

Freedom from Hunger Campaign

BASIC

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STUDY

MALNUTRITION AND DISEASE



WORLD HEALTH ORGANIZATION • GENEVA • SWITZERLAND

FREEDOM FROM HUNGER CAMPAIGN

Basic Studies Series

A series of Basic Studies supporting the Freedom from Hunger Campaign is being published by the Food and Agriculture Organization and other organizations of the United Nations.

Sixteen such studies are contemplated in the series ; nine will be issued by the Food and Agriculture Organization (FAO), three by the United Nations, and one each by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the International Labour Organisation (ILO), the World Health Organization (WHO) and the World Meteorological Organization (WMO).

The subjects cover a wide range and include, for example, the possibilities of increasing world food production, the part marketing can play in increasing productivity, education and training in nutrition, animal diseases and human health, economic development through food, population and food supplies, education in relation to agriculture and economic development, hunger and social policy, malnutrition and disease, weather and food.

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MALNUTRITION
AND
DISEASE



16897

**MALNUTRITION
AND
DISEASE**

**A Major Problem
of the
Human Race**

WORLD HEALTH ORGANIZATION
Geneva 1963

ACKNOWLEDGEMENT

This study was prepared with the assistance of Dr V. Ramalingaswami, M. D., D. Phil., Professor of Pathology, All-India Institute of Medical Sciences, New Delhi.

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The first half of the twentieth century has witnessed three major revolutions. The political revolution has given self-government to nearly a third of the world's population and has brought their aspirations for a better life to the forefront of world attention. The revolution in communications has broken down the barriers of distance and language, and the dynamism of ideas can no longer be contained within the limits dictated by social privilege or political considerations. The demographic revolution has imparted to the challenge of poverty and want a new dimension.

It is against this background that the Freedom from Hunger Campaign was launched by the Food and Agriculture Organization of the United Nations in 1960. Its main objectives are twofold ; first, to create a world-wide awareness of the problems of hunger and malnutrition which afflict more than a half of the world's population and which, apart from the human suffering and human degradation that they involve, pose a serious threat to peace and orderly progress, and second, to promote a climate of opinion in which solutions to these problems can be organized both on a national and on an international basis.

In the short time since its launching, the Campaign has already provided a focus for co-operative endeavour for international organizations, national governments, non-governmental organizations and various citizens' groups all over the world. The 104 Member Nations attending the biennial FAO Conference in November 1961 paid unanimous tribute to the significance of this Campaign for the future well-being of the world.

The Freedom from Hunger Campaign attempts to attack the problem of hunger on a broad front and at all levels of economic and social thought and action, but for practical purposes, it defines three sectors of operations : (a) information and education, (b) research, and (c) action.

The information and education sector will help bring to citizens everywhere a living awareness of the concrete facts and issues, and provide bases for deciding what new national and international policies and action programmes are needed. This effort to create informed and active awareness will rise to a climax with the World Food Congress to be held under FAO auspices in 1963. Many international professional and citizens' groups will hold forums on Campaign issues in 1963. Many national Campaign Committees will also organize similar discussions. Representatives from all these bodies are expected to participate in the World Food Congress and help bring into focus policies and action plans for the future.

The series of Basic Studies has been prepared by FAO and other co-operating international organizations to aid citizens in discussing the great issues involved. These documents attempt to summarize the known facts and agreed conclusions of experts in each special field, and thus provide useful and reliable background material for study groups and public discussions.

The volumes in this series cover broad subjects such as the adequacy of food levels in the world, the possibilities of producing more food, and the ways in which economic development and training in the newly developing countries can raise buying power and thus help hungry people to buy more food for themselves. They bring out the central importance of good nutrition for health and working efficiency, and study how people can learn to choose their foods better. They appraise the efforts being made in individual countries to raise food output, to increase jobs and incomes, and to train and educate people in ways to increase production and in better dietary habits. The volumes cover the relation of food production to climate and weather, the better distribution and marketing of food, and the use of available surpluses to relieve hunger and provide an incentive to economic and social development in the developing countries.

I trust that these Basic Studies will stimulate thought and action on the critical problem of hunger and contribute to an ever-expanding understanding of the related social, economic and technical issues.

B. R. SEN

Director-General

*Food and Agriculture Organization
of the United Nations*

INTRODUCTION

Malnutrition is one of the most important health problems of the world. It is estimated that between one-half and two-thirds of the world's population suffers from it. This is the result either of chronic insufficiency of food or of inadequacy of the protective foods necessary for a healthy life, or a combination of both situations. Thus, general hunger or hunger for specific essential nutrients ensues, the effects of which are far-reaching.

Infants born of malnourished mothers start life with a handicap. In the first year or two, many of them die of malnutrition alone or, due to their state of malnourishment, succumb easily to gastrointestinal and respiratory infections. The survivors are exposed during growth and adolescence to continued malnutrition and, when adult, show the ill effects in poor stature, low state of health and a comparatively low working capacity.

The prevalence of various communicable diseases in the areas in which hunger also prevails makes the situation still more serious, for resistance to infections in these populations is low, severity of the infectious process in the malnourished host is greater than in healthy persons, and mortality from it is high. Thus, the effects of hunger and malnutrition go far beyond those expected from a mere insufficiency of food. They form the sombre background against which prevalence of disease in the hungry part of the world must be seen, and against which the control and prevention of disease is indeed a difficult task.

This basic study, which has been prepared by WHO as one of the series in the FAO Basic Studies in the Freedom from Hunger Campaign, briefly describes the story of hunger and malnutrition and their effects, and thus focuses world attention on this important problem. It is hoped that this study will stimulate readers in different countries and spur them to action in order that hunger—which is, after all, preventable—may be banished from this world of ours.



U. Thoden
Director-General

World Health Organization
Geneva
December 1962

PART I — APPROACHES TO THE PROBLEM

General considerations

*“ Let us remember that two-thirds of the world’s people are underprivileged—under-fed, under-healthy, under-educated—and that many millions live in squalor and suffering. They have little to be thankful for save hope that they will be helped to escape from this misery . . . these [problems] are all symptoms of a new evolutionary situation ; and this can only be successfully met in the light and with the aid of a new organization of thought and belief, a new dominant pattern of ideas relevant to the new situation. ”*¹

During this century, a “ new organization of thought and belief ” has slowly been forming with regard to the special problem of the hunger of the underprivileged people of the world. An early phase, fostered in Great Britain by Boyd-Orr and Drummond before the war, was the revolutionary idea that people should be fed according to their needs rather than their economic ability, and that the welfare of the rich and of the poor in that country was inextricably interwoven. The acceptance by the majority of a system of food-rationing based on this principle during the Second World War showed how successfully the idea had taken root. The consequences showed how necessary it had been, for there were sustained increases in the heights and weights of the children of working-class families.

The post-war years provided rich soil for the growth of “ ideas relevant to the new situation ” not only among the well-fed people of the economically rich countries, many of whom had glimpsed for the first time the way the other half of the world lived, but also among the precariously nourished in many parts of the world, whose traditional habits and expectations had been even more disturbed by contact with strangers. Emergency measures inaugurated by many different agencies to cope with the starvation and chaos left by war have developed into generously-conceived, persistent efforts to prevent hunger and disease, especially among children. The creation of one international agency, the Food and Agriculture Organization of the United Nations, to assist countries in their tremendous task of ensuring that people everywhere have enough of the right kind of food, and

¹ Huxley, J. (1961) Address given in Chicago on Thanksgiving Day, 1961, and quoted in *The humanist frame*, Huxley, J., ed., Allen & Unwin, London, p. 21.

of another, the World Health Organization, to help in national efforts to improve standards of public health, has done much to stimulate research and action in the field of nutrition. At the same time, the problems of malnutrition and ill-health have been studied intensively in different countries. Appalled by what such studies revealed, governments, national and international agencies and teams of scientists in the field of nutritional and sociological research, economics, agriculture, health and education have been striving to find ways to break the vicious circle of poverty, malnutrition and more poverty. Gradually the idea has grown that the welfare of the privileged and of the underprivileged anywhere in the world is interdependent.

An intensive effort is now being made to free the world from hunger—an effort that will be successful only if it can enlist the vigorous, imaginative co-operation of people everywhere, in the affluent and the hungry countries alike.

But co-operation without comprehension, like thought without knowledge, is perilous. This study presents some of the known facts about nutrition and health in the world today, and describes the main difficulties that have to be overcome if freedom from hunger is to become more than a dream for millions of people.

The “epidemiological” approach

Study of the great epidemic diseases which have from time to time ravaged populations has gradually developed into a science with recognized methods appropriate to its task. The “epidemiological approach” includes the study of three separate but interacting factors—the disease-producing “agent”, the “victim” on whom the destructive agent acts, and the “environment”. For many years the identification and study of the agent (bacillus, parasite or virus), claimed most attention, and limited consideration of the victim and the environment—the conditions of life, climatic and geographic, economic, social and educational, religious and cultural. Now, with the realization that the disease-producing effect of the agents is highly variable, it is becoming more and more obvious that study of the whole man—his physical, mental and social state within his environment—is a necessary step towards understanding the actual disease in the individual, or the maintenance of health in the community.

Nowhere is this more necessary than in the field of nutritional health. The increasingly successful control of some of the major communicable diseases has not resulted in as general an improvement in health as was expected. Their disappearance has, in fact, revealed the devastating effect of the interaction of agent, victim and environment in the production of various forms of malnutrition. Here the agent may be an inadequate total food intake, or a deficiency of one or more specific nutrients. The victim may be the unborn child, the infant, the pre-school-child or the schoolchild,

the woman, particularly when pregnant or lactating, the wage-earner or the lonely old man. The environment may present an infinitely complicated pattern of influences which vary widely in form and intensity in different parts of the world.

The need to understand the part played by all three elements has invoked the skills and co-operation of many different scientific workers. A considerable amount of knowledge has now been acquired, some of it from the fortuitous coincidence of observation and imagination followed by planned research and experiment in laboratories and in the field, and some from the study of the health records—the vital statistics—of various countries. More recently, economic, agricultural, anthropological and educational studies have added to the understanding of the nature of nutritional problems, and of possible approaches to their alleviation.

The sources of nutritional knowledge

Food and health have long been linked in the minds of men, though most of the early dicta have been in the form of prohibitions for the avoidance of ill-health rather than prescriptions for the promotion of health. “Thou shalt not...” occurs much more frequently than “Thou shalt...” in the ancient books.

Nevertheless,

“It is interesting to note that food folk-lore, which is based on many millions of observations made since man was able to communicate the acquired knowledge of one generation to the next, anticipated some of the discoveries of the modern science of nutrition. For example, it is now known that pregnant and nursing women require a diet rich in calcium. In Northern China powdered deer antlers, which are rich in calcium, have long been used to prevent the ill-effects of calcium deficiency in mothers. It is now known that endemic goitre is due to lack of iodine. The Chinese, and later the Greeks, used certain kinds of seaweed which are rich in iodine to cure these diseases. The North American Indians used pine needles, which are rich in ascorbic acid, to cure scurvy, long before the discovery of vitamins. Natives of Kenya, on long and arduous journeys in tropical heat, sucked salt-rich earth to prevent the onset of muscular pains, fatigue and malaise, long before a distinguished British scientist discovered that these symptoms in miners are due to the loss of salts in heavy perspiration, and can be prevented by the consumption of food and drink rich in salt.”¹

One of the earliest sources of information, the dramatic description by Hakluyt in 1600 of the discovery by a French explorer, Jacques Cartier, of a cure for scurvy—a decoction of pine needles—was unfortunately ignored for many years during which this nutritional disease continued to ravage the crews of ships on long voyages. So also was “The Treatise of the Scurvy” published by Lind, a Scots naval surgeon in 1753, though Captain Cook on his voyage of discovery round the world in the 1770’s made good use of its recommendations and, by providing his men with fruit and vegetables

¹ Boyd-Orr, Sir John (1953) *The white man's dilemma*, Allen & Unwin, London, p. 36.

whenever possible, saved them from the dread disease. But it was not until 42 years later that the Lords of the Admiralty were persuaded to put Lind's precepts into practice and thus immediately eradicated scurvy in the Royal Navy. The disease lingered on, however, in the merchant navies of the world for a further 50 years. A long interval between the discovery of new knowledge and its application to the benefit of people's health occurs only too frequently, even today.

