human individual include (1) Delayed Physical Maturation and Smaller Physical Size: The malnourished child grows at a slower rate than the well-nourished child, while high intake of nutritionally well balanced foods results in increased physical size. Other factors, such as climatic conditions and ritualized physical stress during infancy are also important. (2) Increased Susceptibility to Infectious Disease: The interaction between malnutrition and infectious disease is complicated by parasitic infestation. Prolonged or frequent diarrhea in infancy has a particularly telling effect on early child development and nutritional status. Modern medical practice, better sanitary conditions, programs of immunization, and perhaps, better developed natural immunities apparently greatly reduce the effects of certain common diseases of childhood on children in the developed countries. (3) Increased Mortality: The relationship between malnutrition and mortality, particularly between the ages of one and four, has been clearly demonstrated in the developing countries. The relationship between malnutrition and infant and preschool mortality has not been well studied in the developed countries. (4) Retarded Brain Development: Severe malnutrition at an early age interferes with normal development of the brain. When malnutrition occurs after the end of the period of cell division, animal experiments suggest the cells may be smaller than normal, but the change may not necessarily be irreversible. Evidence has been provided to indicate that marasmus and kwashiorkor produce deficits in intellectual ability. However, these results must be interpreted with caution. Most of these studies have been of children who have been hospitalized for an extended period. The effects of hospitalization stem both from separation from parents and from the lack of stimulation in the hospital. When the child is malnourished, lack of proper stimulation will be complicated by general lethargy and an inattention to stimulation, thus further confusing the interaction between the nutritional disease and its sequelae. In addition, all of these studies have been retrospective rather than prospective. Thus, the possibility exists that a preexisting mental incapacity leads to a relative lack of success in competition for food within the family, and therefore,
may make the child more vulnerable to malnutrition. Under such conditions, mental retardation would be a cause of, rather than a consequence of, malnutrition. The evidence that severe malnutrition is associated with reduced intellectual capacity is reasonably clear, but the evidence for an association of mild or chronic malnutrition and intellectual incapacity is not. Questions can be raised about each of the major human studies supporting the concept that normal malnutrition leads to intellectual deficit. Stock and Sythe's report made clear that the malnourished children were marasmic. In addition, the malnourished children came from families replete with social pathology. The data of Cravioto and his associates can be interpreted as indicating a lag in the development of intersensory integration rather than as a permanent disability. On the other hand, Ramos-Galvan and associates suggest that rural residence and/or lower class status may be more important predictors of intellectual incompetence than nutritional status. By age 10, there were no differences in the scores of the well and poorly nourished lower class urban children. Monckeberg studied urban children in Chile; in the lower class a relationship was observed between growth retardation, low intellectual capacity, and low intake of animal protein. It seems possible that if a given threshold of nutrition is reached, particularly during the early developmental years, nutrition does not have an independent effect on intellectual capacity. Certainly, on the basis of the evidence reviewed above, any relationship is a highly complicated one. (5) Apathy: Malnutrition is associated with apathy, listlessness, and unresponsiveness to external and internal stimuli. Malnutrition is most apt to be found in those segments of the society which have other characteristics which independently interfere with optimal development. Apathy and uninvolvement may stem independently from two forces. Increasing nutritional intake will not reduce apathy if the apathy stems from both sources. But changes in social conditions will not reduce apathy if it stems from malnutrition.

In the developing countries, prevailing levels of nutrition may interfere with successful attempts to institute population control programs. The high infant and preschool death rate associated with malnutrition, parasitic load, and infectious disease may independently interfere with the willingness of individuals to limit family size. Failure to limit family size in turn contributed to malnutrition. Malnutrition may, in some instances, contribute to the lack of industrialization by a nation. While adequate nutrition will not insure the development of a nation, or even the successful implementation of a population control program, it may be a necessary precondition. Stimulation may affect the size of the brain. If the child is passive and unresponsive, a lack of interaction with the mother may interfere with adequate language development, as well as with other developmental tasks. Rosenzweig and associates have demonstrated in rats that small, but statistically significant, differences in the size of the cerebral cortex result from variations in the stimulatory aspects of the environment. No information has been provided as to whether the changes are caused by differences in cell size or cell number.
Malnutrition is not the only deterrent to a good mother-child relationship. Improved nutrition would not necessarily improve the mother-child relationship. But an adequate start for the child is not possible without adequate nutrition. Pollitt points out that in areas where malnutrition is endemic, the lack of responsiveness of the child is expected and normal.

The child who lags in the performance of his developmental tasks will be ill prepared for the learning tasks required of him when he enters school. This may be the greatest impact that nutrition has on intellectual performance -- not an effect on "innate ability" or "general intelligence" but in the utilization of the ability that the child does have.

Keyter, Carl, "Feeding Customs and Food Habits of Urban Africans", S.A. Institute of Race Relations, No. 11, pp 1-2

Of 1,037 workers questioned in Pretoria and Germiston, 1,034 stated that they would find extra money more acceptable than food.

Of 692 workers questioned in Pretoria, 39 percent (270) said they would neither support a canteen with reasonable prices, nor one providing free food; 13 percent (90) said they would support a canteen with reasonable prices, but would not accept free food; and 48 percent (332) said they would be willing to accept both.

Lower-paid non-compound workers tended to reduce on their home meals, when they were fed at work.

Higher-paid compound workers bought fruit and milk more frequently than did lower-paid compound workers.

One firm reported a 40 percent rise in production within four months after introducing a feeding scheme, and another firm reported a 53 percent decrease in absenteeism over a three-month period.


The goal of nutrition in the development process is basically threefold. (1) It may increase productivity in the agricultural and industrial sectors when labor itself is the limiting factor. Preschool age malnutrition and its effect on mental development probably have a more pronounced effect than caloric deficiency among adults. (2) Nutrition may also increase the motivation of reproductive age parents to accept birth control measures by decreasing infant mortality and increasing the likelihood that existing sons will survive. (3) It improves health directly, a basic subgoal of development.

A national nutrition policy based on such a role could proceed along three paths: (1) nutrition intervention programs, (2) increases in income, and (3) infection and parasite control. There is clearly a synergistic relationship among the three.
Nutrition intervention programs include a wide range of alternative strategies which must be compared by various criteria. These criteria might be grouped into the following categories (1) relative nutritional effectiveness, (2) costs and distribution, (3) consumer acceptability, (4) a series of general requisites (e.g., foreign exchange, speed of implementation, and political acceptability), and (5) economic multipliers or the benefits of intervention programs back to other development sectors.

Lowenstein, F., "Nutrition and Working Efficiency (with special reference to the Tropics)", unpublished paper

In order to be able to calculate approximate requirements for groups of people, whole communities or even countries, standard values for a so-called "reference man" and "reference woman" have been compiled by FAO in the report of the Second Committee on Calorie Requirements (FAO 1957) (4). "Reference man" and "reference woman" are defined as adults aged 25 years, weighing 65 and 55 kg., living in a temperate climate (mean annual temperature of 10°C) and working eight hours a day in a nonsedentary occupation, which requires only occasional periods of hard physical labour. He is assumed to require 3,200 calories daily on an average for the entire year and the woman 2,300 calories in order to keep in energy balance, that is, neither lose nor gain weight. From this it is possible to calculate what energy expenditures ought to be if agricultural production is to be increased.

If the energy intake, i.e., the calorie content of the diet, is sufficient to cover requirements, the protein consumed is used for the specific anabolic needs of the body; if, however, the calorie content of the diet sinks below the minimum requirement, part of the protein consumed is burnt to cover energy needs and lost for the specific needs of the body. Sufficient calorie intake is, therefore, the first requirement in order to be able to study any specific effect of protein on working efficiency of the body.

There is scanty evidence for a possible beneficial effect of single vitamins on working performance and all the work done in this field has been done in cool industrialized countries.

If work is performed in a hot environment, the ascorbic acid excretion in urine is increased and, in addition, a loss occurs in sweat which may amount to several mg in four hours. This may be important to workers in the tropics performing hard physical labour.

The time of a meal and its size are important factors in determining productivity. It seems that frequent, small meals are more advantageous than few big meals, particularly in heavy work. The authors concluded that the extra meals definitely increased productivity.

The importance of eating breakfast before starting work was shown by these same authors in observations preceding the above where those workers, omitting breakfast, but eating lunch, had lower production rates than those having three meals a day who, in turn, had lower rates than the ones eating five meals a day.
The mere provision of a rest period during mid-morning and mid-afternoon working hours, with or without food, had a beneficial effect on working efficiency.

Recommendations: To improve the health and nutrition, and thus the working efficiency of workers in the developing countries, several measures would need to be taken by the management in cooperation with the unions and the labour department in the Government:

(a) The organization of cooperative or subsidized stores where workers could buy the main foods for their families cheaply.

(b) The organization of canteens where one or more balanced meals are being served at a low enough price that the lowest paid worker can afford it.

(c) In conjunction with a canteen, an educational campaign in health- and nutrition-education should be organized with the technical assistance from the Health- and Education-authorities.

(d) Whenever possible, a medical doctor with training in occupational health should look after the health needs of the workers, including their nutrition. His responsibility extends into the field of health- and nutrition-education of the workers where he should take a leading role.

(e) In regard to the independent farmer, in order to ensure better nutrition he would need
   i. improved facilities for food storage,
   ii. improved methods of food production, and
   iii. nutrition- and health-education.


The problem of combating malnutrition requires the coordination of health, agriculture, industry, education, and community development programs not only of the United States, but of the entire world. The kinds of activities which should be strengthened or initiated as the case may be, in order to combat malnutrition may be divided into these five categories, but it must be emphasized that in order to obtain the common goal, those responsible for each area must work closely with their counterparts.

(1) Health programs should include projects aimed at the following: education for mothers, maternal and child health centers, utilization of existing health facilities, emphasis on nutrition; (2) Agricultural programs should include projects focused on the following: quality and quantity of food, diversion of land, harvesting practices, agricultural and food marketing systems, agricultural practices; (3) Industrial programs should include projects aimed at the following: expansion and modernization, enrichment of processed staples, loan and risk guarantee programs, tax rebates and tariff waivers, research; (4) Educational programs should include projects in the following areas: basic skills and professional competence, specialized training, research.
Coexistent with frequently inadequate family income the trend toward early weaning has been accelerated in the West Indies, often owing to the economic necessity for the mother to seek gainful employment but certainly reinforced by exposure to "modern" ideas and tastes, including inappropriate advertising and guidance. This very early weaning is most likely to occur in an impoverished, unstable family situation, where the lack of sanitation and improper feeding practices, especially intermittent use of overdilute food, frequently leads to recurring diarrhea and moderate or severe malnutrition. Gastroenteritis and malnutrition combined are recorded as the most important cause of death among children under 3 years of age in Jamaica (McKenzie, et al, 1967).

In the other countries of the Caribbean, recent spot checks indicate that at any given time, 20-45 percent of the pediatric beds in hospitals are filled with children with diarrhea/malnutrition.


The construction of a complete quantitative model of the world economy incorporating all production demand, institutional and behavioral relationships, is beyond the capacity of economists, agronomists, demographers, and space and systems engineers. Food production can be approximated, but knowledge of population growth determinants is scanty. Demographers have related a few behavioral hypotheses to educational income and nutritional factors, but empirical evidence is almost nonexistent. Without such a system we should look at food and population independently.

