INSTITUTO NACIONAL DE LA NUTRICION
México, 1982

Growing Up in a Developing Community

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CULTO LECTOR

Trate este libro con el cuidado que exige todo objeto precioso y delicado; por ninguna razón escriba notas o marginados en sus páginas, ni mucho menos mutile ninguna de sus partes; abra sus páginas con cuidado; no coloque sobre él, cuando esté abierto, otros libros u objetos, ni introduzca entre sus hojas lápices; no le doble las esquinas a guisa de señales; no lo emplee en usos ajenos a su objeto.

CONTRIBUYA A CONSERVAR EL ACERVO DE LA BILBIOTECA QUE LE AYUDA EN SU DESENVOLVIMIENTO CULTURAL Y A RESOLVER SUS PROBLEMAS DE TRABAJO.

P-2503

Growing Up in a Developing Community

AIN-MEXICO

Growing Up in a Developing Community

A BIO-ECOLOGIC STUDY OF THE DEVELOPMENT OF CHILDREN FROM POOR PEASANT FAMILIES IN MEXICO

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The original Spanish edition was made possible by the support of the National Commission for the International Year of the Child.

The Spanish edition was dedicated by the authors to the children from the peasant families of poorly developed areas, but especially to those who participated in the study.

The authors expressed their recognition to Miriam Muñoz de Chávez for her faithful support in the realization of this research.

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combine their efforts for the benefit of the community, the country, and man himself.

The authors do not judge. They evaluate but do not condemn. They measure and analyze the phenomena just as they are. Properly, they do not seek previous patterns of comparison. Thus, it is appropriate to point out the importance of the methods of observation used, which are the most valuable and certainly the most difficult: the direct and long-term observation of the families within the home itself. This was done with great success, mainly in the study of maternal lactation and in the behavior of children and their interaction with other members of the family. Uninterrupted periods of 72 hours, seven times at different ages, in 34 children is certainly a very valuable feature. It required real devotion to the task and merits special mention on behalf of the researchers. It need not be said that there are not precedents in the literature in this field: an "intervention" carried out with persons who follow their habitual way of life in their own homes, with such satisfactory control that has already been achieved.

Right from the start the authors attack the myth that the farm dweller is happy in his poverty. They support tha fact that he is very limited in several aspects of his total development, that he suffers a great deal in his effort to adapt as a "survivor", with a strong feeling of insecurity.

Without explicity saying so, the authors accept and demonstrate that primary malnutrition is a biological phenomenon, it is not inherited except as a social phenomenon, and therefore it frequently affects families and whole groups.

Their research, they affirm, was of the etho-ecological type, with focus upon the behavior of the poorly fed man in relationship with his environment. In their planning they concerned themselves particularly with studying the lesser known areas of that interaction. The general intention of the study is thus made very clear: the independent variable was nutrition, while the dependent variable was child development.

The study of the consequences of malnutrition on fertility is a pioneering work. Because of this study, it is possible to set forth the characteristics of a syndrome of "uncontrolled maternity", which practically all rural women in underdeveloped countries experience. Furthermore, this is of great importance for the biological, psychic (especially emotional and intellectual) and social future of these people.

Some factors in this syndrome are indeed dramatic in the biological area: average height of mothers 147 ± 5 cm (which implies that 17 out of 100 women must have a height of 142 cm or less), severe anemia; delayed menarche (15.3 ± 1.4 years of age); a long post-partum amenorrhea (14 ± 4 months), and early menopause (40.4 ± 2.5 years of age). As a consequence of all this, there is a drop in fertility that has nothing to do with another obvious fact: the high rate of demographic growth due to the high number of births per population. One will have to read carefully the corresponding chapter in order to appreciate the relationship of these factors with nutrition and habitat, in order to learn the magnitude of that problem and its social implications. Other aspects, such as the emotional state and intellectual behavior of these women, inevitably crop up in the complete reading of this work.

Clearly established is the influence of maternal diet upon the child

at birth as well as the impact of supplementary feeding of the mother on child development. The longitudinal study of milk production in poorly fed women and in those who received complementary feeding is, to the best of my knowledge, unique. Moreover, their conclusions are of great importance and should be made known because they set forth objective and up-to-date aspects that operate against the belief in unduly emotional attitudes —well intentioned, to be sure, but evidently erroneous— for example proclaming on a universal and indiscriminate level that "mother's milk is the best food for the child until the child is two years old". No one denies the advantages of breast-feeding, but for the advantages that there may be, there is the requirement that, at least: a) the child starts breast-feeding the same day it is born so that is may benefit from the colostrum, b) there is actually milk secretion, and c) weaning is begun at an appropriate time.

A milk production that averages 590 ml a day during the first six-month period may be considered acceptable but not optimal; a production of 500 ml during the second six-month period makes the beginning of weaning obligatory. Such is the situation of the rural women studied here, and of many others.

Different researchers in the field of emotional development —particularly Erickson— point to the fact that the nursing child goes through a crisis of "basic confidence" during the first year of life and that, if all goes well, if the environment responds to the child's necessities, it emerges from that stage with a definite and clear "faith in life". That is what I refer to when —using elements of the "development syndrome" proposed by Fromm. I state that the task of the nursing child is to learn to love life. The child achieves that, basically, in its social relationship with the mother and in her unrestricted offer of food to the child. Foncerrada, in turn, finds that, at least in urban areas, the Mexican woman achieves those objectives to varying degrees, but within acceptable limits; he also finds that failure in the mother-child relationship begins after the eighth month and worsens when the child acquires a sense of duality, that of the ego and the non-ego.

But this is not the case in the impoverished rural environment —as in Tezonteopan. If a child is fed for 18 months or more on a maximum of 500 ml of mother's milk, it most certainly cannot acquire a love for life or have faith in life. That is why Chávez and Martínez find a deep insecurity as a dramatic characteristic in those children. As a confirmation of this, there is the finding that the children of mothers whose secretion of milk increases rapidly suffer less and progress better than those children in whom the maximum availability of milk comes at a later time.

Apparently simple, but profound in its consequences, is the affirmation that "malnutrition upon weaning" (and perhaps to a good measure, the diarrhea of weaning caused by anatomic and functional alterations brought about by malnutrition in the epithelium of the small intestine) is, in reality, malnutrition resulting from late and poorly managed weaning.

In the chapter on utilization of nutrients, the authors open a study of the "survivor", already rendered vulnerable, and gather data for the better understanding of what has been called by myself "homeorrhesis",

establishing a relationship between "this acquired somatic equilibrium of the survivor and the cultural patterns of the population". Also, with the ethologic approach they were able to define differences in behavior between the two sexes.

In this longitudinal type of study, the authors made highly interesting observations, that child deterioration begins at three months, adaptation is achieved between the third and the eighth month, and after, when malnutrition is established there is no further increase in weight. At the same time, they question the value of cross-sectional studies in the field of pathogenesis of defective growth. Thus, they delve into the kinetics of this phenomenon, they discuss the significance of height, and comment upon the alterations in body proportions: lower segment/height; cephalic perimeter/thoracic perimeter (in this latter factor calling upon the observations of Jelliffe), and biachromial diameter/height.

After indicating the differences between male and female, they confirm the necessity for studying somatometric variables in the light of their genetic, neuroendocrine, and environmental influences. At the same time, they insist that groups and nations must give priority to good nutrition, focusing to the good growth of woman, since woman is the prime biological receptacle and is obligated to bear the human progeny.

The study of prevalent infections and their influence on child growth and development is done very carefully and is, to a large extent, new in the achievements of the application of the techniques selected. From the social point of view, they say, the complex that malnutrition and infection make up are, in reality, a single syndrome, or a single illness.

I am in total agreement with them! We must recognize –citing the authors– that poorly-fed children almost always live in a highly contaminated environment, in inadequate homes, have poor personal habits, and do not have potable water. There are cases, as in Tezonteopan, where there is the added fact that the people in the area do not speak Spanish well (the official language, that of the Departments of Health and Public Education).

Moreover, in such communities, it is frequent that the nursing children spend 90o/o of their time without any stimulus, in small, dark huts. Consequently, the syndrome is something more than malnutrition-infection. It is "social privation" it is the inability for adequate humanization –as I shall state over and over again– and in this phenomenon the causes are multiple, they interact, they are overlapping, they complement each other, and they take on added strength. That is why they cannot be reduced to a simplistic biological scheme.

The finding of retardation in neurological growth is consistent with the observations made within this country and elsewhere in the world; it constitutes a well-documented phenomenon in relationship with tissue growth. It seems especially fortunate that it is described in a chapter separate from other activities of the more integrated nervous system and related to the "function" and the complexity of their interactions and not to the "size" or growth of the nervous system. It seems to me equally prudent that the authors insist that what they observed was "retardation" in neurological behavior, while keeping from making extrapolations, or from inferring subsequent behavior in the intellectual sphere. Such a procedure is congruent with what is indicated by Dodge and his

group who, after an exhaustive review, concluded that it is not demonstrated that nutritional aggression during maturation cause irreparable brain damage or is it demonstrated that phenomena similar to the "imprinting" in birds occur in the nursing child, or that the nervous system can be accelerated by manipulation during the critical periods.

I hold that most studies on "intelligence" have met with many difficulties, not only because of the emotion and lack of objectivity it has inevitability run into with regard to nutritional status, but because intelligence is most surely ". . . a dynamic succession of functions in development in which the most advanced and complex functions in the hierarchy depend upon the previous maturation of earlier and more simple functions (given, of course, normal conditions of child care)" (Bailey), all of which becomes more complicated in light of Dodge's conclusions.

On the other hand, intelligence may be seen –and eventually studied– as a potential, as a capacity, as an ability, and the intelligence quotient, whatever its form may be, measures basic abilities. In this regard, I find the affirmation valid that the intelligence quotient is more closely related to the level of social development than it is to nutritional status or to the levels of "homeorrhesis" achieved.

We come now to the eighth chapter, which discusses the total behavior of the children. In this chapter I find arguments that support what I have said above. In particular, I wish to express the pleasure, astonishment, and admiration that reading this chapter produces in one who reads it with his interest immersed in the significance that the problem has for a less developed country. The reaction that the reading of this chapter brings about is due not only to the conclusions that are extremely useful; it is due principally to the impression that the method of study engenders and to the fact that there is a clear narration of an extraordinary, patient, and sustained effort that ends quite successfully.

The chapter is subdivided into the following paragraphs: activity of the child; closeness to the mother; actions of the mother toward the child; care of the mother; attitudes of the child; participation on the part of the father; manifestations of effect of the family; family stimuli; environmental stimuli; the character of the child; open field tests; commentaries, and conclusions. Each one of these factors stands out because of the originality of the method of study.

The importance of stimuli in human behavior and of the lack of stimuli in these children is very clear. Everything that has been called the "laws of learning" become apparent: organic maturity; the sequence of abilities; initial stimulus; those of purpose; those of cultural influence; those of interactions among achievements. The better-fed children practically did not sleep during the day beginning at 40 weeks of age and persisted in remaining outside the huts: they were more alert, they evidenced greater physical activity, they were more independent. Their behavior brought about an important impact on the behavior of the mother, she normally being so subject to the husband and the mother-in-law. Later, these children also influenced the father. In short, the child drew greater attention from all other members of the family.

By contrast, the poorly fed were apathetic, insecure, and very limited in their expressive capacity, all of which is the result of a great deal of passivity in the mother-child interaction. This situation began, according

to the authors, with a system diachronic (within the natural history of the growth of a child) because of lack of energy at the cellular level and resulted in restricted activity. Yes, this is true, but all the other factors influence a non-lineal diachronic system within which the lack of stimuli becomes crucial. Without stimuli there is no motivation, and without motivation intellectual work diminishes, since, following Piaget, we must accept the idea that there is no purely intellectual act: all acts have an affective point of departure –the desire to act. Nor are there purely effective acts they all take shape through intellectual work.

Be that as it may, the vulnerable survivor, the socially restrained, is denied the possibility of fully achieving the objective in life; he is denied the possibility of being allert, of permanently being able to say ". . . as long as I live I shall go forth", because his spirit is chained.

The reading of this book produced in me a feeling of envy for not having had the opportunity of working with such an effective and valuable group on a so transcendent project, envy for not having served my country in such a beautiful way. The National Institute of Nutrition in its entirety should enjoy the intimate satisfaction of having professionals of this stature in their ranks. The book should be read over and over, slowly, thoughtfully. It should be read with co-executive attention –as Lain Entralgo would say–, feeling the pain and the tragedy of our fellow countrymen, feeling the magnitude of the injustice that is commited upon them. It should be read, too, without despair, remembering that there are Mexicans who can give part of their own being, hours of their lives, to a labor of love in the search for total knowledge of that reality, and that they do not do it for personal advantage but rather with a sense of responsibility and with a desire to accept responsibility. They are of a dutiful spirit and of a profoundly accepting nature so that others, the subjects of the research, open to them the intimacy of their days, let them see and become astonished at their lives, which go by so monotonously, and upon so doing, let them see the tragedy, but at the same time, the richness of their hearts.

Dr. Rafael Ramos Galván

CONTENTS

Introduction

This monograph describes a research project that was done in a poor rural community over a period of ten consecutive years. The objective was to learn the consequences of deficient nutrition on the development of children and upon the formation of the people and communities who live, or rather, survive under very precarious social and economic conditions.

The intention was to identify the roots of the health problem of poor farmers by means of longitudinal observations of a group of mother-child units. For this purpose, health was defined as the full development of the genetic capacities, not only on a physical as well as intellectual basis, but also that of social behavior. In the less developed world the farm dweller does not reach full potential because, in spite of the fact that he is the one who produces food, he himself lacks it, and because of poverty, his environment is heavily contaminated. Beginning very early in his life, he has to adapt in order to subsist. It is traditionally said, perhaps with some evil intention, that the farmer lives happily in his poverty; that he is content with his fate, and environment. The truth is, as this study shows, that he finds himself very limited in several aspects of his overall development and that, even though he adapts to his marginal situation, he suffers just as any other human being does, but with the added burden of a great deal of insecurity in being able to obtain the basic needs for his sustenance.

There is no doubt that, in any country, the existence of social groups having a high incidence of malnutrition and of transmissible diseases constitutes a threat to the health and well-being of all because of the possibilities for contagion and because progress is impossible amidst such inequality.

Throughout the world very little money is spent on research that seeks to shed light upon the poor and the ill-fed, those who form the base of the economic pyramid in all societies, and those who still make up the majority of humanity. This form of denying the problem is a confession of little interest on the part of the intellectual sectors in knowing about man himself. It explains why, at this present date, there is more interest shown in investigating the characteristics of the moon than there is in learning about the possibilities of development in the poor regions of the world, which are, and for a long time will be, the true source of social

wealth: man is the end and the means of development, without whose participation every long-range sociopolitical project is lost.

Knowledge about the nutritional problems of the most vulnerable sectors has a high priority. Only with this knowledge will it be possible to set forth a policy of food and efficient nutrition so as to reduce, in a more or less short period, the differences in human development, in complete health, and in the true quality of life that exists among different social sectors and among different regions. It is only in this way that it will be possible to bring about more coherent and better organized countries, that will allow for aspirations, on a solid foundation, toward true socioeconomic development.

In this monograph we do not treat child malnutrition as it is treated in most medical publications, particularly those that come from hospitals. We are not dealing with sick children, severely malnourished, who have many symptoms caused by lack of food. We describe here the characteristics of an ordinary group of small-village children who are brought up as children in the majority of poor communities of underdeveloped countries: *fed in traditional ways, with a scarcity of food and an abundance of contamination.*

The village chosen for this study, Tezonteopan, is one of so many, a poorly developed community in which the child is not fed to satisfy because the adults do not even know that the child needs food for growth and development. What is more, they feed the child sparingly because he gets sick frequently and they attribute the disease to the food. That is, the community public opinion about foods is more negative than positive: it is necessary evil that must be administered in the smaller quantity as possible. These cultural believes, as well as the economic and social problems, result in a majority of children with a "mild-to-moderate" form of malnutrition.

This moderate form of malnutrition is, actually, an adaptation to the lack of food. Due to the absense of adequate nutrients for growth, the amount of body mass in the children is extremely limited, and as a consequence of the scarcity of energy intake these children reduce their activity and their interaction with their environment. This adaptation is, in reality, a strong limitation for their possibilities of human expression. The child survives, but does not bring to fruition his possibilities of living, of enjoying his environmental interaction with the other members of his society, and with nature in general.

This moderate chronic malnutrition is the rule in poor societies, to the extent that they accept this condition as normal, because all the people around them are in the same circumstances and because they have no point of reference for comparison. The urban sectors with higher incomes do not pay much attention to the problem, perhaps because basically they know, or at least have an uneasy feeling that the existence of the such conditions is a consequence of inequality, which is the fault of everyone, and therefore everyone would have to contribute something in order to do away with it. Few people are disposed to do anything: until now the world has rendered itself blind and deaf in the face of evidence of the negative impact of poor feeding on the development of the rural sectors of less developed areas. This has always been the burden of the peasant, working hard to produce food without receiving an equitable payment

from the higher-income sectors. This is the reason why, in practically all societies, the farm sector has been on the fringe of what is called progress.

Different studies done in several countries of the less developed world show that only a third of the children of low-income families suffer from malnutrition, qualifying it as an important defect in growth, with a weight deficit of 25% or more. This information is not exact. The experience of the authors, in this community and in many others, shows that the real figures are much higher. The majority of the prevalent studies do not take into consideration: 1) that the study is always done by weighing and measuring the children who are found in the village and that this group constitutes, in reality, the survivors, while many malnourished children are already in their graves as a consequence of their malnutrition and infections; 2) that in the samplings there are many small children who have not yet become malnourished because the mother's breast protects them during the first months, although there is no doubt that many of them will become malnourished; and finally, 3) that the older children have already recovered from malnutrition though at some prior moment they were malnourished. Very probably the truth may be that at least two-thirds of the children in the world suffer, or have suffered at some time in their lives, this syndrome of moderate, chronic malnutrition, if not so glaring in its symptoms, certainly glaring in its consequences.

This moderate, chronic malnutrition rarely kills directly, but it always leaves its mark on child development. This problem —the causes and consequences of moderate, chronic malnutrition— is the central theme of this book. Our intention is to attract the attention of doctors, nurses, aides, promoters, and different personnel who work for social welfare, and make them devote more attention to the solution of the problem. It is our intent to reveal the "enemy" of development so that the guns may better be focused on it. We insist upon this because it is our conviction that malnutrition must be the greatest concern of health workers and of all those professions that are engaged in human welfare, with no doubts that moderate, chronic malnutrition is not only the greatest prevalent syndrome in the world, but the one with more consequences for individual and collective life.

Although many results of a scientific type were expected, the objectives of the research at all times were applied. The research group always considered that the fundamental purpose of this study was to observe the interaction of the child with its environment from early life to learn more about the causes of malnutrition in order to better prevent them. The results show that many questions could be answered, but that there are still many questions. Therefore, it is important that the project continues. The sampling of mother-child units is still under observation, thus making it possible to obtain even more information and knowledge. There is now under study the levels of success among the children who have reached school age. They will soon be adolescents, and there is great possibility of formulating new questions and obtaining new answers at this all-important age. At the present moment new hypotheses have come up; it is hoped that some day we will have the resources to be able to test them.

A select group of researchers collaborated in the project on specific aspects of the various stages of the work. They are given due credit in the

original publications, which are indicated in the bibliography. Consequently, they are mentioned here solely in recognition of their work and with our gratitude. In the aspects of physical development there was the collaboration of Samir Basta, Rafael Ramos Galván, Miguel Nieves, Albert Oude Ophuis, and Olinda Garcidueñas. In the work on neurological and mental development there was help from Recaredo Rodríguez, Francisco Rubio, Pilar Martínez, Tamara Yaschine, and María Antonieta Rodiles. Dr. Ruth Huenemann was the advisor on problems of community nutrition. Héctor Bourges, Samir Basta, Marta Coronado, Yolanda López, Cristina Cárdenas, Maricela López, Margarita Tapia, and Imelda Ríos were co-workers for nutritional biochemistry investigations. In the ecological fields Margarita Castillejos and Alfonso González contributed valuable insight. Ricardo Moncada, David Díaz and Roberto Flores provides statistical support and Rosa María Espino and María Luisa Guerrero were the administrators. Some have followed along the whole road while others participated partially, but to all the people mentioned I wish to express my gratitude for their decided and effective collaboration.

We recognize that, above all, the project owes its results to strict field work. The research group has always held that nutrition is a continuous process that takes place night and day, on holidays as well as on ordinary week days. Thus, to learn about nutrition it is necessary to work beyond the 40 hours a week that the bureaucratic mentality conceives. This is exactly what the field group did, headed by Celia Martínez, one of the authors of this monograph.

The main sources of financing were, in addition to the National Institute of Nutrition itself, the National Institutes of Health in the United States, and the Mexican National Council of Science and Technology. We wish to express our sincere gratitude for their support.

CHAPTER 1

The focus of the community study

Many of the problems in the physical and social development of the farm dweller have been transmitted from one generation to the next through mechanisms that must come into play very early in life. In all less developed areas, early nutrition depends almost exclusively on the mother. That is why we decided that this research project should begin with the study of human development at a point prior to birth, at which we might identify factors that could act through the placenta, and follow this by giving special importance to the duration of breast-feeding to lactation itself and its effects on nutritional status as well as physical, mental, and behavioral development. Lactation is a poorly understood stage that has received little consideration in most research work that has been done in the third world.

The research was of the *etho-ecological* type (from the Greek *ethos*, which means disposition or character of people) because it studied the interrelationships between the environmental factors surrounding the child –especially child-feeding– and a series of phenomena linked to child, maternal, or family behavior. The experimental plan was devised in such a way as to permit identification of the impact of a physical phenomenon –nutritional insufficiency and the physiological changes it brings about– upon the psychological phenomenon of child behavior. This was done within the framework of the way of life of the family and of the community. The plan of study was also devised so as to allow for research in the lesser known areas of the interaction between man and his environment, starting at the most basic physiological roots in search of those factors that limit the possibilities of man for reaching his optimum physical, mental, and social development.

In some cases the problem was analyzed in reverse: we began with the study of the environment and tried to identify its effect on the physical or mental functions of the children. This means that the research constituted an effort to understand the problem of health in its entirety, considering child development as the basis of health, not as an isolated individual phenomenon, but rather within the child existential framework –its environment– which, for the small child is, in great measure, the mother. For this reason, throughout this work, we speak of mother-child units, their nutrition, their illnesses, and their behavior.

We are dealing here with an epidemiological study because we are

trying to find out how certain environmental conditions act upon the health of the most helpless of humans. But we did not follow an experimental plan typical for this kind of research, nor did we select representative samplings to simply projecting the results from them to the universe of similar cases. We used a research model that resembles that of physiology, of case studies that are more or less typical. For this reason, this study offers only knowledge of a general type that according to the case, may or may not be extrapolated to the reality of different human groups. It is therefore accepted that they are useful only to recognize –and in some cases, to interpret– some phenomena regarding health and human development that are frequent among certain population groups left on the fringes of development. Its practical application for solutions requires discernment on the part of researchers who may use them.

The experimental plan of the research employs a system of variables. The independent variable was food, while the dependent variable was child development and behavior. Within this system it was expected that any change in the former would result in a corresponding proportional change in the latter. It was believed that in this way we could test the direct hypothesis to the effect that good nutrition favors human development as well as the null hypothesis (the country) to the effect that bad nutrition restricts the possibility of the individuals reaching the potential "written" in his genes.

In order for this plan of variables to be successful, it was necessary to resort to a model called "intervention", by means of which the independent variable, "nutrition", could be modified in order to observe the impact on the dependent variable: development and behavior. It wa known from the beginning that this method is difficult to apply in humans, above all to people in their natural environment, but, as the results show, it is highly productive.

A plan of intervention among humans in their natural environment is particularly difficult to carry out because the so-called intermediate variables cannot be controlled very well. In the case of this research project, the intermediate variables consist of all the other biological and social factors, aside from food, that may affect the development and behavior of a child. What we did in this project was not control the variables, but rather simply standardize them. This means that a great effort was made, first in planning and then in execution, for the intermediate variables to be present in the same manner in the intervention group and in the control group. In order to succeed in this, it was necessary to take special care in selecting the community, in training our personnel, in selecting the study groups, in regularizing methods of measurements, and in taking care of all the details regarding the environment of the project.

The basic method of research was objective and longitudinal observation of feeding, as well as of the variables it was thought might depend on it, of two groups of mother-child units: one in which the research personnel made every effort to avoid modifying the usual conditions of life, and the other, the intervention group in which the mother and child were given good foods and were then watched so as to assure compliance with the principles of good nutrition. The experimental plan assumed that the differences that might be found between these two groups regarding the dependent variables, development and child behavior, could be attributed to the effects of the intervention, that is, a better diet.

The project was carried on by means of a very detailed process of planning and execution in the field, with all tact and respect for the subjects, but with all scientific strictness in order to achieve the most accurate results. There are no precedents of any other model of intervention carried out with subjects following their usual manner of life, within their own homes, and with the situation being handled satisfactorily.

This model of intervention greatly facilitated interpretation of the results because it had the advantage of forming its own comparison group, known as "control group", based upon the supplemented children. The advantage lies in the fact that the better-fed comparison group is from the same village, that is, from the same environment, having similar genetic and socioeconomic characteristics.

In no case was it necessary to compare the results with those of city children or with children in other countries because there was always the possibility of analizing the data on a comparative basis with the "norms" created by the program.

A problem that we faced from the very beginning was how to form a concept of "human development". In principle, we accepted the fact that it could not be defined with only one parameter. Therefore, we did not try to measure only the effect of nutrition on physical development or so-called mental development. Rather, we tried to evaluate the impact on several simultaneous aspects, stressing behavior, which is, perhaps, the most valuable manifestation of human progress.