Less sadly dilatory is the story of another naval surgeon who added an important discovery to nutritional knowledge. Takaki, a surgeon in the Japanese Navy, was the first to demonstrate the nutritional origin of the disease beriberi. In 1883 and 1884, after some years of study, he persuaded the authorities to replace a part of the rice in the sailors' diet by wheaten bread, and to increase the allowance of vegetables and milk—with the result that the number of cases of beriberi in the navy was reduced from 1485 in 1878 to three in 1886 and nil in 1887. Takaki attributed the success of his innovation to an increase of protein in the diet of the sailors. The first clue to the direct relationship between rice and beriberi, and incidentally to the whole idea of "vitamins", came from a combination of accident and observation. A Dutch physician, Eijkman, working in a military hospital in Java, observed that domestic fowl fed on left-overs from the diet of beriberi patients developed weakness of the legs and head retraction. He then discovered that he could almost invariably produce this peripheral neuritis by feeding the birds exclusively on highly milled rice and that under-milled rice, or highly milled rice to which husks or pericarp had been added, would not produce the disease. It was not until several years later that the true cause, the loss of an essential vitamin in the process of milling, was established.

The first half of this century saw great interest and activity in the study of individual nutrients in the diet, in the identification of the newly-recognized protective substances, vitamins, and in the production of synthetic forms, again with the hope that here might lie the solution to much ill-health throughout the world. In spite of this improvement in the treatment of the specific vitamin-deficiency diseases, however, hunger and malnutrition still persist, and the search for ways and means to relieve this enormous burden of nutritional ill-health continues.

The problem is now being attacked and fresh knowledge sought from another angle. The nutrition workers who have contributed so much by their study of the disease-producing agent are now turning their attention to the victim and to the environment.

Statistics as a source of new knowledge

Public health workers have always been concerned with the environment, and to them the vital statistics of a population have been a constant source of information and guidance. Unfortunately, in the countries most affected by malnutrition, these records are almost always inadequate and unreliable.

Unless a country possesses a good system of communications, a literate population, the means whereby sick people can be efficiently examined by medically qualified persons, and accurate records of the number and causes of disease and death, there will be little or no sound knowledge on which to base an idea of the extent of disease and the level of health. In few places do such conditions exist. Nevertheless, information from existing records, combined with the results of intensive surveys and pilot studies, provide at least some indication of present conditions.

Undernourishment as it affects different age-groups

This form of malnutrition exists all too widely throughout the world, and its full effect is probably immeasurable at present. A state of chronic undernourishment has been the "normal" state for so many people for so long that it is only just beginning to be realized that some so-called "national characteristics" are, in reality, the characteristics of a continuing and apparently unchangeable want—want of food.

Some of the physical effects of undernutrition are measurable and known. They vary with the victim, the unborn child, the young child in the period of rapid growth, the pregnant or lactating woman, and the adult wage-earner.

Numerous studies have shown that, where hunger and malnutrition exist, an unusually large proportion of the babies born alive have a low birth-weight. Fig. 1 shows a comparison of the birth-weights of babies born to well-to-do and to poor, ill-nourished mothers in a town in Indonesia.¹ The birth-weights of infants born in Singapore, India and several parts of Africa show a similar pattern. Birth-weights are no doubt influenced by several factors, such as the genetic make-up of the offspring, its sex, whether it is one of twins or not, whether it is the first or the fifth child, the age of the mother, etc., but the importance of maternal nutrition is easily demonstrated by supplementing the diets of the expectant mothers with essential nutrients. It has been shown that a more adequate maternal diet results in an appreciable increase in the birth-weights in a community.

The *baby* of a malnourished mother appears on the whole surprisingly normal, though somewhat underweight. Some nutritional deficiencies of the mother, however, are reflected in the offspring. For example, maternal deficiency of vitamin A may, because of the resultant poor foetal storage, predispose the infant to vitamin A deficiency in late infancy and early childhood.

The incidence of prematurity among the newborn is also higher in economically underprivileged regions and among the malnourished in any

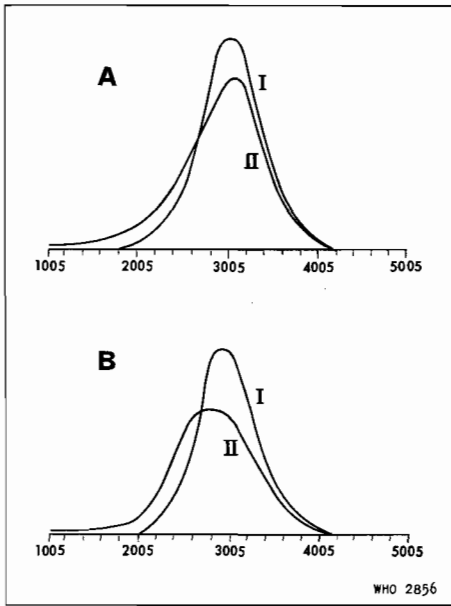


FIG. 1. FREQUENCY CURVES OF THE BIRTH-WEIGHTS OF MALE AND FEMALE CHILDREN OF (I) WELL-TO-DO AND (II) POOR JAVANESE MOTHERS IN JOGJAKARTA

A = Males
B = Females

community. The premature infant poses a problem of great complexity, but there is now no doubt that maternal malnutrition plays a predominant part in causing this problem.

The risks to a child in his *post-weaning years* are very considerable (see page 20). Inhibited growth and development, lowered resistance to infection, and the frank manifestation of various types of nutritional deficiency are all the outward evidence of undernourishment in this age-group—culminating in high mortality rates.

Later, the spurt of growth in *adolescence* demands an adequate supply of basic foods. Failure of growth and the inability to attain the standards of height and weight considered normal for any one age-group is conditioned by a multiplicity of genetic and environmental factors. It is, however, an established fact that decrease in the expected rate of growth accompanied by actual loss of weight is the consequence of nutritional failure, and especially of an inadequacy of proteins and calories.

It has been demonstrated time and again that if underfed children are given a balanced diet in adequate amounts, or even a midday school lunch or a milk supplement, their heights and weights, and ultimately their physical and mental performance, improve considerably.

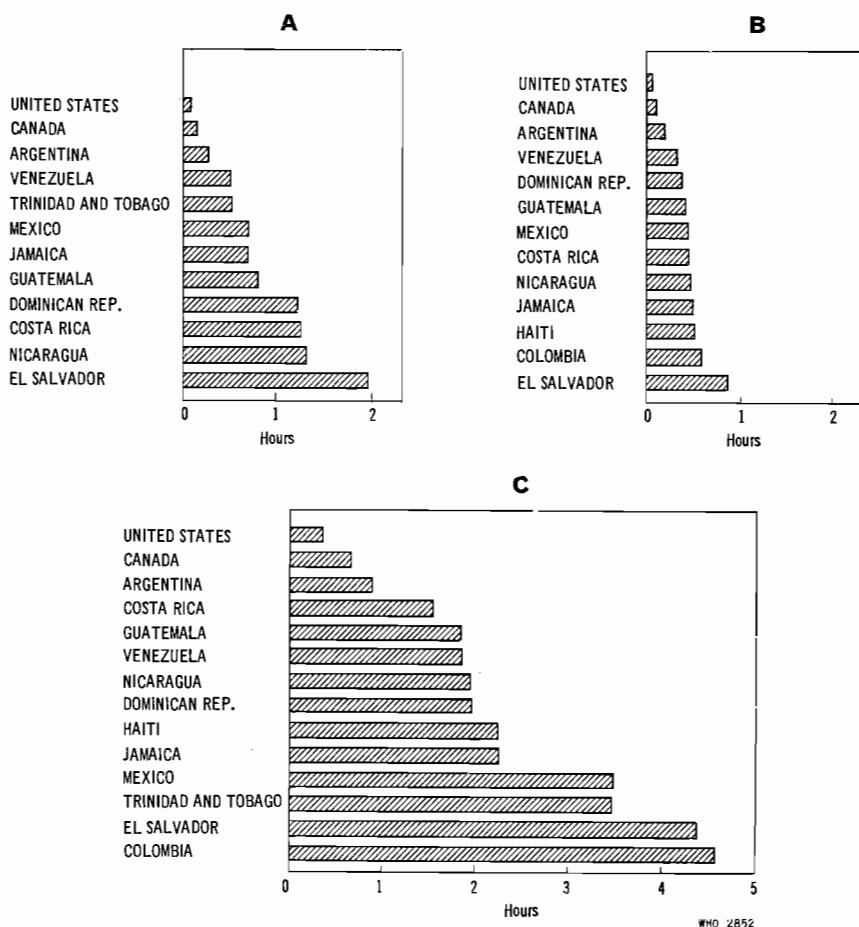
During pregnancy the nutritional needs of the mother are enhanced, and continue throughout the period of lactation, the duration of which varies in different parts of the world and is frequently prolonged among malnourished communities.

In some of the more prosperous countries of the world a healthy, well-nourished mother apparently gains 12 kilograms during pregnancy. Weight

gains of women during pregnancy in malnourished populations are considerably less, and indeed pregnant women in some populations do not increase their bodyweight at all. Considering the prolonged period of lactation and the late weaning of children in such populations, the drain on maternal reserves of nutrients must be extreme and accounts for either stationary bodyweights or even loss of weight during this period.

It appears, however, that within a certain range of nutritional variation, the pregnant woman is capable of retaining and utilizing nutrients much

FIG. 2. WORK-TIME REQUIRED TO BUY SPECIFIED AMOUNTS OF WHITE WHEAT BREAD, MILK AND BONELESS BRISKET IN AREAS OF THE AMERICAS, OCTOBER 1959 *



A = 1 kg white wheat bread

B = 1 litre milk

C = 1 kg boneless brisket

more efficiently than the non-pregnant one, except in the face of severe nutritional deprivation such as followed, for example, the siege of Leningrad. There the severe starvation resulted in a marked fall in the birth-rate and an increase in the incidence of prematurity (40% of the total live births); nearly 31% of the premature babies died during the first month of life.

The relationship between *maternal nutrition and lactation* is not yet fully understood. The ability of malnourished and undernourished mothers to lactate successfully over prolonged periods contrasts sharply with the failure of lactation in well-nourished, sophisticated societies today. The malnourished mother can apparently produce breast milk with approximately normal concentrations of protein, fat and carbohydrate: the vitamin content of her milk, however, depends on the adequacy of her own reserves of these substances. Unfortunately, with increasing sophistication the practice of prolonged breast-feeding is declining, even in developing countries, at an alarming rate—alarming because there is usually no satisfactory substitute available for the weaned child. This trend is creating one of the most disastrous hazards to child life in the world today.

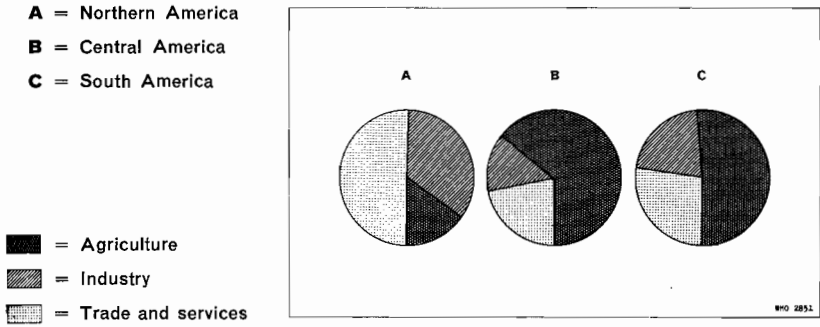
The poor nutritional status of the adult population in many countries is due largely to the inadequate production of essential protective food and to lack of purchasing power, combined frequently with ignorance of the value of certain foods for the maintenance of health. The first two factors working together are alone enough to perpetuate the vicious circle of malnutrition and poverty. To earn the price of one kg of white wheat bread takes seven minutes of work in the United States of America but two hours in El Salvador (see Fig. 2). To pay for one kg of meat (boneless brisket) takes 20 minutes of work in the USA (Chicago) as compared with 4.5 hours in Colombia (Bogotá). Five minutes of work will pay for one litre of milk in the USA, but in El Salvador 52 minutes are necessary. The purchasing power of the unskilled worker is even more restricted, and that of the agricultural labourer worst of all, because wages in agriculture are usually much lower than in industry (see Table I), and in the countries where

TABLE I. HOURLY WAGES (US\$) IN MANUFACTURING INDUSTRIES AND IN AGRICULTURE IN AMERICAN COUNTRIES (1958)

Country	Wages (US\$)	
	Manufacturing industry	Agriculture
Canada	1.80	0.92
Chile	0.20	0.04
Colombia	0.17	0.07
Costa Rica	0.25	0.17
Mexico	0.51	0.07
Peru	0.23	0.10
United States of America	2.22	0.76

malnutrition is rife, the majority of the population is employed (or self-employed) in agriculture (see Fig. 3).

FIG. 3. DISTRIBUTION OF LABOUR FORCE INTO THREE SECTORS IN THE COUNTRIES IN THE THREE REGIONS OF THE AMERICAS, 1950



The undernourished adult has neither the energy nor the initiative needed for maintaining a high standard of productivity: he is neither physically nor psychologically fit for work.¹

¹ Freedom from Hunger Campaign (1962) *Nutrition and working efficiency*, Basic Study No. 5, Rome, Food and Agriculture Organization.