Food production and population statistics in the less developed countries are bad. Food gap does exist especially with respect to protein production of food per se cannot be separated from the overall process of economic development. There must be enough effective demand to buy the food. Low growth means problems to supply agricultural imports either domestically-produced or imported. Income distribution must be even. Increased production can lead to increases in employment. There is a need for income growth outside of agriculture to be able to afford marketable surplus. Farmers are responsive to monetary incentives. Minimum wages, fringe benefits, and union pressures force the market price of labor above its equilibrium value, while overvalue at exchange rates subsidize interest rates and various tax exemptions reduce the market price of capital below its equilibrium value. This leads to adoption of relatively capital intensive techniques that contribute to unemployment. Three major negative effects of population explosion are:
(1) Age structure applied by high fertility and low mortality leads to high dependency ratios.

(2) Aggregate output and income has to grow at a rate substantially higher than the rate of population growth if any notable improvements in per capita income and standard of living are to be realized.

(3) Accepting assumption that 3 percent increase in productive capital leads to 1 percent increase in capital output ratio of 3 to 1. A 6 percent GNP rise requires an 18 percent saving ratio without population growth, and 3 percent population growth adds an additional 9 percent to the required annual savings ratio.

The National Academy of Engineering, A Symposium on Food People Balance. This is a panel on "World Nutritional Resources", chairman, Herbert Pollack; members, Chichester, Kriesberg, Old, Rockwell, and Pearson. Washington, D.C. (April 29, 1970)

The study of individual factors in nutrition and their interdependence and interaction are all important. Rigorous analysis is difficult, but we can identify the important dimensions of the problem and areas requiring major attention. The adequacy of food resources depends upon determinance of individual and population food requirements. The total population, its age and sex distribution, must be known in order to determine nutrient requirements.

Malnutrition lowers resistance to infection and classical nutritional deficiencies may be precipitated by an episode of acute infection. Malnutrition is the end result of failure to supply the nutritional requirements in acceptable forms for the conditions under which the individual is living. Requirements must be stipulated and how they are modified by environmental conditions is important. Dietary allowances are usually based upon good health and absence of disease.

Respiratory tuberculosis increases basal requirements by about 20 percent. Malaria and dysentery increases requirements by about 20 to 40 percent; and the peak of these diseases usually occurred during the planting season. Worm burdens impose further loads on the cost of living and penalizes calorie utilization. Recommendations are: (1) The technical innovations be made in the flow of food supplies (a) designing better storage, (b) relevant processing, (c) improved preservation, (d) efficient and economical market systems; (2) Increasing efficiency of human utilization (a) ten percent is lost to the effect of disease, (b) sanitary water, (c) effective sewage disposal, (d) primary prevention of disease, (e) farm machinery and agricultural chemicals.
Disorders of nutrition are divided into seven parts: (1) Deficiencies of water soluble vitamins of the B complex include (a) Beriberi and Wernicke's encephalopathy, (b) Pellagra and ariboflavinosis, (c) other nutritional disorders of the nervous system; (2) Disorders due to deficiencies of fat soluble vitamins include (a) night blindness and Keratomalacia, (b) rickets and osteomalacia, (c) hypopsylthrom binaemia of metabolism of def. K, (d) deficiency of fatty acids; (3) Scurvy; (4) Anemia; (5) Nutritional edema; (6) Liver damage and cirrhosis; (7) Early childhood malnutrition (Kwashiorkor).


Little is known about the effects and interrelations of iron deficiency anemia. Even less is known about deficiencies of other nutrients except when they occur in their most gross state. Children and adults with diets under the recommended daily allowance (RDA) are actually functionally impaired. A definition of "health problem" is not an easy task. Serious respiratory infection is 10 times more common in children of the lowest socio-economic status than in children of highest status. What mechanisms mediate this difference? Not simply exposure to infectious agents, not medical care. Is it nutritional status, anemia, physical activity, child-rearing practices, or combinations of all of these? The dollar cost of protecting and enhancing a child's health ranges from $15 to $300 per year per child. Headstarts run about $70 per child per year on medical and dental services. There are no published studies of the actual cost of bringing needed health services to all children in a defined community. It seems likely that a total annual cost would fall somewhere between $100 and $200 per child.


Whenever nutritionists propose a program to improve the health of a population economists are likely to ask what the economic advantages are of such a program. Any estimate of the economic cost of malnutrition should include a consideration not only of those children classified as suffering from malnutrition but also of those classified under some other disease heading but whose illness was contributed to be malnutrition. The health costs to be considered are those of running the medical services and the cost to the parents. Another economic aspect in relation
to malnutrition is the effect of child-wastage as a factor influencing the attitude to family planning in developing countries.

Malnutrition may result in physical handicaps, but an estimate of the economics of this is difficult to make. There is an increasing body of research to show that severe malnutrition may have a retarding effect on mental development (Nutrition Reviews 26, 197 (1968). Perhaps the most important economic effect of malnutrition is the relationship between diet and productivity. The annual cost of in-patient care and of child-wastage combined is over one million dollars for the Commonwealth Caribbean countries.

Funds spent to improve the nutritional status of a community or a nation could be justified on humanitarian ground alone. The expense of preventive programs can also be viewed in hard economic terms and in relation to the heavy financial losses caused by malnutrition. It is necessary in addition to studying the economic cost of malnutrition, to evaluate the effectiveness of nutrition programs. Only then will it be possible to add sound economic arguments to the humanitarian pleas for a larger slice of the economic pie for nutrition programs.


There has been considerable recent interest in the relationship between malnutrition and infection (Nutrition Reviews 22, 161 (1964); 25, 108 (1967). It is an unfortunate fact for the research worker that protein-calorie malnutrition in young children seldom occurs in isolation. It is almost always associated with many other factors common to people living at a low socioeconomic level. These include, among others, a low level of education, poor housing and sanitation, crowding, a high incidence of infections, low incomes, ignorance, and often a lack of social stability. A recent study was designed to evaluate the relationship between nutritional status and infection. It is interesting that the study does not succeed in defining the relative importance of malnutrition and of infection in child morbidity but strongly concludes that there is a close association between both these factors and socioeconomic circumstances.

It is not clear whether children become malnourished mainly because they have many illnesses, including severe recurrent diarrhea, or because of their inadequate diet. Infection and malnutrition in many instances are believed to be synergistic. In order to apply preventive measures, it is important to know whether the vicious circle can best be broken by preventing and treating the infection or the malnutrition. A study in South Africa, while demonstrating this interaction of malnutrition and infection, also shows the close association between them both and poor socioeconomic circumstances. This suggests that in attempts to improve child health and nutrition a third avenue of intervention would be to improve social circumstances.
It is important that physicians and nutritionists explore the myriad factors that contribute to malnutrition, poverty, and disease. It is unlikely that any easy solution lies in attention to a single factor.

Pollack, Herbert, "Disease as a Factor in the World Food Problem", Institute for Defense Analysis.

Increasing developing countries' food supplies is not the optimum conclusion in solving nutritional problems and results from failure to discriminate between primary and secondary malnutrition and the effects of acute and chronic disease and nutritional requirements. Primary malnutrition is the result of inadequate food intake to meet normal demands. People can survive for long periods of time in this condition. Secondary malnutrition is seen when metabolic processes are increased by disease or trauma. With fever present metabolic requirements of the individual are increased. Heat production of the human body increases about 13 percent for each degree of centigrade, or 7.2 percent for each degree Fahrenheit. For example, in malaria chill episodes caloric requirements approach a rate of 5,000 kilo calories per day per individual.

As far back as 1901 it was shown that people with typhoid fever used more oxygen than a normal individual. In addition, protein metabolism is elevated in the presence of infections. At body temperatures over 39 degrees centigrade, caloric requirements have been known to increase 50 to 70 percent. The burden of parasitism exhibits such a synergistic cost that should not be overlooked in calculating the magnitude and consistency of the added need. Infection intensifies poor nutrition.

Overcrowded housing, lack of sewage disposal, inadequate potable water, poor personal hygiene, and exposure of children to contamination facilitate the rapid transmission of disease and, consequently, statistics on malnutrition should not be attributed just to food deficiency. Protein calorie malnutrition is most realistically regarded as a result of ecological imbalance rather than dietary disorder.


No program related to the nutritional problems of a country can be separated from the total health problem of that country. This includes social and economic factors as well as the attitudes of the population groups to whom these nutrition programs are to be applied. To date, there has been no real effort to develop a technique for measuring the impact of a nutrition program on changes in health, social, and economic factors.

The clinical manifestations of nutritional diseases are essentially the same all over the world. However, the social manifestations are determined in a large part by environmental factors which differ from place to place and with time. Thus, it is necessary that each society
have at any given point in time its own tailor-made system of nutritional improvement associated with general public health improvements suited to its own resources, needs and particular demands.

Malnutrition and its secondary infections constitute the two most important causes of disease and death in developing countries. The most urgent problems to be solved before malnutrition can be diminished in these developing countries cannot be solved by scientific medicine alone, but require in addition attention to the sociologic factors. The objective would be to improve nutrition to the extent that disease and its subsequent disability would be prevented.

Coincidentally, environmental factors such as water pollution, sewage disposal and housing have to be improved. A short-term program would focus directly on the therapeutic aspects of supplying the immediate food needs. At the same time, the long-term program, which would cover agricultural developments, nutritional information, housing, recreational facilities, improved working conditions, water supply, sewage disposal, and insect vector control, would be promoted.

Nutrition programs must serve as a background for the future so that the people can take care of themselves; and any large-scale program should include training in both nutrition and agriculture. The problem of nutritional inadequacies and the corrective measures designed to relieve the situation must be considered from the total point of view. Nutrition must compete with all the other aspects of the economy of the country in the allocation of scarce resources.

Pollitt, Ernesto, and Riscuiti, Henry, "Biological and Social Correlates of Stature Among Children in the Slums of Lima, Peru", American Journal of Orthopsychiatry (October, 1969)

Short children are likely to have shorter mothers who had more pregnancies, less years of schooling, and a greater number of marriages. The results suggest that although difference in stature reflects difference in nutritional background, they are likely to reflect other important biologic factors. It would be virtually impossible to specify whether behavioral or intellectual differences between tall and short children are a function of nutritional factors or some other factor associated with stature. In studies of undernutrition and psychological development it would be very unwise to use differences in stature as a principle index of previous nutritional history. Studies should be designed to permit an assessment of interactions between known variables and nutritional status, dietary intake, parent-child relationship, amount and kind of stimulation for learning, as these all affect psychological development.
The causes of the diseases of man can be understood only in terms of his relationship to his environment. The agent of nutritional disease is the relative lack of an essential nutrient, but the etiology of the disease includes host factors which determine whether or not a given nutrient intake will be adequate, and environmental factors which affect both agent and host.

The environment includes biological and social as well as physical factors. All three influence the availability of nutrients, the requirements of the host for specific nutrients, and the consumption of nutrients. Determining the cause of a nutritional disease is a study in human ecology -- of the interaction of host, agent, and environment.


Median values for height and weight of culturally deprived children are below standard populations and closer to malnourished groups from underdeveloped countries. Significant correlations were found between height and weight, height and age, weight and age, height and head circumference, weight and head circumferences, and age and mental maturity.