There were problems in defining and in establishing indicators of what is known as human behavior. It was decided that we would apply to the study a focus similar to that used by researchers in animal behavior (ethologists), who base their work only on objective observations and directly describe the behavior of their subjects without trying to interpret their findings in accordance with established theories.

The community in our study was selected very carefully. We did not select one in which there had been previous facilities or a community certain to collaborate. Rather, the selection was made of a community that from the genetic and socioeconomic point of view, offered the best experimental conditions.

Using a computer, we looked for a community that was poor, homogeneous from the socioeconomic point of view, having a high rate of endogamy, and made up of about 300 families who followed the basic cultural patterns of the Mexican farm-dweller, especially in his food habits. It was required that his diet be based on the traditional foods, that is, maize and beans, and that the children be fed in accordance with traditional habits: that they be breast-fed –their main food source– for more than two years, without adding any solid and sufficient supplementary foods. It was also required that the community be an isolated one so that external factors would not interfere, and that there would be little emigration so as to avoid loss of cases.

The community selected was Tezonteopan, situated near Atlixco, 180 kilometers (112 miles) from Mexico City. Throughout the research project there was concensus that the selection of this community was opportune, not only because it really fulfilled the required conditions, but the people also collaborated with us much more than was expected. The

project thus received great support. Because the community is located in the State of Puebla, in several previous publications the study has been called the "Puebla Project".

A great deal of effort was put into what is known as community control, in order to assure maximum cooperation on the part of the people in the study and to avoid loss of cases. Before the project began, direct contact was established with the families in order to sensitize and explain the program to them. Later, we set up a system of surveillance of the selected families as well as of all the other families in the community. To this end, amid a wide diversity of measures, we carried out some efforts for social benefit in such a manner as not to affect the variables under study. Rather, these efforts did progressively support future opportunities in the community, setting the foundation for a better environment for those who were then children but who would soon be adults. In this sense, the Puebla Project has been a study of human development as well as an effort toward communal organization, tending, in the long run, to establish a human and material infrastructure upon which the people in this community might begin to develop.

Within the context of community control, the most difficult part of the project was to achieve total participation on the part of both groups, the supplemented as well as the group who received nothing from the program. We received equal cooperation from the latter in spite of their not receiving supplementary food, because they were convinced of the social importance of the project. Although they have never completely understood exactly what the project was, they have been sufficiently generous with only the knowledge that what they were offering might be useful in undertaking better health programs in other towns.

The groups were made up in accordance with a system of double selection based on a series of criteria of previous regularization. The first group received no supplementary diet. It included all the women in the community who became pregnant in 1968 and who fulfilled the following requirements: they belonged to the middle socioeconomic stratum of the farm population; that they did not show any evidence of illness, they had from one to four children; they be from 1.37 meters to 1.54 meters in height (the normal height in this community), and that they be between 18 and 36 years of age. The total number of mother was 39.

A longitudinal study of reproduction and health was made in these mothers. A dietetic and clinical survey was made at the eighth month of pregnancy in order to evaluate their nutritional state.

After the birth, a second selection was made, according to the condition of the child at birth. This consisted of only those units in which the child was sound, weighed more than 2.5 Kg, and had an APGAR (a qualification of cerebral integrity) of more than 8. The remaining mother-child units numbered 20, all quite similar among themselves.

In order to make community control easier, i.e., to avoid transfer of knowledge between the two groups, and not to use too many personnel, the sampling for intervention was selected a year later. We began by establishing contact with all the women in the town who were at risk of a new pregnancy, who by socioeconomic characteristics, by physical condition and health stating were the most similar to the mothers in the group previously chosen. As soon as these women missed their first menstrual

period they began to receive a dietary supplement. We initially had 41 women who were studied in the same manner as the first group.

The supplementary food consisted of whipped milk in different flavors, mixed with vitamins and minerals. The amount was 64 g of powder daily. Half-skimmed milk was given during pregnancy and whole milk during lactation, taking into consideration the existing differences between their real diets and their theoretical necessities, in accordance with the nutritional recommendations for the Mexican Population. A great effort was made to have the mother consume the supplementary food together with her regular meals in two or three doses a day.

The latest that the supplementary diet was begun was 45 days after the calculated date of fertilization of the ovule. A method of surveillance was established in order to be certain that the mother consumed the supplementary food. She was given supplementary food during her entire pregnancy, during the entire period of lactation, and until a new pregnancy occurred. In each case a record was kept of the quantities consumed. At the eighth month of lactation a dietetic survey was made in order to measure total consumption. Periodic examinations were also made of the mother to watch her health, her increase in weight, and her nutritional status. To this purpose, we used a group of community aides who were specially trained.

When the child was born, a selection was made of the 20 units that were most similar to the group that did not receive supplementary feeding, and they were paired off. The child also received supplementary feeding, as provided for in the program; no fixed date was established for beginning the supplement for the child. Rather, the child was given supplementary feeding as soon as it was noted that consumption from the breast was no longer increasing, or when the increment in weight was less than expected. This generally occurred between the third and fourth month of lactation.

The supplement was administered according to the child's demand *(ad-libitum)*. We began by giving the child a bottle containing 180 ml of milk at night, and thereafter increasing amounts of strained food from jars and more milk in a similar fashion to what is done in families of higher socioeconomic bracket. We strongly insisted on the continuation of breast feeding and on the mother herself administering the foods to the child, but under the careful vigilance of our personnel.

All the mother-child units, those who received supplementary foods and those who did not, that in the graphs will be called supplemented and non-supplemented, respectively, were studied longitudinally with different periodicity for each one of the parameters included in the plan. Thus, for example, regarding the independent variable "nutrition", food and clinical surveys were made –including the measurement of the consumption of maternal milk on the part of the child– every two months during the first year and every six months during the second year. Periodic surveys were made regarding the dependent variable "child development", every month during the first year, every three months during the second year, and every six months during the third year. Growth and physical development were measured, Gesell mental tests were administered, and a neurological examination was made.

Child behavior was studied every two months at the beginning, and

every six months later on. Finally, we also carried on several longitudinal studies of some intermediate variables; our purpose here was to find out in what measure they were similar in both groups. For example, a weekly register was kept of each child's illnesses; on two occasions we carried out detailed studies of the home and of the nearby environment; and, in particular, a great deal of importance was placed on the evaluation of the mother-child interaction.

Most of the data obtained were electronically processed, and as we proceeded, the necessary statistical tests were made. All the information on behavior required non-parametric analysis. The type of specific tests is mentioned briefly in each area of study. We are aware that some researchers in other countries have expressed the opinion that this research project does not always present mathematical evidence of the differences between both groups. The authors are certain, however, that in a well-planned longitudinal study it is not necessary to follow so many statistical tests, nor is it necessary to fill this publication with numbers that are unintelligible to the non-specialized reader.

Resorting to statistics unnecessarily is very much in vogue among researchers who wish to give a scientific countenance to research projects that are inadequately planned and that are put into practice under inappropriate conditions. If the authors of this work chose a longitudinal type of study, in spite of its difficulty, it was precisely for the purpose of directly observing and measuring the phenomena, and of seeking constancy and consistency over the period of time, with the statistical certainty that the finding of a phenomenon over a long period of time shows its validity, since the probability that chance may be the cause of a persistent phenomenon is all but non-existent.

This means that if, for example, it is found in a cross-sectional study that one group of children is more active than another, it is very important to evaluate the role of change in the differences found. However, if the study continues over a period of time and it is found that, not only does the difference persist, but that it increases in accordance with a fixed pattern, it can no longer be thought that it is a random occurence. By definition, random, over a period of time, cannot function in a single direction, and even less can it follow a fixed pattern. Therefore, in cases such as this, it is absurd to waste time on tests of statistical significance. Besides, the fact that this book does not present all the statistical information does not mean that such information has not been compiled because of lack of knowledge or ability; rather, we prefer not to complicate information that is simple and obvious in itself.

This model of intervention research, in which only one half of the children under observation received supplementary feeding while nothing was done for the other, may be considered somewhat unethical. We considered this problem very carefully from the time we began to plan the project, and we came to the definite conclusion that there was nothing unethical involved. All the activities in the program were always of a positive nature; that is, nothing was ever taken from anyone. On the contrary, quite a lot was given to one-half of the participants. Moreover, in any research project, especially one of an epidemiological type, what is done is to observe without acting, and this does not result in any blame whatsoever. The group of twenty non-supplemented children make up a

minimal fraction of the millions of children who are developing under the same conditions of poverty and lack of food in small towns of the world, and they exist whether or not anybody studies them longitudinally.

Upon observing these twenty children in their natural environment, with no modification, the project hoped to obtain knowledge that would lead to proposals for better solutions to the problem for all children who live under similar conditions. Not to have followed them would have meant acting like an ostrich, hiding our healds in the ground so as not to see what is happening. It would be like saying that all those who live well, with no knowledge of the existence of malnutrition, and therefore with no need of assuming any social responsibility, have nothing to do with the problem, and that the conduct of the persons in the research group, who have seen the children painfully grow in their misery, suffering their anguishes along with them, is immoral. It is true that in the course of the research the personnel in the project were seeing a small group whom they were not helping. This is to reveal to society what is happening and to prevent its continuance, considering society's passiveness under the pretext that no one knows what is happening.

The research group has never felt guilty for the problems of the children and the families in this community. It is true that our personnel had to make an extraordinary effort not to act, but they did so realizing that they always had in mind that to show the all-important effect of malnutrition on human development, in the very homes of the subjects and in close and direct contact with malnutrition, would sooner or later lead to more and better procedures for eliminating it. At the same time, this would unmask the main consequences of the greatest ill that afflicts the country: social inequality.

CHAPTER 2

The family and its reproduction

When the project began, Tezonteopan was an isolated town in spite of being only 9 kilometers (5.5 miles) from a paved road. The population was 1,495, with a large predominance of children. Those less than 5 years of age made up 24.3o/o of the population, while 48.3o/o were under the age of 15. A point of difference with other towns was that there were more men than women, although the difference was relatively small (52o/o vs 48o/o). There were no public utilities, not even electricity, let alone potable water or medical services.

The town is relatively new, it was established in 1884, when 18 families of Indian origin, peasants from a nearby hacienda, came and rented a farm settlement. The entire current population comes from this original group. Immigration, as well as emigration, has been rare. After the Mexican revolution of 1917 they were given 200 hectares (500 acres) of the hacienda divided into small sections of family property. After further agrarian reform in 1948, the group benefitted by receiving another 552 hectares (1,380 acres); these, too, were distributed in parcels, now under the ejido system.

The school was founded in 1939 and was the principal source of motivation for the people to learn Spanish. Previously, the predominant language has been Náhuatl, but first, with the revolution, and distribution of land under the agrarian reform, most of these people began to become interested in the change. Unfortunately, and we will comment on this later, they forgot Náhuatl and learned Spanish poorly. Thus, their communal language has been narrowed. More recently, the transistor radio has helped a great deal in broadening their language. By 1968, when this study began, more than half of the population was already listening regularly their transistor radios.

The main activity of the people is agriculture. All families except three do most of their work in the fields. Most of the families, except the youngest heads of family, have parcels of land on which they produce food for their own consumption as well as several products for sale. The land they have is private property (30o/o of the families), collective (ejido) (40o/o), or rented (15o/o). About 15o/o of the population has no land and work as day laborers.

The parcels of land are very small, really sub-family units that average about 3.3 hectares (8.25 acres) and are totally dependent on rain for

water. In the whole town there are four pices of property that are relatively large —from 8 to 20 hectares (20 to 50 acres)— where the more needy people work as day laborers during the different stages of the agricultural cycle.

The economic situation in the town is very homogenous, and this was one of the criteria for selecting it. The families are very poor; in 1968 the average family income was 6,200 pesos per year (about one dollar per day); about half comes from corn, beans, and other food items. Another portion derives from the sale of agricultural items, and the rest from wages for their labor on other parcels of land.

The main agricultural crops are maize, peanuts, beans, and tomatoes. In addition there are squash, some edible greens, fruits, and farm-animal products such as hogs and goats, the latter two on a small scale.

The amount of maize they produce meets about two-thirds of their consumption needs, while their bean production meets less than half of their needs. Consequently, the rest must be bought. The town is almost self-sufficient in animal products, greens, and fruits, this being due to the fact that their consumption is rather low. Peanuts and tomatoes are commercial products and are only occasionally used for home consumption. Peanuts provide one-half of the town's income, and tomatoes are often the business of the larger growers.

The people themselves handle very little money. As we know from previous studies that have been carried out in rural Mexican areas, they are almost always in debt to the so-called caciques ("boss", "leader", "strong man"), who are persons with greater resources and who manage commerce and, therefore, the capital. Every year the farmers have to hand over their harvest to him, always at a very low price, in order to pay off part of their debt. It does not take long before they must once again borrow money for the following year's production and for various other expenses, especially of a religious nature, as well as for social affairs and family obligations, such as baptisms, weddings, and burials. In recent years there has been an appreciable increase in the importance of debts for medical expenses and for other unforeseen situations. The result is that these families never see all their income. This means that these people are poorer and less free than would appear from the description of their economy as we described it above.

A special study of the social condition of the mother-child units, which is the focus of this monograph, showed that they are very much subordinated to the authority of the man. Women do all the housework, and they also work hard in the fields during at least half of the year. When they do so, they take the child to the field with them, regardless of the child's age. If the child is small, they leave it in the shade of a tree for the whole day, under very inadequate conditions. Most of the time the woman works on the family land, but it is not rare for her to work also as a day laborer on someone else's land. In the latter case, it is the man who collects the salary. In general, the man gives the woman free access to the maize and beans stored in their own home, but not so to money needed to buy other consumer products; she must ask him for the money. When they go to the regional market place in Atlixco every two weeks, it is the man who does the purchasing.

The women always mention, and sometimes in a complaining tone,

that their possibilities of feeding themselves or their children better are very limited. The always feel under pressure from the needs and demands of the children and from the lack of support and economic aid from their husbands. In many of these cases this situation finds expression in anxiety and frequently in substitutional symptoms such as back or abdominal pains.

Very early in life, at the age of 15, hardly having had their first menstrual periods, the women in the town get married. They then begin to suffer a syndrome that we have called "uncontrolled maternity" because they are always either pregnant or breast feeding. In a cross-sectional survey that was done during one week in the life of the town, it was found that 85o/o of the women of reproductive age were either pregnant or breast feeding.

During the first years of the study in the town, there was no useful method for birth control. Only three women had, at some time, tried a highly unsuccessful, traditional recipe made up basically of a concoction of flowers of white rosebay, roots of wild herbs, and a piece of bull's hoof.

All the men think that they should have as many children as possible, since "that's what marriage is for". Only during serious illnesses do the fathers complain of the expenses that children entail. Three-fourths of the women believe that they must accept "all the children that God ordains". However, one fourth of the women began to show some signs of unrest in this regard; it had come to their knowledge that in the nearby city there were some women who could regulate their reproduction.

The food consumption habits of this population group are typical of that of the highlands of Mexico. This was shown in a dietetic survey done at the beginning of this project for the purpose of determining how typical the characteristics of the population were regarding their food habits and the conditions under which the children were fed.

A study was made of a sampling of 42 families selected at random from the entire population. The sampling was taken from a census that had previously been done by a house-to-house visit. The survey was of a mixed type, part qualitative and part quantitative, combining the method of questioning consumption in the household with weights and measurements of food over a 24-hour period.

In table 1 we see that the diet could not be poorer or more monotonous. Tortillas provide 69o/o of calories; 11o/o comes from beans, and 10o/o from sugar. The remaining 10o/o is from various sources, mainly fats, bottled sodas, some greens, and very few animal products.

As it is known, maize is a cereal of little nutritional value and its taste is neutral. Prepared in the form of a tortilla, to which lime is added. it makes a very voluminous diet. Beans are of a certain complementary value since they contain more than 20o/o protein and an amino acid composition complements maize. Recently, perhaps because of the scarcity of beans that the Mexican rural sector has suffered during the last few years, the people are substituting them with pasta soup, whose price is similar and are easier to cook. Besides, pastas enjoy a great social prestige. However, this habit is inadequate from the nutritional point of view because wheat products do not complement maize. The amino acid deficiencies in both are similar and, therefore, a diet of tortillas and pasta soup results in a greater degree of malnutrition than the traditional diet of

Table 1. Most frequent menus among 42 families

Types of breakfasts	
Coffee or tea, tortillas, beans and sauce	47.7o/o
The same, without beans	35.7o/o
Maize atole (porridge of ground maize) and bread	14.2o/o
Drink milk	2.4o/o
Types of dinners	
(In Mexico the main meal of the day is eaten at early afternoon)	
Beans, tortillas, sauce	52.3o/o
In addition, soup with pasta	33.4o/o
Soup instead of beans	9.5o/o
Only tortillas and sauce	4.8o/o
Types of suppers	
No supper	59.6o/o
Only tea or coffee, tortillas and sauce	21.5o/o
In addition, beans	14.2o/o
With milk or meat	2.4o/o

tortillas and beans.

Chile sauce is an important flavoring that makes eating so much tortilla easier; besides, it offers the advantage of being rich in vitamins A and C. Unfortunately, because chile sauces are made as hot as possible, they are not consumed in significant quantities and they are not given to small children.

The rest of the foods are used in small amounts, some only a few days a week and others only during certain seasons of the year. Greens are usually gathered, and fruits are bought in the regional market, to which people go once every two weeks. Because of their agricultural characteristics, immediately after harvest peanuts are frequently eaten, boiled with the atole (porridge of ground maize) or mixed ground with the maize from which tortillas are made. The community diet, poor and limited in flavor, provides very few calories or proteins. Table 2 shows *per capita* consumption of the principal nutrients.

The consumption measured was less than 2,000 calories per day, in

Table 2. Average consumption of nutrients per person per day

Nutrients	Consumption
Energy (Kcal)	1,981
Proteins (g)	55.6
Calcium (mg)	677
Iron (mg)	20.1
Vitamin A equivalent (μg)	532
Thiamine (mg)	1.29
Riboflavin (mg)	0.67
Niacine equivalent (mg)	15.8
Vitamin C	10.2

Table 3. Daily consumption of foods per pre-school child

Foods	*Average (g)*
Tortillas	169
Beans	22
Bread	22
Pastas	5
Oatmeal	1
Sugar	17
Vegetables	19
Fruit	2
Milk	33
Animal fat	5
Bottled drinks	10
Others	9

spite of the fact that the survey was made during the month of September, which is a time of great agricultural activity. During this period, everyone above six years of age is at work sowing the fields. Nevertheless, considering the short body stature and, above all, the large proportion of children, the theoretical recommendation for them is also low: 2,176 Kcal. For that reason, they have a deficit of only about 10o/o. This deficiency, in spite of appearing to be small, is highly important because the organism cannot compensate for it as it does with deficits in other nutrients. If energy is lacking, the individual reduces the amount of work, or loses weight and tends to become sick.

The NPU protein ingestion is also reduced; the protein quality is poor, being only 63o/o. According to the Mexican recommendations of the National Institute of Nutrition, the requirements for this type of population consuming protein with a quality this low are 83 g a day. So marked a deficiency can be appreciated; nevertheless, several recent studies done in the Institute itself have proven that, under normal circumstances, these people succeed in balancing their energy expenditures against such a low consumption, which shows that the deficit in calories is more important than the deficit in proteins.

Together with the survey on family feeding, we also did a study on the dietary consumption of preschool children between one and four years old. It was found that their diet was very similar to that of the adults (table 3).

Maize is also the main food for children, even though, in proportion to the adults, they are given a little more beans and wheat products, which balances their diet a little more. They are also shown a certain preference in the allotment of greens. In September, the time of the survey, there is some milk in the community, and the children are given a little. It is not the season for fruits, but in any event, fruit is not given to children because of the many taboos that exist in this respect (see table 1).

With this inadequate diet, the preschool children in the community do not satisfy their nutritional needs. They consume an average of 725 calories and 19.2 g of proteins a day, very far below the required minimum, which is 1,250 calories and 32 g of protein, respectively. Further

on, the strong impact of this low consumption will stand out sharply, especially the energy factor, in different aspects of human development.

It is also possible that the inadequate consumption of some amino acids may be limiting, especially tryptophan, lysine, and methionine, several vitamins, particularly vitamin A, niacin, riboflavin, and ascorbic acid, and even several minerals, such as iron and zinc.

During the period 1967-1971 the average annual birth rate in the village was 53.7 per 1,000 inhabitants while the general mortality rate was 15.9. This situation resulted in a high rate of natural increase, 37.8 per 1,000, a figure higher than the national rate, which for the same period was 33.5 per 1,000.

In 1972 we visited the 332 houses in the town, and we found that 213 of the 349 women over the age of 15 were either pregnant or lactating. If we subtract 98, who because of advanced age could no longer bear children, we then find that 85o/o of the women in their reproductive years were in a maternal state.

Table 4 shows the classification of families according to their reproductive status. The presence of two or more pregnant women in the same house is rare but always possible in rural Mexican areas, where a man may have two wives under the same roof.

The high number of families who have stopped having children is explained by the early onset of menopause. Almost half of the women stop bearing children approximately by the age of 33, by which time they have already had quite a few.

Figure 1. A family eating in the field.

Table 4. The reproduction pattern in the homes

Type of family	*Number*	*o/o*
Simple families in reproduction	177	53.4
Families with two or more women in reproduction	16	4.8
Women alone but in reproduction	2	0.6
Non-fertile families*	16	4.8
Families that no longer reproduce**	98	29.2
Only men	10	3.3
Women alone who no longer reproduce	13	3.9
Total	332	100.0

* Have never had children.
** Stopped having children due to menopause or pre-menopause.

The typical diet of pregnant women is similar to that described for the community as a whole. They have a tendency to eat more vegetables and fewer animal products than the men. Their diet consists mainly of maize tortillas (385 g a day) with hot pepper sauce and, three or four times a week, boiled beans in a quantity equivalent to 50 g a day. During a certain time of the year they eat peanuts, and at another time they eat pumpkin seeds or leucaena seeds (*Leucaena leucocephala,* a leguminous tree).

At the time of greatest scarcity, at the beginning of the rainy season, it is not rare for the women, even though pregnant or lactating, to eat only tortillas with chile and some quelites (a wild leafy green, somewhat fibrous, but of good nutritive value). When they have money, they consume pasta soup.

Under these poor dietary conditions it was found that, at the eighth month of pregnancy, the mothers studied had an average consumption of 1960 calories and 55 g of protein of low quality. The protein score of their diet was 67.5, a little better than the community average.

For the sake of comparison, non-pregnant women were also studied. It was found that they consumed a similar diet, except that in more limited quantity, 1,730 calories. The lactating woman consumed practically the same amount of calories as the pregnant one, that is 2,040 calories.

The small increments in consumption, 230 calories for the pregnant women and 310 for the lactating, are much below the internationally recommended figures of 300 and 800, respectively. In the case of pregnancy, even though the difference is not so great, it is easy to detect its consequences: the mother gains only 4.8 Kg in weight in the nine months and the child is born underweight at about 2.79 Kg instead of the desirable 3.40 Kg.

In the case of lactation, it is hard to understand how the mother can nurse her child in spite of such a great dietary deficiency. Calculating the cost of lactation, it is found that the woman produces, on average, half a liter of milk which, even though it is low in energy because it is low in fat, represents an expenditure of at least 300 calories. In addition, there is the energy cost of producing it; as it is not an efficient process, this

means at least another 300 calories, implying that a lactating woman should increase her consumption over the basal by a minimum of 600 calories. Actually she does not do this, and yet she can continue to lactate for many months, losing small amounts of weight. There is no doubt that this phenomenon requires more study. It is possible that poorly fed mothers, in some way, are more efficient, or that in some way their metabolism adjusts to the circumstances.

There is no doubt that women deteriorate physically with maternity. At about the eighth month of pregnancy they look and feel bad, and anemia is frequently found. Incredibly enough, signs of malnutrition do not appear; some show signs of swelling or even edema, but since this also happens in well-fed mothers, it cannot be affirmed that it is due to malnutrition. This may be an adaptation, which makes it very difficult to diagnose malnutrition in the mother. In spite of losing quite a bit of fatty tissue, and especially muscular tissue, they continue to work at the same pace, or even harder. Since they have several consecutive pregnancies, deliveries and lactation cycles they do not get the chance to recover in the interval. With time, their nutritional situation becomes progressively worse, although it is well-known that at the third or fourth pregnancy they seem to reach a point of stabilization and do not deteriorate further.

The authors have observed not in this community, but in other similar communities, rare cases of sudden death in pregnant women who were nutritionally very deteriorated, but there is no certainty that malnutrition played a role in this mortality.

Not all lactating mothers stop producing milk even in a state of advanced malnutrition; we have observed some mothers with adult kwashiorkor who could still produce some milk. In other geographic areas, like the Yucatan Peninsula, where there is a tendency toward pellagra, lactation makes it clinically evident, but the mothers can continue to produce milk for a certain period.

The mothers in this study who, it must be remembered, represent the median of the peasants in the town were small: their height was 144 ± 5 cm, and their weight at the eighth month of pregnancy was 51.1 ± 7.9 Kg. Anemia was present in 35.7o/o of the women (with less than 10 g of hemoglobin). Some of them really looked run-down, but only one of them had any complaints except, at times, vague weakness and muscular pains.