PART II — THE FACTS REVEALED

The infant in its first year of life and the young child are extremely vulnerable. They succumb readily where the environment is insanitary, overcrowded and inadequately sheltering; where infectious diseases and infestations are rampant; where the quality of mothering is poor, due either to ignorance or to the absence, for one reason or another, of the mother. Where foods suitable for the immature creature are scarce or non-existent, or where they are unused because of ignorance or prevailing misconceptions of the needs of children and the nature of health, disease and human beings in general, the threat to child life is greatly increased.

These conditions existed widely in the industrialized countries at the beginning of the century, and gave rise to infant mortality rates¹ of over 100. Well-established public health services have controlled or eliminated the communicable and vitamin deficiency diseases, and there is an abundance of foods, especially milk, suited to the needs of the infant and young child. In addition, the number of children in the individual family has decreased, and parents, literate, more or less educated, and with energy to spare, have increasing opportunity to put into practice at least some of the constant flow of advice and information about child care that reaches them from many sources.

Where these improvements have been established for some years, the infant mortality rate has rapidly declined. This rate, in fact, provides a reliable index of the standard of health and socio-economic conditions in a country, and is often used as such. Today, about 15% of the world's population lives in countries where infant mortality is between 16 and 30, and about 7% where it is approximately 40. The rest, unhappily the majority, live in circumstances that give rise to an infant mortality that varies between 60 and 150 or more, and where 50% of all deaths occur in children under five years of age.²

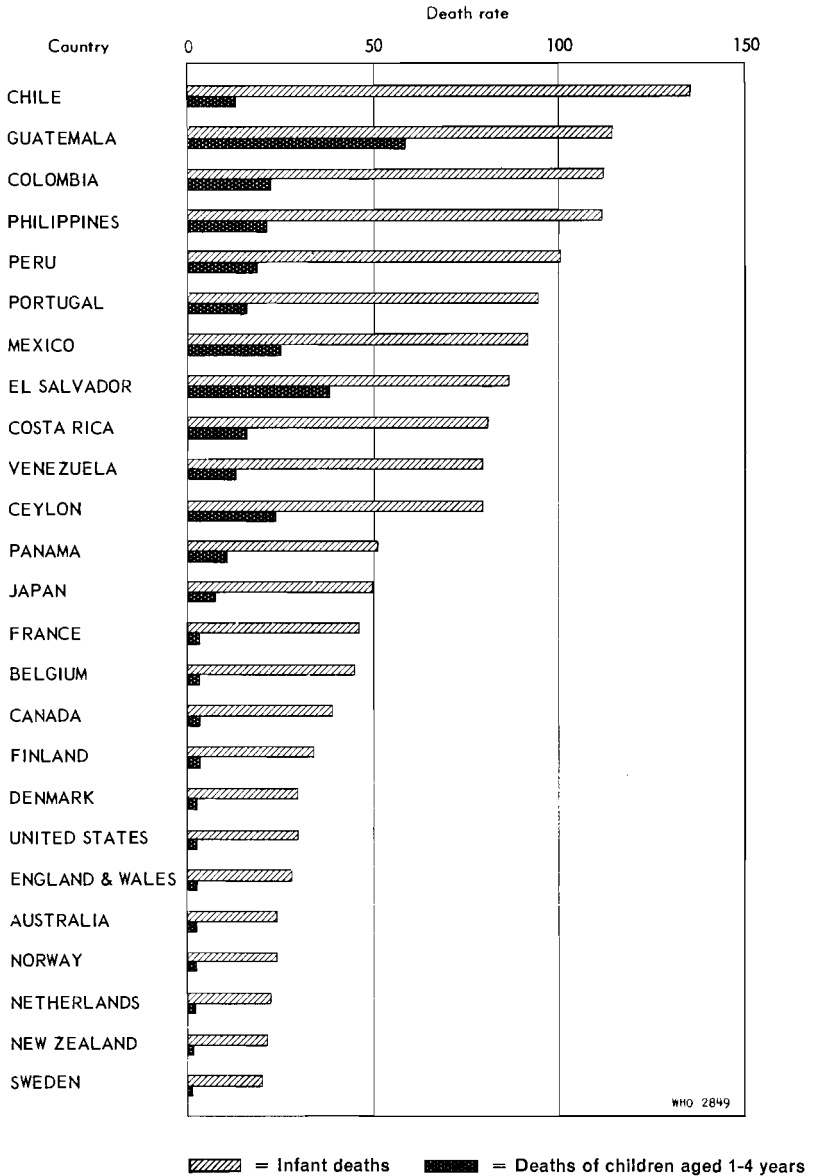
On analysis, infant mortality rates show that improvement of the environment has had more effect on the deaths of infants in the later months of the first year of life, but they do not show (unless scrutinized together with records of the causes of death) the relative importance of any one of the life-saving improvements that have taken place. The study of other statistics

¹ Infant mortality rate is the number of deaths of infants in the first year of life per 1000 live births.

² Verhoestraete, L. J. & Puffer, R. R. (1958) Challenge of fetal loss, prematurity and infant mortality—a world view. *J. Amer. med. Ass.* **167**, 950.

has recently thrown some light on the importance of the nutritional element in the hazards affecting child life.

FIG. 4. INFANT DEATHS PER 1000 LIVE BIRTHS AND DEATHS OF CHILDREN 1-4 YEARS OF AGE PER 1000 POPULATION FOR 25 SELECTED COUNTRIES *



* Reproduced by kind permission of the editors from Verhoestraete, L. J. & Puffer, R. R. (1958) *J. Amer. med. Ass.*, 167, 950.

The child under five years of age

When the *rate of decline* of infant mortality figures is compared with the *rate of decline* of the mortality figures for children aged 1-4 years, the latter is found to be greater. During the past 30 or 40 years, several of the wealthy countries have been able to reduce mortality rates in the 1-4 years age-group dramatically, thus proving how extremely vulnerable the child of this age is to a harsh and unhealthy environment, and how responsive to the improvements that have taken place.

In the countries where economic, social and cultural conditions combine with a difficult terrain and climate to hinder environmental changes for the better, the picture is lamentably different. There the infant mortality, though declining, may be ten or more times higher than in the economically-developed countries, but the mortality among children of 1-4 years of age is 30 or 40 times higher or even more (see Fig. 4). The picture in different parts of the Americas is shown in Fig. 5. Infant mortality rates in most American countries are from two to four times the rate in the USA, but the lowest recorded rate for the 1-4 years age-group in a Central American country is eight times as great as in Northern America, and the highest is 42 times as great.

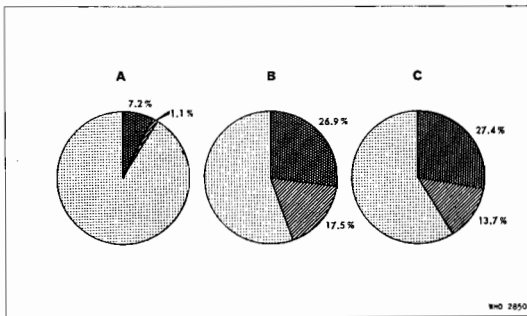


FIG. 5. PERCENTAGE OF TOTAL DEATHS THAT OCCUR IN INFANCY AND EARLY CHILDHOOD IN THE THREE REGIONS OF THE AMERICAS, 1956

A = Northern America
B = Central America
C = South America

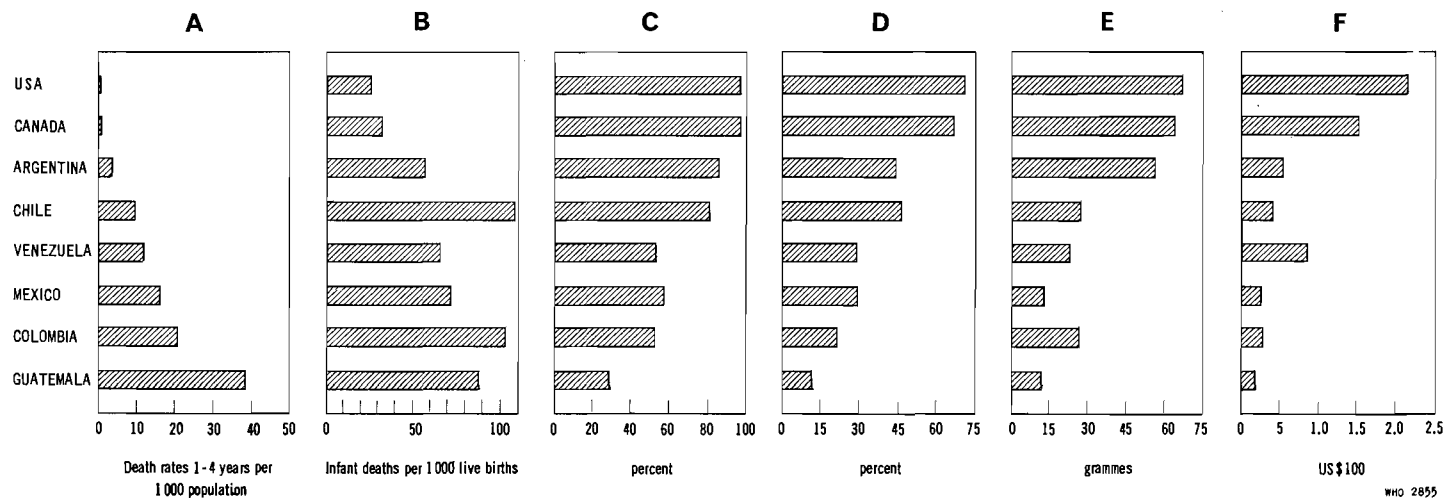
■ = Under 1 year
▨ = 1-4 years
▩ = 5 years and over

The relationship between environmental conditions which can be controlled and the mortality of children in the 1-4 years age-group is shown in Fig. 6, where the death-rates for under one year and for 1-4 years are given for eight countries of the Americas together with four measures of socio-economic development (literacy rates, extent of water service, consumption of animal protein, and per caput national income). As income, protein consumption, sanitation and literacy decrease, the death-rates in the 1-4 years age-group increase.

The causes of death in infancy and early childhood

It seemed natural to presume that these high death-rates were due to the special hazards of a tropical climate, but it is now known that this is not so.

FIG. 6. FOUR MEASURES OF SOCIO-ECONOMIC DEVELOPMENT, COMPARED WITH CHILD DEATH-RATES IN EIGHT COUNTRIES OF THE AMERICAS *



A = Death-rates 1-4 years per 1000 population
B = Death-rates 0-1 year per 1000 live births
C = Literacy: percentage population literate

D = Water supply: percentage population with water service
E = Animal protein consumption: grammes per caput per day
F = Income: US \$ 100 per caput per year

* After Horwitz, A. (1960) *Amer. J. publ. Hlth*, 50, No. 5, Part II (Suppl.), p. 20.

Contrary to expectation, the most dangerous diseases of childhood are not the tropical diseases but the cosmopolitan, those which, 50-100 years ago, were killing children in the now-prosperous countries. Infections, especially the diarrhoeas, respiratory infections, tuberculosis, measles, whooping-cough, all take a heavy toll of child life in India, Africa and Latin America and the countries of the Middle and Far East, with the tropical diseases such as malaria acting as additional hazards.

Among children under five years of age the gastrointestinal infections cause many deaths. Some of these infections are hand-carried and for their prevention water readily accessible and easily available to each family is necessary. A recent survey reveals a typical picture: 39% of the urban population in countries of Latin America were without water service from a community piped-water supply. In small cities of 2000-10 000 inhabitants, 70% were without water service, and the same is probably true for at least as large a proportion of those living in smaller communities and rural areas. In such circumstances, 20-40 times as many children die from gastrointestinal infections as in Northern America.

Infectious and parasitic diseases are also responsible for the excessive mortality of children under five years of age in many countries. There is, in fact, evidence that the infectious diseases of childhood have more serious effects among the underprivileged people of the world than is usual elsewhere. Whooping-cough death-rates in Latin America, for example, are 40 times greater than those in the USA and Canada. In the 1-4 years age-group, the death-rates from measles and poliomyelitis are also higher: in some parts of the world they may be 100-200 times higher than in the prosperous countries.

Malnutrition—the real killer

It is not difficult to understand why, in any environment which provides no safe water, no sanitary method of sewage disposal and often inadequate shelter from extremes of climate, many babies and young children die from the diarrhoeal diseases or from respiratory infections. But why should they succumb in their pre-school and school years to the common diseases of childhood, such as measles or whooping-cough, which are not universally lethal? Recent investigations carried out in typical small population groups in different parts of the world have shown that *malnutrition contributes considerably to this very high mortality, especially among children 1-4 years of age.*

In Java,¹ for example, an investigation into the causes of death in 1300 children who had died in hospital during the years 1954-58 showed that malnutrition was responsible for 9% of the deaths in infancy, 36% of the deaths in the second year, 40% of the deaths in the third year, and 19%

¹ Timmer, M. (1961) *Child mortality and population pressure in the D. I. Jogjakarta, Java, Indonesia: a social-medical study*, Rotterdam (Thesis).

in the sixth and seventh years. In addition, many diseases were found to have a higher mortality rate than is usual among well-fed children.