The study of relationships between physical characteristics demonstrates that one measurement alone is not a sufficient index of general health. Multiple measurements including height, hematocrit, skin fold, and head circumference enlarge upon the meaning of a basic measurement such as weight. The existence of correlations between some of these measurements and the absence of correlation between others suggests an opportunity to give appropriate weights to the former to construct a combined index of general health.

Third Far East Symposium on Nutrition, Manila, Philippines (February 14-21, 1967)

Sufficient experimental findings on enforced semi-starvation show that chronic undernutrition reduces the duration and degree of physical activity. In developing countries, the duration and degree of undernutrition may limit the productivity of population groups concerned. It would appear impossible to affect maximal improvement of the country's economy or the productivity of individuals without first doing the utmost to improve the state of nutrition.
The state of nutrition depends on the kinds and amounts of food available for consumption and the factors determining the distribution and consumption of available supplies. Because of unequal calorie intakes among different geographical areas, socio-economic groups, seasons of the year, and other factors it is better that calorie supplies exceed average requirements. Inequalities among regions are more marked for proteins than for calories. Eighty percent of protein intake in developing countries is of plant origin. Twenty percent of the population in developing countries subsist on diets less than adequate for full calorie and protein requirement. Differences in food consumption between income levels and urban and rural areas are very common. Calorie, total protein, calcium, iron, thiamine, and niacin intakes are higher among the rural populations compared to the urban populations. On the other hand, the quality of protein in the urban areas is better. Increases in income lead to improvements in protein, calcium, iron, riboflavin, ascorbic acid intake, and decreases in caloric intake. The size of the family determines the level of food consumption. Important factors that affect trends in food consumption are: (1) Population growth, (2) Improvement in general economic performance that raises total food demand.

The population effect and income effect give projected increases of food demand of over 140 percent by 1985 over 1962, or an average of 3.9 percent per year. Because the world has not maintained this rate of growth with respect to agricultural productivity, it will have to increase even faster in the remaining years. In countries with low calorie levels demand will increase with staple foods. Large proportions of the population of these countries will continue to be undernourished, because of supply problems and inequalities in distribution. Importance is given to food and nutrition as they are influenced by social, cultural, and psychological factors. Some of these factors are: (1) Cultural values, attitudes, and beliefs, (2) Social and political organizations as these define roles for individuals, families, and groups, (3) Educational systems -- formal and informal -- and opportunities for employment upon completion, (4) Degree of monetarization of the economy, (5) Availability of relevant information regarding nutrition and health, (6) Accessibility of facilities for implementing recommendations diffused through educational information programs.

In order to improve nutrition, these factors must be identified and their influences assessed in the development of individual, family, and community food habits. Social factors are influential in the production, utilization, and consumption change. Some of these are: (1) Maintenance of status quo, (2) Cooperation only with kin or close neighbors, (3) Land tenure or inheritance systems, (4) Untimely harvesting and inadequate storage and processing, (5) Poor education of women, (6) Consumer education, (7) Social class differences, (8) Status of women and children, (9) Family size, and (10) General lack of education.
Prestige foods may be purchased with rising incomes with the resulting loss in nutrition. Conspicuous consumption lessens capacities to save and invest. Population growth, compounds inadequacies and infrastructure of rural services and facilities such as credit and marketing systems, communication networks, and rural employment opportunities. Social cultural factors should be taken into consideration when planning improvement programs not done partly because of lack of appreciation and partly due to lack of adequate data. It is now increasingly accepted that positive action to improve nutrition will accelerate the pace of development and may be vital for development. What is needed is a policy to coordinate nutrition, agricultural, health education, economics, and sociology. Such a policy would accelerate progress and food production and storage processing, marketing, imports and exports, legislation, pricing, distribution consumption, preventative and curative medicine, health education, school education, home economics, extension education, feeding programs, and special foods. Food and nutrition policy must be formulated in order for economic development to move forward.

United States Senate Select Committee on "Nutrition and Human Needs" (December, 1968)

**Dr. Gene Mayer.** Distinction between hunger and malnutrition is important. Hunger equals undernutrition or even starvation, while malnutrition refers to eating the wrong type of food. Nutritional criteria should be established for entire populations and not just for parts of population. Cravioto did studies showing there was an irreversible deterioration of intelligence as measured by special I.Q. tests in children who were poorly fed or badly fed at the beginning of their lives. Hungry children have a small attention span.

**Dr. Michael Latham.** "When we hear about one case of kwashiorkor, then we can think of it as a tip of an iceberg." Carlyle doing work in Colombia on the effects of malnutrition on brain development found it difficult to separate out the nutrition component from the other component. The lack of intellectual stimulation is very important. Poorly educated mothers and lots of infectious diseases also contribute to malnutrition.

**Dr. Herbert G. Birch.** At birth the brain of a full-term infant is 25 percent of adult weight. Subsequent weight gain derives from laying down of lipides particularly myelin and cellular growth. Animal experiments in the rat, Davison and Dobb in 1966; the pig, Dickerson, et al, 1967; McKantz, 1960; and the dog, Platt, et al, 1964, have all demonstrated a significant interference with brain growth and differentiation associated with severe dietary restriction, particularly protein during the first month of life. Relation of these data make comparisons to humans difficult. Barnes, et al, 1966, indicate some tendency for poor learning in a nutritionally-deprived animal. Animal findings suggest (1) A direct influence of malnutrition on brain growth and development, (2) Resulting in interference with learning at critical points in development. Inadequacies in
nutritional status may interfere with the learning process manifested by: (a) loss of learning time, (b) interference with learning during critical periods of development, (c) motivation and personality changes.

Darling, of Manchester, and Winnix, of Cornell, are both interested in reduction in cellular size and number as a result of malnutrition, especially those that were not repaired as a consequent of later improvements.

Charles Upton Lowe. If he had his choice he would pick the first 5.6 years of life and the last 3 months of pregnancy as being the most important influences on nutrition. He would scrap the school-lunch programs if that were the alternative.


The investment made in a child up to age 18 is $10,000 for a family with an income of $2,500. Low-income groups reach peak of earning capacity at 35 to 40 years of age. Therefore, death at 40 represents a slight net gain to society, and death at 65 a gain twice as great. A U.S. committee on the cost of medical care indicated that if 7 days per year were lost because of illness between $3 billion and $4 billion would be annual cost of temporary and permanent disability in the U.S. It has been estimated in Ecuador that economic loss due to shortened life costs the country 2 million sucre (13.5 to the dollar). Permanent disablement costs another 100 million sucre and temporary loss of productive capacity 150 million sucre.

Illness cost Sweden more than 1 billion krona per year, equal to $50 per capita per year. In Detroit a 5-year program for control of TB cost $200,000 per year and saved $1.4 million in sanitorium costs alone. In 1942, malaria in Egypt cost 135,000 deaths, and one plantation reported a cost of $600,000 which was equal to one-half of the wheat crop and one-third of the sugar crop in the country. In Pakistan one season's work on malaria control has increased the rice yield by 15 percent. Savings of wages lost through malaria would pay for all the expenses of DDT spraying, not counting savings on drugs and funerals or economic benefits due to increased agricultural production.

In the Transvaal in Natal, 30 to 40 percent more workers than necessary were recruited to leave a margin for absenteeism on account of sickness, whereas today only the necessary number is recruited. New lands in South Africa are now cultivated in the absence of malaria. In the coffee belt of Northern Rhodesia 2,030 days were lost in 1945, and 1946 the drainage work was extended still further and treatment of houses began. In 1949 only 270 lost working days were reported. Rubber output per man in Malaysia went up from 45 kilograms per worker to 770 kilograms as a result of the malaria eradication program. A small-framed man in the tropics requires 1400 heat calories per day in order to survive.
In the Ruhr Valley a classic study showed that 20 workmen were given 820 calories in excess of the 1600 to 1800 calories needed. They dumped 1.5 tons of material per day. Thirteen hundred calories of work energy resulted in their dumping 2.2 tons. With the added incentive of cigarettes they dumped 3.4 tons and they lost 3.5 kilograms of excess weight. In another study, 31 miners had 1200 more calories and produced 7 tons of coal per day. At 1600 work calories production rose to 9.6 tons, 155 work calories per ton versus 170 work calories per ton previously. At 2,000 work calories production was raised to 10 tons and weight loss was checked.

In another study on the Pan-American Highway in Costa Rica, kitchens were installed and 10 to 15 pounds of body weight gain was reported within a few months. Concrete paving went from 1.8 cubic yards to 5.9 per man per day.

Flour enrichment in Newfoundland in 1944 resulted in a 10 percent drop in the general death rate, a 25 percent drop in the tuberculosis death rate, and 40 percent in infant mortality attributed to this cause. In California aircraft workers were given vitamins 5 days per week for 9 to 12 months and showed less absenteeism and turnover of the labor force and in merit ratings based on efficiency.
**BIBLIOGRAPHIC INPUT SHEET**

| 1. SUBJECT CLASSIFICATION | A. PRIMARY: Food production and nutrition | AS00-0000-0000 |
| 2. TITLE AND SUBTITLE | The economics of malnutrition, final report, v.2 |
| 3. AUTHOR(S) | Cesario, F.J.; Simon, S.R.; Kinne, I.L. (101) Battelle Memorial Inst., Columbus, Ohio |
| 4. DOCUMENT DATE | 1970 |
| 5. NUMBER OF PAGES | 62A |
| 6. ARC NUMBER | ARC |
| 7. REFERENCE ORGANIZATION NAME AND ADDRESS | Battelle |
| 8. SUPPLEMENTARY NOTES | (Sponsoring Organization, Publishers, Availability) |
| 9. ABSTRACT | |
| 10. CONTROL NUMBER | PN-AAD-759 |
| 11. PRICE OF DOCUMENT | |
| 12. DESCRIPTORS | Malnutrition, Reviews, Economic analysis |
| 13. PROJECT NUMBER | |
| 14. CONTRACT NUMBER | CSD-2840 GTS |
| 15. TYPE OF DOCUMENT | |
THE COLUMBUS LABORATORIES of Battelle Memorial Institute comprise the original research center of an international organization devoted to research.

The Institute is frequently described as a "bridge" between science and industry - a role it has performed in more than 90 countries. As an independent research institute, it conducts research encompassing virtually all facets of science and its application. It also undertakes programs in fundamental research and education.

Battelle-Columbus - with its staff of 3,000 - serves industry and government through contract research. It pursues:

- research embracing the physical and life sciences, engineering, and selected social sciences
- design and development of materials, products, processes, and systems
- information analysis, socioeconomic and technical economic studies, and management planning research.

505 KING AVENUE • COLUMBUS, OHIO 43201
INTRODUCTION

An important part of the project on the Economics of Malnutrition was devoted to searching the literature. The thrust of this search was twofold: (1) to discover other work that was being carried out on the economics of malnutrition and related subjects such as the economics of education, health, and welfare, and (2) to isolate those factors upon which nutritional influence is particularly significant or which act together with nutrition to influence economic development.

The important literature that deals with the first part of the search, the economics of malnutrition and related subjects, is covered in Volume I. The rest of the material is contained here in Volume II. The material in this volume is divided into two parts. The first part (Part A) contains the bibliography, with each item coded according to content, while the second part (Part B) contains the articles that were annotated during the course of the investigation.