In spite of pregnancy, mothers continued to carry on their customary domestic activities, and frequently they helped in various agricultural chores as well. In addition, it was found that their blood pressure was very low, an average of 80-85/40, and that a systolic cardiac murmur was quite common, that could be only partially explained by their anemia. This cardiovascular problem is another important area that requires further study, since it is known that nutrition of the fetus depends not only on the concentration of nutrients in the mother's blood but also on the quantity of blood that passes through the placental bed. There are many interlocking factors that are known to affect the mother-child malnourished pair, like size of the placenta, total blood volume, and blood pressure. Consequently, there must be a correlation between the different maternal hemodynamic constants –such as the placental flow of nutrients and fetal growth.

The age at menarche in the town is very late. In the cross-sectional survey that was done in 1972, the women said that they had had their first menstrual period at the age of 15.3 ± 1.4. This was later corroborated in a prospective sampling of 39 girls who were followed longitudinally; by referring to their birth certificates, a similar age of menarche was found among them: 15.5 ± 1.4. In other studies of poor communities, this research group had already found that poor nutrition is the cause of delayed menarche. As a point of comparison, menarche among middle-class urban girls is about three years earlier, at the age of 12.

The fathers in the community marry off their daughters immediately after the appearance of the first menstrual periods. Thus, early pregnancies are common, in effect, before the girl reaches the body morphology of a mature woman. Most certainly, there is nothing more destructive to the health of the rural woman, nor more limiting in the possibilities for her future development, than this early marriage. It not only makes her travel toward malnutrition, but also lays the foundation for social exploitation. She is practically sold to her husband's family, she has no rights, and she does not receive an adequate level of education or social information. The repeated pregnancies contribute to the deterioration of her health status, although, on the other hand, they do result for her in a greater intrafamily acceptance and thus the granting of some rights.

Menopause sets in prematurely. The average age is 40.4 ± 2.5, at least 10 years earlier than its occurrence in well-fed populations in other countries. Moreover, almost half of the women during the last seven or eight years of the reproductive period are not fertile. We may be dealing here with a period of anovulatory menstruation, or a period of infertility resulting from alterations caused by so-called uncontrolled maternity, such as scars from infections or traumas.

There are also several manifestations of premature aging in the postmenopausal woman, something that is definitely not observed in a well-fed urban population. It is common for women in towns such as these, at the age of 40 or 50, to show such physical deterioration in their appearance that, in some cases, they look as though they are in full senescence. This premature aging also occurs in the men, particularly those between 50 and 60, although it is not rare for some younger men also to have the appearance of being much older than they really are.

What has just been described contradicts the traditional belief in Mexico that the rural population ages more slowly than the urban and can reach a very advanced age. This misconception may arise from seeing the same person look older than his or her years over a long period of time. Such premature aging may begin by the early middle years, making people look "old" many years before advance age is reached. Because of the short period between generations largely caused by early marriage, men and women may become great-grandparents before the age of 50. The truth is that, in this study and in many others done by the Division of Nutrition in rural areas, when efforts are made to corroborate the age of the people who look and say they are "very old", it is found that only in very few cases it is possible to prove that they are older than 70.

The situation described regarding late menarche and early menopause theoretically indicates a rather short period of reproduction of approximately 25 years. However, this period is even shorter –less than 20 years– because in nearly half the women the six or seven years that precede menopause are not fertile. All this information apparently contradicts the high birth rate recorded in the town.

Even more contradictory is the time lapse between pregnancies in the same mother, which is greater than it is in an urban environment. The period between the previous birth and the appearance of first post-partum menstruation was 13.5 ± 3.8 months for the 80 mothers observed in this study, 13.3 ± 4.1 months for the mothers who did not receive supplementary feeding, and 13.7 ± 3.6 months for the mothers who later received supplementary feeding.

The length of post-partum amenorrhea could be corroborated by direct longitudinal observation of the mothers who did not receive supplementary feeding because they were followed until their next pregnancy and birth. Under these circumstances, we again found a similar figure, 14.4 ± 4.0 months. Of course, during the whole period under analysis, all the mothers breast-fed their children in such a manner that menstruation began again, and a new pregnancy was initiated, while lactation was still in progress.

After this post-partum amenorrhea, the mothers menstruated an average of 3.8 months before becoming pregnant again. These figures, added to the nine months of pregnancy, show that the mothers in the town have a child on an average of every 26 months. This situation also indicates, undoubtedly, that individual fertility is low.

The late onset of menarche, the early menopause, the long period between births, the possibility of late anovulatory cycles, and the high rate of abortions (almost one –0.9– per mother), means that each mother in the town could have, on average, only nine live births during her entire reproductive life. This theoretical figure is also the real figure, confirmed by questioning a sample of women already in their menopause. They had not become pregnant during each ovulating cycle and actually had had an average of nine live children during their lifetimes.

These results are apparently contradictory. On the one hand we speak of low fertility, and on the other we speak of these women having nine children. This is incomprehensible to people of better means who restrict their reproduction. We must remember that, from the biological point of view, in all species the capacity for reproduction is in excess. This means that, even if fertility drops, reproduction continues. What happens is that in a setting of low educational level, as is the case in this town, the families use their fertility to its fullest: they marry early in life, and they use no mechanisms to restrict births. Furthermore, in this environment, about four of the nine children who are born die before reaching the age of five. This figure has also been corroborated in practice. In the last analysis, then, each couple –exercising reproductive capacity to the maximum– brings only five new beings into the population.

Why, then, is there such a high demographic growth rate in the community? The answer probably lies in the already described lack of birth control in the very early age at marriage, and, in to a certain extent in the skewing of statistics caused by the population structure: predominance of young people in their reproductive years. The situation of women beginning to have children at the age of 15 or 16 greatly shortens the time between generations and results in mothers and daughters, and sometimes

even granddaughters, having children at the same time, helping each other, even exchanging babies among themselves for breast-feeding.

In order to understand this situation better, we may take the example of the other mammals, for example, the gorilla. In spite of the fact that female gorillas can have only one offspring every two years, their birth rate could double that of Tezonteopan. This high birth rate does not reflect births per mother, but rather births per population. The reproductive age of the female gorilla begins at 8 years; there are almost no old individuals, and there are two females for each male.

An important implication of this is that prevention of high birth rates is of tremendous importance in a rural environment, often overlooked in the underdeveloped countries. The most obvious measure is to prevent the early marriage of women. This, in addition, would protect women

Figure 2. A supplemented mother-child unit in the rural research center.

from becoming excessively dependent on their husbands and provide them with greater probabilities of undergoing their first pregnancy in a better nutritional state.

In order to determine whether some of the reproductive phenomena previously mentioned have to do with nutrition, an analysis was made of the 41 mothers who received supplementary feeding. According to the survey done, they were, in fact, eating much better. At the eighth month of pregnancy they were consuming 2,410 calories and 70.7 g of protein. As a result, they gained 3.4 Kg more by the end of gestation. They did not have anemia, and the periodic clinical examinations showed radically different results.

This group of better-fed mothers began to menstruate again 7.5 ± 2.6 months after their last delivery. Also, they had only 2.6 months of menstruation without becoming pregnant. These differences between better-fed mothers and those poorly-fed are very significant. Thus, the total non-fertile period between pregnancies was shortened by 30o/o (8 months), since the well-fed women in this group had their next child 19 months after the previous delivery.

Because the only difference between this group of mothers and the rest of the mothers in the community was better feeding, it was concluded that poor nutrition was the cause of the prolonged period of post-partum amenorrhea, and that it was also the reason why mothers had a child every 27 months. In other words, low fertility is caused by poor nutrition.

Another factor that could have had an influence was the supplementary feeding of the infant. This might have resulted in a decrease in suckling and therefore in the stimuli that inhibits ovulation. However, these supplemented mothers lactated for at least 13 months. At 7.5 months after delivery, when they began to menstruate once again, the child was still suckling on an average of 7.3 times a day. This cannot be said to be a low level of stimulation.

Traditionally, the prolonged period of amenorrhea after delivery has been attributed solely to hormonal mechanisms caused by lactation. This study, however, shows that, although lactation does play an important role, its most important action is nutritional in nature. In other words, lactation is a trong nutritional stress that results in delayed menstruation and ovulation. With better nutrition, in spite of lactation and the lactogenic hormone, menstruation and ovulation appear sooner. If the hormonal factor were so important, we would not find that most pregnancies in the less developed world begin during lactation.

Considering these factors, we can add that recommending prolonged breast-feeding to mothers in order to avoid pregnancies is not helpful. It does not work in favor of nutrition and health of women because it prolongs the nutritional stress, brings about a serious nutritional depletion of the mother, and is not protective against pregnancy after several months of lactation. Lactation should be recommended for what it is, the feeding of the child. Better methods now exist for preventing pregnancy.

Among pregnant women who did not receive supplementary feeding, 14 of the 39 infants born (36.9o/o) had low birth weight, weighing less than 2.5 Kg. The average weight for the whole group was 2.79 Kg.

In the case of the supplemented mothers, whose nutritional status was

therefore better, only 3 of 41 infants (7.3o/o) weighed less than 2.5 Kg. The average weight for the whole group was 2.97 Kg, 180 g heavier than for babies of the non-supplemented group.

As a matter of fact, the infants of the non-supplemented mothers lost more weight during the first few days, and the difference in weight at 15 days of age between the infants of well-fed and poorly-fed mothers was even greater (2.2 Kg). This loss of weight in children from the non-supplemented may be due to greater loss of fluid.

The difference in birth weight is more important than appears at first sight. The fact that the infants of the supplemented were born with 8o/o more weight than the ones from the non-supplemented not only establishes a better opportunity for future growth but, most certainly, there is also a greater possibility for survival during early life. It is well-known that mortality in infants who are born below 2.5 Kg weight is several times greater than for infants of normal weight.

It must be remembered that the greatest amount of human growth takes place within the womb. There, after the egg is fertilized, the body mass increases 300,000 times. After birth the increase in only 20 times. Surely this is why it is very difficult for the low-birth weight infant to grow normally unless it is well nourished from birth on ward.

CHAPTER 3

The importance of lactation in child nutrition

It is surprising that in most classical texts on infant nutrition, and even in several recent studies, little importance is attached to the lactation period. This surely is due to the prevalent idea that breast-feeding, regardless of any other conditions always assures adequate nutrition.

Specialists in the past considered that the nutritional problems of the child came as a consequence of weaning, because most of the malnourished children brought to the hospitals were those who had just been weaned. It never occurred to them to think that malnutrition, being an illness of slow development, had actually begun long before in the very period of lactation.

In view of the incontrovertible fact that in most underdeveloped populations in the world, children depend wholly on their mothers for food, especially on maternal milk, and, nevertheless, do not develop well and and present numerous health problems, frequently reaching severe stages of malnutrition, we decided to center this project around the earliest periods of mother-child development and dedicate a very important part of our efforts to the study of lactation. We worked on the hypothesis that so-called "weaning malnutrition" was but the culmination of a chronic situation that had begun long before the weaning stage, that it was caused by a progressive and prolonged caloric deficiency, which, in turn, was caused by insufficient lactation.

The poor population groups in the world depend on breast-feeding too much. They use it as the only source of child nutrition during the first 7 to 14 months of life, and then believe that they can continue using it as the basis of child feeding for periods sometimes more than twice that long.

Studies from around the world show that, in the human species breast-milk is insufficient as the sole source of food from very early stages in the life of the child:

1. It is a common observation in the underdeveloped countries that children begin to decelerate in growth starting at the 4th month of life, when breast-milk is apparently plentiful.
2. It is almost always possible to detect so-called weaning malnutrition during the lactation period itself. However, mothers take their children to the doctor only when they are severely ill, i.e., when they suffer dehydration brought about by diarrhea, which is always aggraveted by the

weaning process.

3. In the developed countries, it is only the textbooks that say that lactation is always sufficient. In practice, all doctors advise, and people are accustomed to, early supplementary feeding, long before the age of 3 months.

4. In many growth charts of normal children from developed countries like France made at the beginning of the century, there was a clear slowing of growth from the 4th to the 10th month, while more recent growth charts show that this growth faltering can be prevented by introducing supplementary feeding at early ages.

5. Most of the studies on the amount of milk produced as cited in the classic European literature, showed that women were able to secrete 800 ml on average, but these studies of wet-nurses rather than of samplings of women selected at random. In recent studies, using more modern methods, and with more representative groups of women, such high volumes of production were not found.

6. Several previous studies done in India and Indonesia showed that in undernourished women lactation is really poor. During the first semester milk production amounts to 500 to 750 ml/day, during the second semester it is from 500 to 600 ml, and during the third and fourth semesters it is about 400 ml daily (see table 5).

7. There are may biological differences among the upper primates, within which man is the most representative, and the rest of the mammalian class. Thus, for example, the human does not grow uniformly; he grows more slowly and has a much longer metabolic life. According to his body size and metabolic rate his life span should be 20 years, like that of the burro or goat, but it is comparable to the elephant's. His longevity is more similar to that of the birds. Also, the human is quite different from the other species with regard to lactation, it is enough to recall that the concentration of protein in human milk and in the milk of the other upper primates is quite far out on the line of reggression formed by the velocity of growth in the mammal, measured by the time of duplication of weight at birth and the concentration of protein in the milk of the species. In theory, human milk should contain one gram of protein for every 30 calories, but it contains one gram for every 60 calories.

In reality, any discussion as to whether human milk has an adequate concentration of nutrients should take into account the quantity consumed. It makes no difference if the concentration is poor as long as a large volume is consumed. This study shows that this is what happens in the human being. During the first three or four months of life, it does not matter if the milk is low in proteins because the child consumes a large quantity of milk and accumulates a lot of fats due to high energy intake. Under these conditions there is not a protein problem. At most, the child consumes its reserves of iron and maintains its levels of vitamin C. After three or four months of age the situation becomes reversed. The protein concentration may be adequate for the lower velocity of growth, but there is a lack in quantity, thus calories become the limiting factor.

Table 5. Production/consumption of milk in underdeveloped areas (ranges of averages in different studies)

Countries	*1st*	*2nd*	*3rd*	*4th*	*5th*	*6th*
Indonesia*	400-700	340-600	280-400	170-350	160-250	130
India**	530-730	600	480	400	375	345
Mexico***	590	510	510	380	380	—
Average of the studies	590	500	410	325	290	240

* Oomen and Bailey (seven studies).
** Gopalan, Rao and Velavady (three studies).
*** Chávez and Martínez (one study in Oaxaca)

After the third or fourth month mothers can no longer keep up milk production sufficient for the needs of the growing child. In fact, practically no other species can, which is why all species resort to mixed feeding at an early date, even using special mechanisms, such as regurgitation, as occurs in some carnivores.

This study was planned to derive longitudinal information on the production of milk in a group of mothers under natural conditions, so as to evaluate the effect upon child development, and to learn the influence of improved maternal nutrition on the quantity secreted. It was for this reason that the study included a second group of mothers, paired off against the first group, but supplemented with a beverage based on milk.

The customs that exist in a community in connection with lactation are very important from the point of view of public health. In general, some habits have quite a negative impact on the child, to the extent that at time there seem to be veritable "tests of survival" in which the most "apt" children are unconsciously selected, either because of their physiological condition or their metabolic capacity to resist "stress". Some of these habits originated in Western culture, which now, being more scientific, does not even remember them.

The child in this study community is not breast-fed during the first 48 hours of life because maternal milk is considered to be "raw" during this period and therefore, harmful. During this time the child is given a liquid concoction made from leaves, with a little bit of sugar added. It is only when the child cries excessively that mothers will ask another woman, who is already in an advanced stage of lactation, to give the infant some milk; this may be done once or twice a day, and in very small quantities. After 48 hours, the mother must bathe in a "temazcal", which is very similar to a sauna bath. After this bath, they say that her milk is already "cooked" and may now be given to the child *ad-libitum*.

The habit of giving the child the breast entirely on demand is observed in this community to a point of exaggeration. Each time the child cries, the first thing the mother does is give it her breast. It is only when the child does not take the breast and continues crying, that they think something else should be done. The practice of giving the breast in this way goes on all during the night as well as during the daytime. We have noted several cases in which the child was given the breast more than 20 times in 24 hours without the mothers thinking that their milk might be insufficient.

As time goes by, the child's dependence upon the breast becomes extraordinary, and separation from the breast becomes a very difficult task. The mother has to resort to a variety of methods, such as smearing

her breat with bitter herbs, with tabasco and even with chile pepper so that the child will reject it.

The mother almost always terminates lactation when there is a new pregnancy, at about the third or fourth month of amenorrhea, when she "already feels the new child". She terminates lactation also because she begins to feel bad; she says that she feels a greater fatigue and pains in the back. Another reason for her terminating lactation is that the people in the town say that the milk of a pregnant woman is harmful for the child; that it causes diarrhea and makes the child cry a lot; his character changes –he becomes sad and does not want to leave the mother. All of these symptoms, especially the mental ones, form a syndrome that, here in Mexico, is known as "the chípil child". In the Aztec language "chipil" means jealous; it is said that the child knows that there is going to be a new arrival, and he becomes sick with jealousy. The real fact is that at this time maternal milk production drops off, and what the child feels is an aggravation of his malnutrition. Later on we will present data that clearly show the relationship between nutritional insufficiency and personality changes.

The procedure for measuring the quantity of milk a child consumes is very difficult since a direct measurement cannot be made.When using the method of extracting the milk manually or with a milk extractor, natural conditions are definitively altered, especially in regard to stimulus to production. Besides, there is no assurance that an accurate measurement is being made.

In this study the method used was to weigh the child on a precision scale before and after each breast-feeding, and to atribute all weight increase to the milk consumed. This is exact in the positive sense, but it is not totally so in the negative sense, because in prolonged lactation the child may incur weight losses due, for example, to perspiring (urine collections were weighed and controlled) or to the simple loss of CO_2 through respiration. In any event, as far as the use of this method is concerned, we consider that the quantities lost through these routes are very small.

This procedure was carried out in the child's own home over a period of 72 consecutive hours, during which time the researcher lived in the home (usually a hut made of sticks or adobe), having with her a precision scale specially designed for the purpose (the scale sometimes occupied the greater part of the free space in the hut).

The researcher had to be very watchful for all occasions on which the child requested the breast because during the nights the mother could feed the child without being fully awake since she slept next to the child. In such instances and to the extent possible, the researcher had to be very alert in order to weight the child before and after feeding without altering the customary rhythm of lactation. We realize that this method is indirect, but it is the best procedure for measurement without changing the usual characteristics of lactation (figure 3).

The production of milk was measured seven times in mothers of each of the 34 children in the study, when the infants were 2, 8, 16, 24, 36, 56, and 78 weeks of age. A total of 116 surveys of 72 hours each were made. In each instance the same method and equipment were used, and they were all done by the same person (C.M.).

Some people have objected to this method, claiming that what is being measured is consumption and not production. However, this is absurd because both factors are equal. Maternal production cannot exceed child consumption, and vice-versa. In any event, what one might ask is: what is the limiting factor, offer or demand? the results of the study clearly showed that after the first 8 weeks, the limiting factor is maternal milk production. As will be seen later on, milk production does not increase in spite of the child's increased demand.

After the three days of measuring, one more day was used to take a sample of the milk. Throughout the day, a small quantity was taken at each feeding. The samples were mixed and then frozen to await subsequent analysis.

During the study it was possible to ascertain the very high frequency of infections in the mothers and especially in the children. However, we decided not to suspend the studies on this account, unless the illness was serious. About 15o/o of the research days were carried on while the child was sick with respiratory or digestive symptomology. No attempts were made to alter the situation because the presence of illnesses is customary in this group to the extent that minor illnesses are almost "normal" in the mother-child units in the town.

In calculating the differences in milk consumption in the cases in which a child became sick during a study (for example, when the child was well on the first or second day but became sick on the second or third day), it was found that the sick child reduced consumption by an average of 15o/o –much less during the first two months, when the child really had to be very sick to reduce consumption. The percentage was higher after one year, when any illness resulted in anorexia.

It must be remembered that the so-called undernourished mothers are

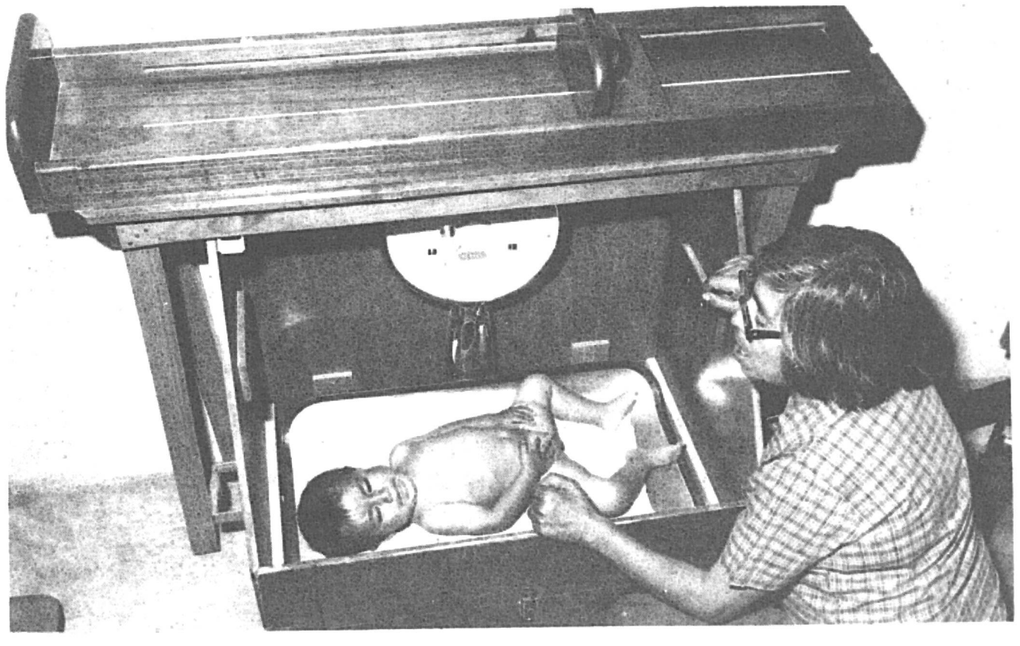


Figure 3. The weight is taken in a precision scale before and after each breast-feeding.

not suffering from malnutrition as such; their diet is poor, tortillas and beans, but they maintain an apparent nutritional equilibrium. The supplemented mothers are not exactly well-nourished since they received supplementary feeding only from the beginning of their pregnancy. We really do not know whether, in this relatively short time, all the alterations caused by malnutrition, undoubtedly present since their own infancy, have been corrected.

The levels of milk production by each of the undernourished mothers is sumarized in table 6, in which the averages per case per day are shown. In the 78 weeks column information is lacking for five units in which breast-feeding was stopped before that time was reached. There were 6 children who nursed for more than 2 years, that is, they were surveyed until 112 weeks of age; however, these values are not presented here because they varied considerably, and their interpretation requires special analysis.

If the areas under each one of the curves are integrated, we find that this group of children consumed an average of 183.23 liters of maternal milk during the first year of lactation, or an average equivalent of half a liter daily. It sould be noted that there is little variation from one case to another. Note also the fact that there was almost always a curve, with a low start, a period of progressive increase until a peak was reached, a sharp drop, and a long period of stabilization with a small, but constant decrease.

The finding of a drop after the peak is a medical problem in child nutrition, insofar as preventive medicine is concerned, because this pattern of milk secretion is not in accord with the child's necessities, which are always progressively increasing. The discrepancy between what the

Table 6. Production of maternal milk *(in ml per day at different ages)*

Sex	*2nd wk*	*8th wk*	*16th wk*	*24th wk*	*36 th wk*	*56th wk*	*78th wk*	*Tot. vol. (lt/yr)*
F	542	842	437	523	487	447	315	198.5
M	403	763	563	582	358	498	—	184.8
M	457	732	530	478	432	425	—	182.4
M	360	678	603	507	417	493	392	184.1
M	558	627	617	555	595	412	373	210.9
F	465	507	588	460	387	462	375	166.1
F	365	585	455	462	475	472	373	173.9
M	558	527	577	500	358	423	297	169.1
F	335	500	433	432	442	413	372	159.0
M	465	558	557	850	570	463	385	214.2
M	468	588	568	723	537	565	—	212.6
F	390	638	663	718	670	533	287	230.2
M	270	353	482	718	337	345	322	157.4
F	440	492	587	463	545	412	—	187.4
F	398	540	467	560	445	432	339	172.4
F	398	433	488	550	463	383	372	166.8
M	317	447	460	442	345	372		143.9
$\bar{X}$	422.9	577.1	537.4	560.7	462.4	444.1	350.0	183.2
S.D.	85.4	125.9	70.2	125.4	99.4	67.5	43.9	23.5

mother produces and what the child requires, beginning with the third month of life, is the origin of malnutrition in all those human groups who are not given early supplementary nourishment.