The infant is protected, to some extent, against malnutrition and the gastrointestinal infections during breast-feeding, but the pre-school-child is exposed particularly to the risk of an inadequate, unsuitable and unhygienic diet. Moreover, it is likely that a great deal more frank malnutrition actually exists and is lethal in this age-group than is recognized and recorded. A recent study¹ carried out by members of the Nutrition Institute of Central America and Panama (INCAP) has shown that a large proportion of the deaths of children under five years of age attributed either to diarrhoea or to parasitic infection were in fact due to malnutrition. Of the 109 deaths of children aged 1-4 years that were investigated over a two-year period, 40 occurred in children with the signs and symptoms of severe malnutrition, yet only one was officially listed as death resulting from malnutrition (see Table II).

TABLE II. DEATHS OF CHILDREN 1-4 YEARS OF AGE IN FOUR GUATEMALAN VILLAGES, 1956 AND 1957

Causes	Source of information	
	Civil Register	INCAP study
Respiratory infections	15	15
Infectious diseases	11	14
Parasitic diseases	45	0
Diarrhoea	15	25
Severe malnutrition (mostly kwashiorkor)	1	40
Other	22	15
Total	109	109

It is possible that in any country a high mortality rate in the 1-4 years age-group indicates widespread malnutrition² and that the death-rate in this age-group can be used as an index of the nutritional status of the population³ in much the same way as the infant mortality rate is used as an index of health and socio-economic standards. What kind of malnutrition is it that so undermines the health of children that they cannot survive the ailments common to their years, and which their well-fed contemporaries take in their stride? What is the destructive agent? How does it interact with the environment to produce such disastrous effects?

¹ Scrimshaw, N. S. & Behar, M. (1959) World-wide occurrence of protein malnutrition. *Fed. Proc.* **18**, No. 2, p. 82.

² Bengoa, J. M., Jelliffe, D. B. & Perez, C. (1959) Some indicators for a broad assessment of the magnitude of protein-calorie malnutrition in young children in population groups. *Amer. J. clin. Nutr.* **7**, 714.

³ Wills, V. G. & Waterlow, J. C. (1958) The death-rate in the age-group one to four years as an index of malnutrition. *J. trop. Paediat.* **3**, 167.

PART III — THE DEFICIENCY DISEASES

Protein-calorie malnutrition

Most forms of malnutrition are caused by a deficiency of some essential food or nutrient—either because the total quantity of food taken by the individual is inadequate, or because some special nutrient is lacking in the diet, or is present only in inadequate amounts.

The cult of vitamins has been so highly developed in Western countries that, for many people, any mention of dietary deficiencies invokes ideas of the diseases such as rickets, scurvy and beriberi that are primarily due to lack of vitamins. Indeed, for a long time the medical profession sought an explanation of the widespread ill health of children in the underprivileged countries in terms of vitamin deficiency.

In 1933, however, Dr Cicely Williams, a paediatrician of wide experience then working in West Africa, described an illness in the children there which she called by its local name “kwashiorkor”, and which, she demonstrated, was curable by giving the children milk. She concluded that the illness was a form of malnutrition due to the lack of protein in the diet of the weaned child. The name itself means “the sickness the child develops when another baby is born”, and has been widely adopted to describe the protein malnutrition that is found in practically every economically underdeveloped country in the world.

In these countries there is seldom any food suitable for the weaned child, whose need for the body-building protein is relatively great during the period of rapid growth. For people born and brought up in the privileged countries, milk is so closely associated in their minds with young children and weaning that it is sometimes difficult for them to realize that most of the world's children have to pass straight from breast-feeding to a diet largely composed of starchy foods. In some countries these foods are too coarse and bulky for an immature digestive system, and the child therefore suffers from a moderately-deficient calorie intake and a grossly-deficient protein intake. In fact, the condition, particularly in its less acute form, is now usually referred to as “protein-calorie malnutrition” and may manifest itself at any point along a continuous range from the classical forms, in which calories are adequate or even abundant (as in the “sugar-baby” type described in Jamaica) to those in which there has been a severe calorie deficiency accompanied by considerable wasting or even gross emaciation.

Kwashiorkor

The following description of what happens in Africa can be regarded, with some minor variations depending on local conditions and customs, as typical of what is happening to many children in many countries today.

The African child is a splendid little creature so long as he is being adequately breast-fed. He is plump, vigorous and active, and usually grows faster than his European counterpart. His appearance and behaviour belie any possibility that he suffers, as Mexican children have been said to suffer, from a congenital inborn state of malnutrition. It is all the sadder, therefore, that when he is weaned, which may be at 12 months in some tribes, and at 24 months or even later in others, he is often a puny creature with hair that is brown instead of black, skin that is paler than it should be, thin arms and legs, and a pot-belly. It is not unusual to find that such children, at the age of 18 months, weigh no more than they did at nine months. They may not show the signs of recognizable disease: the discoloration of the hair and skin may be so common in a population of children that it is regarded as normal, and in most societies a certain slimness is expected in children after the plumpness of babyhood. Nevertheless, a comparison with children of the same tribe who are known to have been given a well-varied and full diet containing adequate amounts of fresh cow's milk will reveal not merely discrepancies in hair and skin but an extensive degree of "dwarfing". There is little doubt that nutrition is the chief cause; and little doubt, too, that in the majority of cases the deficiency is not in the caloric value of the diet but in its protein. The shortage of protein may reduce appetite, so that even if the food offered is adequate to satisfy calorific requirements, the child takes less than he would do if it included more protein. If a complete survey could be made, there is little doubt that very large numbers of African children would be found to be small for their age by the standards of the higher social grades of their own people.

The period of poor growth in children who are faultily nourished in the way described lasts until about the fourth year. After that age the rate of growth usually improves, but it is fairly clear that in many children complete compensation is not possible, and the full potential for growth is never realized.

The acute disease kwashiorkor should perhaps be regarded as the logical extension of the dwarfing that has just been described. It occurs in all degrees, of which the slightest, like the dwarfing, have been unsuspected until recent years. The children affected are nearly always not only small for their age, with hair and skin of a pale colour, but also exhibit feet and legs swollen from an accumulation of excess fluid; their appetites are capricious, and they are easily liable to digestive upsets. Those more severely ill may have hair of any colour to greyish-white, very pale skins, and swellings of the legs and thighs, hands and face. In the most advanced state the hair is so loosely embedded that it can be pulled out in tufts without causing pain; the eyes may be closed with the swelling.

which occurs in nearly every part of the body, and the skin may break down as though it had been burnt. At this stage the child appears to be desperately unhappy or sunk in apathy (see Fig. 7). He will not stand or walk and will not willingly move in his bed except to pull the covers over his head. He resists any interference, even feeding.



FIG. 7. CHILD WITH KWASHIORKOR, SHOWING TYPICAL ATTITUDE OF APATHY

The chief cause of kwashiorkor is almost certainly a diet that is lacking in protein, but other factors are involved : simple starvation must include a starvation of protein, but does not result in kwashiorkor. Probably some pathological processes supervene that bring about drastic alterations in various functions. The processes may be initiated by several means : by an excess of starches and sugars over proteins in the diet, by the lack of proteins of high nutritional value, by the reduction or absence of some other part of the diet that might be protective, or by an infection that increases the need for nutrients beyond the capacity of the diet to supply them. There is even the possibility that the state of mind of the child may play some part by translation of unhappiness into a reluctance to eat well.

Once the stage of gross swelling, severe skin lesions and apathy has been reached, kwashiorkor is fatal unless it is skilfully treated, and even where the best care and attention can be given the mortality may be as high as 30%. On the other hand the mortality in early cases, where the child can be given a week or two of the correct feeding, is almost negligible. Sometimes the daily addition to the home diet of a suitable concentrated food, rich in protein, suffices without admission of the child to hospital.

Marasmus

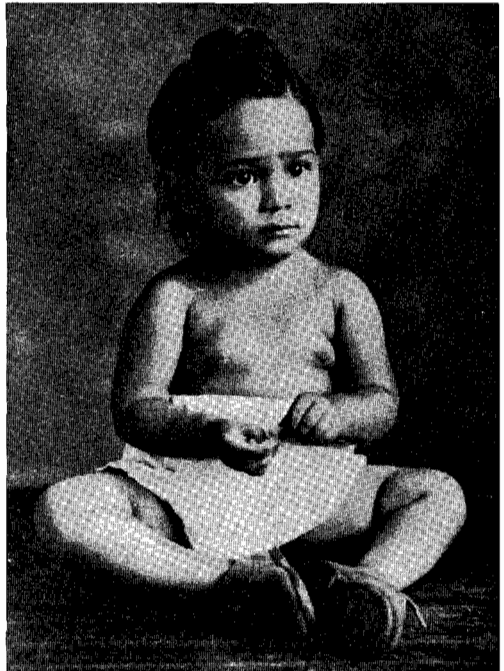
In addition to the many children who suffer from nutritional dwarfing and from kwashiorkor, there are as many, or more, who develop the condition known as marasmus, a form of starvation that is less specifically related to a shortage of protein. It can be caused by the almost complete absence of food but, except in times of famine, this is rare. Much more frequently it develops when breast-feeding fails for one reason or another, or when the child suffers from some disease that prevents the utilization of the food eaten, or renders the diet inadequate for the maintenance of health. Such a disease is most often one of the type causing diarrhoea, and the greater proportion of the victims are children under a year old. In European countries in which marasmus caused by summer diarrhoea used to be a severe problem, it was noticed that the majority of the children affected had been bottle-fed or inadequately breast-fed, and in Africa and elsewhere there is a fairly close relationship between marasmus and poor breast-feeding. In many countries today, breast-feeding is on the decline and marasmus is increasing. If the mother is unable to breast-feed her child, or ceases to do so prematurely, an adequate substitute for her milk can

FIG. 8. VENEZUELAN CHILD WITH MARASMUS (A) BEFORE AND (B) AFTER TEN MONTHS OF NUTRITIONAL REHABILITATION

A



B



seldom be found. The child is given some unsuitable, inadequate and often contaminated concoction, highly-diluted dried or sweetened condensed milk, rice-water, or gruels made of corn-flour, arrowroot or sago, coloured with milk.

Marasmus also occurs after the first year of life ; diarrhoeal diseases are most commonly in the background but respiratory diseases—not only tuberculosis but other infections that have long-lasting effects—are also important. Severe epidemics of the usual childhood diseases, such as whooping-cough and measles, increase its incidence.

Marasmus differs from kwashiorkor in various ways (see Fig. 8). The marasmic child is wasted, not swollen. His hair is dull and dry, but not discoloured. The skin is thin and wrinkled and has lost its elasticity, but it does not break down. The child does not refuse food and does not show the same resentful apathy as in kwashiorkor. The terrible wasting makes the eyes look enormous and staring, and there may be, in some cases, a stiffness in the limbs, due to muscle spasm. Why marasmus develops, rather than kwashiorkor, is not understood but it seems that in kwashiorkor something happens that starts a series of changes in the chemistry of the body—perhaps in the complex process of the constant renewal of proteins—that causes the characteristic signs to appear. The child who has marasmus is much less likely to be depleted of proteins, and dies chiefly because his diarrhoea and vomiting, or the other causes of his condition, have brought about great losses of body fluids, and such gross wasting of all the tissues—fat, muscles, intestinal walls, etc.—that they can no longer perform their various biological functions. Only too often marasmic children are brought to hospital in such a moribund state that nothing can be done to save them.

Prevalence of protein-calorie malnutrition

It is impossible at present to estimate accurately the total number of children in the world who are affected by these two allied forms of malnutrition—kwashiorkor and marasmus. Surveys of admissions of children to hospital, or of limited population groups, offer some clue. In South India, for example, a survey¹ was recently carried out in four states where 85% of the population of 100 million live in small rural villages and have a monthly income of less than 100 Indian rupees (US \$20). About 1% of the children aged 1-5 years showed signs of kwashiorkor. In addition, for every one case of kwashiorkor, two cases of marasmus, three to five of vitamin deficiency and five of anaemia were found.

This figure of 1% of the child population under five years of age does not sound excessive, but it means, in fact, that at any given time there will be, in that part of the world alone, 120 000 children suffering from kwashiorkor and an additional 240 000 suffering from marasmus. In another recent survey in Trinidad, it was found that among 163 deaths of children aged

¹ Rao, K. S., Swaminathan, M. C., Swarup, S. & Patwardhan, V. N. (1959) Protein malnutrition in South India. *Bull. Wild Hlth Org.* 20, 603.