The material in Part A is coded with numbers one to nine. Each of these numbers indicates one category of information covered by the article as follows:

1 - morbidity
2 - mortality
3 - physical development
4 - physical growth
5 - mental development
6 - mental growth
7 - behavioral development and growth
8 - economic, environmental, and cultural factors
9 - general nutrition.

These numbers appear after the first line of each bibliographical entry and are placed in one of nine columns to the right of the entry. Some entries may refer to more than one category and therefore have more than one number after them.

In addition, asterisks are placed before some entries to identify them in other ways. One asterisk before an entry indicates that the entry has been annotated in Part B, while two asterisks designates that entry as one of the presentations at an international conference on Malnutrition, Learning and Behavior held at the Massachusetts Institute of Technology from March 1 to 3, 1967, and subsequently published in 1968 by the MIT press as Malnutrition, Learning and Behavior, edited by Nevin S. Scrimshaw and John E. Gordon.

The annotated entries are of varying length depending on their accessibility in the literature and their pertinence with respect to the material covered in Volume I of this report. Although certain of the more classic studies have not been annotated, they are referred to in other of the studies mentioned here.

Time and money constraints prevented annotating more of the bibliographic entries, and although the choice of those included was indeed subjective, it is hoped that they illustrate some of the problems that concern the role that nutrition plays in economic development.
PART A

BIBLIOGRAPHY


Adams, Richard N., "Cultural Aspects of Infant Malnutrition and Mental Development".


Ahuja, S. P., "Some Economic Aspects of Malnutrition in India", paper presented at the meeting of the Association of Food Technologists, Eastern Regional Branch, Calcutta, India (February 1969).

Allen, Gordon, "Genetic Variation in Mental Development".


Altman, Joseph, "Effects of Early Experience on Brain Morphology".


Andriasov, A. N., and Makarychev, A. I., "The Importance of Protein Contained in Food for the Functional Condition of the Highest Sections of the Nervous System", (Review of literature) Voprosy Pitaniia, Moscow, 16, 8 (1957).


**Behar, Moises, "Prevalence of Malnutrition Among Preschool Children of Developing Countries", Malnutrition, Learning and Behavior.


**Birch, Herbert G., "Field Measurement in Nutrition, Learning, and Behavior".


**Canosa, Cipriano A., "Ecological Approach to the Problems of Malnutrition, Learning, and Behavior.


**Collier, G. H., and Squibb, R. L., "Malnutrition and the Learning Capacity of the Chicken".


**Collis, W.R.F., and Janes, Margaret, "Multifactorial Causation of Malnutrition and Retarded Growth and Development".


**Coursin, D. B., "Vitamin Deficiencies and Developing Mental Capacity".

**Cowley, J. J., "Time, Place, and Nutrition: Some Observations from Animal Studies".


Cravioto, J., and DeLicardie, E. R., "Intersensory Development of School-Age Children".


**Dobbing, John, "Effects of Experimental Undernutrition on Development of the Nervous System".


**Eichenwald, H. F., "Prenatal and Postnatal Infectious Diseases Affecting the Central Nervous System".**


Frankova, S., "Influence of a Changed Dietary Pattern on the Behaviour of Rats with a Different Excitability of the Central Nervous System", Ceskoslovenska Psychologie, 10, 13 (1966).

**Frankova, S., "Nutritional and Psychological Factors in the Development of Spontaneous Behavior in the Rat".**


Graham, George B., "Effect of Infantile Malnutrition on Growth", Federation, proceedings, 26 (1) 139-143 (Jan.-Feb. 1967).


**Guzman, Miguel A., "Impaired Physical Growth and Maturation in Malnourished Populations".


**Hein, Alan, "Labile Sensorimotor Coordination".

Heron, A., "The Economical Use of Scarce Higher-Level Manpower", Lusaka, Institute for Social Research, University of Zambia (1966).


**Jelliffe, D. B., and Jelliffe, E.F.P., "Field Assessment of Dietary Intake and Nutritional Status".


**Kerr, George R., and Waisman, Harry A., "A Primate Model for the Quantitative Study of Malnutrition".**


<table>
<thead>
<tr>
<th>Reference</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Levine, S., &quot;Endocrines and the Central Nervous System: Hormones in Infancy and Adult Behavior&quot;.</strong></td>
<td>7</td>
</tr>
<tr>
<td><em>Lowenstein, F., &quot;Nutrition and Working Efficiency (With Special Reference to the Tropics)&quot;, unpublished paper.</em></td>
<td>89</td>
</tr>
</tbody>
</table>


**Monckeberg, F., "Effect of Early Marasmic Malnutrition on Subsequent Physical and Psychological Development".


<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Title</th>
<th>Journal/Branch/Issue/Publication Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicholson, J.</td>
<td>Shifts in Food Consumption Patterns by Income Groups for Selected Food Items and Nutrients</td>
<td>AID/India Staff Research Memorandum and Accompanying Graphs (May 1969)</td>
</tr>
<tr>
<td>Nutrition Reviews</td>
<td>&quot;The Infant Brain Following Severe Malnutrition&quot;, 27 (9) 251 (1969)</td>
<td></td>
</tr>
<tr>
<td>Nutrition Reviews</td>
<td>&quot;Iron Deficiency and Growth&quot;, 24 (11) (November 1966)</td>
<td>34</td>
</tr>
<tr>
<td>Nutrition Reviews</td>
<td>&quot;Mental Development Following Kwashiorkor&quot;, 27 (2) 46 (1969)</td>
<td></td>
</tr>
<tr>
<td>Nutrition Reviews</td>
<td>&quot;Subsequent Growth of Children Treated for Malnutrition&quot;, 24, 267 (1966)</td>
<td></td>
</tr>
<tr>
<td>Nutrition Reviews</td>
<td>&quot;Undernutrition in Children and Subsequent Brain Growth and Intellectual Development&quot;, 26 (7) 197 (1968)</td>
<td></td>
</tr>
<tr>
<td><strong>Ogata, K., Kido, H., Abe, S., Furusawa, Y., and Satake, M.</strong></td>
<td>&quot;Activity of Protein Synthesis of the Brain of Protein-Deficient Rats&quot;</td>
<td></td>
</tr>
</tbody>
</table>


*Pollack, Herbert, "Disease as a Factor in the World Food Problem", Institute for Defense Analysis.


President Nixon's message to Congress, "Hunger in America", (May 1969).

President's Scientific Advisory Committee report, "The World Food Problem" (May 1967).


**Rafalski, Henryk, and Mackiewicz, Maciej, "An Epidemiological Study of Physical Growth of Children in Rural Districts of Poland".


**Richardson, Stephen A., "The Influence of Social-Environmental and Nutritional Factors on Mental Ability".


**Robinow, Meinhard, "Field Measurement of Growth and Development".


Scrimshaw, N. S., "Nutrition and Mental Development", a speech presented at the Twenty-Fifth Anniversary Commemoration of the Nutrition Foundation, Inc. on November 17, 1966.


**Stewart, R.J.C. and Platt, B.S., "Nervous System Damage in Experimental Protein-Calorie Deficiency".**


**Strodtbeck, Fred L., "The Latent Intellective Factor in the Food Cycle".**


Stuart, H. C., and Meredith, H. V., "Use of Body Measurements in a School Health Program. Part II. Methods to be Followed in Taking and Interpreting Measurements and Norms to be Used", Amer. J. Public Health, 36, 1373 (1946).


*Third Far East Symposium on Nutrition, Manila, Philippines (February 14-21, 1967).

**Thomson, Angus M., "Historical Perspectives of Nutrition, Reproduction and Growth".


**Thorpe, William H., "The Evolutionary Stages of Learning Capacity".


United Nations, FAO, "Malnutrition and Disease", *Freedom from Hunger Campaign--Basic Study #12*.


U.S. House Committee on Agriculture, "Hunger Study Supplement" (June 1968).


*U.S. Senate Select Committee, "Nutrition and Human Needs" (December 1968).


**Vernon, P. E., "Measurements of Learning".


PART B

ANNOTATED BIBLIOGRAPHY


Physical work tests making use of bicycle ergometry and dynamometry were performed on six groups of children and adults in Addis Ababa. It was not possible to demonstrate any definite correlation between the results of the physical work tests and the nutritional status of the subjects or the quality of the diet as measured by a 24-hour recall. In spite of often very inadequate diets, the achievements were on the whole reasonably good. The implications of these findings with respect to the definition of various types of "requirements" warrant further discussion.


Government policy makers labor under a universal malady: there is too much to be done with too few resources. The relationship of malnutrition to economic development, therefore, needs to be known. How much more productive is the properly nourished man? How much more will a man with full mental and physical capacities contribute to his society? Conversely, what are the costs to society of malnutrition in the form of medical treatment, welfare-type relief, and waste through death of those who have a limited number of productive years? What are the implications of better nutrition to family planning?

Nutrition has grown beyond its public health parenthood. It now also involves economics, agriculture, industry, education, family planning, labor, management, and marketing. To work effectively requires a different kind of experience or training, or both. This is not to suggest that the nutritionist or food scientist would not in some cases fill this role. Only that, if so, he should be able to devote full time to it and he should be appropriately equipped for it. There should be a conscious decision to prepare people for this kind of position.


Malnutrition often results from people's making poor use of the foods that are available, through ignorance or adherence to blind custom.
Education in proper diet can help to overcome this. Efficient food marketing system is important. Changes in demand may require changes in the "mix" of products commercially produced and distributed... requires not just increase in production or imports but an increase in the kinds and quantities of foods produced for commercial sale, plus expansion of marketing channels. Failure to increase commercial supplies of food leads to increases in food prices -- malnourishment for economically vulnerable groups, labor unrest, and political upsets.

Appraising food and nutrition situation: (1) estimate consumption of food, (2) convert this into intake of major nutrients, (3) compare results with standards...usually very difficult in LDC's. Can attempt to evaluate nutritional status directly: (1) analyze statistics of health and mortality, (2) have teams make detailed studies of nutritional status of sample groups, (3) correlate data with differences in food consumption among different populations...in both methods must know food consumption. Can use two methods: (1) compute averages from national aggregate data on supplies and utilization of commodities...using food balance sheets, and (2) making cross section surveys of actual food consumption of sample families.

In addition efforts must be made to increase agricultural production and improve distribution, the battle against hunger and malnutrition must take account of food habits and must include efforts to get people to want better diets and to help them improve their consumption practices. Research in these areas requires cooperation among specialists in the social sciences, education, and the medical sciences.

Call, David L., "Research Findings on the Social Consequences of Malnutrition", Cornell Agricultural Economics Staff Paper, No. 8 pp 1-20 (August, 1969)

Malnutrition and hunger in the United States is probably having its major impact on the school performance of children. The problem appears to be more closely connected to motivation and mental attitude than pure physical condition. It does not appear that this is due to any permanent reduction in mental capacity due to serious protein-calorie malnutrition (a minor problem in the U.S.). Hunger appears to be more important than malnutrition. Improved school performance would seem to be one of the major benefits to be expected from a comprehensive intervention program. For preschool children from poverty areas malnutrition is probably contributing to a higher morbidity rate.