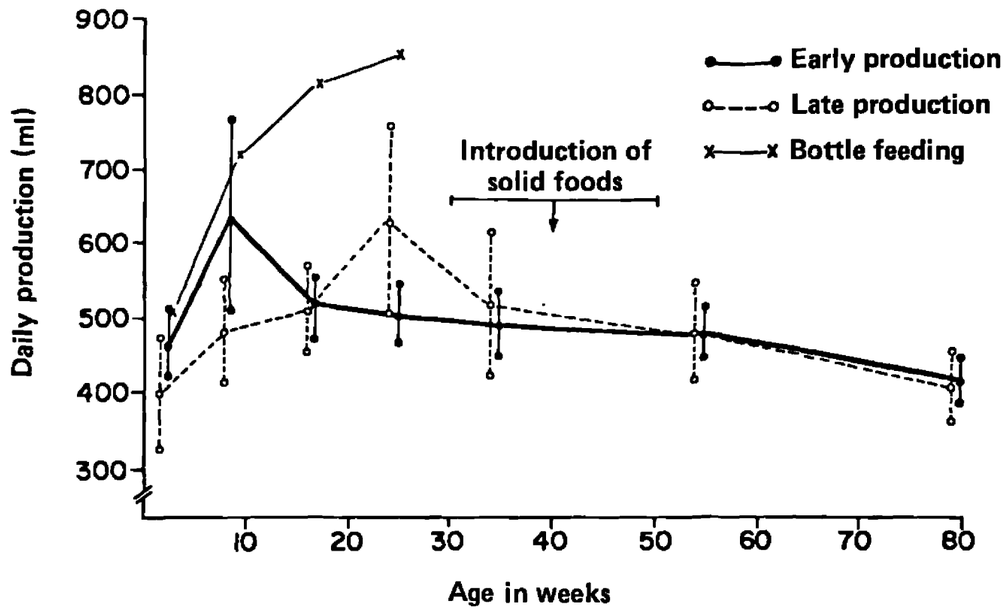
There was only one case, the last on the list, in which the maternal milk volumes were significantly inferior and without a real curve. Curiously enough, her child was occasionally given its grandmother's breast; the grandmother had a child one month younger, and it seems that she had enough milk to be able to help her daughter. This undoubtedly lent support to the growth of the child, who thus did not show a serious state of malnutrition.

In the original sampling of the 20 non-supplemented mother-child units there was a similar case in which there was an initial normal volume of 360 ml; however, this volume never increased. The child went into a progressive state of malnutrition to the point where it became necessary to administer supplementary feeding with cow's milk at an early stage. This case was eliminated from our study. This child would have died without our intervention because the mother was not aware of this hypogalactia.

Of course, the presence of an important maternal hypogalactia in two cases out of 20 is conducive to the idea that this phenomenon does exist, though the small number of cases in this sample is not predictive for its general occurrence. The authors have studied this phenomenon in other rural samplings, especially in a town in the State of Oaxaca, in which milk production was measured semilongitudinally in more than 70 cases. In addition, qualitative studies have been made in many more cases. The impression that we have is that true agalactia, that is, mothers who produce no milk, is very rare. We have seen only two cases: the first was a woman who produced no milk with her first child but did produce it with her second child; the other was a woman who produced only a blood-colored liquid. But hypogalactia appears to be more frequent than is believed; if it does not reach 10o/o, it is surely more than 5o/o. This may possibly indicate a figure of approximately one mother among 15 who cannot significatively increase production above initial values. In the rural environment the children of these mothers face an extremely high risk and, in fact, almost all of them die.

The averages that are placed at the end of the table do not offer a clear curve, but rather one that is flattened, with a tendency toward being bimodal. In effect, what happens is that approximately half of the mother increase production very rapidly, giving an early maximum peak at eight weeks. The other half increases production more slowly giving a late peak, at 24 weeks. We recognize that the division of the sample small to begin with, into two subgroups of 9 and 8 cases, respectively, is very risky because it greatly limits the possibilities for generalization. This was done because the differences are so clear. In graph 1 we present curves that show the production and consumption of each one of these groups. These will now be called "early production" and "late production", respectively.

The older and more multiparous mothers (perhaps for this reason also the worst nourished) are those who make up the group of early production, while the younger and less parous mothers are those who take longer to increase milk production to he maximum. Consequently, we are led to



Graph 1. Among the non-supplemented mothers, only the group that produces milk early can cover the initial necessities of the child.

to think that what we may call "training for lactation" is the factor that has the greatest influence on the type of lactation. In the poorly-fed mothers we did not find an intermediate type; this was found only in the supplemented mothers.

The total volume of milk produced during the first year is identical in both groups, and the peak production for each group is equally about 700 ml. The basic difference between them, however, lies in the stage of greatest availability of the milk. While the children in the early secretion group get a lot of milk at the beginning, the supply drops off after two to three months. The slow-production mothers reach a late peak; their availability of milk increases slowly until the sixth month, when it also drops off, although more slowly. This difference has important nutritional consequences: the children who have a good supply of milk available at the beginning, even though there may be a lack later, grow better than the children of the mothers with a slow start.

During the second semester, lactation is characterized by stable plateau. There is not much variation among mothers, most of whom produce around 500 ml per day. During the third semester, production progressively decreases. The breaking point between the most stable period and the clearly descending one is around the 13th month of lactation, the month for the reinitiation of the menstrual period (14th month after delivery). In total, during the sixth to eighteenth months, availability follows a constant downward path from 560 ml to only 350 ml, or a 35o/o drop. This phenomenon is, of course, inverse to the increasing necessities of the normally growing child.

The curves in graph 1, as well as the experience of the authors, suggest

that there are three different stages in the lactation phenomenon in the community, each one having a different significance. Early lactation that is very dynamic, is characterized at first by an abundant production in response to the demand of the child because it is small, as well as because maternal physiology has a greater capacity for response. This phase ends more or less bruskly, between the second and third months, due to the inability of the mother to continue producing at the same rate. Perhaps the difference between the well-nourished and the malnourished mothers lies in the abruptness with which this increasing phase ends, for in the latter it was found that production reached a veritable crisis, not only coming to a standstill and a stabilization, but to a drop.

Then there is a second period, which can be called intermediate lactation, that is fundamentally characterized by stability. During this period, the mother establishes a real limit to consumption because she can produce only a certain quantity and no more, usually between 450 to 600 ml, in spite of what the demand of the child may be. Production during this stage is significant to prevent serious malnutrition, but by no means sufficient for the normal growth pattern of the human being; thus if supplementary food is not added the child's development suffers.

Finally, there is a third stage, which may be called later lactation, characterized by a tendency of accelerated drop in production. This happens after the child has reached the age of about 13 months. In addition, during this period of later lactation, important changes may occur in milk quality as well as quantity; this is related to the resumption of menstruation or to a new pregnancy. Under these circumstances, lactation becomes a two-edged sword: the small quantity of milk produced undoubtedly helps the child somewhat, but neither the mother nor anyone else knows just what she is producing. If too much confidence is placed in this milk, and if additional food is not provided, serious malnutrition of the child may result. During this later lactation stage it might be better to wean the child so that the mother may take on the responsibility of beginning to act more quickly in giving the foods the child requires.

According to the customs in the town, it was not until the eighth or tenth month that the mothers began to introduce solid foods to the child —especially tortillas, pasta soup, and sometimes crackers or bread. Since they do not do this for nutritional purposes, but rather to help the child's teeth come out, the quantities given are small. Graph 1 clearly shows that solid foods are introduced late, when the production of milk is insufficient. The length of the period between the drop in milk production after the peak and the beginning of a definite introduction of solid foods is of decisive importance for the future of the child. It produces a nutrition gap in many aspects and determines the future of the child. This is the stage during which the child must adapt, learning to survive on little food.

For purposes of comparison, we also present in graph 1 the consumption curve of a group of Japanese children whose weight at birth was similar to that of the children in our study. The Japanese children were fed with breast-milk administered by bottle: it is very clear that there is early discrepancy in consumption between the two sets of children. Only at the beginning is there a similarity between the groups after that, the Japanese children, who eat *ad libitum*, progressively continue to increase their demand, following a sharp up-curve in a manner very different from

that of the children in Tezonteopan.

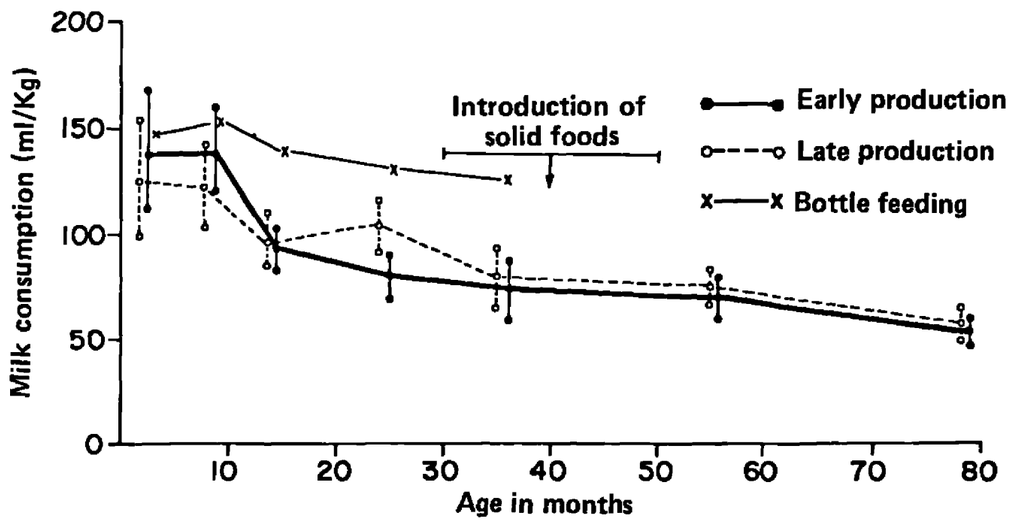
If the daily consumption of milk is calculated per Kg of weight, the situation does not appear dramatic (graph 2). The children in the rapid production group have enough milk —142 ml/Kg— during the first two months, a quantity that later decreases vertically to almost half that amount at the fourth month. From that moment on, the provision of milk per Kg becomes stable at about 68 ml/kg (what actually stabilizes is the weight of the child).

In the slow initial production group the pattern is different. Supply is restricted from the beginning, but remains steadier. For example, it is 128 ml at the beginning of lactation, and at six months it is still around 100. But it later decreases progressively until it equals the other group.

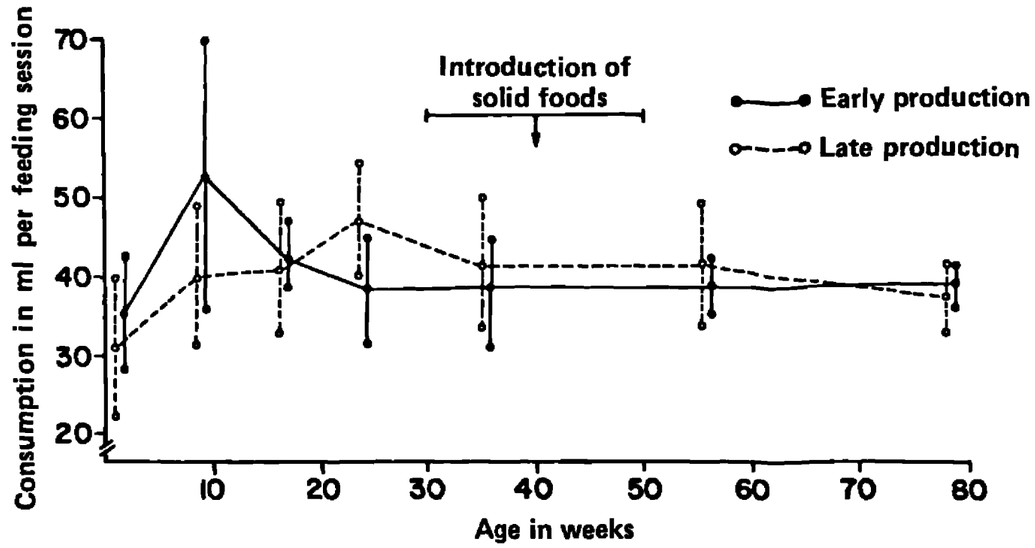
If this situation is compared with that of the Japanese children who are bottle-fed *ad libitum*, it is found that the infants of the early-production group of mothers in Tezonteopan show equal consumption at the beginning, which declines sharply after two or three months. The slow production group maintains parallel outputs for a longer period, but in quantities that are 20 to 30o/o less right from the beginning.

It is clear, therefore, that only half of the Tezonteopan children begin their development with sufficient milk, even though the supply is abruptly reduced after two or three months, while the other half does not receive a sufficient quantity of milk even at the very beginning. During the intermediate period of lactation it can be seen that the availability of milk per Kg progressively declines, but never to less than 60 ml/Kg. This minimum limit is fundamentally due to the fact that the weight of the child adjusts itself to the level of consumption; in other words, the child does not grow more because of the lack of milk. This quantity of 60 ml/Kg, in reality, is what could be called the level of maintenance— the minimum that allows life to be sustained, but without growth.

Graph 3 shows the curve for the quantity of milk supplied by the mother at each feeding session; its changes throughout lactation are parallel to the total production curve. This means that the frequency of



Graph 2. The quantities that the children consume per Kg of weight are lower than the quantities consumed by the bottle-fed children.



Graph 3. The curves of production of milk per feeding among the non-supplemented resemble those of total dairy production.

suckling has little importance when compared with the quantity that the child receives each time. If the child demands the breast more frequently, the only thing he accomplishes is to consume less each time.

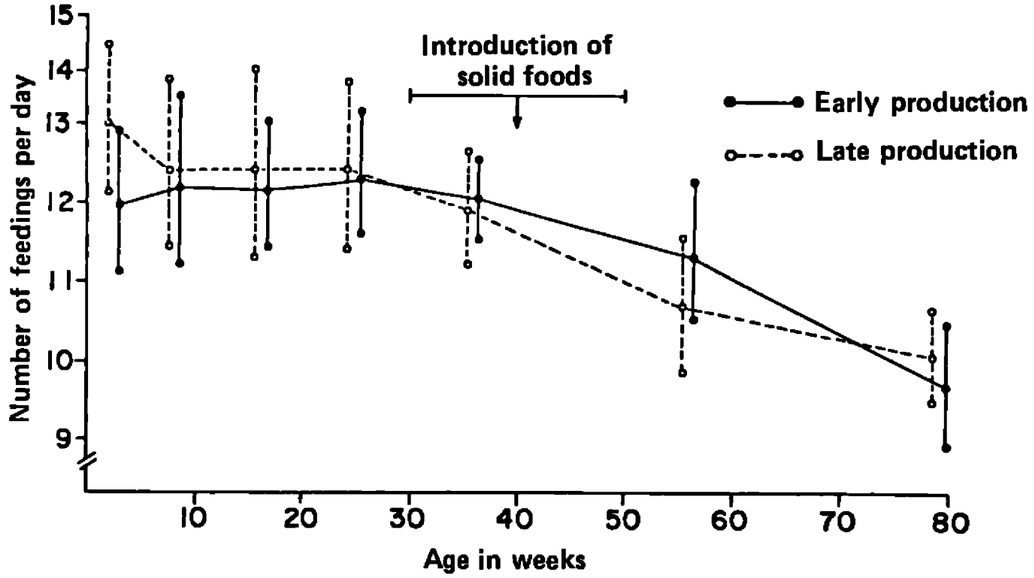
On average, during the total period of lactation, the volume that the child receives at each feeding is very low —about 40 ml. This most certainly result in the child's demanding a number of feedings during a 24-hour period. It is only in the rapid production group, and for a short period of time at the start, that the child consume more than 50 ml. Despite that, however, this group demands the breast an average of 12 times in a 24-hour period during the first height months (graph 4). This high frequency of demand shows that the child is hungry.

After the eighth month of age, and even though the child is in a more pronounced state of malnutrition, there is a gradual drop in the number of times that the child demands the breast. This may be attributed to the well known fact that malnutrition causes anorexia and also to the fact that the mothers begin to add complementary foods to the children's diet. We know that some of these foods, like atole (porridge of ground corn), take away the feeling of hunger.

In the mother-child units of slow initial milk production, demand for the breast is a little higher from the beginning, but soon equals that of the other group.

At one year of age, the whole sample still demands the breast more than 10 times in 24 hours, which average corresponds to almost two hours of suckling and nibbling. At this age there is a higher demand during the day, since the child normally awakens only three or four times during the night.

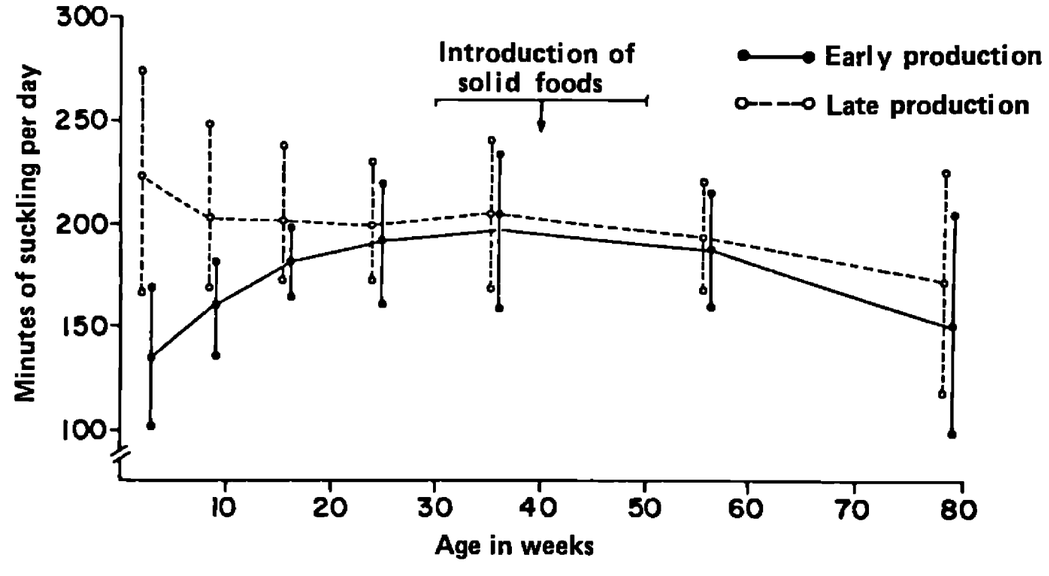
This high level of demand is shown somewhat more clearly in graph 5, which presents the amount of time that the child spends in suckling. It is about 200 minutes a day, or 3 hours and 20 minutes in a period of 24 hours (15o/o of the total time of the mother's life). All this effort is expended to acquire hardly more than half a liter of milk. It is not possible



Graph 4. The number of breast feedings during a 24-hour period among the non-supplemented group is very high during the entire time of lactation, especially before the introduction of solid food.

to say exactly how much time the child actually spends at suckling to get milk and how much merely playing with the nipple.

The number of suckling sessions and the suckling time are a measure of demand that the child establishes. Only at the beginning of lactation do the infants of the rapid production group of mothers have a lower demand simply because they get more milk at each feeding session and are thus more satisfied. Progressively, however, they level off with the other group.

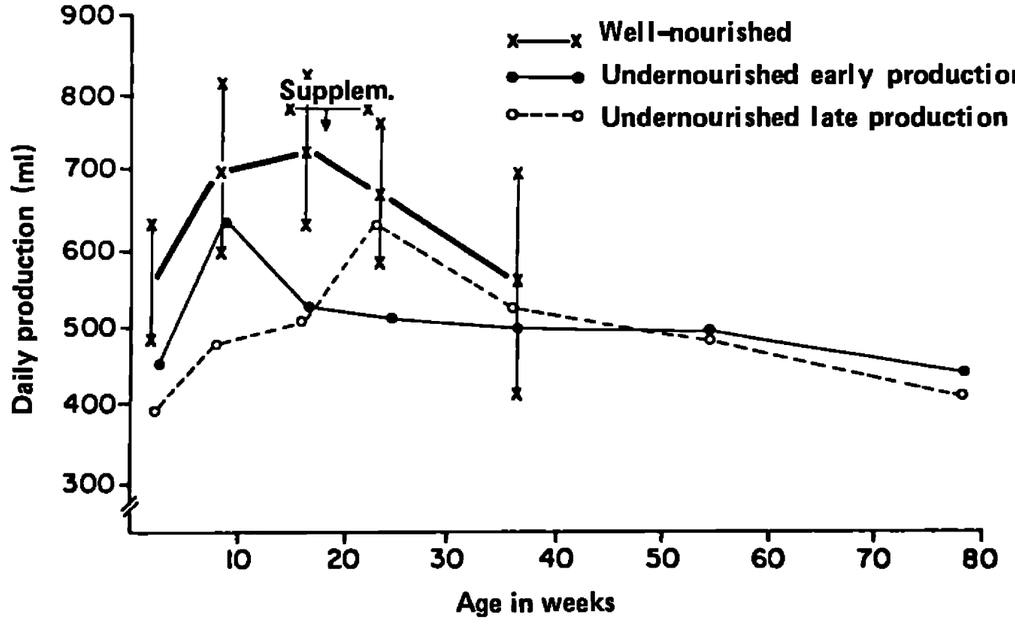


Graph 5. The time that the child spends suckling each day remains high during the entire period of lactation.

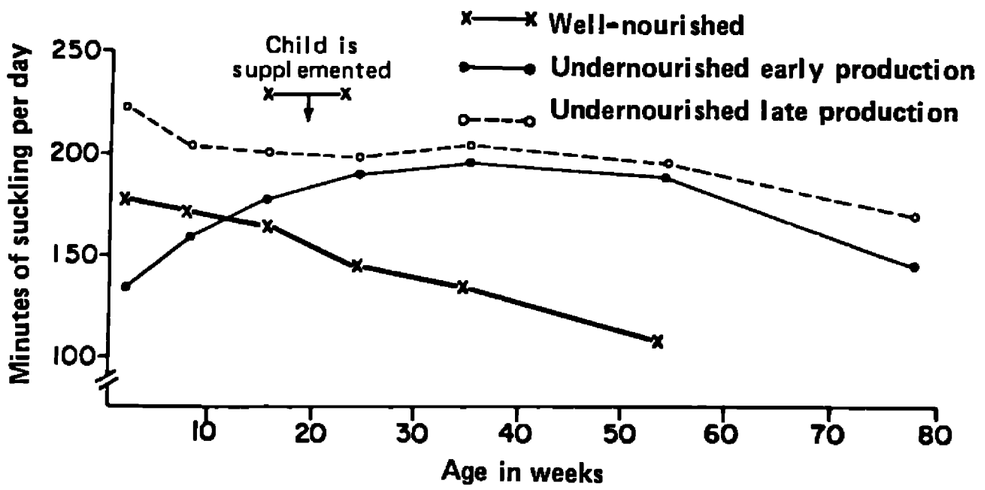
In the supplemented, and therefore better-nourished mothers, the following differences are found: 1) they show a different pattern of milk secretion. Graph 6 shows that their curve of daily production is more regular, with a progressive increase that lasts longer –16 weeks– and a subsequent drop that is more gradual; 2) there were not two groups among them, with an early maximum at 8 weeks or a late maximum at 24 weeks; rather, all of these mothers reached their highest production at 16 weeks; 3) they reach a higher level of secretion, with an average of 732 ml; and 4) the standard deviations among the observations were less, which means that the supplementary feeding made production more similar among these women.

In any event, even in the well-nourished mothers, there is a decrease in milk production, which means that the food supplement leading to better nutritional status does not prevent a decrease. This is important, because at 36 weeks of age for the child, mother's milk reaches an average level of production similar to that of the non-supplemented mothers. After nearly 8 months of lactation the study of the supplemented mother-child pair no longer allowed for further conclusions because the child started preferring supplements, especially bottles that give more with less effort, and rejected the breast. Therefore, weaning in this group came earlier. Several of these mother-child units reached the 56th week of lactation at our request, but neither the mother nor the child displayed great interest in lactation any longer.

Graph 7 shows the amount of time that the child spends suckling: it is clear that there is a progressive decrease in suckling time, although this is not pronounced. For example, at the 24th week the supplemented child is still suckling for about 2 hours a day, and at the 36th week for an hour and a half. These figures by no means constitute a low stimulus. It is only after this date that suckling time decreases sharply in response to



Graph 6. The curve of daily production of milk in the supplemented mothers is more regular.



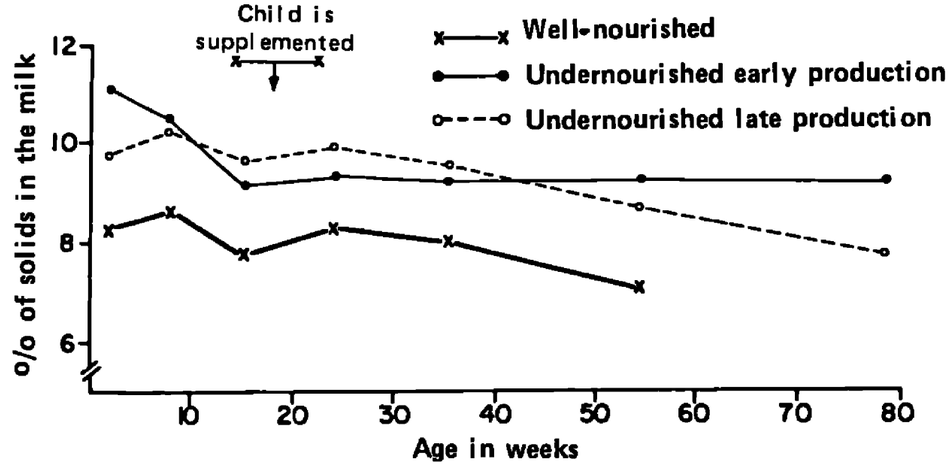
Graph 7. The total time of suckling per day on the part of the chilcren of the supplemented mothers is less, especially after 8 months of age.

decrease in production.

However, in order to clarify the point as to whether the lack of demand affects the supply of milk, a collateral study was done on a small group of four mother-child units; but in this case supplementary feeding was given only to the mother, not to the child. It was found that the curve of production-consumption during the first 36 weeks was parabolic, in the same manner as that of supplemented children, reaching a maximum at the 16th week. In spite of the higher child demand, it was followed by a decrease until the 36th week. After that, instead of production continuing to decrease consumption maintained a level at about half a liter; the latter is similar to what happens with the non-supplemented children. This result, although experienced in a small sample, suggests that the demand factor, that is, the lack of suckling on the part of the child, operates only when the volume of milk supplied by the breast is already low, after eight months.