1-12 months, malnutrition was the sole cause of death in one third, and a contributory factor in another third.¹

The number of children suffering from moderate protein-calorie malnutrition—stunted growth and development and increased susceptibility to infectious disease—is unknown. It can be presumed, however, that for every child with frank kwashiorkor in a given area there will be many others less obviously affected but in constant danger of being precipitated into severe malnutrition by some relatively trivial infection. From the public health point of view, these children are the greatest problem in the world today. Control of the communicable diseases, the installation of safe water supplies and sanitary sewage disposal would probably save many lives, but without adequate food, and especially adequate protein, these malnourished children will never attain their full potential of growth. It is the special protein needs of the young victim that are distinctive in the interaction of agent (the deficiency of protein relative to calories), victim and environment (the conditions of life) in this particular nutritional disease.

*Environmental and cultural factors*²

Protein-calorie malnutrition in young children usually occurs as the result of a number of factors acting on the child directly or indirectly, and with different emphasis in different situations. One basic condition is always present—an inadequate diet, due either to a lack of suitable protein foods, or to a failure to make use of the available resources.

Lack of suitable foodstuffs. Lack of suitable foodstuffs may be due to low productivity of the land, lack of the knowledge or facilities which enable people to produce, process and preserve suitable foods, lack of the means of distribution of food from an area of plenty to where it is needed, and lack of money to buy imported foods.

Poverty affects most severely those who cannot grow their own food. In some areas the cost of a litre of milk may be more than 25% of a day's earnings. Poverty may endanger the child's health from the start if there has not been enough food to ensure the mother's good nutritional state during pregnancy and lactation. The male members of the rural family may be driven to seek work in the towns, with a subsequent deterioration in the amount and quality of the foods grown by the women; or the mother may be forced to become a wage-earner, working outside the home, weaning her child early and leaving it inadequately fed during working hours. Though the older children "make do" on scraps until the mother returns to cook the evening meal, the very young child cannot eat enough at one meal to make up for the day's hunger.

¹ Symonds, B. E. R. (1958) Clinical studies on Trinidadian children. I. Fatal malnutrition. *J. trop. Paediatr.* 4, 75.

² Most of the following material is taken from Burgess, A. & Dean, R. F. A. ed. (1962) *International Conference on Malnutrition and Food Habits, Cuernavaca, 1960*, London, Tavistock.

Where part of the land is cultivated for cash crops, there may be periods when there is not enough money to buy the family food. Some correlation has been found in one country between infant malnutrition and the price of the principal export. In another, an increase in eye diseases in very young children, often resulting in blindness, has been an untoward sequel to times of prosperity which permitted an increased use of milk preparations deficient in vitamin A.

Failure to use available resources. Failure to use the available resources may be due to a lack of adequate knowledge of what children should and can eat, and especially of the fact that the growing child has a relatively greater need for the scarce protein items in the family diet than the wage-earner or the respected elder for whom they are usually reserved. The distribution of food within the family is a potent factor in the nutritional deprivation of children; the belief that only adults should eat meat or other "rich" or "heavy" foods is not restricted to the poverty-stricken or illiterate peasant family, but is also found in many educated communities anxious to do their best for the child, and with the means to do so. In many regions the idea of buying or preparing food specially for the child is totally unfamiliar.

Traditional aversions to, prohibitions on, or beliefs about the use of some foods (either separately or in combination with others) all limit the range of choice of foods which might be used to provide some protein for the child.

Where the traditional way of life is breaking down, new dangers threaten the child's nutritional health. Old practices which guaranteed the infant a prolonged period of breast-feeding are being abandoned, but with no compensatory improvement in the methods of feeding the weanling. The belief that certain protein foods such as fish and eggs are harmful to young children probably did not matter much as long as the child was breast-fed for two years, but when the mother begins to wean the child early so that she can go out to work these beliefs can become dangerous. In many regions the drift towards the towns of rural families deprives the family of the familiar selection of home-grown foods, while ignorance and poverty prevent the purchase of possible replacements.

In some countries one of the great resources—the mother's own capacity to feed her child—is being used less and less. Where breast-feeding is still taken for granted as the normal procedure, the baby usually grows steadily for the first six months and, with luck, continues to do so (though with some retardation of growth and weight gain) for the first year or 18 months. Even when the mother's diet appears to be inadequate the child apparently does well for at least the first six months, and if breast-feeding continues (with the addition of some food such as soft rice) the risk of protein-calorie malnutrition is reduced.

Where, however, there has been some contact with so-called Western ideas, or with shops and a more sophisticated way of life, there is a decline

in breast-feeding and a growing tendency to wean the child early. The reasons given by the mother for this action are usually that her milk is "poor" or "insufficient" or "does not suit the child". Some mothers think that bottle-feeding is socially superior, and that breast-feeding is "an old-fashioned, peasant practice". Others believe that bought milk must be more nutritious, and will make considerable sacrifices to purchase milk or patent baby foods for their children. Unfortunately they can seldom afford to buy sufficient, and the child is fed on a highly dilute and often contaminated mixture. In some countries rice or corn-flour gruels are given to eke out the meagre supply of the expensive milk (which is usually sweetened) and the child's diet consists mainly of carbohydrates until the onset of malnutrition. As one mother explained, "I feed the baby arrowroot but whiten it with milk".

The nutritional health of the child is also influenced by environmental hazards. An attack of measles, malaria or diarrhoea, an unusually heavy infestation with intestinal parasites (and the home treatment of this condition, which often includes purging and starvation), may exhaust the child's meagre reserves.

Unexpected financial stress, a bad harvest or fishing season, a prolonged illness of one of the parents, or the mortgaging of the family fortune for a pilgrimage, and the more permanent stresses that affect some cultures such as the instability of marriages, the irresponsibility of the male parent for the maintenance of the home and offspring, the custom of sending, lending or giving children away to live in other families, and the subordination of the young mother to the wishes and demands of the older parents or parents-in-law, may all affect adversely the feeding of the child.

Very little is known about the relative importance of many of these factors. The picture is further confused by the fact that, though poverty and ignorance are nearly always present where protein malnutrition is found, some children are reasonably healthy under apparently unfavourable circumstances, while others succumb to malnutrition where outwardly, at least, poverty is not severe.

To understand why this and other apparently illogical things happen in the field of nutritional health, more study of the "victim"—the child, the family or the community—is needed, and is being carried out by various people. Today the students of human behaviour, the anthropologist, the social psychologist and the educationalist, are contributing their specialized knowledge to the search for possible solutions to the infinite variety of problems associated with the cause and prevention of malnutrition in young children.

Other forms of malnutrition

Avitaminosis-A

Another disease often found in conjunction with protein-calorie malnutrition is avitaminosis-A. This deficiency disease which, in its most

severe form, manifests itself by a drying of the membranes of the eye (xerophthalmia) and other changes (keratomalacia) that cause destruction of the eye and total blindness, occurs frequently but not constantly in association with protein-calorie malnutrition. The agent in this case is a deficiency of vitamin A, and the victim most frequently the young pre-school-child, though people of all ages may be affected. The children of South India, Ceylon, Burma, Malaya and, above all, Indonesia, are those most stricken. Milder forms of the disease are found also in Latin America and in some of the more arid areas of the Middle East.

Vitamin A is essential for the healthy functioning of the surface (epithelial) tissues, the skin and its sweat glands, the eyes and their tear glands, and probably other body substances as well. The exact way in which it acts, however, is not yet explained in biochemical terms except in one situation, the retina of the eye. The ability of the eye to see in dim light is dependent on the presence of the retinal pigment rhodopsin (visual purple), which is bleached in the presence of light. Vitamin A is an essential component of visual purple. Night blindness—inability to see in the dusk or when suddenly coming out of the light into the dark—is therefore a frequent complaint where vitamin A deficiency is prevalent.

The vitamin is found in fresh milk, butter, cheese and egg-yolk, and is abundant in fish liver oils. A precursor, or pro-vitamin, carotene, which is found especially in the red and yellow fruits and vegetables and one vegetable oil, red palm oil, and also in the green leaves of vegetables, can be converted by the body into vitamin A, but the process is wasteful. Only about a quarter of the carotene in carrots and less than half the amount in green leafy vegetables is ultimately used by the body as vitamin A. When the victim is a young child in whom the absorptive function of the intestine wall has become impaired by infections or infestations, the final intake of vitamin A is probably even less. It is not surprising that a child whose diet consists mainly of rice and salt and an occasional small piece of fruit or green vegetable frequently develops signs of vitamin A deficiency. Where red palm oil is consumed regularly, however, as in parts of Africa, avitaminosis-A is rarely seen.

In some desert areas of the Middle East night-blindness affects the poverty-stricken tribes, especially during the hot, dry summer. The yellow sprouts of onions are eaten as a local cure for the condition. Trachoma is common in Eastern countries and, with other infections of the eye, may well account for the appreciable occurrence of blindness in some countries of the Far East. At present there are 17 000 known cases of blindness in China (Taiwan); in Malaya and Sarawak, where active steps are being taken to deal with blindness from the sociological point of view, many more cases are being discovered than was anticipated. Infection of the eye is one of the important causes of blindness, but in tropical countries vitamin A deficiency, possibly in association with relative protein deficiency, may be an equal or more important cause. It seems unlikely that deficiency of vitamin A of a degree which leads to permanent blindness does not at

the same time seriously affect the health in other ways. For a long time vitamin A was known as the "anti-infective vitamin" and lack of it was regarded as a cause of susceptibility to disease. Recently this aspect of the vitamin's role has been somewhat neglected, but experimental work is still being done in this field, with some positive results.

Hypovitaminosis-A arises from much the same background. In Indonesia, where the population, and therefore the number of landless peasants, is steadily increasing, the incidence of xerophthalmia is greater among the families which have no plot of land or only a very small one on which to grow vegetables.¹

Unhappily, when the sufferer is a young child, he is often unable to describe the early stage, night-blindness, and it may go unheeded partly because the child is already inactive and apathetic from protein malnutrition and partly because the mother is too busy or too tired to notice until the more obvious effects of vitamin A deficiency are all too visible on the surface of the eyes. By then it is usually too late to save the eye, though this can be done easily at an earlier stage.

The distribution of food within the family in Indonesia, especially with reference to the vitamin-rich foods, favours the adults and the small girls. However, these foods are often disliked and avoided by many who need them. In Orissa Province, India, a search for the reason why keratomalacia occurs mainly in one group of people (the Oriya) and not in another (the Khonds), though both live in fairly similar conditions and have a similarly mild deficiency of vitamin A in their diets, has revealed how closely nutritional health is linked with the whole life of the people.² Among the Khonds, pregnancy is regulated by traditional practices—post-natal intercourse is forbidden or avoided till the child can walk, and pregnancies are therefore well-spaced, allowing the breast-fed child a good nutritional start. The Oriya have no such custom and intercourse is resumed soon after child-birth. Here keratomalacia, like protein malnutrition, is a disease of the deposed child who has been deprived too soon of its mother's milk and attention. In parts of Africa, where protein-calorie malnutrition occurs frequently, xerophthalmia is rarely seen. Red palm oil is an accepted food, and its use supplies the needed vitamin in the form of carotene.

Beriberi

Beriberi is a deficiency disease due to the lack of vitamin B₁ (thiamine) in the diet. Thiamine is concerned with the breakdown of carbohydrate in the body, and the disease is found where the diet contains too much carbohydrate in relation to the amount of the vitamin. All plant and animal tissues contain thiamine, but the only rich dietary sources are the seeds

¹ Timmer, M. (1961) *Child mortality and population pressure in the D. I. Jogjakarta, Java, Indonesia: a social-medical study*, Rotterdam (Thesis).

² McLaren, D. S. (1956) A study of the factors underlying the special incidence of keratomalacia in Oriya children in the Phulbani and Ganjan Districts of Orissa, India. *J. trop. Paediatr.* 2, 135.

of plants—the germs of cereals, nuts, peas, beans and other pulses, and also yeast. In rice most of the thiamine is present in or just beneath the pericarp which surrounds the grain, and is removed during the process of milling. Hand-pounding or under-milling removes much less of the pericarp, and therefore of the vitamin. Parboiling, a process whereby the rice is soaked and partially cooked before being milled, conserves most of the thiamine. Except in India, where parboiled rice is eaten, and in those rice-eating countries where the degree of milling is controlled by law, a highly-milled white rice is usually eaten. It is preferred by the people who eat rice constantly, and also by the commercial dealers, partly because it keeps better than under-milled rice and partly because the residue from milling can be sold to feed animals.