There is little doubt that poor nutrition before and during pregnancy is one of many factors affecting birth weights. Short of actual starvation of pregnant women the relationship is complex and difficult to pinpoint. The risks associated with low birth weights of greatly increased mortality and a probability of mental damage indicate that preventive programs are needed. The relationship between the higher incidence of low birth weights in poverty areas implies deficiencies in nutrition, education, and medical care and facilities.
It is clear that past research does not provide many guidelines that would be useful in attempting to assess the social benefits in terms of physical productivity of improved nutrition of poverty or other groups.

Research is needed to examine the relationship between nutritional status of poverty groups and work performance. Work performance in terms of physical productivity is extremely difficult to measure and past attempts have limited applicability. The indirect effects of nutrition on job turnover, absenteeism, performance in training programs and job advancement may be more susceptible to isolation.


Social scientists have long used a questionnaire method to gather social and economic data. To test the usefulness of such a method in obtaining information on food habits, the replies to questionnaires used in sociological survey in an industrializing rural area in Mexico were analyzed. The findings support the hypothesis that, in the process of industrialization or urbanization, food habits or food patterns change progressively, becoming increasingly more complex and varied, and that such changes are related to other similar changes (e.g., simple to complex) in the social and economic milieu.

Where it is not essential to have quantitative information on food consumption, the questionnaire method would seem to have two special advantages over the traditional type of food consumption survey: it does not require highly trained interviewers and a much larger sample can be covered. The method permits a study of the changes in food habits which take place under the impact of such major forces of change as industrialization and urbanization. Such information is important for the nutrition educator, food planner, and others concerned with nutritional levels of populations.


The disturbing indications revealed by studies in Africa, Asia, and Latin America are that permanent damage to mental capacity may result from malnutrition during early life even though the individual may later appear to be physically normal. A vast misallocation of resources may be taking place in the developing areas of the world where malnutrition is a widespread phenomenon.

Dr. Joaquin Cravioto found that Guatemalan children who had experienced nutritional deprivation at an early age showed significantly retarded performance on tests designed to measure development of
intersensory organization among three sense systems -- touch, vision, and kinesthesia. His findings suggest, that an individual whose intersensory organization is retarded may require a longer training period in order to acquire job skills, may be less adept at manipulating industrial equipment, and may be more accident prone.

Many illnesses experienced by the world's poverty-stricken populations are a direct result of malnutrition or become considerably more frequent and severe because malnutrition has lowered resistance to infections.

In addition to the possible consequences for educational, industrial, and health programs, the effects of infant malnutrition hold more general implications for a society's vitality.

For the total population, infant nutrition is only one of a system of variables bearing upon the capacity for productive activities. The synergistic effect of malnutrition, infection, parasites, and inadequate adult-child interaction in hindering the mental development of children has been reported in detail.


Nutrition of pregnant and lactating women is seriously defective in most countries of Latin and South America, results in poor physical health among mothers, and in poor growth and development and high mortality rates among infants. Need better diets and education (resources, customs, and beliefs).


The minimal daily calorie allowances prepared by the National Research Council (NRC) and the Food and Agriculture Organization of the United Nations (FAO) have been devised to provide energy in sufficient quantities so when consumed over extended periods of time they will maintain body weight or rates of growth at levels that are helpful in promoting the well-being and health of man. Daily requirements and allowances are dependent on many variables including sex, age, environmental temperature, physical activity, relative humidity, body composition, radiation, and probably altitude. The calorie allowances are increased with an increase in body weight and are decreased with an increase in age.

The new NRC allowances in hot environments now suggest that the energy requirements are increased in man performing prescribed work and living at high environmental temperatures.
Allowances in the cold, assuming an adequately clothed individual, are not increased except to compensate for the two to five percent increase in energy expenditure due to carrying or wearing cold weather clothing.

Physical performance is dependent on many factors including good physical condition, technical skill and muscular strength to overcome a given load, motivation to perform to the best of one's ability, limitation of all the inhibiting psychological factors and above all, optimal nutrition.

Calorie restriction for short periods of time, with a subsequent decrease in body weight, in some instance, has been shown to improve performance.


Some estimates of the influence of nutritional conditions on working capacity, productivity, and economic growth are presented.

Only direct observation (or experimental data) permits us to discover the relationship between nutrition and working capacity. In India and El Salvador the working capacity of the labor force is only 50 percent of the normal level. A comparison of the results for developed and underdeveloped countries shows that it is reasonable to assume that better nutrition is a determinant of higher productivity.

Production and its increments are the results of the interaction of several inputs, one of which is labor. If not all the inputs are available, then the productivity of all the others will be low. Results show that the influence of nutritional conditions on economic development is extremely important.


There is a great lack of knowledge regarding the importance of proper nutrition to specific aspects of growth and development. There are still the questions of whether it is reversible or permanent and of whether or not it alters the affected child's functional capacity. Studies are needed not only to answer such questions about nutritional effects but also to answer questions about the physical, biological, and sociocultural factors that also influence growth and development and are intimately related to nutrition.

For many years there has been controversy among biomedical scientists regarding the effects of a woman's nutritional status on the product of conception. Until the Second World War, it was generally believed the fetus was a parasite that could obtain all it needed from even a nutritionally deficient mother. Further information on the effects of maternal
nutrition on fetal development is needed to determine whether a small difference in birth weight makes a difference in the child's prenatal and postnatal development and functioning. Studies in this area are especially important since maternal malnutrition is known to be associated with increased rates of morbidity during pregnancy and of premature delivery. However, a cause-and-effect relationship between maternal malnutrition and either morbidity or prematurity has not been established.

In studies of maternal malnutrition, it is important to distinguish between an acute, sudden onset of malnutrition of a specific duration in a population -- as in a war -- and the type of chronic malnutrition that exists in developing countries. This means that where malnutrition occurs in critical periods of development, such as adolescence, future generations may be affected.

Many studies in developing countries also suggest that growth progresses satisfactorily during the first 4 to 6 months of life while the child is breast feeding and the mother's milk supply is adequate. In cases where the mother's milk is not supplemented with other foods, after 6 months the growth patterns of breast-fed children begin to diverge from the North American standards. If the supply of maternal milk is insufficient or if the mother is unable to nurse, the life of the infant is greatly jeopardized, for inadequate substitution of other food may result in serious protein malnutrition and poor hygienic conditions may result in fatal infection from contaminated, prepared formulas.

A graph shows that both weight and height for age in Guatemala fall below the Iowa standards throughout all ages, but the deficit is very small in the first few months of life. This graph brings out the marked importance of the second year of life in demonstrating growth deficits. This is the age when the classic picture of severe protein malnutrition (Kwashiorkor) frequently becomes evident.

In humans the greatest growth spurt for the brain occurs during the fetal period. By the end of the first year of life, the brain has assumed approximately 70 percent of its adult weight, and by the end of the second year its growth is almost complete. Studies of the human brain have shown a very rapid increase in DNA content toward the end of the period of gestation; the increase slows down after birth but continues until the child is 5 or 6 months of age.

The most obvious solution to the problem of malnutrition would seem to be to provide food. But this is a markedly oversimplified solution for such a complex problem. Any attack on the malnutrition problem must also include an attack on related sociocultural problems, especially the problem of psychosocial deprivation in early life.


For assessing nutritional status there is no substitute for family dietary surveys, especially when a new area is being investigated. The
minimum number of days for such a study must be a week, the normally
universal period during which the cycle of the family's customary life
is repeated. The most advisable method is a combination of recalling
previous meals and weighing the food that is to be consumed by the family
or the individual.

To assure a successful interview, the field worker should be well
trained and should possess a high degree of sensibility in order to
understand the person with whom she is to work. Shorter periods for
dietary surveys may be used when enough information is secured from
seven-day dietary studies to permit estimation of the standard deviation
of the intakes.

Fresancho, Garn, and Ascoli, "Unequal Influence of Low Dietary Intakes
in Skeletal Maturation During Childhood and Adolescence", in the
American Journal of Clinical Nutrition, Vol. 23, No. 9 (September,
1970)

Retardation in skeletal maturation in childhood is greater than
during adolescence. Postulated graded childhood retardation and lesser
delay in skeletal maturation during adolescence are factors that are
responsible for the small stature of Central American populations. Both
sexes are equally delayed.

Gopalan, C., "A Report on the First Fifty Years of the Nutrition Research
(January, 1970)

Since their inception, the Laboratories have felt it to be their
role, first to discover the true nature of our serious nutritional problems,
and then to find a means of dealing with them. Our first concern,
therefore, has been the prevalent and destructive deficiency diseases
associated with malnutrition.

This is probably the most important and widespread nutritional
problem in India today. Research in these Laboratories has shown that
locally available, relatively inexpensive vegetable foods -- can be used
successfully in combating protein malnutrition, instead of the rarer and
more expensive foods, meat and milk.

While there are still comparatively few studies on the specific
nutrient needs of Indians, over the past few decades we have attempted
to establish requirements for calories, protein, the B vitamins, vitamin
C, iron, and calcium in different physiological groups. The results
have been used in formulating the latest recommendations of dietary
allowances for Indian subjects.

Extensive investigations on nutritional problems of pregnancy and
lactation have been carried out in the past several years. Attempts have
been made, not only to identify problems and to assess their magnitude,
but to find the most practical approaches to their prevention and control.
Physical environment, biologic surroundings, economic circumstances, social habits, cultural taboos and customs, along with the genetic constitution and phenotypic development of the human host, all have a part in the genesis of nutritional and infectious disorders. When these two conditions exist in the same individual, they commonly interact in synergistic fashion. Malnutrition worsens infectious disease in clinical course and increases the likelihood of fatality; infection enhances nutritional disease. The organic disorder exaggerates the social situation. The problems of the developing countries are deeply affected by this cyclic maladjustment.

The plight of children in preindustrial areas, however, is the result of the everyday infections of the intestinal and respiratory tracts and of the five communicable diseases specific to early life everywhere: measles, whooping cough, rubella, mumps, chickenpox.

Many nutritional surveys in less developed countries demonstrate a general departure from optimal nutritional state in two-thirds of the child population and sometimes more. Discrepancies in height and weight for age range from 10 percent to values occasionally exceeding 40 percent. Diet is the direct source of the difficulty, yet it fails by far to explain all of the trouble.

Acute diarrheal disease in developing countries seemingly owes its importance, in clinical effect and as a cause of death, to the particular form of the disease called weanling diarrhea, a clear synergism of nutrition and infection.

Upper respiratory diseases, of the chest, multiple intestinal parasitic infections, and dermatological conditions have not been evaluated individually because in most underdeveloped areas information about their impact on persons and communities is inexact and often grossly incomplete.

Growth and development after malnutrition and disease concern primarily the population of preschool children and the extent to which their experiences will set the future nature and characteristics of their community. The question of whether or not malnutrition is also able to affect mental growth and development is past the stage of hypothesis. It clearly holds for clinical pellagra and kwashiorkor, although the extent of the damage, how persistent it is, and whether it is reversible, are questions to which the answers are still indefinite. The main and broader concern is: do lesser degrees of protein-calorie malnutrition and still other nutritional deficiencies have such a result?


A study made by Dr. Herbert Birch on a group of Mexican children hospitalized at an early age with severe malnutrition has shown that they scored lower on intelligence tests in later life than did their siblings who had not suffered from the disorders.
Dr. Birch said women who have suffered from malnutrition early in their lives have more complications and problems in child-bearing than do healthy mothers, and these complications and problems affect the health of their children.