Surprisingly laboratory analysis to compare milk from supplemented vs non-supplemented mothers, revealed a significant difference in the concentration of solids; the supplemented mothers, contrary to expectations secreted milk having 15o/o less solids. This result was consistent throughout the lactation period. Graph 8 shows that the poorly-fed mothers whose initial milk production was high have the concentration of solids classically described in text books. The first milk is more concentrated and then becomes progressively dilute during the first 16 weeks until it reaches a level of approximately 9.4o/o of solids at the third semester.

This means that at two weeks of age milk protein in these mothers is at the expected level of 1.6o/o, while at 6 weeks it is 1.15o/o, a value considered to be normal, that is maintained for a long period. In order to corroborate the laboratory procedures and show that this milk from the non-supplemented mothers is normal, we made a simultaneous study of several samplings of human milk from urban mothers, using the same methods and reagents. We found an average figure of 9.7o/o solids and 1.1o/o proteins for the intermediate lactation period, that is, practically the same figure as our village mothers, classified as non-supplemented,



Graph 8. Concentration of solids in the milk of supplemented mothers is more diluted.

early producers.

Table 7 shows, in comparative form, the composition of mature mater-milk exactly as found in different studies that our research group has carried out in different areas and at different socioeconomic levels. The first column presents data for the supplemented Tezonteopan mothers; the second column shows data for non-supplemented Tezonteopan mothers. In the third column are the data on the women of San Jorge Nuchita, a community poorer than Tezonteopan, and even closer to a critical nutritional level. The fourth column gives results for middle-class women in Mexico City, used as methodological controls, most of them wives of medium-income civil service employees. In the fifth column are data from mothers of a high socioeconomic level obtained at the Children's Hospital of Mexico. Protein level is similar in all samples except that in the supplemented mothers in Tezonteopan, that were much lower due to the previously mentioned phenomenon of dissolution.

Among the groups of poor mothers milk has fewer calories because it is lower in fats. In general, there is also a lesser quantity of some of the vitamins.

The dilution of the milk among the supplemented mothers partially conceals the benefit of their better curve of milk secretion. Graph 9 includes the curves for the production of milk solids in each of the groups studied, and shows the nutrients provided by mother's milk. This graph is the most important one for interpreting the phenomena in infant nutrition in a rural environment. It shows that the mothers in the early production group justify the term applied to them. During the first 8 weeks they produce a veritable explosion of nutrients because they produce not only more milk but a more highly concentrated milk; containing high quantities of solids, almost 70 g a day. The graph stresses the presence of the peak, because after that the supply of milk solids drops rapidly to 47 g at the 16th week and to 37 g at the 78th week; in other words, it shows the sharp drop after the peak and, therefore, the magnitude of the nutritional gap.

In the group of mothers whose milk supply was initially less, the amount of solids in the milk increases slowly from 40 g at the beginning of lactation to 62 g at the 24th week, and then it, too, decreases.

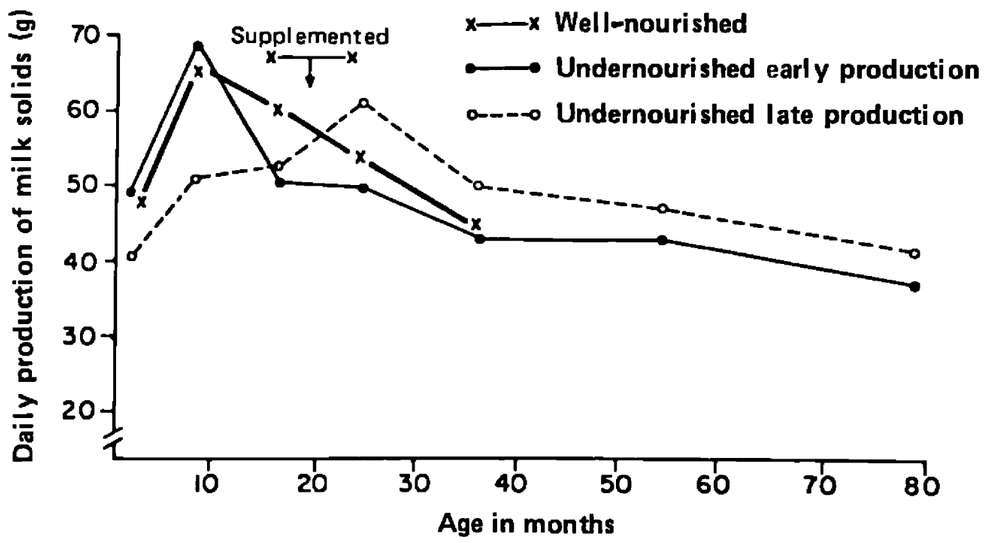
Table 7. Nutritive value of maternal milk (approximatly at six months of lactation)

Nutriments	*Tezonteopan* *Suppl.*	*Non-Suppl.*	*San Jorge Nuchita**	*Mexico City***	*Mexico City****
Energy (Kcal)	42.0	52.5	57.8	60.0	71.0
Protein (g)	0.89	1.14	1.04	1.11	1.20
Rel. E/P	47.2	46.1	55.5	54.1	59.2
Lactose (g)	4.1	6.0	7.0	6.6	7.0
Fats (g)	2.4	2.9	2.8	3.2	3.8
Thiamine (μg)	14.3	16.1	18.1	18.3	16.0
Riboflavin (μg)	22.2	26.6	24.3	—	43.0
Niacin (μg)	66	152	155	217	170
Vitamin C(mg)	2.8	2.2	1.8	2.9	4.3
Calcium (mg)	15.7	25.3	28.0	28.3	33.0
Iron (μg)	49	57	60	64	100

* A poorer and more poorly nourished rural community than Tezonteopan.
** Sampling among low income civil service workers.
*** Middle class mothers (data from Children's Hospital of Mexico).

As shown in graph 9, the production of lacteal solids in the better-fed mothers is much more regular. It rises rapidly during the first 8 weeks, as in the non-supplemented mothers, but with the difference that after that it decreases more slowly, without the sharp drop.

In total, the quantity of milk solids produced by the supplemented mothers during the first eight months is barely greater than that of the non-supplemented. If we integrate the curves, we find that the better-fed mothers supplied a total of only 18o/o more solids. Although this



Graph 9. The daily production of milk solids in supplemented mothers does not fall as abruptly and is more regular.

amount could be decisive, what seems more important is the more regular and more constant supply, without the characteristic drop after the peak found in the mothers whose early milk supply contained more solids.

Therefore, the data obtained in this community suggest that in all mothers, those supplemented and those not, lactation covers the infants' requirements only during the first few months of life. Th milk of the supplemented mothers met the child's requirements for four months, while that of non-supplemented mothers produced more milk earlier in lactation probably met infant needs for two to three months. The milk of younger non-supplemented mothers with fewer children, whose milk supply took longer to increase, probably never totally met the infant's nutrient requirements for normal growth and development.

As lactation advances, the poorer milk supply from the breast becomes more apparent. Even in the case of the supplemented mother-child units, the role played by lactation is more limited than generally accepted. The gap between actual consumption and needs starts in a very insidious manner. About six weeks after the peak in production there are not many signs of deficiency, perhaps only increased demand for the breast by the child and a slowing of weight increments, not always attributed to lack of food.

While there is no doubt that the number of cases was small the number of studies was large. From the very beginning, it was considered that in order to fill in the gaps that exist in the information on lactation in less developed areas, precise and well-standardized data, in longitudinal form were more important than less firm data based on large samples obtained without sufficient control. The results indicate our decisions to be correct. Even though our results may not contradict previous conclusions that appear in the literature in this area, they do show with greater clarity details on human lactation unknown until now.

Of course, the study corroborates the poor state of lactation among women in low socioeconomic circumstances previously described by Oomen and Bailey in Indonesia, by Gopalan, Rao and Belavady in India, and by the authors themselves in a very poor community in the southern part of Mexico. But in this study we also considered it of great interest to define whether this low lacteal secretion is directly caused by deficient maternal nutrition or by other physiologic or environmental problems. Moreover, as previously mentioned, the authors have always considered the possibility that there could be a tendency among nutrition and health specialists to over-estimate the role of lactation for humans. There is the possibility that low-level lactation in poor countries may instead be a characteristic of those particular groups, mainly as a result of small lean body mass of the mothers. Among mammalian it may be that humans are not as good milk producers, as previously considered on the bases of studies on biased samples of women who in many instances were wet nurses.

It seems clear that the information available up to the present regarding the pattern of lacteal secretion in the human species is imcomplete mainly because of the great difficulty involved in obtaining such information. In most of the recent studies, including those done in well-nourished women in Sweden and England, it has been proven that woman is not as good a producer of milk as has been believed. The discrepancy

between theory and reality has been outstanding. All the books on infant nutrition say that a mother can secrete daily an average of 800 ml of milk, but some of the same books also insist that children who are only breast-fed do not sustain sufficient growth after the fourth month of age. This is self-contradictory, because a child of, for example, eight months of age, weighing eight Kg, should certainly continue to grow with 800 ml of milk, which is 100 ml per Kg.

The curve of production of milk solids found in the supplemented mothers does not show three periods (described when speaking of totat output of milk) but rather two periods, one a short rising phase followed by another of slow decrease. This curve is similar to that of most mammals, and clearly shows the function of lactation: an initial period offering a great nutritional support, while the offspring is very immature, when lactation is a continuance of the placental trophic function and totally satisfies necessities; and a second period when the breast is only a help, constituing the basis upon which the offspring must progressively consume additional foods appropriate to the species.

This biological situation, normal for all mammals, explains why, after a given point at around the third or fourth month of age, a progressive discrepancy starts between what the maternal breast supplies and threoretical requirements of the child. Considering consumption per Kg of weight, a child who gets "maternalized" milk *ad libitum* begins by consuming an equivalent of 150 ml of "maternalized" milk per Kg during the first two months; the quantity per Kg then decreases slowly until it reaches 120 ml by the eighth month. Under natural circumstances lactation performance among undernourished mothers the situation is very different: the infants of the early secretion group achieve a high level of consumption, 138 ml during the first two months, but this then drops to about 70 ml at the eighth month.

Right from the beginning there is relatively lower consumption by infants whose mothers are in the group called late production. During the first two months, consumption is 125 ml per Kg of weight. This then goes down to 100 ml, a figure maintained for another two months an relatively stable until the age of six months, it then drops further to 70 ml per Kg, the figure mentioned above.

Lactation performance has a great deal to do with infant growth. The children of the later producing mothers have a slow start, and reach one year of age weighing half a kilo less than the children of mothers whose initial milk supply is plentiful. This shows the value of having enough milk available when there is a great potential for growth. Although not supplemented themselves, the children of supplemented mothers weighed half a Kg more than the children of rapid production mothers and one Kg more than the children of mothers whose early milk supply was low. This difference is due solely to the fact that their mothers' milk supply did not drop abruptly after it peaked, and milk production was sustained for a little longer.

The mothers of the children in the non-supplemented group began to introduce solid foods to the children, on average, at the 40th week. In almost all the graphs it can be seen that this introduction of solid foods does not substantially modify the curve of milk secretion, nor even the total suckling time. This is because the late introduction of solid foods is

very limited. Few foods are given, and the quantities are minimal. To exaggerate just a bit, it could be said that, in the first year of life, children are given more bacteria than nutrients.

Our research provides sufficient evidence to show that the fundamental problem is that maternal production is insufficient, because in spite of the fact that the children maintain a very high number of breast-feeds as well as an almost incredibly long suckling time, the milk per individual feed, the milk per Kg of weight, and the total amount of milk consumed decrease astonishingly at a certain given moment. This shows a fact that is now obvious but that was once highly debated: after at least two or three months of lactation, the mother is the limiting factor. She is the one who sets a maximum limit, and it is only on some occasions, when the child is sick that he does not consume all the milk available. This means that the infant factor is not important given that lesser demand occurs only when the child is very ill. In this case the determining causes are anorexia resulting from malnutrition and infections, asthenia caused by the fatigue of suckling and, sometimes, respiratory incapacity.

According to our own information, obtained by comparing consumption on days when a child was ill with the intake of the other days in the same survey, illness caused a reduction in consumption of 15o/o. Considering that about 30o/o of the time the children have some kind of infection especially respiratory or digestive, that have an overall systemic effect, the "lesser infant demand" would cause a reduction of only 5o/o in what is theoretically available. This situation is far less important than "low maternal production", which is what establishes the real limit to child nutrition.

If this were not so, it might be assumed that in order for a child to obtain more milk, he would only need to suckle more often, but such is not the case. A correlation was drawn between the time from one breast-feeding to the next, that is, the time that the mother rests, and the volume of milk the child receives. The figure obtained, which is very significant, was an r of 0.77. This means that the longer the child waits, the more milk it consumes. With time, the child must surely become aware of this and accept the condition that it must not demand the breast too frequently.

Late lactation, possibly from the 13th month on, is even less efficient because the quantity of milk with which the child is supplied diminishes and the concentration of solids decreases. Perhaps also by adaptation, the child somewhat reduces the number of breat-feedings and suckling time.

From the public health point of view, it is probable that milk secretion after the maximum peak –at two months in the early secretion group or at six months in the late secretion group– may be the most important factor in child health of all the factors found in the poorly-nourished mother-child dyad as well as the critical point in the whole process of human nutrition and development in poor societies. The supply of milk decreases at the precise moment when the child should be receiving it in ever increasing amounts. Thus, we have a situation which, epidemiologically, may be identified as the origin of nutritional problems among children in most of the population in the poor regions.

From the epidemiological point of view, there are two other crucial aspects useful for creating possible solutions: the evaluation of the impact of poor maternal nutrition on low milk production, and the role of sup-

plementary feeding in correcting that situation. With respect to the first point, by making a comparison with supplemented, and therefore better-nourished, mothers, it is apparent that poor nutrition in the group of younger mothers and those less experienced in lactation, results, in the beginning, in lactation being slower and more difficult, which impedes the initial volumes of maternal milk from being sufficient when the child needs it most. In the group of more multiparous mothers, on the contrary, the poor nutrition brings about an abrupt drop after a phase of abundant production. In both cases, the cutting down on the quantity of milk is not really great, but what is important are the consequences for the child. The children of the first group of mothers failed to gain one Kg while the children of the second group of mothers could not gain one half Kg.

Regarding the second aspect (corrective supplementary feeding), the findings are that supplementary feeding of the mother does help. We do not know if through betterment of nutritional status *per se,* or in a more immediate way, by bringing about a more direct conversion of more food to higher milk production. The former seems the most probable, in which case it is important that mothers eat better from the beginning of pregnancy, as was the case with our supplemented group. The second mechanism is similar to that in cows bred for a high output of milk: if they are given a ration of value "x", they produce "x" quantity of milk; if they are given a better ration, say "2x", they produce "2x" quantity of milk. This latter possibility was not studied, and it may possibly not be true. Cows that are capable of modifying their milk production in accordance with diet are of selected breeds that have a high maximum potential. Women in general, however, and especially the women in our sampling, always produce to their maximum; it is therefore improbable that they could achieve more efficient conversion of their food intake.

A factor that requires explanation is the dilution of the milk caused by supplementary feeding. To begin with, the effect is real, not only because it has been corroborated many times, but also because it was later observed in India by Dr. Belavady in a large group of mothers who received a supplementary feeding of milk. Under study is the hypothesis that the cause of the dilution is not better feeding in itself, but rather the milk given to the women. This is attributed to the fact that powdered milk is very rich in salt. If we take into consideration the small amount of salt that women in a rural environment are accustomed to consuming, it is possible that this excess salt may bring about problems in the handling of liquids and electrolytes, and that the latter, in turn, may be responsible for the phenomenon of diluting breast milk.

As a conclusion to this part of the study, it can be stated that for human beings, especially those in poor areas, breast-feeding should be considered only as a contribution on the part of the mother toward the development of the child; only at the beginning is it as efficient as the placenta in maintaining the child's growth; Later, however, breast milk must be progressively complemented with other foods. We accept that breast-feeding is excellent, but in order for the child to continue developing adequately later, after the age of two months, a mixed diet is required and should begin at the third month of life with the introduction of solid foods in sufficient quantity.

This study establishes the basis for thinking that calories are fundamental because the milk of mothers who are poorly fed is hypocaloric. This is so not only because the quantity is insufficient, but also because the milk has a low fat content. Therefore, at the age of three months the addition of any kind of food, including sugar and its derivatives, can be useful, although it is better that it be more nourishing and, always, hygienic.

We see no reason for recommending that the introduction to complementary feeding must be progressive, which is something that always pediatricians do, because the child itself will do precisely that. Consequently, the most important thing is that complementary feeding should begin in a decisive manner, while the child has not yet had the opportunity to resort to an adaptative mechanism to counterbalance an insufficient supply of energy-giving nutrients. This is accomplished by giving the child the complete variety of foods that may be found in the home or in the community.

To have the child reach a weight of 8 Kg in the first eight months of life should be the first objective in any preventive intervention in the field of malnutrition. This is what may be called the "true birth" of the child; it means passing the barrier between what may be called an extra-uterine fetus before reaching that weight, and a true human being with capacities of its own. The level of development constitutes the critical body mass, as well as critical neurological development, upon which may be fixed the physiological foundations of an active and demanding child who, by itself, begins to request, and even seek, foods, and who, as an adult, may have many more possibilities of reaching his or her maximum physical, mental, and social potentialities.

CHAPTER 4

Nutrition of the children and their utilization of nutrients

In the chapter on lactation we put a great deal of emphasis on the fact that the non-supplemented children (and undoubtedly, too, most of the children born into the lowest social strata and whose nutrition for a long time depends on what they can get from maternal breast) consume a sufficient quantity of nutrients only during the first 2 to 4 months of life, when the mother is able to produce milk to an extent that parallels the increasing needs of the child. After that, there is a progressive discrepancy between requirement and intake that is considered the origin of the type of malnutrition most frequently found in underdeveloped areas —"weaning malnutrition". What happens is that a child who does not receive adequate nourishment adapts by reducing its growth, development, activity, and even its metabolism. This adaptation is what is known as moderate malnutrition. The child can reach a stage of serious malnutrition only when this adaptation breaks down, usually because of the presence of several intercurrent illnesses.

Just as in many other towns in the country, the mothers in Tezonteopan start the child on supplementary feeding in a very deficient manner and, above all, at a very late stage, when the child has already made these negative adaptations, when it has already lost the sense of hunger and therefore, makes very few demands for food.

This belated introduction of supplementary foods has traditionally been associated with a cultural phenomenon known as "fear of foods", which is common in the rural environment of this country as well as in many others. The nature of this phenomenon is that mothers attribute more negative than positive effects to certain foods. They believe that foods are the cause of many illnesses, and they only vaguely relate foods and feeding to the development and health of their children.

This problem has always been related to the so-called food taboos, but this is not really the case. Beliefs about the harmful effect of some foods under certain circumstances is one thing, but the constant resistance to giving the child sufficient and varied foods because of an irrational fear, because of the feeling that the food that they are offering, whatever it may be, will do the child harm, is another thing. That is why mothers always begin supplementary feeding timidly, and later constantly try to reduce the amount. All foods, perhaps with the sole exception of maize, may be considered responsible for any illness in the children. The mother

may attribute a noxious effect to food according to how soon after consumption an illness developed or to the circumstances under which the food was given to the child. Some foods, such as fruits, greens, meat, and eggs, are those most frequently accused of doing harm.

Of course, mothers are not familiar with the bacteria theory of illnesses. Therefore, they do not know that there is, indeed, a relationship between the consumption of foods and illness, not as a result of an intrinsic characteristic of the foods themselves, but rather as a result of the conditions of preparation, or conservation, and, above all, of consumption.

In spite of the fact that this fear of foods is real and very widely held, this study shows that there are other factors that are just as important. Even though there is evidence of insufficient milk production the mother and the family in general place excessive confidence in lactation. The other side of this same coin is the lack of demand on the part of the child because of the so-called adaptation to the poor diet. As shall be seen later, this lack of appetite, which is a sympton of malnutrition and a manifestation of adaptation, is at one and at the same time the consequence and the cause of malnutrition.

Another factor is that in this town, and perhaps in most similar ones the mother never takes the initiative in providing foods; rather, she simply responds to the demands of the child. On the other hand, the child will make demands only when it comes to understand the concept of "food" and realizes that there is an alternative to the breast. That is why children do not begin to demand other foods until a very late stage. They continue to demand the maternal breast and, of course, the mothers respond by simply giving only the breast.

The closeness of the observations in this study show that the child does play a role in determining its own diet. When children were given supplementary food they learned how to eat other foods at a very early age. Therefore, very early in life they displayed the behavior of demanding whatever the mother put into her mouth. Contrary to what might be expected, the mother responded by unrestrictedly giving the child such foods in spite of the aforementioned fear of foods. In the case of the non-supplemented children, never before the eighth month were they observed to ask for foods that the mother was eating nor did it occur to the mother to offer the child such foods.

Besides, and it is important to recognize this, the mother never realizes that the child is malnourished because she has no point of reference. All the children in the town go through the same process, and so, the mother believes that the situation is normal.

As a consequence of this complex socio-biological situation, the children in poor communities adapt to a low level of food intake to such a degree that, as can be seen in the curves at the left in graph 10, calorie-protein consumption is maintained at an incredible low level. Thus, for example, it is hardly until after the 13th month that the child recovers the consumption level of 450 calories a day that it had at 2 or 3 months, when lactation was at its maximum. Only rarely do they reach a level of 600 calories at the age of 18 months.

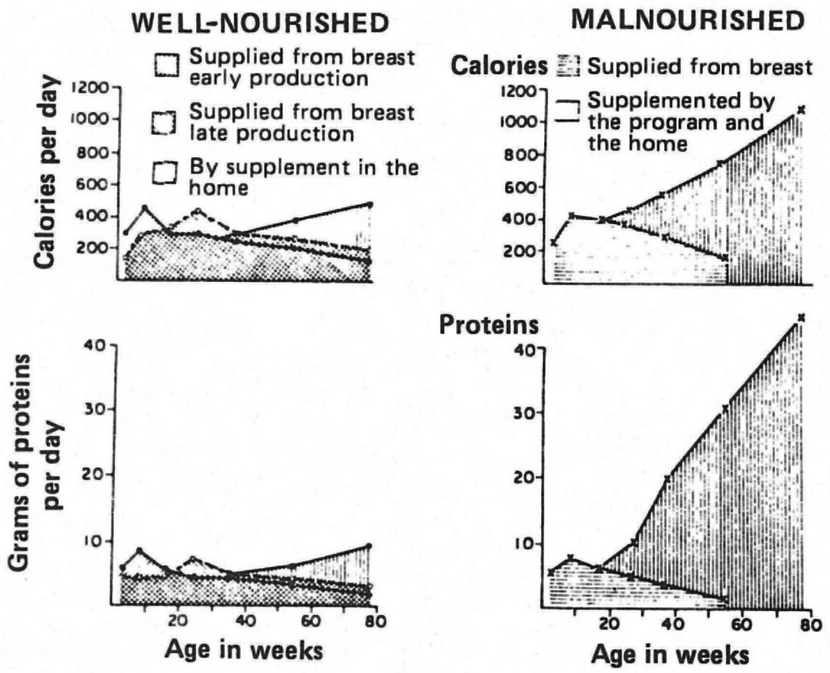
This study shows the relative falsehood of an old Spanish proverb that says: "One can learn to do anything except how to go without eating".

The children in our sampling learned very well how to live on half a liter of maternal milk and a truly minimum quantity of supplements of poor quality per day. The contrary circumstance can be seen in the curves at the right in graph 10, were the children who were supplemented by our program reached very high levels of consumption. Some of this was because the mother could maintain her milk supply at more than 400 calories per day for a longer time. The main reason, however, was because as soon as the child began to receive foods *ad-libitum* it increased its consumption very rapidly, reaching a level as high as 1,100 calories at 18 months, more than double the consumption of the non-supplemented children.

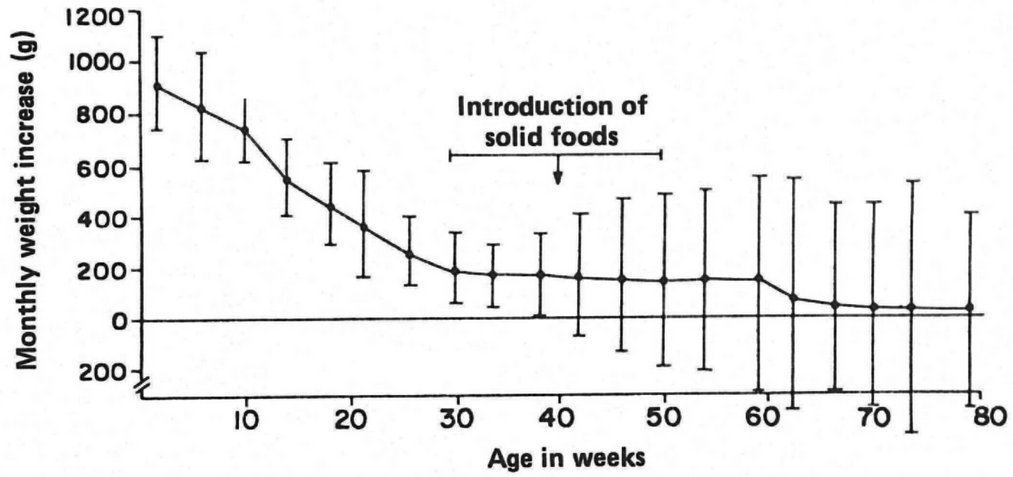
Malnourished children can survive on less than half of the energy intake of well-nourished ones because their weight is less, their rate of growth slows down a great deal, and above all, as will be seen later, their physical activity diminishes greatly. Furthermore, there are some data to show the possibility of other adaptive mechanisms entering the picture. For example, it was found that there are differences between both samplings in body temperature and in quantity of perspiration, thus, suggesting the possibility of different metabolic rates.