Beriberi is therefore found among those whose nourishment is derived from highly-milled rice and little else, other than small amounts of salt fish or dried fish, vegetable or fruit and some flavouring substances—that is, among the poor people of the great rice-eating areas of the Far East. The better-off, though they may eat the same kind of rice, obtain their vitamin supply from the other items in their more varied diet.

Infantile beriberi. Beriberi affects men and women at all ages, especially the expectant and post-natal mother, but it strikes the breast-fed infant, usually between the first and fifth months of its life, with dramatic suddenness and catastrophic results. Infantile beriberi kills rapidly if not treated in time, and is thought to account for a large proportion of the high infant mortality rates found in the Philippines, Burma, Cambodia, Laos, Viet-Nam and probably also in other rice-eating countries. The picture is clear—

“ The baby around three months of age, apparently in good health, nursed entirely by its mother, is abruptly seized with an attack of screaming. As he utters his loud piercing cry his body stretches, the abdomen becomes hard, the pulse thready, the respiration laboured, his face either deadly white or cyanotic, and an expression of profound terror or suffering grips the entire being. This state may last anywhere from one half to one hour. It disappears spontaneously, only to reappear with increasing severity and frequency until death supervenes or specific treatment is given promptly.”¹

The curative effect of injecting large doses of thiamine is immediate, but must be accompanied by prolonged dietary and vitamin therapy for the mother, whose own deficiency state has produced the acute disease in her breast-fed child.

In adults, vitamin B deficiency is a much more chronic condition leading, in “dry” beriberi, to wasting and paralysis of the limbs, and in “wet” beriberi to dilatation, impaired functioning and sometimes failure of the heart, accompanied by oedema (dropsy).

Prevalence. There is evidence that beriberi—a public health problem since the beginning of the century—is again on the increase, especially in

¹ Albert, J. & Abud, M. B. (1947) Infantile beriberi in the Philippines. *Acta med. philipp.* 4, 7.

Burma. It caused over 10 000 deaths in the Philippines in 1959, and in the same year over 42 000 cases were reported in Viet-Nam. In Thailand a survey covering 2355 pregnant women showed that 10% had beriberi, and it was estimated that the number of lactating women affected would be greater, because of the habitual restrictions on the diet of the nursing mother in that country. For several reasons it is almost impossible, at the present time, to estimate the extent to which infantile beriberi menaces child life.

The reasons for the increase, and for the difficulties in the accurate assessment of the prevalence of some forms of the disease, lie partly in its nature and partly in the environmental factors which favour its occurrence. The suddenness of the onset and swiftness of the course of infantile beriberi militate against the likelihood of the baby's being seen by a professional person, especially as beriberi is to some extent a seasonal disease, occurring more frequently in the wet season when the paths across the rice-fields to the hospital are flooded and practically impassable. In such circumstances parents are more likely to try home remedies, and no one competent to diagnose or treat the disease sees the child in time. Also, where tradition decrees that the mother must not leave the house for a period of several weeks after child-birth, she is unlikely to seek professional advice for any symptoms she may have, and the fact that she is a sufferer from beriberi may remain unrecorded.

When people are living on the verge of hunger, enduring tropical storms as well as tropical sun, hard physical labour and perhaps recurrent bouts of "fever", muscular pains, discomfort and feelings of lassitude are apt to be considered normal accompaniments of life. Thus, the milder forms of beriberi may go unrecognized until an acute stage develops or an apparently healthy mother produces infantile beriberi in her child.

Environmental factors. Beriberi affects mostly the poorer people who, for one reason or another, cannot obtain the variety of foods which would balance the lack of vitamin in the highly-polished rice that they consume daily. When they are rural peasants who grow and pound their rice at home, they have hitherto generally escaped the disease. Ironically enough, "progress", the opening-up of the countryside with roads, and the introduction and rapid spread of small rice mills, has led to an increasing incidence of beriberi among these farming communities. In two areas in Thailand, for example, one with a rice mill for every 8700 persons and the other with a mill for every 13 000, it was found that the incidence of peripheral neuritic conditions, especially among expectant and lactating women, was twice as great in the area with more rice mills.¹

Equally unfortunately, periods of prosperity have apparently resulted in an increase of beriberi, for when there is money to spare it is spent

¹ Ramalingaswami, V. (1958) Nutritional disease: beriberi. *Fed. Proc.* 17, Suppl. no. 2, pp. 7, 8.

on buying the “ socially superior ” highly-polished white rice on sale in the shops.

Other factors which are extremely important in the causation of beri-beri are: the traditional restrictions on the diet of women, especially during pregnancy and lactation (in some Moslem countries child-birth is often followed by a 40-day period when the woman is allowed little to eat other than rice and salt and limited fluids); the cultural standards of beauty (slimness in Burmese and Indonesian women is highly valued); the cultural standards of politeness (too large a helping of the “ side-dish ” which accompanies the rice and may contain some thiamine-rich foods is frowned on as greediness in Thailand); the status of women (who may eat only after the men have finished, as used to be the custom in Japan); and the traditional beliefs about the properties of certain foods, especially the beneficial qualities of the rice itself (in the Malay language, the equivalent of the English term “ to eat ” is “ to eat rice ”).

Anaemia

A great deal of ill-health, sapping energy and productiveness in many countries and causing tragedies in child-birth, is due to anaemia. The maintenance of an optimum blood supply depends on the capacity of the body to replace continually a number of the blood cells by others, well-made and adequately charged with haemoglobin, the oxygen-carrying pigment of the blood. For this task certain basic materials are necessary, the most important being iron, protein and certain vitamins. These, after very early infancy, must be obtained in their crude form from food, and the body has several physiological mechanisms by which it conserves the essential elements.

Where there is a continued deficiency of either iron or protein in the diet the reserves and adaptation mechanisms are unable to maintain the level of circulating haemoglobin within normal limits. The resulting fall in the haemoglobin concentration and oxygen-carrying capacity of the blood produces the condition of anaemia. Even when anaemia has set in, however, the body uses other adaptive mechanisms which, by adjusting the dynamics of circulation, can maintain the efficiency of tissue oxygenation.

A simple test will give an estimate of the haemoglobin concentration in the blood. Such estimations have now been carried out in many parts of the world, and provide useful indicators of the nutritional status of population groups. The results show that anaemia exists on a global scale, particularly among pregnant and lactating women and among growing children who have enhanced nutritional needs.

Nutritional anaemia of pregnancy and lactation. Anaemia of pregnancy is a mixture of several entities with various causes. It is now known that iron deficiency anaemia is the commonest type, and its high prevalence among pregnant and lactating women presents a serious health problem.

The iron requirements of women during reproductive life are high because of the constant blood losses due to menstruation, and because of the needs of the foetus. In adolescence also iron requirements are accentuated. Where early marriages take place and pregnancies occur at relatively frequent intervals, a progressive deficiency of iron can rapidly develop in the absence of adequate supplies in the diet. This is the root cause of the high prevalence of anaemia among pregnant and lactating women in tropical countries.

Other types of anaemia are also of considerable significance, though less frequent. In these also nutritional factors play a dominant part, particularly iron, protein, vitamin B₁₂ and folic acid. Deficiencies of these elements may occur either separately or in various combinations, producing different forms of anaemia in different regions, depending on the dietary pattern.

The high maternal mortality observed in some countries such as India is closely associated with the prevalence of anaemia. Anaemia of pregnancy also affects adversely the incidence of prematurity and stillbirths and depletes the foetal reserves of iron, thus leading to anaemia in infancy and childhood.

Prevalence of nutritional anaemia. The prevalence of nutritional anaemia is much greater in the underprivileged countries than in the well-to-do nations. For a long time this knowledge was based mostly on hospital experience and, as in the case of protein and calorie malnutrition, the appearance of so many severe cases of anaemia in hospitals is now recognized as an outstanding aspect of an extensive anaemia problem in the community.

Recent evidence shows that nutritional anaemia is, in fact, quite widespread. In Mauritius, where malaria has been eradicated and the population (450 000) is fairly static, anaemia, in 1953, was second only to accidents among the causes of hospital admissions. Many of the cases were severe, about 5% having less than 3.5 g/100 ml haemoglobin (normal, 14-15 g/100 ml). In Kenya, 80% of the population have been shown to have iron deficiency. In Sierra Leone up to 40% of the adult females suffer from iron deficiency anaemia. The incidence of anaemia among Nigerian peasants is equally high. From the beginning of this century, anaemia has been reported from India as a major problem among agricultural labourers, tea-garden workers and especially among pregnant and lactating women. There, in a survey of about 4000 adult men and women, it was found that 14% of the population studied suffered from severe anaemia characterized by a level of haemoglobin of less than 8 g/100 ml. The condition was most severe in pregnant women and was due to iron deficiency in nearly 85% of them. It responded to oral administration of an iron supplement. The same story could be repeated from many different parts of the world, bringing with it high death-rates, and especially high maternal mortality rates. The death-rate from anaemia in the USA is about two per 100 000 of the population, but

in many of the Central and Latin American countries it varies from 12 to 32 per 100 000.

Environmental factors. Nutritional anaemia occurs wherever poverty and malnutrition exist, and an insanitary environment increases the risk. In many countries hookworm infestation contributes much to the severity of the condition but, in spite of the infestation, the individual's blood supply can be improved by better nutrition, and by medication with iron. Such medication, however, is not always as successful as might be expected in iron deficiency anaemia—as has been shown in mass feeding experiences. The causes of anaemia are multiple, and are not simply the result of a reduced intake of nutrients. Infections and infestations, absorption defects of the bowel, the character and composition of the diet itself, the phase of growth and nutritional needs of the individual, the customs of the country as regards marriage and child-birth, and the foods permitted to pregnant and lactating women, are all intimately involved. The vicious circle of poverty—anaemia—deeper poverty is only too real, for a severe anaemia adversely affects the working capacity, and a country's economic loss due to this form of malnutrition is probably great.

Rickets and osteomalacia

Nutrition is closely connected with the normal processes of bone formation, growth and remodelling, for the skeleton is not a static unalterable structure. Constant changes are going on whereby minerals are laid down in a proteinous matrix. The bones of children with protein malnutrition are known to be smaller, poorly calcified and retarded in development. If the diet contains too little calcium and phosphorus, or an unbalanced amount of these minerals, or substances which interfere with their absorption, and if vitamin D is not available, the growth, maturation and calcification of the bones will be disturbed.

Rickets is a disease of infants and young children, whose bones are growing rapidly, and is caused primarily by an insufficiency of vitamin D, which results in poor absorption and utilization of calcium and phosphorus: a lack of these minerals in the diet aggravates the condition.

Vitamin D occurs naturally in butter, cream, eggs and certain fish. It also occurs as a pro-vitamin in or on the skin, and is converted into its active and usable form by the action of sunlight on the skin. Calcium occurs in most foods, the richest source being milk. Smaller amounts are available in green vegetables, in shellfish, in the bones of small fish (cooked, dried or salted and eaten whole) and in the lime used in the preparation of some foods in certain countries.

Rickets is then a disease of those who are deprived of sources of vitamin D or of sunlight, and is more severe in those whose diet includes inadequate amounts of the calcium-containing foods, particularly milk.

Osteomalacia is the same disease occurring in adults. It affects particularly women during pregnancy and lactation, for during these times

the mother's body must supply the essential nutrients for the child as well as for herself. During lactation most women throughout the world are excreting more calcium than they are absorbing, and though calcium can be stored in the body against such times of need, chronic undernourishment and frequent pregnancies must greatly deplete the store in many women.

The vicious circle of osteomalacia has been vividly described :

“ With each child the condition takes a step forward as the body is further drained of its minerals and vitamins. And with each child the condition becomes more piteous : the mother is more imprisoned in the house by pain and deformities ; her chances of earning more money, of gaining more food and more sunlight are curtailed ; her pelvis collapses further, making her next confinement even worse than the last. Sometimes her downward progress halts between her pregnancies ; sometimes she may even improve if she does not suckle her infant in the vain hope of thus warding off her tragic fertility. ” ¹

The disease in China has tended to occur in the middle classes, too poor to get adequate food, and to whom outdoor work is not acceptable.

Prevalence. In the past, rickets was thought to be rare in tropical countries because of one environmental asset—the abundant sunshine which, combined with the habit of wearing few clothes, should guarantee a constant activation of the pro-vitamin in the skin. Indeed, most tropical and sub-tropical countries would probably be faced with a more serious problem of deformed limbs and bones if this were not largely true. Nevertheless, wherever rickets has been looked for in such climates, it has been found, and the closer the scrutiny the more clear it has become that rickets does, in fact, occur widely in many different countries. The disease is found more frequently in urban than in rural settings, and especially in the cities of the Middle East. In Egypt, for example, it has been estimated that 40% of the children admitted to hospital in one large city showed some evidence of this nutritional disease.