"In this research, we are exploring hunger and malnutrition as factors which can handicap children as learners", Dr. Birch said.

"But we try to make it clear that it is not food alone or compensatory education alone which make the difference between school success and school failure for poor children", he continued. "One-shot treatments will not overcome handicaps brought on by generations of neglect. A complex and sustained attack will be required to remedy what is a complex and international problem."


**India**, by C. Gopalan. Preschool child centers are important and would facilitate the operation of nutrition programs. Women centers are also being created. The total health care is very important for the overall picture.

**Central America**, by M. Behar. Common infectious diseases are a frequent cause of death, and also an important cause of malnutrition in children living on marginal diets. Care should be used to select foods for food programs that have efficient uses. Food should be both nutritionally indicated and also fit within the dietary practices of the population, and be of the type they can acquire in the local market. Nutritional deficiencies acquire greater importance as infectious diseases are controlled with dramatic advances.

**Israel**, P. Robinson. Considerable money is spent on health care so that there is relatively little wastage through infant and children's death and considerable savings in curative services. Pilot projects in developing countries tend to carry on without ever being implemented into full-blown projects.

**East Africa**, L.A. Musoko. Five percent of preschoolers suffering from severe malnutrition. Twenty-five percent were moderately undernourished. A malnutrition rehabilitation unit was established and funded by a grant from the Save-the-Children Fund in Britain.

**Central Africa**, D.M. Blankhart. Eighty percent of deaths of school children due to gastro-enteritis (23 percent), protein calorie malnutrition (17 percent), respiratory diseases (15 percent), measles (11 percent), smallpox (9 percent) anemia (4 percent), and tetanus (3 percent). In rural areas malaria is about 8 percent. Malnutrition, more common in rural areas, caused by imbalanced feeding. Rehabilitation centers are being established where the care of the child by improved feeding is a never-forgotten practiced life-saving lesson for the assisting mother.

**West Africa**, R.G. Hendrickse. After neonatal period morbidity and mortality occur principally as a result of infective disorders interacting
with malnutrition. Many non-specific infections, gastro-enteritis, and a variety of respiratory infections, measles, malaria, and tuberculosis, tetanus, whooping cough, and meningitis are also significant contributors.


The combination of poor nutrition and various social and economic dysfunctions tends to lead to the perpetuation of a disadvantaged group in the society.

The known or postulated consequences of malnutrition during the development of the human individual include (1) Delayed Physical Maturation and Smaller Physical Size: The malnourished child grows at a slower rate than the well-nourished child, while high intake of nutritionally well balanced foods results in increased physical size. Other factors, such as climatic conditions and ritualized physical stress during infancy are also important. (2) Increased Susceptibility to Infectious Disease: The interaction between malnutrition and infectious disease is complicated by parasitic infestation. Prolonged or frequent diarrhea in infancy has a particularly telling effect on early child development and nutritional status. Modern medical practice, better sanitary conditions, programs of immunization, and perhaps, better developed natural immunities apparently greatly reduce the effects of certain common diseases of childhood on children in the developed countries. (3) Increased Mortality: The relationship between malnutrition and mortality, particularly between the ages of one and four, has been clearly demonstrated in the developing countries. The relationship between malnutrition and infant and preschool mortality has not been well studied in the developed countries. (4) Retarded Brain Development: Severe malnutrition at an early age interferes with normal development of the brain. When malnutrition occurs after the end of the period of cell division, animal experiments suggest the cells may be smaller than normal, but the change may not necessarily be irreversible. Evidence has been provided to indicate that marasmus and kwashiorkor produce deficits in intellectual ability. However, these results must be interpreted with caution. Most of these studies have been of children who have been hospitalized for an extended period. The effects of hospitalization stem both from separation from parents and from the lack of stimulation in the hospital. When the child is malnourished, lack of proper stimulation will be complicated by general lethargy and an inattention to stimulation, thus further confusing the interaction between the nutritional disease and its sequelae. In addition, all of these studies have been retrospective rather than prospective. Thus, the possibility exists that a preexisting mental incapacity leads to a relative lack of success in competition for food within the family, and therefore,
may make the child more vulnerable to malnutrition. Under such conditions, mental retardation would be a cause of, rather than a consequence of, malnutrition. The evidence that severe malnutrition is associated with reduced intellectual capacity is reasonably clear, but the evidence for an association of mild or chronic malnutrition and intellectual incapacity is not. Questions can be raised about each of the major human studies supporting the concept that normal malnutrition leads to intellectual deficit. Stock and Sythe's report made clear that the malnourished children were marasmic. In addition, the malnourished children came from families replete with social pathology. The data of Cravioto and his associates can be interpreted as indicating a lag in the development of intersensory integration rather than as a permanent disability. On the other hand, Ramos-Galvan and associates suggest that rural residence and/or lower class status may be more important predictors of intellectual incompetence than nutritional status. By age 10, there were no differences in the scores of the well and poorly nourished lower class urban children. Monckeberg studied urban children in Chile; in the lower class a relationship was observed between growth retardation, low intellectual capacity, and low intake of animal protein. It seems possible that if a given threshold of nutrition is reached, particularly during the early developmental years, nutrition does not have an independent effect on intellectual capacity. Certainly, on the basis of the evidence reviewed above, any relationship is a highly complicated one. (5) Apathy: Malnutrition is associated with apathy, listlessness, and unresponsiveness to external and internal stimuli. Malnutrition is most apt to be found in those segments of the society which have other characteristics which independently interfere with optimal development. Apathy and uninvolve ment may stem independently from two forces. Increasing nutritional intake will not reduce apathy if the apathy stems from both sources. But changes in social conditions will not reduce apathy if it stems from malnutrition.

In the developing countries, prevailing levels of nutrition may interfere with successful attempts to institute population control programs. The high infant and preschool death rate associated with malnutrition, parasitic load, and infectious disease may independently interfere with the willingness of individuals to limit family size. Failure to limit family size in turn contributed to malnutrition.

Malnutrition may, in some instances, contribute to the lack of industrialization by a nation. While adequate nutrition will not insure the development of a nation, or even the successful implementation of a population control program, it may be a necessary precondition. Stimulation may affect the size of the brain. If the child is passive and unresponsive, a lack of interaction with the mother may interfere with adequate language development, as well as with other developmental tasks. Rosenzweig and associates have demonstrated in rats that small, but statistically significant, differences in the size of the cerebral cortex result from variations in the stimulatory aspects of the environment. No information has been provided as to whether the changes are caused by differences in cell size or cell number.
Malnutrition is not the only deterrent to a good mother-child relationship. Improved nutrition would not necessarily improve the mother-child relationship. But an adequate start for the child is not possible without adequate nutrition. Pollitt points out that in areas where malnutrition is endemic, the lack of responsiveness of the child is expected and normal.

The child who lags in the performance of his developmental tasks will be ill prepared for the learning tasks required of him when he enters school. This may be the greatest impact that nutrition has on intellectual performance -- not an effect on "innate ability" or "general intelligence" but in the utilization of the ability that the child does have.

Keyter, Carl, "Feeding Customs and Food Habits of Urban Africans", S.A. Institute of Race Relations, No. 11, pp 1-2

Of 1,037 workers questioned in Pretoria and Germiston, 1,034 stated that they would find extra money more acceptable than food.

Of 692 workers questioned in Pretoria, 39 percent (270) said they would neither support a canteen with reasonable prices, nor one providing free food; 13 percent (90) said they would support a canteen with reasonable prices, but would not accept free food; and 48 percent (332) said they would be willing to accept both.

Lower-paid non-compound workers tended to reduce on their home meals, when they were fed at work.
Higher-paid compound workers bought fruit and milk more frequently than did lower-paid compound workers.

One firm reported a 40 percent rise in production within four months after introducing a feeding scheme, and another firm reported a 53 percent decrease in absenteeism over a three-month period.


The goal of nutrition in the development process is basically threefold. (1) It may increase productivity in the agricultural and industrial sectors when labor itself is the limiting factor. Preschool age malnutrition and its effect on mental development probably have a more pronounced effect than caloric deficiency among adults. (2) Nutrition may also increase the motivation of reproductive age parents to accept birth control measures by decreasing infant mortality and increasing the likelihood that existing sons will survive. (3) It improves health directly, a basic subgoal of development.

A national nutrition policy based on such a role could proceed along three paths: (1) nutrition intervention programs, (2) increases in income, and (3) infection and parasite control. There is clearly a synergistic relationship among the three.
Nutrition intervention programs include a wide range of alternative strategies which must be compared by various criteria. These criteria might be grouped into the following categories: (1) relative nutritional effectiveness, (2) costs and distribution, (3) consumer acceptability, (4) a series of general requisites (e.g., foreign exchange, speed of implementation, and political acceptability), and (5) economic multipliers or the benefits of intervention programs back to other development sectors.

Lowenstein, F., "Nutrition and Working Efficiency (with special reference to the Tropics)", unpublished paper

In order to be able to calculate approximate requirements for groups of people, whole communities or even countries, standard values for a so-called "reference man" and "reference woman" have been compiled by FAO in the report of the Second Committee on Calorie Requirements (FAO 1957). "Reference man" and "reference woman" are defined as adults aged 25 years, weighing 65 and 55 kg., living in a temperate climate (mean annual temperature of 10°C) and working eight hours a day in a non-sedentary occupation, which requires only occasional periods of hard physical labour. He is assumed to require 3,200 calories daily on an average for the entire year and the woman 2,300 calories in order to keep in energy balance, that is, neither lose nor gain weight. From this it is possible to calculate what energy expenditures ought to be if agricultural production is to be increased.

If the energy intake, i.e., the calorie content of the diet, is sufficient to cover requirements, the protein consumed is used for the specific anabolic needs of the body; if, however, the calorie content of the diet sinks below the minimum requirement, part of the protein consumed is burnt to cover energy needs and lost for the specific needs of the body. Sufficient calorie intake is, therefore, the first requirement in order to be able to study any specific effect of protein on working efficiency of the body.

There is scanty evidence for a possible beneficial effect of single vitamins on working performance and all the work done in this field has been done in cool industrialized countries.

If work is performed in a hot environment, the ascorbic acid excretion in urine is increased and, in addition, a loss occurs in sweat which may amount to several mg in four hours. This may be important to workers in the tropics performing hard physical labour.

The time of a meal and its size are important factors in determining productivity. It seems that frequent, small meals are more advantageous than few big meals, particularly in heavy work. The authors concluded that the extra meals definitely increased productivity.

The importance of eating breakfast before starting work was shown by these same authors in observations preceding the above where those workers, omitting breakfast, but eating lunch, had lower production rates than those having three meals a day who, in turn, had lower rates than the ones eating five meals a day.
The mere provision of a rest period during mid-morning and mid-afternoon working hours, with or without food, had a beneficial effect on working efficiency.

Recommendations: To improve the health and nutrition, and thus the working efficiency of workers in the developing countries, several measures would need to be taken by the management in cooperation with the unions and the labour department in the Government:

(a) The organization of cooperative or subsidized stores where workers could buy the main foods for their families cheaply.

(b) The organization of canteens where one or more balanced meals are being served at a low enough price that the lowest paid worker can afford it.