Graph 11 shows that the average increase in weight gain for the non-supplemented children is high only during the first three months of life. It then decreases progressively until the 8th month, when growth levels off at less than 200 g per month. It continues at this rate until the 60th week at which time it coincides with the new drop in lactation and, as a consequence, growth practically comes to a halt.

This means that, in their natural surroundings, the children in this community have four well-defined periods of growth: 1) the first three months of life, when they increase in weight normally and partially



Graph 10. The calorie-protein consumption of the non-supplemented children increases very slowly, especially when compared with the supplemented children.



Graph 11. The monthly weight increase in the non-supplemented children is insufficient after three months of age.

recuperate from the low birth weight observed at delivery for the first and only time in their lives they look healthy, stout and robust; 2) from three to eight months, when growth decelarates and physical status deteriorates; however, they do not necessarily reach a state of malnutrition because they continue to use the reserves accumulated during the first period; 3) from 8 to 13 months, when they achieve a really incredible adaptation, the explanation of which will be given in the next section of this work; in spite of their inadequate diet, they maintain an increase in weight of about 200 g per month; 4) from 13 to 24 months, during which time there is practically no increase in weight and there may appear signs and symptoms of malnutrition. This stage is a dangerous one for life because the children are in a very precarious state of equilibrium. There is an oscillation, i.e., at times they gain weight but then lose it because of illnesses. The evidence that this fourth period is not at all stable, but rather that one of oscillation, with increases and decreases, lies in the magnitude of the standard deviations seen in graph 11.

An important question is: why does this study show a homogeneous situation among children in a rural environment, with these four stages in initial development, while the cross-sectional surveys on nutritional status show that the situation is heterogeneous, with approximately 20o/o of the children well-nourished, while the majority, or 50o/o, are classified as being mildly malnourished, approximately 25o/o are moderate, undernourished and 5o/o are in an advanced stage of malnutrition.

The explanation of this apparent contradiction lies in the fact that what is heterogeneous is the age and not the condition of the children. The well-nourished are the younger children who have not yet reached a stage of malnutriton, or the older children who have survived. There are no longer many serious cases of malnutrition because those who reached that state are already dead as a result of the intercurrent infections. The differences between the frequency of mild and moderate rate malnutrition can indeed be given as a measure of the problem, if the sample is large enough. One way of improving the statistics in cross-sectional

surveys would be to narrow the age limits to perhaps between 12 and 30 months, when malnutrition is at its maximum.

In 1977, Dr. Ramos Galván and a group of collaborators studied 426 children –practically the whole child population– from one to four years of age, in the town of Tezonteopan. They found what is shown in table 8.

In this cross-sectional study it was found that 31.5o/o of the females and 21.2o/o of the males had a weight deficiency of 25o/o or more, that is, malnutrition of grades II and III. This implies that, in all, one-fourth of the children in the community were suffering from important degrees of malnutrition.

This situation contrasts with that of the group that was followed longitudinally. In which practically all the children (with the exception of two cases), at their lowest nutritional status, were classified as Grade II malnutrition. There were, in effect, two cases that had reached a level of grade III, with evidence of edema, but their condition improved spontaneously. If this could be corroborated in larger samplings, it would merit a great deal more attention because it contradicts the prognostic opinion of hospital physicians that Grade III malnutrition if not attended medically, is always progressive and fatal. The two cases cited contradict this point because they were of a fleeting type, not progressive, and there was spontaneous recuperation.

This dynamic situation of infant nutrition, or malnutrition, in the communities has a great deal of epidemiological importance because it allows for an understanding of many aspects of the problem in the populations of the Third World. The epidemiological studies show that only between one-fourth and one-third of the infant population is suffereing from malnutrition at a given moment. But that definitely does not mean that the same proportion is not affected in their physical, mental, and social development. The reality is that, at a given moment, practically 100o/o are affected by malnutrition that is prolonged for a greater or a lesser amount of time; consequently, almost 100o/o become vulnerable survivors as a consequence of the adaptive process.

In table 8, it can be seen that there is a wide difference in the frequency of malnutrition between male and female. Females much more frequently suffer Grade II malnutrition and even grade III. This has already been described especially by Dr. Ramos Galván in Mexico. This has been attributed to cultural factors. In most of the Third World preference is shown toward the male child. Consequently, it may be supposed that the male child receives better care, for which reason he enjoys better conditions than the female child does.

We are not in accord with the idea that the difference between the sexes is based exclusively on the cultural factor. No matter how much preference may be shown toward male children, the females are given the breast in exactly the same pattern as the male. If breast-milk is practically the only source of food during the first year, there is no possibility for the cultural factor to enter the picture. Furthermore, it is known well enough that the mortality rate during the first year of life is higher for male children than it is for female children. This also contradicts the cultural theory of the male child receiving better care.

The suspicion of there being biological factors in the differences in

Table 8. Frequency of malnutrition in pre-school children according to weight

Nutritional status	*Male*		*Female*		*Total*	
	Num.	*o/o*	*Num.*	*o/o*	*Num.*	*o/o*
Normal (more than 90o/o of weight)	64	29.5	48	23.0	112	26.3
Mild malnutrition (Grade I) (from 75 to 90o/o)*	107	49.3	95	45.5	202	47.4
Moderate malnutrition (Grade II) (from 60 to 75o/o)*	38	17.5	52	24.9	90	21.1
Severe malnutrition (Grade III) (less than 60o/o)*	8	3.7	14	6.6	22	5.2
Totals	217	100.0	209	100.0	426	100.0

* According to the classification by Gómez and collaborators and the Ramos Galván tables of normal weights and heights for Mexican children.

health and nutrition between the sexes originated largely from data obtained in other species of primates, wherein the mother always supplies all her milk, regardless of the sex of the offspring. The males, however, grow a great deal more because of more efficient cal[illegible]rotein utilization. This is most probably what makes the male m[illegible] susceptible to environmental trauma, thus resulting in a higher mortality rate.

The consequence of this situation of higher efficiency but lower resistance to environmental stress is that among the different groups of apes there are fewer, although larger and stronger males, which allows them many advantages for survival. The extreme case is the Japonese baboon, a species in which the male reaches three times the size of the female, but at least 95o/o of the males that are born do not survive. The final result is that the groups achieve adequate alimentary and defense capacity because the males, even though scarce in number, are sufficiently aggressive, large and strong to defend the group. In the case of the higher primates, the gorilla and the chimpanzee, for example, the differences between the males and the females are fewer. The body mass of the male gorilla is perhaps 30o/o greater than the females, and the proportion is two females for every male.

Humans can be expected to have the characteristics of their zoological family. Therefore, it was hypothesized that if the male is 20o/o larger than the female, he must also be more efficient metabolically during the first year of life as well as more liable to environmental aggression.

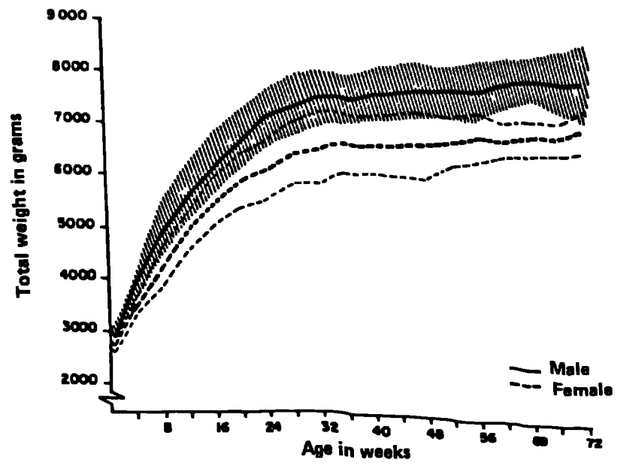
This study had the advantage of favorable design. Lactation was being measured longitudinally and there were very precise measurements of weight increases. Therefore, it was very easy to discern whether there was a difference in level of efficiency between the sexes. There are no studies in the world regarding the efficiency of using human milk in a natural environment and, therefore, at such a low level of intake which, furthermore, can be considered as "normal" or usual for the human being under the ecologic conditions of prolonged and uncomplemented lactation.

The data concerning the nine male children and the eight female children who were not supplemented were tabulated separately with respect to consumption of milk and growth per gram of protein consumed.

The consumption of milk by sexes was similar during the first year of life. The male children consumed 184.4 ± 25.0 and the females consumed 181.8 ± 23.3 liters. The differences are not significant. In spite of this similar consumption, and in accord with the hypothesis, there was a great difference in weight increase during this same period males increased 5.13 Kg and females 4.28 Kg. These differences are significant to the level of 0.05. This wide difference in weight increase between the sexes has already been described with reference to very undernourished communities (see graph 12).

In spite of the fact that both sexes consumed the same quantity of milk, males gained the first 3 Kg in only 102 days, having consumed 52.6 liters of milk, equivalent to 591.4 g of protein. Females required one month more, or 135 days to gain their first 3 Kg, and consumed 30o/o more milk, or 69.4 liters, equivalent to 793.7 g of protein.

If the deficiency of the milk during the period in which they gain their first 3 Kg is calculated, the males increase 57 g in weight per liter of milk



Graph 12. Fed the same, the male children show a greater growth than the female children.

consumed, almost 5 g in weight per gram of protein, which is a very high figure, in fact, much higher than what had previously been reported, and the females, meanwhile, gained only 44 g per liter of milk, which is equal to 3.7 g in weight increase per gram of protein. These data are very different, to a level of significance greater than 0.001.

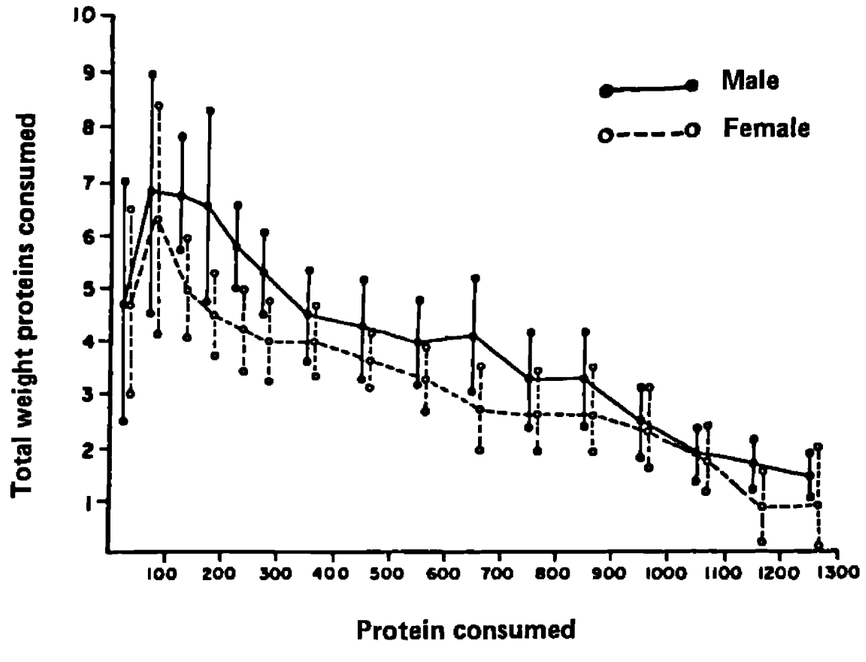
There are, of course, other factors that must be considered when calculating efficiencies, especially initial weight. In this regard, we must take into account that the females were born weighing less than the males, but only 120 g less, which is 5o/o. This difference, given the small number of cases, is non-significant.

In order to correct the time factor, the increases in weight per gram of protein were calculated longitudinally. This is shown in graph 13.

It can be clearly seen that the area beneath the curves during the entire period is very different between the sexes and that the total efficiency in the males is 19o/o greater than in the females. The figure is surprisingly similar to the difference in growth between the sexes and, consequently, to the total difference in mass reached at adulthood.

The difference are clearer during the first stages of lactation. Thus, the first 200 liters of milk render a gain of 24.4 g per liter in the male and 20.5 g in the female. The maximum point of difference is at the low levels of consumption, between 150 and 350 g of protein/Kg of weight, when the male gains very satisfactorily while the female almost always cannot do so.

One may think the difference in frequency of illnesses between the sexes can explain these data, but the situation was just the opposite. In effect, the males suffered more illnesses than the females. The males had infections with an impact on general status 45.9 ± 12.8 days during the first year, while the figure for the females was only 39.1 ± 9.6 days during the same period. This situation already described in the literature,



Graph 13. The male uses milk better since he grows more at the same levels of consumption.

whereby males suffer illnesses to a greater extent than do females, in any event lends more support to the hypothesis that the male grows better given the same amount of nutrition, but, at the same time, the rates of illness and mortality are higher. This also suggests that the male is less able to endure malnutrition for long periods of time than the female can, and, consequently, malnutrition in the male is more acute.

The contrary applies to females: they endure it better, they can experience more prolonged interruptions in growth and, therefore, their symptoms are more clinically obvious. This means that in cross-sectional surveys there are more malnourished females because they can withstand malnutrition, while the males who became severely malnourished are already in the grave.

Methodology of this study did not include a metabolic unit, but had the great advantage of permitting the observation of children in their own homes for long periods of time.

Another advantage, and perhaps the most important, the one that resulted in identifying the above-described differences, was derived from the fact that the study was done in children consuming very low levels of food that barely allowed for growth. Previous studies done in metabolic units have generally provided the children with an excess of foods, and therefore, have not measured real efficiency.

Another important finding is the very high levels of efficiency, much greater than those previously known, that explain why the children in poor environments can maintain life, and even grow, in spite of so little food. What also enters into this is the factor of social adaptation, already mentioned, which leads to a great reduction in energy expenditure.

This study also illustrates what has always appeared obvious to the authors, but which a lot of people do not entirely accept, namely, that the limiting factor in infant nutrition is the capacity of the mother to secrete milk. If the mother were able to produce in accord with the child's demand, not only would she be promoting the growth of her child to the maximum, but she would also produce more milk for the male child, who is going to grow more, than for the female.

CHAPTER 5

Growth and physical development

The most widely known clinical manifestation of the effect of a deficient diet in children is surely the deceleration of growth. There is enough information to show that it is a sensitive indicator of malnutrition, and it is the one most widely used in the world. The most practical method for classifying the grade of malnutrition is termed the Gómez classification, which compares the weight of a child with the norm for its age.

It is true that growth is quite sensitive to calorie-protein deficiency, and therefore, measuring body mass is a good indicator of nutritional deficiencies. Nevertheless, there are several other equally important factors. One of them is hereditary, since a child tends to grow according to the command of his genes. For this reason, if we take a specific case in which some retardation is found, it is difficult to know to what measure it is due to a problem of genetics or to what degree it is caused by lack of energy, proteins, and other specific nutrients or some other factor.

In a certain sense, the growth of the human being can be compared with the construction of a building. It can be small because the construction project has so determined it, or because there is a lack of construction materials.

Weight deficiencies at birth are more important for future growth than is commonly believed. There is a 300,000-fold increase in growth inside the womb, while the increase is only 20-fold from infancy to adulthood. Even the extra-uterine growth during the first year is fundamental since, during this short period, the child's mass increases three times.

Another factor that makes judging the nutritional impact on growth difficult is the evaluation of the role that age may have, chronological as well as biological age, in other words, the level of bone maturation. Deficiencies in nutriments affect growth in different ways, according to the age at which they occur. The earlier in life that deficiencies begin, the greater is the effect on growth. When it is found that a child of a given age has a given growth deficit, it is not possible to know whether the cause is genetic or nutritional. If we accept the nutritional factor, it is not possible to know how severe it is or for how long it has been present, since a deficit in height is the result of an accumulation of deficiencies throughout the years.

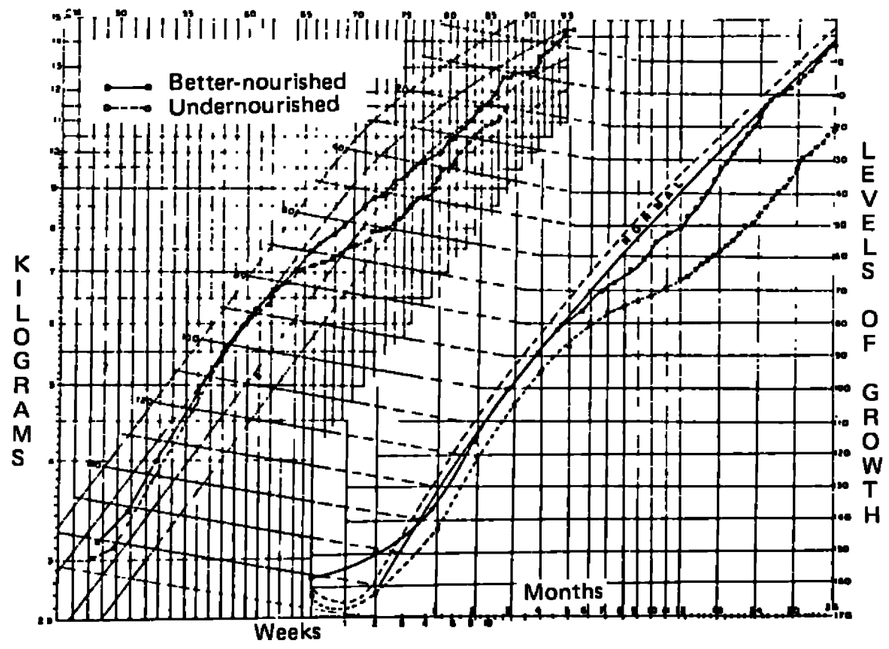
In population groups, however, the situation is different. If the majority of the children in a community do not grow well, it is difficult to

attribute this to the genetic factor, the exception, perhaps, being the pygmies. On the other hand, and with a good deal of certain it can be attributed to nutritional factors, especially when it is possible to determine alterations in the quantity and quality of the foods.

Graph 14 clearly shows the influence of nutrition on physical development in children. As was mentioned in the introduction, the experimental pattern of intervention, to a certain extent, controlled the genetic and socioeconomic factors.

The curves at the left show the body morphology of the children. It can be seen that the infants of non-supplemented mothers are born a little thinner. With the abundant supply of milk that the mother supplies during the first month, they gain weight to an extent equal to that of babies born of supplemented mothers. Thus, when they are approximately 60 cm in length, their weight is within the upper limits of normalcy. This point is the only moment in the lives of the individuals in the most impoverished areas when their nutritional status is adequate. It is from that moment on that they begin to receive insufficient milk, they begin to become thinner, and their physical growth is maintained on the basis of utilization of reserves accumulated during the first period. Upon reaching 75 cm in lenght they weigh barely 8 Kg. This implies that they have developed very much as one would stretch a stick of chewing gum —there is very little real growth.

The lines at the right in graph 14 show a relationship between body surface and age. Also, several interesting things may be seen. Beginning at birth, the non-supplemented children are smaller in spite of the fact that in order to homogenize the groups we removed from the study all infants



Graph 14. While the better-nourished children grow in a manner similar to the normal children, the undernourished become thin beginning with the fourth month of life, and their growth decelerates.

whose weight was less than 2.5 Kg. Furthermore, these non-supplemented children manifested a phenomenon that had not been described previously: it was observed that they lost quite a bit more weight during the first few days. This indicates the possibility of their being more edematous than the children of the better nourished mothers. This is not certain because we cannot discard the intervention of maternal factors, for example, that the supplemented mothers may be capable of producing colostrum more quickly. The difference between the children of non-supplemented mothers and supplemented mothers was 180 g at birth with an increment of difference to 220 g after one week.

The right side of graph 14 shows that the non-supplemented children grow well until the third or fourth month, since their curve of growth of body surface is parallel to that of the children of the better-fed mothers and, especially, parallel to normal auxodromes in USA standards. But from that age to the age of 18 months, their growth diverges a great deal from the norm until it reaches a point at which body surface is at least 30o/o less. This happens at the age when malnutrition may be considered maximum. From 18 months on, the children once again begin to grow in a line parallel to the line of normalcy, but at a much lower level.

The supplemented group also grows normally during the first 4 or 5 months, which is a slightly longer time than the non-supplemented group. This shows that maternal lactation is a little better, but, in spite of the program of supplementation, their growth, in any event, departs a little from the normal auxodrome. This defect in growth continues until the twelfth month, when it undergoes a progressive correction and the children return to the channel of normal growth. This indicates that the supplemented group was not at all a well-nourished group since it went through at least a short period of thinning out. This was because the pat-

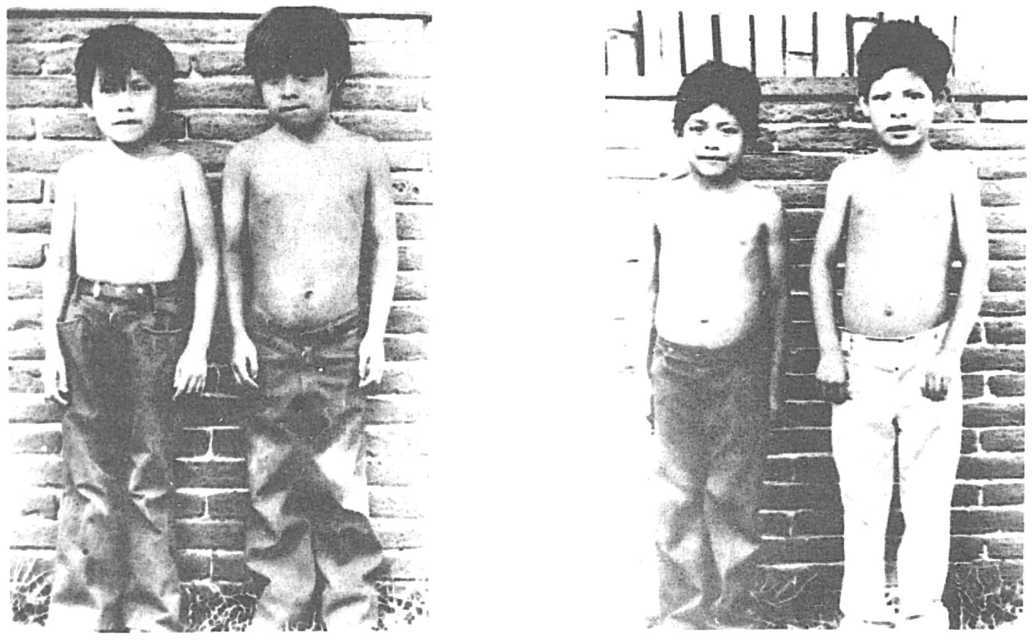


Figure 4. The supplemented children are at the right in each photograph. It must be remembered that they are two years younger.

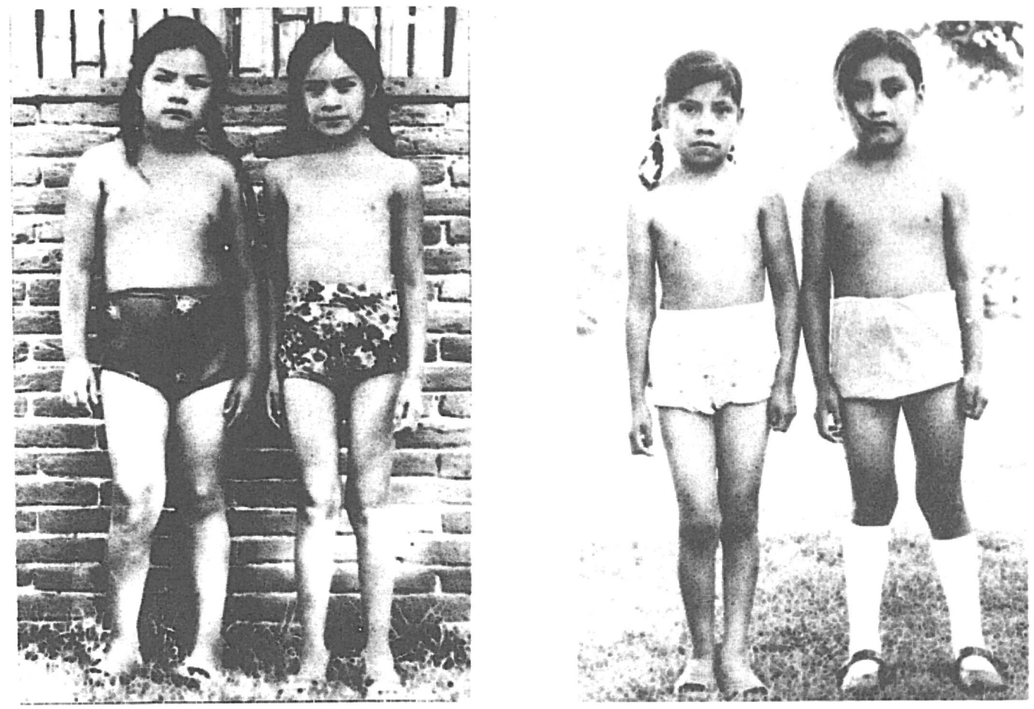


Figure 5. The girls at the right are supplemented, and they are two years younger than their pairs.

tern of the program exerted no control over the rest of the ecological factors, especially illnesses. Between the age of 4 and 12 months, these better-nourished children suffered the effects of illnesses that were many and of appreciable severity. Besides, it is important to point out that the program supplied only supplementary feeding, not complete feeding. The basic diet of these children was supplied by the home, and it was quite poor as well as contaminated (figure 4 and 5).

This area of research offers an appreciation of the relative importance of the impact of nutrition and infections on growth. If it is supposed that the retardation in the supplemented children is only due to infections, it is possible to subtract this figure from the total retardation of the non-supplemented children and thus evaluate the effect of nutrition. Under these conditions when the child reaches 18 months of age (and living in the environment of the town), deficient nutrition is the cause of at least 80o/o of the growth lost, while illnesses account, at most, for 20o/o of the rest.