In Calcutta, Bombay, Singapore, Manila, Johannesburg and Ibadan children showing signs of rickets have been seen in the hospitals. One area, the Kangra Valley in the Punjab, is unique in India in having an unusually high prevalence of rickets (56% of 156 children examined), the average figure for other parts of India being between 0.2% and 3.2%.² The reasons are not completely clear but, as usual, they lie in the interaction of victim and environment.

Osteomalacia is found mostly in parts of India, Pakistan and China.

Environmental factors. Though the primary agent in the causation of rickets and osteomalacia is a vitamin deficiency, the full development of the disease depends on a multiplicity of environmental conditions.

¹ Bicknell, F. & Prescott, F. (1953) *The vitamins in medicine*, 3rd ed., London, Heinemann.

² Patwardhan, V. N. (1962) *Nutrition in India*, Bombay, Indian Journal of Medical Sciences, p. 343.

In the industrialized countries, as cities grew and factory smoke and high buildings shut out the sunlight from narrow streets, rickets spread, and around the beginning of this century 75% of the children in the large cities of the world suffered from rickets. Today the disease has almost disappeared from these places. Many changes have had to take place, more or less simultaneously, and in many aspects of life, before rickets ceased to menace the young. The establishment of child health services for supervision of the child's health and education of the mothers in child-feeding and care ; the organized distribution of cod-liver oil accompanied by education about its usefulness ; the availability of adequate supplies of milk for all children ; the replacement of slums and narrow street alleys by houses and playgrounds where every child can get his share of sunshine ; the extension of smoke-free towns and areas ; the development of smokeless fuels and fires, have all contributed to the abolition of this deficiency in the industrialized countries. Like many nutritional diseases, rickets is a social disease and can be eliminated only by social, and sometimes economic and cultural, changes in the life of the people concerned.

In the tropical countries environmental influences also contribute to the development of the disease. Abundant sunshine is not in itself enough to protect the growing child or the woman in her child-bearing years from the ravages of calcium depletion. The sunshine must reach the skin, and is often prevented from doing so by the high houses and narrow streets typical of many Eastern cities, or by the enveloping covering of the child on its mother's back, or by the custom of *purdah* and the seclusion of girls, or by the social value placed on a pale complexion, which prompts mothers to keep their children out of the sun, or by the fact that the mother is out at work all day and the child is kept in the sunless safety of a city slum. The high incidence of rickets found in the Kangra Valley of the Punjab was thought to be due to a combination of population pressure on the cultivable land, itself poor in lime and phosphorus, and a diet excessively rich in cereals.

Goitre

The visible enlargement of the thyroid gland is known as goitre. There are many causes and many types of goitre : by far the most common and the most significant from the public health point of view is *endemic goitre*, which affects large groups of the population in different parts of the world. The most important known causative factor in endemic goitre is a deficiency of iodine, an essential element required in minute traces for the manufacture of the hormones of the thyroid gland.

Foods now known to be good sources of iodine have been used from ancient times for the treatment of goitre, but the world has had to wait a long time for a full understanding of the scientific principles underlying the ancient remedies. In 1811 Bernard Courtois, while producing saltpetre for Napoleon's army, discovered the element. Since the identification of

thyroxin, one of the thyroid hormones, in 1914, a great deal of knowledge has accumulated about the part played by iodine in their elaboration, and about the consequences of their lack in the human body. It is now known that in the absence of the hormones normal foetal development does not take place, the child's normal phases of growth and maturation are hampered, and adequate metabolic activity is well-nigh impossible. Fortunately, the vast majority of cases of endemic goitre seem to suffer from no obvious disadvantages other than those caused by the large size of the gland.

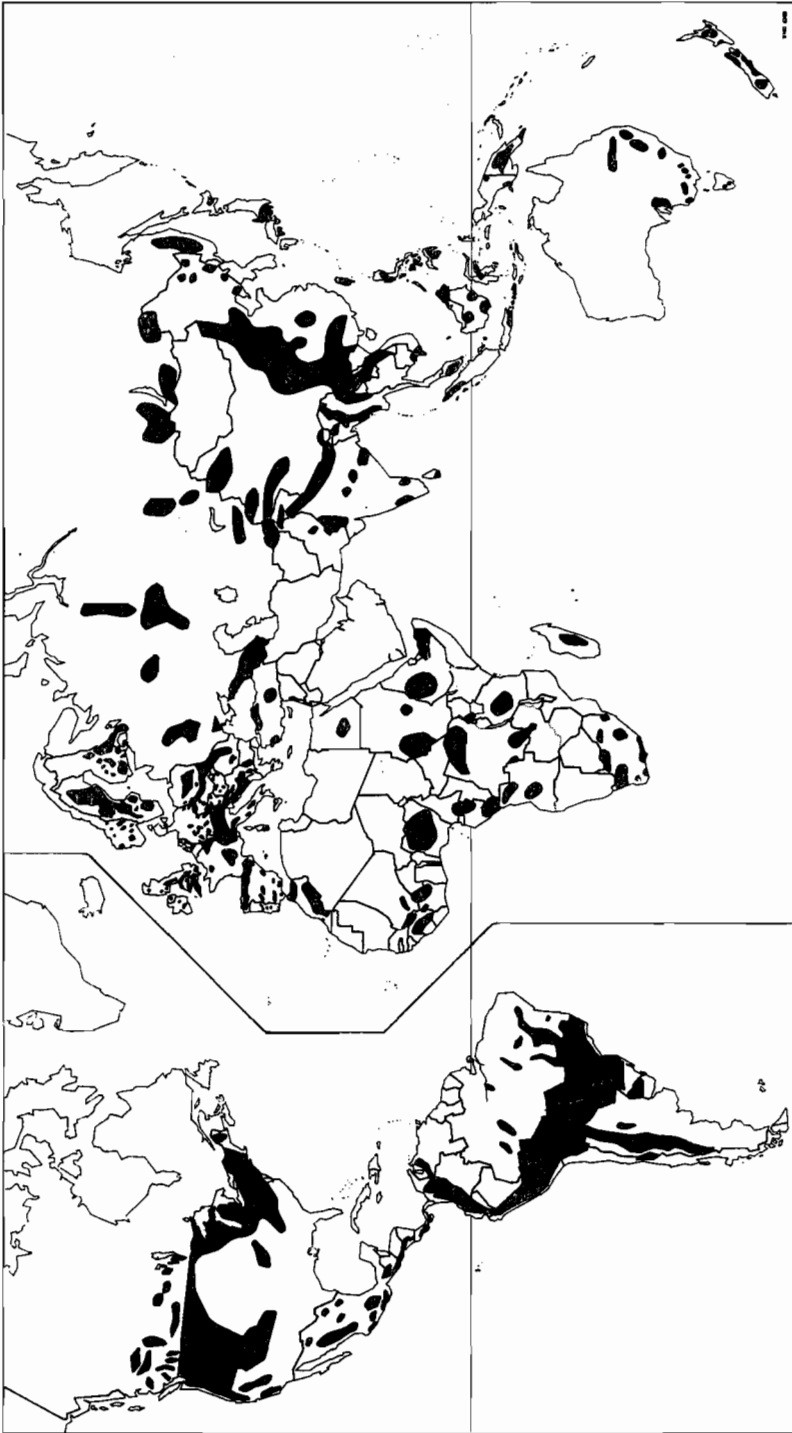
Where the deficiency has existed for many generations, however, children may be born with goitre, and even before they reach school age may have nodular and distorted thyroid glands. In some, physical and mental development may be so seriously hampered that a state of cretinism results. Equally distressing is the condition of deaf-mutism produced by a failure of the development of the hearing (and therefore speech) mechanisms in the growing infant.

In rare instances, other causes may be more important than iodine deficiency. In certain parts of Tasmania and Australia goitre in school-children has been shown to be due to the presence in milk of a toxic substance that inhibits the utilization of iodine by the thyroid gland. The toxic substance has been demonstrated in local plant materials such as narrow-stemmed kale which, when consumed by cattle, is excreted in their milk. The capacity of this plant to accumulate the toxic substance seems to depend on seasonal factors and on the availability of certain substances in the soil.

Prevalence. Endemic goitre is quite different from the other deficiency diseases so far described. It is a form of hidden hunger, confined neither to the developing nations in the tropical and sub-tropical regions nor to populations suffering from poverty. This deficiency disease is widely distributed and occurs with varying intensity in people of all races and in almost every country, independent of climate, season and weather. Mountainous and sub-mountainous regions—the Himalayas, the Alps and the Andes—are the classical sites where endemic goitre is found, but it also occurs in the plains and even along the coastal regions (see Fig. 9). It has been estimated that there are some 200 million people with goitre in the world. Cretins and deaf mutes abound in the valleys of the Himalayas, and used to be numerous in the Alps before the introduction of preventive measures. There is no accurate assessment of the number of these unfortunate victims in goitrous localities, nor any accurate record of the extent of feeble-mindedness and mental defects that are apparently closely associated with regions where goitre is highly endemic.

Environmental factors. Unlike most of the deficiency diseases, the occurrence of endemic goitre is determined, not by the technological and economic advancement of the country, but by the nature of the soil and its content of iodine. The condition can be eradicated, as it has been in many countries (notably Switzerland) by supplementing the diets of the

FIG. 9. GOITRE AREAS OF THE WORLD



affected people with a small daily dose of iodine—most readily achieved in the form of iodized salt. The eradication of this deficiency disease depends more upon the attitude and organizational ability of governments than upon those of the individual victims.

When, as in parts of Australia, goitre suddenly appears in an area where there is adequate iodine in the soil and then gradually disappears, the explanation lies in the agricultural procedures followed in the settlement of new land. Generally, stock are first grazed on the indigenous grasses, while at the same time the land is cultivated for crops: later, when the cultivated land is allowed to lie fallow, it quickly becomes infested with a variety of weeds which flourish more abundantly than in natural pasture. As farming methods advance, weeds are eradicated and pastures improved. Once a tight sward is established the danger of goitre-producing substances finding their way into the milk of the cows grazed thereon is over.

Less widespread deficiency diseases

Other deficiency diseases, such as scurvy (due to the lack of vitamin C) or pellagra (due mainly to the lack of niacin—one of the vitamin B complex—and found among poverty-stricken people whose diet consists mainly of maize) still exist, but not to such an extent that they create worldwide problems.

Though the intake of vitamin C in the form of fresh fruit and vegetables appears to be very low in some parts of the world, scurvy is rarely seen except in times of drought and famine or in some of the arid countries of the Middle East during the dry season. It is also found occasionally in old people living alone in the city slums of the industrialized countries.

Pellagra is essentially a disease of poverty-stricken people whose diet consists largely of maize. It disappears (as it has done in the southern states of the USA in this century) when the agriculture becomes more diversified and the diet more varied, or (as in Yugoslavia) when maize is reinforced with the missing nutrient during the milling process. The exact nature of the processes involved in the causation of the deficiency state is not yet fully understood, but it is cured by giving the sufferer nicotinic acid (niacin), a component of the vitamin B complex that is found naturally in nearly all foods, but mainly in meat, liver, fish, whole-meal cereals and pulses. It may be that niacin is present in the maize in an unabsorbable form, or that an associated deficiency of good-quality protein plays an important role in the causation of the disease. It has been found, in some areas in the Latin American countries, that though the people obtain more than 60% of their calories from maize, they still do not develop pellagra. There the preparation of the maize for making the widely-consumed “tortilla” includes soaking the cereal in lime-water before grinding, and it is thought that this process may have some beneficial effect in the prevention of the disease. Further research is needed, however, to clarify the whole question.

Pellagra, which used to be known as “ the disease of the three ‘ D’s ’ ”—diarrhoea, dermatosis and dementia—seems to have occurred in most parts of the world in the past, and is still a problem in parts of Africa, India, Egypt, Portugal, Yugoslavia and the majority of the Latin American countries. The clinical picture varies in detail in different regions, but the main significance of this preventable disease is the evidence it provides of the poor nutritional resources of the communities in which it occurs.

Ariboflavinosis is another deficiency state (found often in association with avitaminosis-A) caused by a lack of one of the vitamin B complexes—riboflavin. Unlike the other parts of the B complex, this vitamin is found in milk and eggs, as well as in liver, green vegetables and yeast extracts such as Marmite. A diet deficient in riboflavin produces changes in the tongue, in the mucous membranes of the lips and mouth, and in the skin around the base of the nose, which disappear rapidly when the diet improves.