(c) In conjunction with a canteen, an educational campaign in health- and nutrition-education should be organized with the technical assistance from the Health- and Education-authorities.

(d) Whenever possible a medical doctor with training in occupational health should look after the health needs of the workers, including their nutrition. His responsibility extends into the field of health- and nutrition-education of the workers where he should take a leading role.

(e) In regard to the independent farmer, in order to ensure better nutrition he would need

i. improved facilities for food storage,
ii. improved methods of food production, and
iii. nutrition- and health-education.


The problem of combating malnutrition requires the coordination of health, agriculture, industry, education, and community development programs not only of the United States, but of the entire world. The kinds of activities which should be strengthened or initiated as the case may be, in order to combat malnutrition may be divided into these five categories, but it must be emphasized that in order to obtain the common goal, those responsible for each area must work closely with their counterparts.

(1) Health programs should include projects aimed at the following: education for mothers, maternal and child health centers, utilization of existing health facilities, emphasis on nutrition; (2) Agricultural programs should include projects focused on the following: quality and quantity of food, diversion of land, harvesting practices, agricultural and food marketing systems, agricultural practices; (3) Industrial programs should include projects aimed at the following: expansion and modernization, enrichment of processed staples, loan and risk guarantee programs, tax rebates and tariff waivers, research; (4) Educational programs should include projects in the following areas: basic skills and professional competence, specialized training, research.
Coexistent with frequently inadequate family income the trend toward early weaning has been accelerated in the West Indies, often owing to the economic necessity for the mother to seek gainful employment but certainly reinforced by exposure to "modern" ideas and tastes, including inappropriate advertising and guidance. This very early weaning is most likely to occur in an impoverished, unstable family situation, where the lack of sanitation and improper feeding practices, especially intermittent use of overdilute food, frequently leads to recurring diarrhea and moderate or severe malnutrition. Gastroenteritis and malnutrition combined are recorded as the most important cause of death among children under 3 years of age in Jamaica (McKenzie, et al, 1967).

In the other countries of the Caribbean, recent spot checks indicate that at any given time, 20-45 percent of the pediatric beds in hospitals are filled with children with diarrhea/malnutrition.


The construction of a complete quantitative model of the world economy incorporating all production demand, institutional and behavioral relationships, is beyond the capacity of economists, agronomists, demographers, and space and systems engineers. Food production can be approximated, but knowledge of population growth determinants is scanty. Demographers have related a few behavioral hypotheses to educational income and nutritional factors, but empirical evidence is almost nonexistent. Without such a system we should look at food and population independently.

Food production and population statistics in the less developed countries are bad. Food gap does exist especially with respect to protein. Production of food per se cannot be separated from the overall process of economic development. There must be enough effective demand to buy the food. Low growth means problems to supply agricultural imports either domestically-produced or imported. Income distribution must be even. Increased production can lead to increases in employment. There is a need for income growth outside of agriculture to be able to afford marketable surplus. Farmers are responsive to monetary incentives. Minimum wages, fringe benefits, and union pressures force the market price of labor above its equilibrium value, while overvalue at exchange rates subsidize interest rates and various tax exemptions reduce the market price of capital below its equilibrium value. This leads to adoption of relatively capital intensive techniques that contribute to unemployment. Three major negative effects of population explosion are:
(1) Age structure applied by high fertility and low mortality leads to high dependency ratios.

(2) Aggregate output and income has to grow at a rate substantially higher than the rate of population growth if any notable improvements in per capita income and standard of living are to be realized.

(3) Accepting assumption that 3 percent increase in productive capital leads to a 1 percent increase in capital output ratio of 3 to 1. A 6 percent GNP rise requires an 18 percent saving ratio without population growth, and 3 percent population growth adds an additional 9 percent to the required annual savings ratio.

The National Academy of Engineering, A Symposium on Food People Balance.
This is a panel on "World Nutritional Resources", chairman, Herbert Pollack; members, Chichester, Kriesberg, Old, Rockwell, and Pearson. Washington, D.C. (April 29, 1970)

The study of individual factors in nutrition and their interdependence and interaction are all important. Rigorous analysis is difficult, but we can identify the important dimensions of the problem and areas requiring major attention. The adequacy of food resources depends upon determinance of individual and population food requirements. The total population, its age and sex distribution, must be known in order to determine nutrient requirements.

Malnutrition lowers resistance to infection and classical nutritional deficiencies may be precipitated by an episode of acute infection. Malnutrition is the end result of failure to supply the nutritional requirements in acceptable forms for the conditions under which the individual is living. Requirements must be stipulated and how they are modified by environmental conditions is important. Dietary allowances are usually based upon good health and absence of disease.

Respiratory tuberculosis increases basal requirements by about 20 percent. Malaria and dysentery increases requirements by about 20 to 40 percent; and the peak of these diseases usually occurred during the planting season. Worm burdens impose further loads on the cost of living and penalizes calorie utilization. Recommendations are: (1) The technical innovations be made in the flow of food supplies (a) designing better storage, (b) relevant processing, (c) improved preservation, (d) efficient and economical market systems; (2) Increasing efficiency of human utilization (a) ten percent is lost to the effect of disease, (b) sanitary water, (c) effective sewage disposal, (d) primary prevention of disease, (e) farm machinery and agricultural chemicals.
Disorders of nutrition are divided into seven parts: (1) Deficiencies of water soluble vitamins of the B complex include (a) Beriberi and Wernicke's encephalopathy, (b) Pellagra and riboflavinosis, (c) other nutritional disorders of the nervous system; (2) Disorders due to deficiencies of fat soluble vitamins include (a) night blindness and Keratomalacia, (b) rickets and osteomalacia, (c) hypoppsyhotrom binaemia of metabolism of def. K, (d) deficiency of fatty acids; (3) Scurvy; (4) Anemia; (5) Nutritional edema; (6) Liver damage and cirrhosis; (7) Early childhood malnutrition (Kwashiorkor).


Little is known about the effects and interrelations of iron deficiency anemia. Even less is known about deficiencies of other nutrients except when they occur in their most gross state. Children and adults with diets under the recommended daily allowance (RDA) are actually functionally impaired. A definition of "health problem" is not an easy task. Serious respiratory infection is 10 times more common in children of the lowest socio-economic status than in children of highest status. What mechanisms mediate this difference? Not simply exposure to infectious agents, not medical care. Is it nutritional status, anemia, physical activity, child-rearing practices, or combinations of all of these? The dollar cost of protecting and enhancing a child's health ranges from $15 to $300 per year per child. Headstarts run about $70 per child per year on medical and dental services. There are no published studies of the actual cost of bringing needed health services to all children in a defined community. It seems likely that a total annual cost would fall someplace between $100 and $200 per child.


Whenever nutritionists propose a program to improve the health of a population economists are likely to ask what the economic advantages are of such a program. Any estimate of the economic cost of malnutrition should include a consideration not only of those children classified as suffering from malnutrition but also of those classified under some other disease heading but whose illness was contributed to be malnutrition.

The health costs to be considered are those of running the medical services and the cost to the parents. Another economic aspect in relation
to malnutrition is the effect of child-wastage as a factor influencing the attitude to family planning in developing countries.

Malnutrition may result in physical handicaps, but an estimate of the economics of this is difficult to make. There is an increasing body of research to show that severe malnutrition may have a retarding effect on mental development (Nutrition Reviews 26, 197 (1968). Perhaps the most important economic effect of malnutrition is the relationship between diet and productivity. The annual cost of in-patient care and of child-wastage combined is over one million dollars for the Commonwealth Caribbean countries.

Funds spent to improve the nutritional status of a community or a nation could be justified on humanitarian ground alone. The expense of preventive programs can also be viewed in hard economic terms and in relation to the heavy financial losses caused by malnutrition. It is necessary in addition to studying the economic cost of malnutrition, to evaluate the effectiveness of nutrition programs. Only then will it be possible to add sound economic arguments to the humanitarian pleas for a larger slice of the economic pie for nutrition programs.


There has been considerable recent interest in the relationship between malnutrition and infection (Nutrition Reviews 22, 161 (1964); 25, 108 (1967). It is an unfortunate fact for the research worker that protein-calorie malnutrition in young children seldom occurs in isolation. It is almost always associated with many other factors common to people living at a low socioeconomic level. These include, among others, a low level of education, poor housing and sanitation, crowding, a high incidence of infections, low incomes, ignorance, and often a lack of social stability. A recent study was designed to evaluate the relationship between nutritional status and infection. It is interesting that the study does not succeed in defining the relative importance of malnutrition and of infection in child morbidity but strongly concludes that there is a close association between both these factors and socioeconomic circumstances.

It is not clear whether children become malnourished mainly because they have many illnesses, including severe recurrent diarrhea, or because of their inadequate diet. Infection and malnutrition in many instances are believed to be synergistic. In order to apply preventive measures, it is important to know whether the vicious circle can best be broken by preventing and treating the infection or the malnutrition. A study in South Africa, while demonstrating this interaction of malnutrition and infection, also shows the close association between them both and poor socioeconomic circumstances. This suggests that in attempts to improve child health and nutrition a third avenue of intervention would be to improve social circumstances.
It is important that physicians and nutritionists explore the myriad factors that contribute to malnutrition, poverty, and disease. It is unlikely that any easy solution lies in attention to a single factor.

Pollack, Herbert, "Disease as a Factor in the World Food Problem", Institute for Defense Analysis.

Increasing developing countries' food supplies is not the optimum conclusion in solving nutritional problems and results from failure to discriminate between primary and secondary malnutrition and the effects of acute and chronic disease and nutritional requirements. Primary malnutrition is the result of inadequate food intake to meet normal demands. People can survive for long periods of time in this condition. Secondary malnutrition is seen when metabolic processes are increased by disease or trauma. With fever present metabolic requirements of the individual are increased. Heat production of the human body increases about 13 percent for each degree of centigrade, or 7.2 percent for each degree Fahrenheit. For example, in malaria chill episodes caloric requirements approach a rate of 5,000 kilo calories per day per individual.

As far back as 1901 it was shown that people with typhoid fever used more oxygen than a normal individual. In addition, protein metabolism is elevated in the presence of infections. At body temperatures over 39 degrees centigrade, caloric requirements have been known to increase 50 to 70 percent. The burden of parasitism exhibits such a synergistic cost that should not be overlooked in calculating the magnitude and consistency of the added need. Infection intensifies poor nutrition.

Overcrowded housing, lack of sewage disposal, inadequate potable water, poor personal hygiene, and exposure of children to contamination facilitate the rapid transmission of disease and, consequently, statistics on malnutrition should not be attributed just to food deficiency. Protein calorie malnutrition is most realistically regarded as a result of ecological imbalance rather than dietary disorder.


No program related to the nutritional problems of a country can be separated from the total health problem of that country. This includes social and economic factors as well as the attitudes of the population groups to whom these nutrition programs are to be applied. To date, there has been no real effort to develop a technique for measuring the impact of a nutrition program on changes in health, social, and economic factors.

The clinical manifestations of nutritional diseases are essentially the same all over the world. However, the social manifestations are determined in a large part by environmental factors which differ from place to place and with time. Thus, it is necessary that each society
have at any given point in time its own tailor-made system of nutritional improvement associated with general public health improvements suited to its own resources, needs and particular demands.