However, these figures should be interpreted with caution. It is possible that growth retardation among the better nourished is not only caused by diseases, but may actually have a certain nutritional component. If this is so, nutrition should receive even greater attention. This finding is in stark contradiction to investments in the field of maternal and child health by the governments of the less developed countries, which always dedicate much more to the prevention of illness than to the improvement of nutritional status.

Considering graph 14, it is not possible to make clear-cut distinctions between undernourished or well-nourished groups. The former are not really undernourished; rather, they are children who are "normal for their town", that is, fed according to local custom. The latter are not really well-nourished because they had that small deficit in growth, a deficit that undoubtedly existed in their dietary intake, too. Nevertheless, the experimental pattern maintained its validity because ample differences in diet were shown, and these reflected very clear differences (see figure 6).

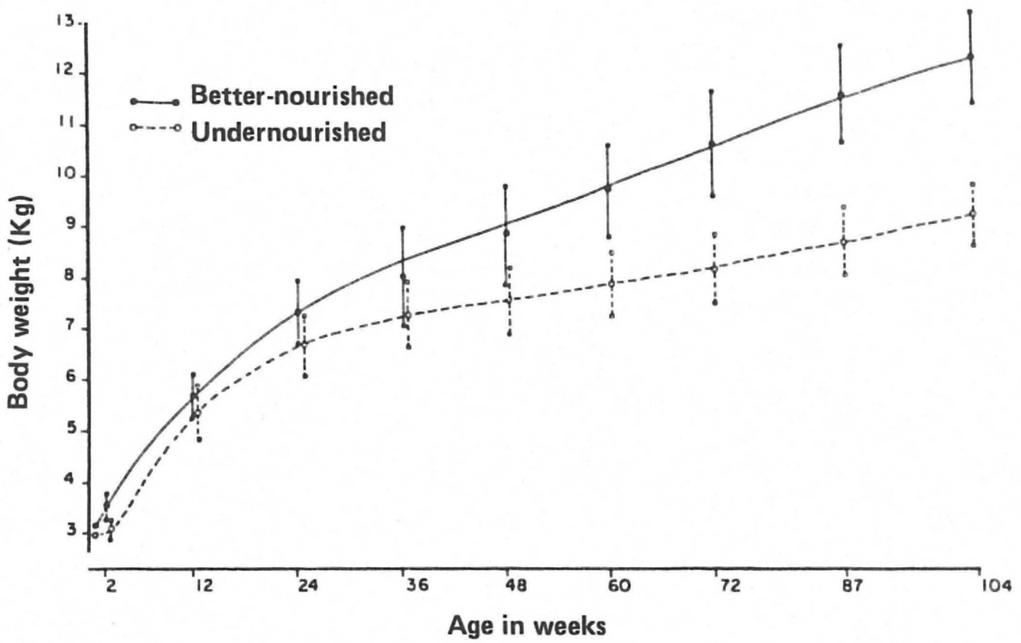
It is important to discuss the consequences of these early disturbances in growth. The question is: are they permanent or is there a possibility for future recovery? In reality, the undernourished children are affected not only in their growth but in their bone maturation as well. This means that if the child grows slowly, he also matures slowly. Therefore, the possibility of catch-up growth is open for a long period of time; he may, up until puberty, catch up with the better-nourished.

Figure 6. The group of children participating in the research project in front of the rural center.

As a matter of fact, in some animal species that grow throughout their lifetimes, such as rats, deficient nourishment makes them grow more slowly and mature more slowly, but curiously enough, they live longer. Thus, they have a similar total metabolic life and at the end reach almost the same total body mass as well-nourished rats. This would be like comparing two marathon runners: one is very good and can run the distance in four-and a-half hours. Both, however, succeed in reaching the end of the course.

In practice this discussion is worthless, because in this environment, favorable circumstances never exist, to permit sufficient quantity and quality of dietary intake, for catch-up growth. Besides, deficient growth in body mass is not the only problem in the undernourished group. There are also several defects in physical development that to a certain degree, answer the question of reversibility. It is not that important whether a person is tall or short. What is important is that his body is in harmonious proportion and correct relationship with the maturation of the other body systems, especially the nervous system. The height person reaches would be of no more importance than that attributed to it in some cultures, if it were not for the fact that alterations, to some measure, also indicate the possible existence of other deficiencies of greater significance to human growth. The worth of a person should not be measured by the distance of the head from the ground but rather from the head to the infinite.

Graph 15 shows, in absolute form, the differences in weight gain between the two groups. The poorly fed group begins to gain less and to show a difference from the better-nourished group starting at approximately the 16th week; beginning with the 24th week, the increase be-



Graph 15. The better-nourished children progressively increase in weight while the non-supplemented children decelerate at about 16 weeks.

comes very slow. This is a well-known situation. The graph is included here simply as a reference point for information in other areas.

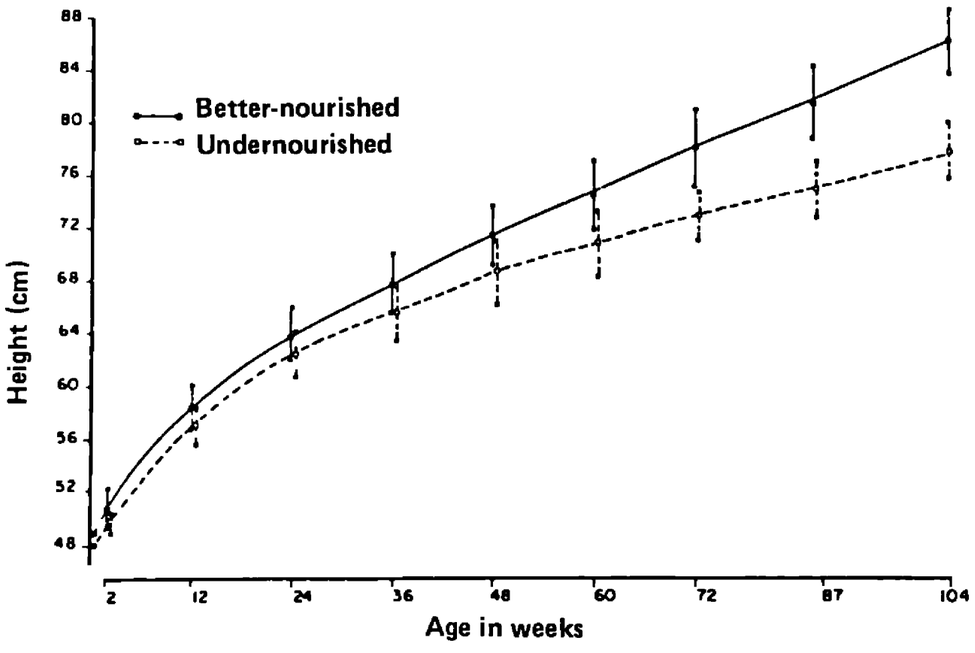
Graph 16 shows that the deficiency in height is more resistant to malnutrition. Divergence from normal begins at the 36th week, and it is not until the 48th week, that is, at the 11th month, that the curve begins to flatten out. This is proof of the phenomenon previously described: during the period between the 16th and 48th week the child maintains skeletal growth by using caloric reserves, growing by sacrificing fatty tissue in order to maintain an increase in height, which is basically increasing the skeletal tissue.

A very interesting aspect here is reference to the lower segment of the body. In these children, the measurement was taken from the iliac crest to the soles of the feet. The results are shown in graph 17.

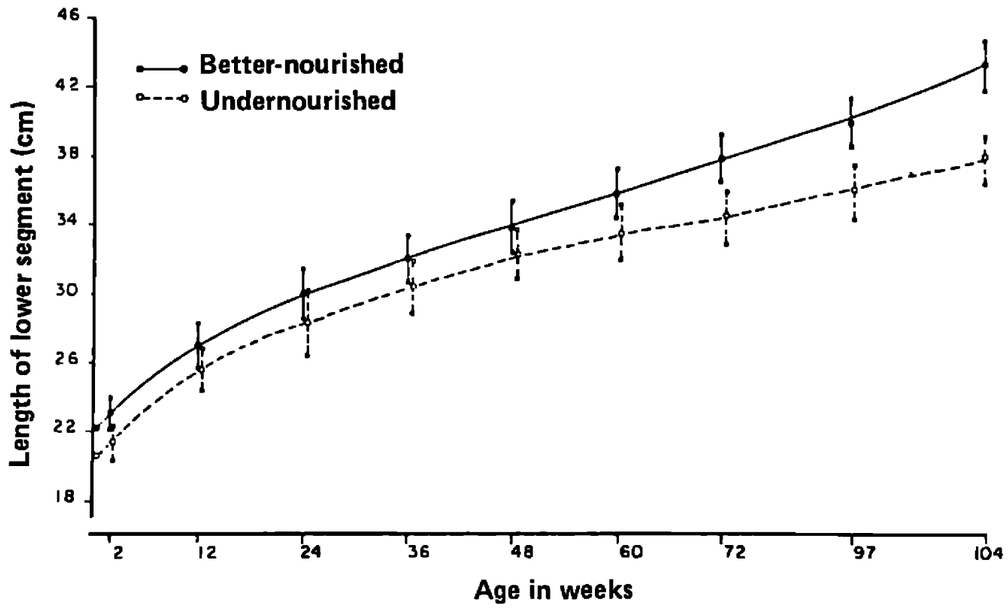
The non-supplemented children have shorter legs at birth a condition that persisted throughout the entire period of observation. This means that poor nutrition especially affects the growth of the long bones.

Graph 18 shows the relationship between the lower segment and height. The difference between the supplemented and the non-supplemented is very great in the newborn. Later, during the first 48 weeks, the relationship tends to correct itself when, thanks to the greater availability of nutrients provided by early lactation the organism achieves harmonic skeletal growth. Subsequently, as the result of poor nourishment during late lactation, the body proportion is once again thrown out of balance.

The last three graphs show a phenomenon that can be interpreted as indicating that poor nutrition has a greater effect on growth of the long bones. It is known that they require more energy than the short ones. Moreover, it is clear that energy deficiency is present beginning with the



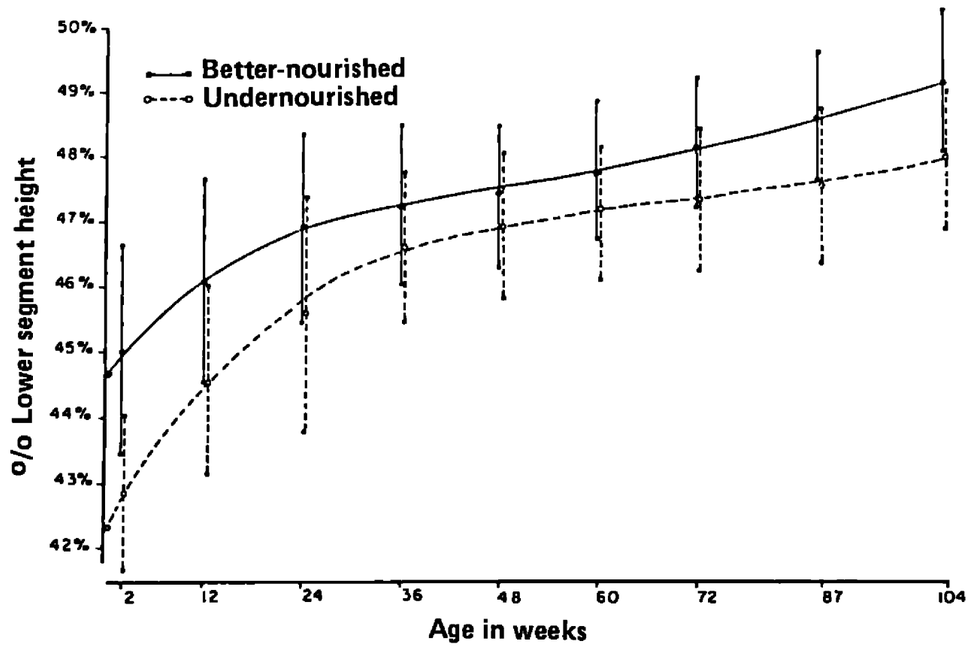
Graph 16. The alterations in the height of the non-supplemented children come later.



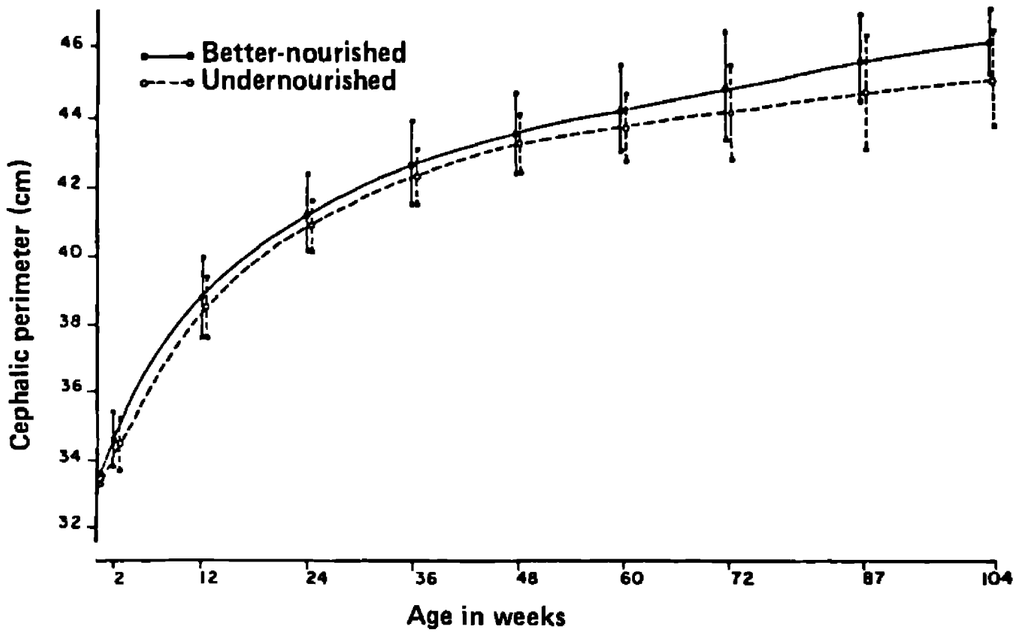
Graph 17. Beginning at birth there are important differences in the length of the lower segment; it becomes more marked during the second semester.

period of gestation. As a consequence, the malnourished child is shorter in stature and its proportions are different. It is, to a certain measure, similar to other simians: short legs with a long trunk.

There was some previous information suggesting the importance of



Graph 18. It is shown that the reduction in height is due to the lack of growth of the lower segment.



Graph 19. The cephalic perimeter of the heads of the undernourished children is only slightly smaller.

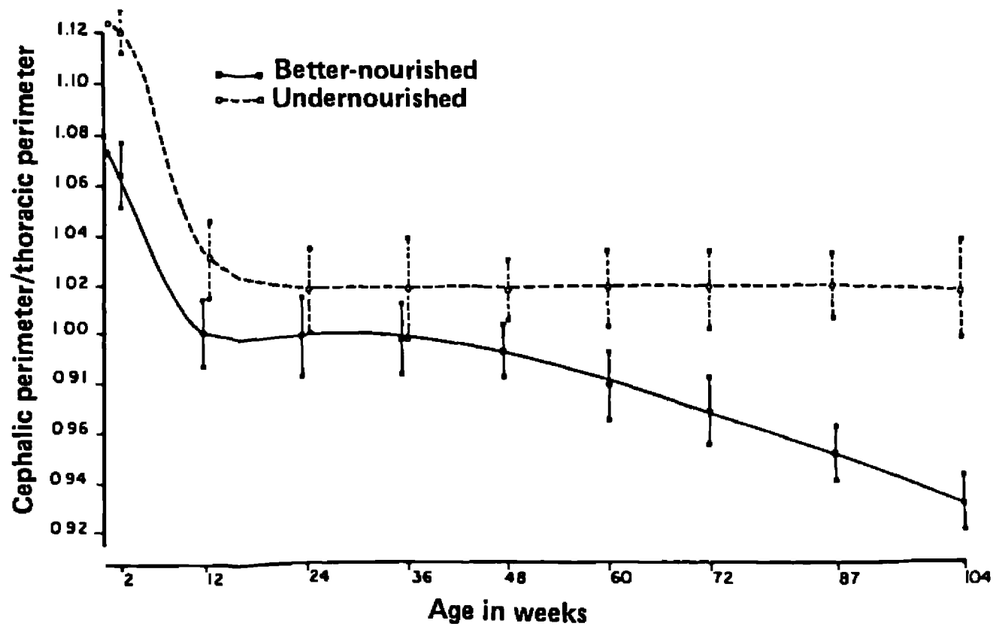
nutritional factors on body proportions. A comparison of some subjects of Japanese origin residing in California with Japanese residing in Japan, showed that the former were not only taller, but that their body proportions were more similar to those of the rest of the average U. S. population. In other words, an increase in height was achieved through an increase in the lower segment.

The short bones also undergo change. In order to study this, photographs were taken of the face of each child in the project. The purpose was to look for facil changes, especially those that make the malnourished look "ugly", first as children and later as adults.

There are several alterations that could be attributed to malnutrition but we were not able to standarize the method sufficiently. The distance and the position of the face in the photographs were not always the same, and this invalidated the results. This area of research must be repeated, perhaps by physical anthropologists; it is considered a promising area of study. The few data that we were able to analyze suggest that malnutrition may be manifested by lack of facial symmetry, larger tooth size in relationship to the jawbone, poor adjustment of the maxillary bones, and greater width of the zygomatic arcs in relation to the longitudinal axis.

It was found that the transverse diameters in the poorly nourished are also affected. For example, thoracic perimeter is smaller in the non-supplemented child than in the supplemented child (graph 21). However, head perimeter is not very different, as may be seen in graph 19.

The small difference between groups in the cephalic perimeter surely indicates that there is no marked difference in brain size. This is assumed from the well-demonstrated fact that the cranium grows in accordance with demand, that is, cerebral growth. Several years ago, Mönckeberg, in Chile, published the finding that, by using a method of trans-illumination,



Graph 20. The relationship between the cephalic perimeter and the thoracic perimeter in the undernourished stays at more than one.

in many malnourished individuals it could be shown that there was a hollow space that is, that the content (the brain) was smaller than the recipient (the cranium). This is absurd, and nobody has corroborated the finding, not even Mönckeberg himself.

It has been demonstrated that, when nutritional deficiency is not very marked, brain development is not impaired, because it has some nutritional priority. Consequently, it suffers less than other organs when the diet is poor.

A very noticeable difference between the undernourished and the supplemented children was the disproportion between the cephalic and thoracic perimeters. Until the age of two years, the former had a smaller thoracic than head perimeter. Their appearance is well known through photographs from the Biafran children who were suffering malnutrition —a very large head in relation to the body. What really happens is that the thorax is narrow in relation to the head, which is almost of normal size.

If the thoracic perimeter is divided by the cephalic perimeter, the index never reaches one among the undernourished; that is, the thorax is never larger than the head. In the supplemented children the thorax perimeter is already greater than the cephalic perimeter at the age of 12 weeks, as shown in graph 20.

This feature allows for the proposal of a new indicator of malnutrition, one that can easily be studied simply by using a length of string. If a child between one month and two years of age has a smaller thorax measurement than head measurement, it is most probable that it is suffering from malnutrition. If the thorax measurement is larger than the head measurement, it means that he is better-nourished.

A study on an epidemiological level has not been designed to test this indicator in large populations, but it would be useful for smaller groups.

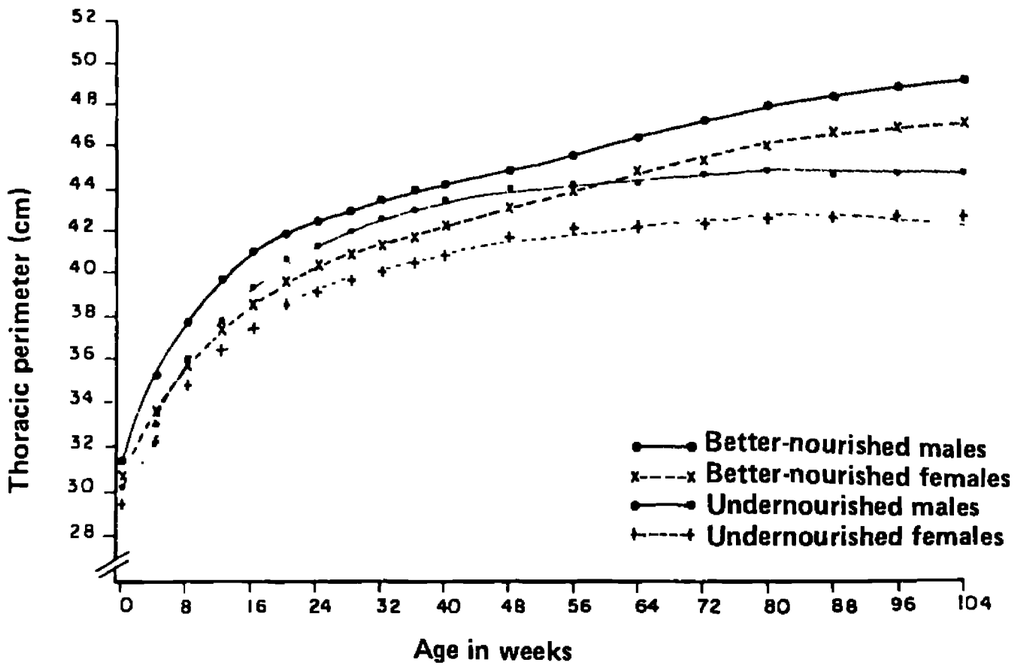
If there is a population in which there is a predominance of young children with larger head than thoracic perimeter, nutritional problems are prevalent.

Of interest to medicine is the possibility of making the diagnosis at birth. This can be assessed by three indicators: 1) the inferior segment/total length relationship, as discussed earlier. The limit of which can be about 43.5o/o; in other words, in those children who, at birth, show a lower segment, measured from the iliac crest, with a proportion that is less than the percentage indicates, there is a high probability that the fetus did not receive sufficient nutriments *in utero*. 2) What may be even more important is the relation of the cephalic/thoracic perimeter, described earlier the critical point at birth being 1.1. 3) The relation between biachromial diameter and height; in children of poorly-nourished mothers it is less than 24o/o.

More importance should be accorded to a diagnosis of malnutrition at birth because the prognosis for a premature child is very different from that for a child with real malnutrition. Nevertheless, there is no previous experience upon which to judge whether these three proposed indicators will really make a distinction. This should be the subject of a study on the part of some specialized group.

A very interesting finding was that all the growth alterations mentioned occurred in larger measure among the females than among the males. Thus, for example, the females are born with even less weight and size, their lower segment is smaller, as is their transverse diameter, as well as the thoracic perimeter and the biachromial diameter.

At the same time, the later alterations that appear with insufficient lactation affect the females at an earlier age. Weight increase, lower



Graph 21. Females always have a smaller thoracic perimeter than males.

segment growth, and transverse measurements in particular are altered (graph 21).

Under these circumstances, and at the end of the first year, the females manifest more anthropometric and clinical signs of malnutrition and the differences between them and the males become outstanding. Thus, for example, at 12 months of age, the females weigh an average of one Kg less. This is very much in accord with what is considered normal in other samplings, especially in urban areas and in the developed countries. In these places, for a long time it was thought that the differences in growth between male and female were not significant, and consequently they were not taken into consideration in pediatric evaluations.

This information shows once again that the female possibly has a greater adaptive capacity in the face of insufficiencies. She grows with a lesser efficiency, but with greater probabilities of survival.

To a certain extent, this situation may also explain the transgenerational adaptation to malnutrition among those human groups who live in a very deprived ecological environment and who adjust body volume to level of consumption. If the females have so great a capacity for survival amidst poverty by growing very little, then most certainly, as adults, their size will be very small. We know that this establishes a limit to intrauterine fetal development which, in turn, affects the weight of the child at birth. This also limits early development, which results in the small adult. This, of course, is an aid toward survival. In that way, small size is transmitted, not exactly on a genetic basis, but rather on what is simply a congenital basis. These circumstances explain, as well, why good nutrition, even though begun very early in life, does not always achieve maximum effects in such an individual. Possibly at least two generations are needed –for the genes to reach total expression.

If we extrapolate this situation to nutrition in these communities, it would imply the necessity for good nutrition early in life, in the manner in which it was provided for the supplemented children in Tezonteopan, so that the women could achieve maximum possible growth in spite of the congenital limitations with which they were born due to the low height of their mothers. Under these conditions, it may be hoped that, for some women, there will no longer be a limitation on the growth of their children. If the females that are born under these circumstances are well fed, they will be able to have children who, in turn, will have the potentiality of their genes reaching maximum expression.

All of this discussion refers principally to alterations in total mass and not to body proportions. Regarding the latter, this study has shown that correction can be made, to a large extent, by providing the mother with a better diet, which can certainly be of greater aid to the unborn child through the placenta. It also provides the child with better nutrition early in life. The supplemented children in our project were born with longer legs and with a greater transverse diameter. Perhaps an adequate diet from the age of four months on would also help.

It would be important to be able to project into the future the consequences that may result from these early alterations in height and body morphology. It has already been mentioned that, in the human being, the physical aspect is perhaps the least important. However, the physical aspect, for example, may be related to the reduced athletic and work

capacity that exists in the malnourished societies. There is already evidence to the effect that the poor growth described intrauterine as well as when there is a lack of maternal milk, is not recuperated later. This study also shows the alterations in the size of the lower body segment and in transverse diameters, which can be of great importance to future athletic activity.