PART IV — INTERRELATION BETWEEN NUTRITION, INFESTATIONS AND INFECTIONS

Infestations

Most of the children in tropical and sub-tropical countries carry a heavy load of intestinal parasites, especially roundworms. One of the harmful effects of the roundworm is the depletion of the child's scanty supply of nutrients. It appears, for reasons not yet fully understood, that the malnourished child tends to be more heavily infested than the well-fed child. Improvement in the quantity and quality of the child's diet not only provides a larger amount of nutrients to be shared between the child and its parasites but also probably lessens the load. Hookworm infestation, also found frequently in the non-arid regions, causes a constant loss of blood and an increasing anaemia which, however, can be improved by better nutrition, even in the presence of the parasite.¹

Infections

The whole question of the role of nutrition in the infections is at present being studied. There is good evidence that susceptibility to, and severity of, most infectious diseases is enhanced by malnutrition. A better understanding of the relationship is, however, necessary and with this aim in view INCAP is conducting a study of three communities in Central America. In the first, every effort is directed towards reducing the duration, severity and incidence of infectious diseases in children. In the second, the attack is against malnutrition, by means of a daily distribution of milk and other foods which are rich sources of protein, accompanied by an active programme of nutrition education throughout the community. The third, without modification, will act as the control population group. It will probably be necessary to repeat this or other similar types of investigations in other areas before the relationship between nutrition and infection can be clearly established. For example, where tuberculosis is rampant in crowded cities such as Hong Kong, the question arises as to whether it can be controlled by isolation and treatment of the infected individual while the nutrition level of the population at risk remains unsatisfactory.

¹ Patwardhan, V. N. (1961) *Nutrition in India*, Bombay, Indian Journal of Medical Sciences, p. 283.

Again, what is the role of the intestinal infections and infestations in malnutrition? Do they merely act as an additional stress and thus precipitate the precariously nourished into a more severe form of malnutrition? Or do they actually cause malnutrition by so damaging the bowel that it is unable to absorb the necessary nutrients? The disease known as "tropical sprue" is essentially a collection of symptoms, a "syndrome" of malabsorption, about which comparatively little is known at present. More understanding of this disease and of the whole "malabsorption syndrome" is important, partly because the disease is apparently more common than was previously thought, and partly because bowel disease and dysfunction so frequently coexist with malnutrition at all ages.

TABLE III. CHANGES IN PREVALENCE OF DENTAL DECAY IN AREAS OF AMERICAN SAMOA *

Location	Year	Age-group (years)	Percentage with decayed teeth
Urban	1934	5-24	22
	1954	3-21	73
Moderately isolated	1934	5-19	9
	1954	3-21	60
Remote	1934	5-19	3
	1954	3-21	42
Isolated	1934	5-19	4
	1954	3-21	22

* Cadell, P. B. (1960) *Dental health in South Pacific Territories*, Noumea, New Caledonia (South Pacific Commission, Technical Paper No. 131).

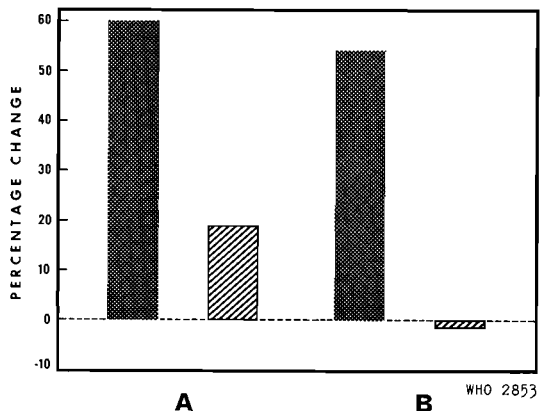
Other diseases, hypertension and some of the degenerative conditions affecting the heart and blood vessels, toxæmia of pregnancy, diabetes and dental caries, have nutritional implications. The degenerative diseases of the circulatory system and dental caries occur more frequently in the "well-fed" countries. The first seems to be associated with a diet rich in certain kinds of fatty foods, and the second with a low fluorine content of the water and an excess of certain kinds of starchy and sugary foods in the diet. Until recent years, dental caries was comparatively rare in isolated communities living on home-grown, home-prepared foods. Now, with increased access to the towns, and increasing facilities for advertising and marketing the more sophisticated foods, caries is rapidly invading these once-remote areas (see Table III).

The deficiency diseases and all forms of malnutrition must be viewed in perspective—the world-wide perspective of demand and supply. The availability of foodstuffs produced or imported is directly related not only to individual and national productivity or income but also to the number of people to be fed in any one country. In recent years, great efforts have been made in most countries to increase food production, but the increase has hardly kept pace with the rapid increase in population. In parts of the Americas, for example, individual (per caput) food production was slightly less in 1956-58 than in 1934-38 (see Fig. 10).

FIG. 10. PERCENTAGE CHANGE IN TOTAL AND PER CAPUT FOOD PRODUCTION BETWEEN 1934-38 AND 1956-58 IN NORTHERN AND LATIN AMERICAN COUNTRIES

A = Northern America
B = Latin America

■ = Total food production
▨ = Per caput food production

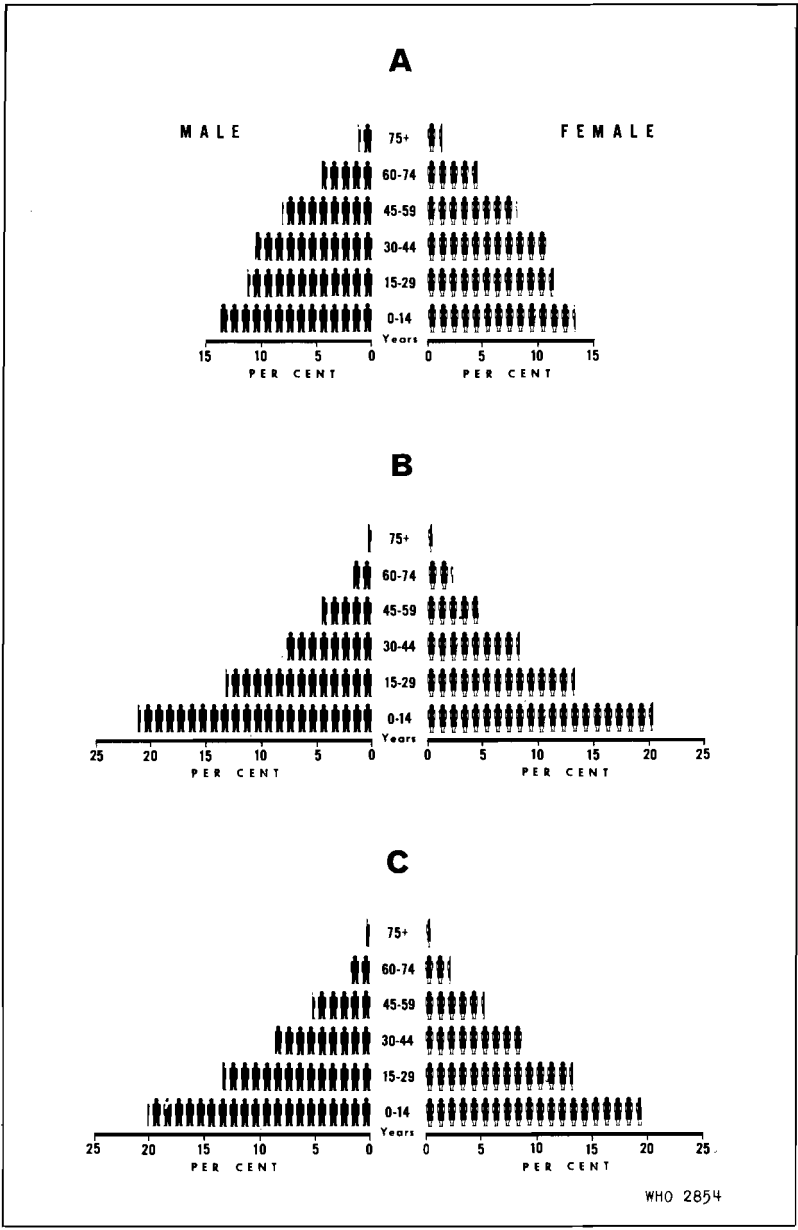


Food supplies and population increase

World population is increasing annually by some 34 million people, nearly 90 000 per day.¹ Most of this increase is occurring in the economically underdeveloped countries, where the death-rate has fallen sharply in recent years, while the birth-rate remains high. The control of some of the major communicable diseases, such as malaria, had produced a dramatic decrease in the deaths of children in the first few years of life,

¹ Rolph, C. H., ed., (1957) *The human sum*, London, Heinemann, p. 14.

FIG. 11. PERCENTAGE DISTRIBUTION BY SEX AND AGE OF POPULATION IN THE THREE REGIONS OF THE AMERICAS, 1950*



A = Northern America
B = Central America
C = South America

* After United Nations ST/SOA/Series A, Nos. 16, 21 and Demographic Yearbooks.

and the population picture in such countries shows a preponderance of young people (see Fig. 11). There are two nutritional implications where the number of infants is high. First, during pregnancy and lactation the dietary requirements of the mother are greater than usual and, second, for a good deal of this period the mother is prevented from undertaking her usual quota of productive work. She and her infant at this time are a liability to the community and, should the infant fail to survive to an age when it becomes productive, there will be a net loss to the family and communal wealth which, in an agricultural community, is directly measurable in terms of food. As public health measures become more and more effective, more and more children will, in all likelihood, survive into adult life if they can be fed. But the problem is immense. Although increasing numbers of survivors may increase productivity and add wealth to the family and the community, the survivors themselves will beget children and add to the expansion of the population.

The burden of dependence of the old and the young will become heavier on the productive young adult. Increasing numbers of young dependents means not only increasing demands for food but also increasing monetary expenditure for education, clothing and the other amenities which accompany changed expectations. Added expenditure for such things sometimes leads to insufficient money for the purchase of an adequate diet. In many agricultural communities, because of traditional laws of inheritance, an expanding population implies the progressive subdivision of land. If the prevailing standards of nutrition are to be maintained the farmer therefore is obliged to produce more and more food on less and less land. In such or similar circumstances, it seems that the only solution is a reduction of the birth-rate, but active measures of birth-control are not acceptable in some communities. Moreover, the lesson of history is that effective control of the birth-rate on a community scale has only followed the development of material wealth and a high standard of literacy. An increasing population, in the presence of static or even decreasing possibilities of food production, gives rise to the most desperately urgent and widespread problem today, hunger and chronic undernourishment.

The world of the hungry

Where poverty and hunger have existed for generations in a community, they have become part of life itself, and have produced attitudes, beliefs and practices that have proved useful in maintaining a certain amount of security and continuity. The peasant living in fear of starvation cannot afford to risk new methods or new crops which some stranger tells him will give better results; he feels he must stick to what he knows will feed him, however inadequately. He cannot afford to give his young children the scarce protective foods—they must go to the workers on whose survival the whole family depends. He cannot risk limiting the number of children he begets; he must ensure that some at least will survive to help him to

work his land and look after him in his old age. Nothing in his past experience has taught him that his children need not die, and he accepts their death philosophically. His whole philosophy embodies the ideas that “the touch of life has turned to truth” for him, and includes strongly-held beliefs about the suitability or otherwise of certain foods for certain people at certain times. He is unlikely to abandon these convictions lightly, though with time he may modify their practical application when he sees some benefit from so doing. Like everyone else, he learns by experience and by seeing and doing things for himself. His freedom from hunger will take time and effort for it involves more than food. The evidence shows, however, that once a start has been made, and the vicious circle of poverty—malnutrition—more poverty is broken, confidence dispels apathy, activity replaces inertia, and new expectations provide a continuing incentive to further experiment and achievement.

SUMMARY

Epidemiological studies, statistics of health, the results of experimental research and other sources of information on the relationship between malnutrition and disease reveal the importance of the problem of malnutrition and the particular vulnerability of the child under five years old. The most widespread form of malnutrition, protein-calorie deficiency, is a disease of childhood associated with weaning, the lack of suitable substitutes for maternal milk, and, frequently, failure to use available foods. The two main manifestations of this deficiency, kwashiorkor and marasmus, affect an unknown but vast number of children; not only do they often prove fatal themselves, but they are contributory factors in the mortality attributed to many of the common communicable diseases. Other manifestations of malnutrition are blindness, which may be caused by avitaminosis-A; wasting and paralysis of the limbs and failure of the heart, caused by beriberi; stillbirths and maternal deaths in child-birth, caused by nutritional anaemias of pregnancy; disturbance of the growth of the bones leading to deformities, caused by rickets and osteomalacia; cretinism and deaf-mutism, caused by endemic goitre; dementia, caused by pellagra; and dermatoses, caused by deficiencies of vitamins B and C. In addition to these serious diseases, a relationship has been shown to exist between malnutrition and certain intestinal infestations and infections. The public health problem of malnutrition is exacerbated by the phenomenal increase in the world's population.

The solution of the problem of the hungry must take into account complex factors affecting almost every aspect of the life of man—climatic, economic, social and educational, religious and cultural. The solution will depend upon achieving co-operation between governments, national and international agencies, and workers in many scientific fields, with the active participation not only of people in the developed countries but also of the sufferers from malnutrition themselves.