Malnutrition and its secondary infections constitute the two most important causes of disease and death in developing countries. The most urgent problems to be solved before malnutrition can be diminished in these developing countries cannot be solved by scientific medicine alone, but require in addition attention to the sociologic factors. The objective would be to improve nutrition to the extent that disease and its subsequent disability would be prevented.

Coincidentally, environmental factors such as water pollution, sewage disposal and housing have to be improved. A short-term program would focus directly on the therapeutic aspects of supplying the immediate food needs. At the same time, the long-term program, which would cover agricultural developments, nutritional information, housing, recreational facilities, improved working conditions, water supply, sewage disposal, and insect vector control, would be promoted.

Nutrition programs must serve as a background for the future so that the people can take care of themselves; and any large-scale program should include training in both nutrition and agriculture. The problem of nutritional inadequacies and the corrective measures designed to relieve the situation must be considered from the total point of view. Nutrition must compete with all the other aspects of the economy of the country in the allocation of scarce resources.

Pollitt, Ernesto, and Riscuiti, Henry, "Biological and Social Correlates of Stature Among Children in the Slums of Lima, Peru", American Journal of Orthopsychiatry (October, 1969)

Short children are likely to have shorter mothers who had more pregnancies, less years of schooling, and a greater number of marriages. The results suggest that although difference in stature reflects difference in nutritional background, they are likely to reflect other important biologic-social factors. It would be virtually impossible to specify whether behavioral or intellectual differences between tall and short children are a function of nutritional factors or some other factor associated with stature. In studies of undernutrition and psychological development it would be very unwise to use differences in stature as a principle index of previous nutritional history. Studies should be designed to permit an assessment of interactions between known variables and nutritional status, dietary intake, parent-child relationship, amount and kind of stimulation for learning, as these all affect psychological development.
The causes of the diseases of man can be understood only in terms of his relationship to his environment. The agent of nutritional disease is the relative lack of an essential nutrient, but the etiology of the disease includes host factors which determine whether or not a given nutrient intake will be adequate, and environmental factors which affect both agent and host.

The environment includes biological and social as well as physical factors. All three influence the availability of nutrients, the requirements of the host for specific nutrients, and the consumption of nutrients. Determining the cause of a nutritional disease is a study in human ecology -- of the interaction of host, agent, and environment.


Median values for height and weight of culturally deprived children are below standard populations and closer to malnourished groups from underdeveloped countries. Significant correlations were found between height and weight, height and age, weight and age, height and head circumference, weight and head circumferences, and age and mental maturity.

The study of relationships between physical characteristics demonstrates that one measurement alone is not a sufficient index of general health. Multiple measurements including height, hemotocrit, skin fold, and head circumference enlarge upon the meaning of a basic measurement such as weight. The existence of correlations between some of these measurements and the absence of correlation between others suggests an opportunity to give appropriate weights to the former to construct a combined index of general health.

Third Far East Symposium on Nutrition, Manila, Philippines (February 14-21, 1967)

Sufficient experimental findings on enforced semi-starvation show that chronic undernutrition reduces the duration and degree of physical activity. In developing countries, the duration and degree of undernutrition may limit the productivity of population groups concerned. It would appear impossible to affect maximal improvement of the country's economy or the productivity of individuals without first doing the utmost to improve the state of nutrition.
The state of nutrition depends on the kinds and amounts of food available for consumption and the factors determining the distribution and consumption of available supplies. Because of unequal calorie intakes among different geographical areas, socio-economic groups, seasons of the year, and other factors it is better that calorie supplies exceed average requirements. Inequalities among regions are more marked for proteins than for calories. Eighty percent of protein intake in developing countries is of plant origin. Twenty percent of the population in developing countries subsist on diets less than adequate for full calorie and protein requirement. Differences in food consumption between income levels and urban and rural areas are very common. Calorie, total protein, calcium, iron, thiamine, and niacin intakes are higher among the rural populations compared to the urban populations. On the other hand, the quality of protein in the urban areas is better. Increases in income lead to improvements in protein, calcium, iron, riboflavin, ascorbic acid intake, and decreases in caloric intake. The size of the family determines the level of food consumption. Important factors that affect trends in food consumption are: (1) Population growth, (2) Improvement in general economic performance that raises total food demand.

The population effect and income effect give projected increases of food demand of over 140 percent by 1985 over 1962, or an average of 3.9 percent per year. Because the world has not maintained this rate of growth with respect to agricultural productivity, it will have to increase even faster in the remaining years. In countries with low calorie levels demand will increase with staple foods. Large proportions of the population of these countries will continue to be undernourished, because of supply problems and inequalities in distribution. Importance is given to food and nutrition as they are influenced by social, cultural, and psychological factors. Some of these factors are: (1) Cultural values, attitudes, and beliefs, (2) Social and political organizations as these define roles for individuals, families, and groups, (3) Educational systems -- formal and informal -- and opportunities for employment upon completion, (4) Degree of monetarization of the economy, (5) Availability of relevant information regarding nutrition and health, (6) Accessibility of facilities for implementing recommendations, and (7) Diffusion through educational information programs.

In order to improve nutrition, these factors must be identified and their influences assessed in the development of individual, family, and community food habits. Social factors are influential in the production, utilization, and consumption change. Some of these are: (1) Maintenance of status quo, (2) Cooperation only with kin or close neighbors, (3) Land tenure or inheritance systems, (4) Untimely harvesting and inadequate storage and processing, (5) Poor education of women, (6) Consumer education, (7) Social class differences, (8) Status of women and children, (9) Family size, and (10) General lack of education.
Prestige foods may be purchased with rising incomes with the result­ing loss in nutrition. Conspicuous consumption lessens capacities to save and invest. Population growth, compounds inadequacies and infra­structure of rural services and facilities such as credit and marketing systems, communication networks, and rural employment opportunities. Social cultural factors should be taken into consideration when planning improvement programs not done partly because of lack of appreciation and partly due to lack of adequate data. It is now increasingly accepted that positive action to improve nutrition will accelerate the pace of development and may be vital for development. What is needed is a policy to coordinate nutrition, agricultural, health education, economics, and sociology. Such a policy would accelerate progress and food production and storage processing, marketing, imports and exports, legislation, pricing, distribution consumption, preventative and curative medicine, health education, school education, home economics, extension education, feeding programs, and special foods. Food and nutrition policy must be formulated in order for economic development to move forward.

United States Senate Select Committee on "Nutrition and Human Needs"
(December, 1968)

Dr. Gene Mayer. Distinction between hunger and malnutrition is important. Hunger equals undernutrition or even starvation, while malnutrition refers to eating the wrong type of food. Nutritional criteria should be established for entire populations and not just for parts of population. Cravioto did studies showing there was an irreversible deterioration of intelligence as measured by special I.Q. tests in children who were poorly fed or badly fed at the beginning of their lives. Hungry children have a small attention span.

Dr. Michael Latham. "When we hear about one case of kwashiorkor, then we can think of it as a tip of an iceberg." Carlye doing work in Colombia on the effects of malnutrition on brain development found it difficult to separate out the nutrition component from the other component. The lack of intellectual stimulation is very important. Poorly educated mothers and lots of infectious diseases also contribute to malnutrition.

Dr. Herbert G. Birch. At birth the brain of a full-term infant is 25 percent of adult weight. Subsequent weight gain derives from laying down of lipides particularly myelin and cellular growth. Animal experiments in the rat, Davison and Dobb in 1966; the pig, Dickerson, et al, 1967; McKantz, 1960; and the dog, Platt, et al, 1964, have all demonstrated a significant interference with brain growth and differentiation associated with severe dietary restriction, particularly protein during the first month of life. Relation of these data make comparisons to humans difficult. Barnes, et al, 1966, indicate some tendency for poor learning in a nutritionally-deprived animal. Animal findings suggest (1) A direct influence of malnutrition on brain growth and development, (2) Resulting in interference with learning at critical points in development. Inadequacies in
nutritional status may interfere with the learning process manifested by: (a) loss of learning time, (b) interference with learning during critical periods of development, (c) motivation and personality changes.

Darbing, of Manchester, and Winnix, of Cornell, are both interested in reduction in cellular size and number as a result of malnutrition, especially those that were not repaired as a consequence of later improvements.

Charles Upton Lowe. If he had his choice he would pick the first 5.6 years of life and the last 3 months of pregnancy as being the most important influences on nutrition. He would scrap the school-lunch programs if that were the alternative.


The investment made in a child up to age 18 is $10,000 for a family with an income of $2,500. Low-income groups reach peak of earning capacity at 35 to 40 years of age. Therefore, death at 40 represents a slight net gain to society, and death at 65 a gain twice as great.

A U.S. committee on the cost of medical care indicated that if 7 days per year were lost because of illness between $3 billion and $4 billion would be annual cost of temporary and permanent disability in the U.S. It has been estimated in Ecuador that economic loss due to shortened life costs the country 2 million sucre (13.5 to the dollar). Permanent disablement costs another 100 million sucre and temporary loss of productive capacity 150 million sucre.

Illness cost Sweden more than 1 billion krona per year, equal to $50 per capita per year. In Detroit a 5-year program for control of TB cost $200,000 per year and saved $1.4 million in sanitorium costs alone. In 1942, malaria in Egypt cost 135,000 deaths, and one plantation reported a cost of $600,000 which was equal to one-half of the wheat crop and one-third of the sugar crop in the country. In Pakistan one season's work on malaria control has increased the rice yield by 15 percent. Savings of wages lost through malaria would pay for all the expenses of DDT spraying, not counting savings on drugs and funerals or economic benefits due to increased agricultural production.

In the Transvaal in Natal, 30 to 40 percent more workers than necessary were recruited to leave a margin for absenteeism on account of sickness, whereas today only the necessary number is recruited. New lands in South Africa are now cultivated in the absence of malaria. In the coffee belt of Northern Rhodesia 2,030 days were lost in 1945, and 1946 the drainage work was extended still further and treatment of houses began. In 1949 only 270 lost working days were reported. Rubber output per man in Malaysia went up from 45 kilograms per worker to 770 kilograms as a result of the malaria eradication program. A small-framed man in the tropics requires 1400 heat calories per day in order to survive.
In the Ruhr Valley a classic study showed that 20 workmen were given 820 calories in excess of the 1600 to 1800 calories needed. They dumped 1.5 tons of material per day. Thirteen hundred calories of work energy resulted in their dumping 2.2 tons. With the added incentive of cigarettes they dumped 3.4 tons and they lost 3.5 kilograms of excess weight. In another study, 31 miners had 1200 more calories and produced 7 tons of coal per day. At 1600 work calories production rose to 9.6 tons, 155 work calories per ton versus 170 work calories per ton previously. At 2,000 work calories production was raised to 10 tons and weight loss was checked.

In another study on the Pan-American Highway in Costa Rica, kitchens were installed and 10 to 15 pounds of body weight gain was reported within a few months. Concrete paving went from 1.8 cubic yards to 5.9 per man per day.

Flour enrichment in Newfoundland in 1944 resulted in a 10 percent drop in the general death rate, a 25 percent drop in the tuberculosis death rate, and 40 percent in infant mortality attributed to this cause. In California aircraft workers were given vitamins 5 days per week for 9 to 12 months and showed less absenteeism and turnover of the labor force and in merit ratings based on efficiency.