It is known that malnutrition can also alter body composition, that is, the proportion among the different tissues. There is the possibility, neither proven nor even studied, that there may be changes in the quality of tissues, the muscle tissue, for example.

All that has been described above lays the foundation for explaining, at least partially, why the majority of people in this country both among –farm groups and the working class, do not produce distinguished sportsmen or athletes. Perhaps under poor nutritional conditions those who suffered from malnutrition as children may have a greater opportunity in those activities that require greater resistance (because they have a greater respiratory capacity, especially in proportion to muscular consumption and perhaps less heat production or proportionally more body surface to disperse heat), than in those that require size and strength. Besides, short legs can be of help in some specific tests, such as walking, which is the sport for which this country is best know.

However, it is strange that in other sports in which, theoretically, resistance and, of possible usefulness, short legs would be of importance, like bicycling or soccer, Mexicans are not outstanding, even though players in other underdeveloped countries are outstanding. The explanation may be found in a factor that will be dealt with in the chapter on behavior, namely, the loss of precious time, during the first three months of life, for the establishment of coordination mechanisms. If the malnourished child is inactive for a great deal of time, if he does not run or play at an early age, if he does not establish intersensorial motor reflexes, especially between sight and foot coordination movements, it is very difficult for him later to stand out in sports such as soccer, which require as a fundamental element the "handling" of the ball.

Other sports or athletic tests are also definitely outside the reach of the Mexican of low socioeconomic level. In particular, very few people participate, for example, in tests of speed or in sports that require height. Also difficult for the Mexican are those sports that require strength combined with coordination.

In conclusion, the non-supplemented, or typical, child in a malnourished community, whose only source of nourishment is the mother's breast for prolonged periods of time, suffers important effects during three periods in its development. 1) The newly born, whose status has been influenced by maternal nutrition, whose weight and body length at birth are smaller, whose legs are short, and whose transverse diameters are narrower. 2) The period of early lactation, when the mother supplies sufficient milk and the child tends to correct these deficiencies, but does not succeed in doing so completely. 3) Later lactation, when the child decreases its weight again a great deal, when longitudinal growth is affected, especially at the expense of the leg bones and thoracic perimeter remains smaller than its cephalic perimeter.

As a consequence of all these changes, the children who go through

the malnutrition characteristic of insufficient breast-milk have a short skeletal stature, short limbs, smaller transverse diameters, and a head that gives the impression of being large even though it is not, because the thoracic perimeter and total size are less.

All this information suggests the possibility of using anthropometry for diagnosis of the nutritional status of children beginning at a very early period in life, even at the time of birth. Furthermore, some of these studies can be done with practically no equipment, using only a length of string, for example, especially after the 6th month, in order to compare head and thorax circumference.

CHAPTER 6

Infections and health

In most of the underdeveloped areas in the world, food deficiencies arise in a hostile environment. Therefore, added to malnutrition there are multiple illnesses resulting from bacteria and parasites that sap to an even greater extent the health and well-being of the people.

The synergy of malnutrition and infection has been observed by health workers over a long time. Several medical descriptions dating back to the beginning of the century discuss the fact that malnourished children suffer more infections, and that in those who became ill the nutritional status deteriorates more rapidly.

Infections favor malnutrition because they alter metabolism, thereby increasing the expenditure of nutrients, and because they cause anorexia, which reduces food consumption by ill people. Furthermore, in most poor areas of the world, because of cultural factors, important dietary reductions are often prescribed either by doctors or by parents.

In the community, the people are accustomed to reducing intake of practically all foods for sick children with the exception of the maternal breast. The more serious the illness, the greater the reduction, no matter how long it may be.

The mechanisms by which malnutrition favor illnesses has not been well-shown. Few alterations in immunology mechanisms have been found in the laboratory in spite of many epidemiologic field studies that have consistently shown that the malnourished are most susceptible to infections.

It is probable that this phenomenon is due, at least in part, to the fact that undernourished children almost always live in a highly contaminated environment, under inadequate housing conditions, without potable water, and amidst poor hygienic practices. This leads us to think that, most frequently, infections are not so much caused by poor nutritional status as by social privation, in other words, by the hostile environment. Before this intervention study, no appropriate experimental patterns had been carried out under the same type of environmental conditions that would allow for showing the role of inadequate food intake during illness.

Among the poor, malnutrition and infection form a complex, a single syndrome, a single illness which has or should have, its own definition, etiology, diagnosis, prognosis, and treatment. Clinical medical books from the developed countries describe it as a separate nosological entity because they do not see many cases of malnutrition or the same types of infections. Furthermore, this syndrome is suffered by those who are at the bottom of the socioeconomic ladder, those who do not appear for medical consultation; consequently, this population has not merited the attention of the more prestigious medical groups.

In the previous chapter it was seen that practically all children in a poor community go through a period of malnutrition. If they simultaneously suffer infections, it is common for them to incur progressive deterioration that frequently ends in death. Everything may begin with an infection that aggravates the anorexia in the malnourished child, plus the fear on the part of the mother to give the child foods. It is not rare for the mother to take advantage of the anorexia and wean the child. This further compounds the state of malnutrition, which, in turn, brings on new infections. A vicious circle is thereby formed, one which, in many cases, ends in death.

From the point of view of health statistics, these cases are usually classified as deaths due only to infection. That is why, in underdeveloped areas and countries, respiratory illnesses, which at times may be simple grippe, or digestive illnesses, which may be simple diarrheas, are statistically listed as the principal causes of mortality. All those who have experience in the rural environment know the gravity of illnesses, so-called characteristic of childhood such as measles and whooping cough. The practice of expressing mortality according to age groupings, or in terms of per thousand live births, or children, or inhabitants, as is done in the developed countries, prevents an appreciation of the real magnitude of the infant mortality problem in poor areas.

In an environment such as the one in our study, at least one out of four children dies, while the other three, with difficulty, manage to survive. The dead constitute an important social burden because they present a life that is lost and a family effort that is frustrated. All the problems of the mother during pregnancy, the efforts at delivery, the whole period of lactation, the medical costs incurred as a result of illnesses —all these things end in frustration, in having to begin anew.

The high number of deaths is just part of the problem. Those who survive, with an important limitation in their physical, mental, and social development, present a health problem perhaps of greater magnitude. It is a situation similar to that of war, affecting society not only by those who die, and this may be the lesser number, but for the wounded who, besides being numerous, undergo many social handicaps.

If the situation were analyzed in the light of laws of selection to which all species are subject, it is found that malnutrition poses an outstanding difference. It is not the strongest who survive, but rather those who can endure the most, those who can resist malnutrition the most, those who are smaller and more inactive, those who succeed in deteriorating the most without dying, those who, in the last analysis, physically and mentally adjust most to misery and poverty. We have here, then, a negative selectivity that carries with it serious individual and social consequences. The majority of the population in the poor rural areas of the world is made up of these vulnerable survivors whose potential has been harshly limited.

In the first chapter, mention was made, that, upon studying the post-menopause women in the town i.e., more than 40 years of age, it was

found that throughout their fertile life they had had only nine live children and that only five of the children had lived more than five years of age. This means that in the past, during the reproductive life of these women, half of their children had died. The situation of the malnutrition-infection complex must have been more serious than it is now. In the immediate future, given a little better nutrition and surely having more preventive resources (the children are now vaccinated) and curative resources (penicillin is now used), it is expected that the theoretical generative potential will be 11 live children per woman with, theoretically, only two deaths; this means that nine children will survive. This will not only speed up the demographic growth of the town, it will also aggravate the problem of the vulnerable survivors. There will possibly be more people, but not necessarily in better condition for development.

This problem opens the way to accusing the current medical systems (that are incordinately geared toward curative medicine) of merely "saving lives" without paying attention to the "quality of life", thereby bringing about a larger population, but one that is very restricted in individual and social opportunities for development.

The effect of the occidental medicine on saving lives, to which the demographic explosion is attributed, is much more limited than believed, because, on one hand medications do not have the impact they are supposed to have in lowering mortality. Once a child reaches a state of severe malnutrition, it is difficult to cure concomitant disease, and he will seldon be saved by the penicillin. If he does not die of one illness, he dies of another. Medication does not do much against the complex of malnutrition-infection. On the other hand, it must be recognized that medicines almost never penetrate into the really poor areas of the world where the majority of people live.

The truth may very possibly be that mortality has diminished in the rural Mexican environment because food availability has increased. However, since this has been only because of the greater availability of maize, it has favored the increase of survivors, but it has not substantially improved their nutritional status.

Another argument that some human deterioration exists in the rural Mexican environment, frequently cited by Dr. Ramos Galván, is that in some communities it has been found that younger persons are of shorter stature than older ones. This may indicate that there has been deterioration in physical development in recent generations. In accord with the data compiled in surveys done by our National Institute of Nutrition, this is not found throughout the whole country, but rather in some regions, especially those surrounding the big cities. Consequently, this situation may well be real, or may be the result of positive selectivity of migrations. Perhaps the more able and tallest young people in these communities decide to move to the cities, while those who remain are the poorest, the most malnourished, and also the shorter in stature.

The experience that we have derived from being in this community has been interesting. The families of our supplementes samplings have noticed the increase in the frequency of births and, to a lesser degree, the drop in infant mortality; they have thus begun to become preoccupied about family size. This has rapidly brought them to realize the necessity of controlling reproduction. Actually, more than half of the women have

initiated some preventive measures. Thus, it was not possible to prove the hypothesis that improving health and food intake will lead to long-term increase in population.

The general conditions of the family setting in poor communities are dramatic and favor infection and infestation. To illustrate this, we made a special study of the characteristics of the environment in 46 homes. The general results may be seen in table 9.

Table 9. Characteristics of the homes

Characteristics	*o/o*
Only one room	84.8
Hut of sticks and mud	23.9
Adobe and tile roof	67.4
Dirt floor, not paved	78.3
Without drainage	100.0
Without water	63.0
With less than 3 m^2 per person	26.7
With less than 10 m^2 per person	42.2
Houses without windows	71.7
Less than minimum ventilations*	99.1
Less than minimum illumination**	93.3
With excessive humidity and temperature***	91.3

* 4.2o/o of the floor surface.
** 12.5o/o of the floor surface.
*** More than 25oC (77oF) and 60o/o humidity.

The houses in this town are of the type commonly found in most of the traditional rural areas of the country. The predominant type of housing is characteristic for the extended family. It consists of one piece of land on which there are several one-room homes, each belonging to a different family nucleus. The largest house accomodates the mother and father and the unmarried children. The other houses accomodate the sons and, on rare occasions, married daughters and their respective children. All the money brought in by the extended family is managed by the father, just as he also manages the land, work, and all products. The sons, even though they may be married, work on the family land, and all their production is used to supply the family in general. If, at some point, they work as farm laborers on some other piece of land, they can keep only part of the money they earn. In most cases, there is only one kitchen, in a separate structure; here, the mother works with the help of one or more of the daughters-in-law as they prepare the tortillas and beans for the whole family. It sometimes happens that each wife will make the tortillas for her own family, but using the maize from the family supply.

Since by law, the family plot of land for agriculture cannot be divided, and because the parcels are already too small, at the death of the father it is inherited by only one of the sons. The other brothers frequently continue living on the same common piece of land, sometimes depending on the brother, under the same pattern of extended family. On rare

occasions they rent land or work it jointly. They sometimes have to work as farm laborers. Since the land is quite fertile and rain fall more or less regular, up to the present time there has not yet been a necessity for any less-favored brothers to migrate.

In this town, 84.8o/o of the family homes that were studied consisted of a single room. Two-thirds are built of adobe and the rest of sticks and mud, in other words, huts that are in a deplorable hygienic condition.

Practically all the houses have a dirt floor. When we first began this study, the houses had a well for each block. The information in table 9 was gathered in 1974, at which time a program of providing potable water was begun. This resulted in one-third of the homes having a water faucet in their patio; the rest of the faucets were on street corners. The community has no drainage, and there are no septic pits so defecation takes place out in the open in 100o/o of the time. The fecal matter is eaten by the family dogs and pigs.

The conditions of crowding are not as dramatic as those found in some of the newly-created urban slum/poverty-ridden districts, since each family unit has its own home. However, the conditions of humidity, temperature, ventilation and illumination are unhealthy. Window surface is minimal and the doors are small. The climate in the house is frequently more fitting as a breeding place for animals, insects, parasites, and bacteria than for human dwelling.

It is considered that one of the most important factors for maintaining a house in good sanitary condition is lighting, since the sun dries out bacteria and its ultraviolet rays have a certain bactericidal action. Table 10 shows that the conditions of life in the houses of Tezonteopan are precarious.

Table 10. Illumination in luxes in different places in the houses at midday, according to orientation

	Places of minimun illumination	*Places of medium illumination*	*Places of maximum illumination*
To the north	14.1	99.1	242.4
To the south	141.8	266.5	367.5
To the east	93.0	369.0	620.0
To the west	50.0	154.2	310.0

500 luxes is the minimum for having bactericidal capacity.

In a study that was carried out during the months of April and May (the months of maximum sunlight in the community), and at the midday hours, it was found that only in the places of maximum light in the houses facing east did the light surpass the minimal limit of 500 luxes, a figure suggested for achieving bactericidal action.

A study was made of bacterial contamination in 20 of the 46 houses. Different spots were selected, and samplings from the surface were taken over an area of a square centimeter, using moist hyssops in the dry places and dry hyssops in the humid places. Samplings were taken during both

dry and rainy seasons to check for the presence of *Escherichia coli* on a plaque of agar mb. Table 11 shows the places and the frequency with which fecal contamination was found.

Table 11. Frequency of fecal contamination

	Dry season	*Rainy season*
Mother's hands	47.4	45.0
Baby's hands	80.0	55.0
Mother's apron	60.0	60.0
Surface of water in a receptacle	47.4	40.0
Kitchen plate	50.0	35.0
Kitchen cup	63.2	35.0
Dog's snout	75.0	81.8
Straw sleeping mat	40.0	94.7
Ground under the mat	80.0	94.7
Walls at 60 cm from the ground	65.0	80.0
Ground at threshold of the house	50.0	75.0
Ground in the patio	35.0	80.0

Contamination was found practically everywhere, which means that hygienic conditions and cleanliness are extremely poor. During the dry season, perhaps because of lack of water, the hands and household objects are more contaminated; during the rainy season, because of the greater humidity, the sleeping mat, the ground, and the walls are more contaminated. Contamination of the mother's apron should be especially noted because she uses it to clean, or as the case may be, to soil. Note should also be taken of the dog's snout, which is contaminated in this environment because the animal eats fecal matter.

These people are not familiar with the bacterial theory of illnesses and so take no precautions in regard to avoiding fecal contamination. The children often defecate within the home, especially at night when they are afraid to go out. It has been observed that the adults do the same thing. This problem becomes more acute when diarrhea occurs.

All this fecal matter is cleaned up by the mother the following morning; she used only a rag that she then leaves lying somewhere around the house. Household cleanliness is relative. Every so often they sweep the house and take the sleeping mats outside and expose them to the sun. But all the animals have completely free access to the house: dogs, pigs, chickens, etc. The smaller children are somewhat more isolated from this contaminated environment because they are almost always put in a crib suspended from the ceiling of the hut. However, the advantage is voided in part by some inconvenient customs. They are always taken down to sleep on the straw mat next to the mother, and in general, next to the rest of the family. The mother contaminates the child because she touches it or "cleans" it with her apron or with dirty rags. On any pretext, she puts her fingers into the child's mouth.

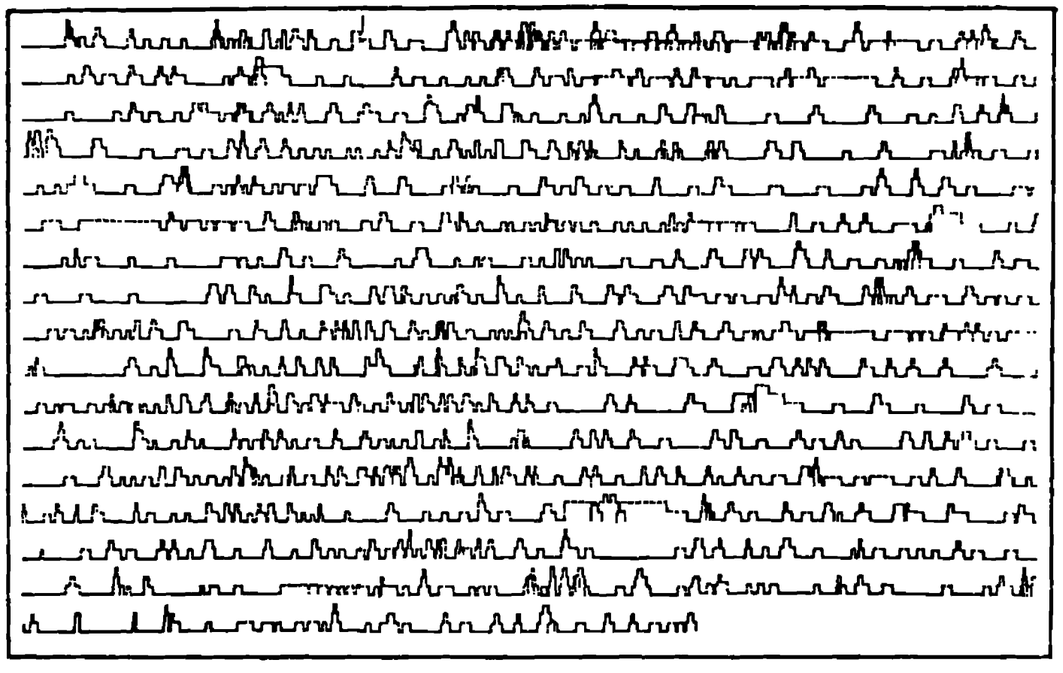
The level of contamination is so high that any difference that may

exist is really of no practical importance. Even if we were to think in terms of reducing contamination by one-fourth or by one-tenth, the people would still come in contact with fecal contamination practically every day at all hours and, consequently, with pathogenic bacteria.

Graph 22 on frequency of illness in the non-supplemented children, shows that some illnesses follow a certain pattern in such a way as to allow us to suppose that their presence depends more on the level of immunity of the children than on the level of contamination. This means that they may be exposed to pathogenic germs all the time, but they do not become sick except when their immunity levels are low.

The "family" ecological medium in contact with the child is made up not only of the humans who live in the house but also the ever-present animals, who freely go in and out, carriers of fecal matter and their own viruses, bacteria, and parasites, to say nothing of the more or less constant presence of insects and bacteria, saprophytic and pathogenic, which, to a certain extent, are quite domesticated by the immunological circumstances characteristic of the family. For this reason, many pathogenic bacteria do not act pathogenically; they are transmitted from one member of the family to another in cyclical form, resulting in a certain level of adaptation on the part of the people, thus modifying, to some degree, the clinical picture.

Other types of bacteria and viruses are also introduced from other houses, from other communities, and even from other countries, and these can result in illnesses that are often more serious.



Graph 22. Illnesses in the non-supplemented children during the first three years. Each accident represents an illness, the height represents the severity. They are classified into gastrointestinal (- - -), respiratory (——), and others (. . . . .).

Some public health measures that do not take the real situation into account at all, has happened with the program of bringing in water, have practically no effect on health. The water supply program succeeded in extending the piping so as to put a faucet in almost all homes. Unfortunately, the faucet was located in the patio and this resulted in somewhat higher humidity. There was also a continuation of the old custom of putting the water for family consumption in a receptacle which is placed at floor level within the house. Thus, the water was as contaminated as as ever by the dog's snout, by putting dirty hands into it, and by no change in the level of fecal contamination within the house. Consequently, the frequency of diarrhea and other illnesses was not modified.

If we had put the faucet inside the house without giving any instructions, the facilities for washing some kitchen utensils might have been improved. On the other hand, though, considering the lack of ventilation and illumination, increasing the amount of humidity inside the house would possibly have resulted in an increase in environmental bacterial contamination. A solution with which we are experimenting now consists of the construction of an open ventilated corridor where the faucet will be placed, and where cleaning operations will take place.

A study was made of frequency of illnesses in the children in order to learn the importance of infections on development and the possible interaction with malnutrition. The study was carried on by a specially trained aide who visited each family weekly, checking on the illnesses that the child had suffered during that period. In the event of illnesses difficult classify, the resident researcher was asked to corroborate the diagnosis. The type and severity of all illnesses of a general order were classified. The only exceptions were some very localized and chronic illnesses, such as dermatitis, conjunctivitis, and minor trauma which practically 100o/o of the children experienced most of the time.

Quite precise gradations were established for each type of illness, and the aide who gathered the information was well trained. Grade I classification considered illness in which there was a generalized moderate attack, such as grippe, cold, cough, diarrhea, which were not severe enough to prostrate the child. Grade II classification included illnesses with important fever, asthenia, anorexia, that obliged the child to remain in bed. Grade III classification was reserved for very serious diseases, that put the child's life in danger, such as pneumonia, acute diarrhea with vomiting, etc.

The frequency of illnesses is generally very high in the community. This high prevalence implies certain adaptations or accomodations on the part of the family and perhaps on the part of the child itself. It reaches such a degree that the mother herself considers as normal the incidence of frequent and watery evacuations, and she does not become worried as long as the general state of the child does not seem to be affected. The same is true when the child has an upper respiratory infection, a frequent occurrence. It is common in this type of community to call the child "snotnose". The result of this almost constant presence of sickness is that the mothers in the rural environment take the child to the doctor only when they think that the child's life is in real danger.

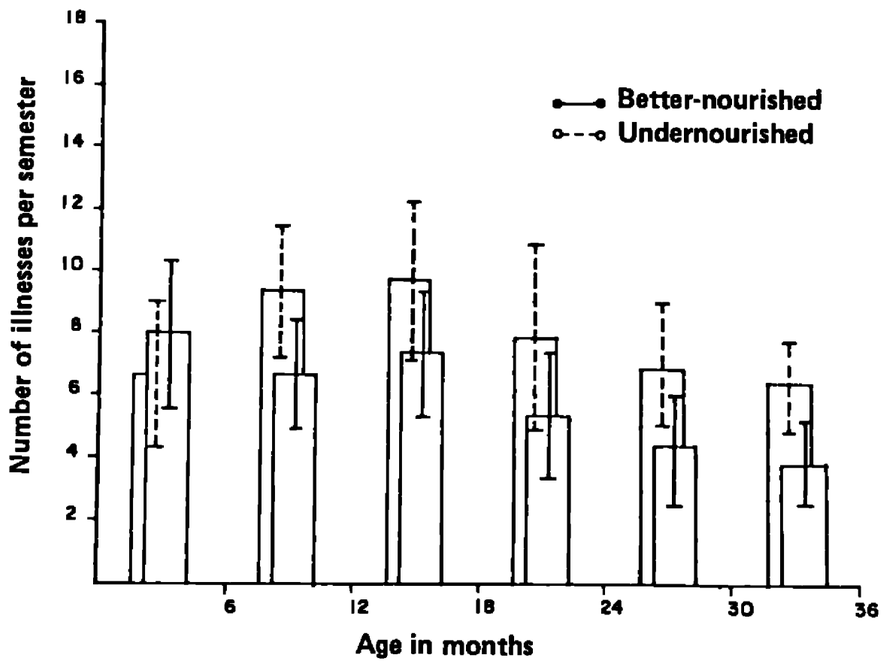
Graph 22 shows overall, the illnesses the non-supplemented children suffer during the first three years of life. Each accident in the line indi-

cates an illness, while the height is proportional to the seriousness of that illness. A broken line indicates gastrointestinal illness, and a dotted line indicates other illnesses.

These data show what most rural children go through. They are sick for more than one-third of their lifetime. It may also be noted that, in several of the cases, some of the illnesses occur in a rhythmic pattern. As has previously been mentioned, this suggests that the frequency of such illnesses does not depend so much on contamination, which is constant, as on rhythms of loss of immunity to "family" germs.

Graph 23 shows the number of illnesses the children had per semester. In the non-supplemented during the first 18 months: a little more than six during the first semester, a little more than nine during the second semester, and as many as ten during the third semester. After the third semester, the frequency then drops progressively until de age of three years.

In the supplemented children, it was found that the first semester was when they had the highest frequency of illnesses, a little more than the non-supplemented children. This may be explained by the fact that supplementary feeding was introduced to these children during this period, and foods came not only from our program but from the household as well. These children had learned to eat, and demanded household foods that contrary to what is classifically maintained, the mothers did not deny them. This influenced the fact that these children had approximately eight illnesses during the first semester. After that however, the supplemented children always had 30o/o fewer illnesses than the non-supplemented. This indicates the possibility that nutritional deficiency favors a higher incidence of illnesses.



Graph 23. The non-supplemented children show a greater number of illnesses after the first semester.

Another explanation of the differences in illness frequency between the supplemented and non-supplemented children might be that the first ones preferably consumed the foods in our program, and that these foods were controlled under more hygienic conditions. But, as has been stated, they also, ate, almost in the same amount, foods found in the household. Besides, because their physical activity was much greater, they were more playful and came into more extensive contact with their parents, brothers and sisters, dogs, and the environment in general, and so they were more exposed to direct contamination. In any event, contamination through fecal matter is such that all the family members, especially the children, are exposed to almost continuous contact with bacteria and other pathogenic germs; in consequence, any difference in contamination exposure that may exist between the two groups is of no practical significance.

Graph 24 compares the illnesses in the supplemented and non-supplemented children during their first three years of life. It shows that the poorly nourished were more unhealthy, not so much because of a greater number of illnesses (only 30o/o higher), but because the illnesses lasted longer and were more serious. Note, too, that it was not rare for two or more illnesses to occur at the same time.

During the third semester, the frequency of illnesses increased a little among the supplemented children. This was because at that age they

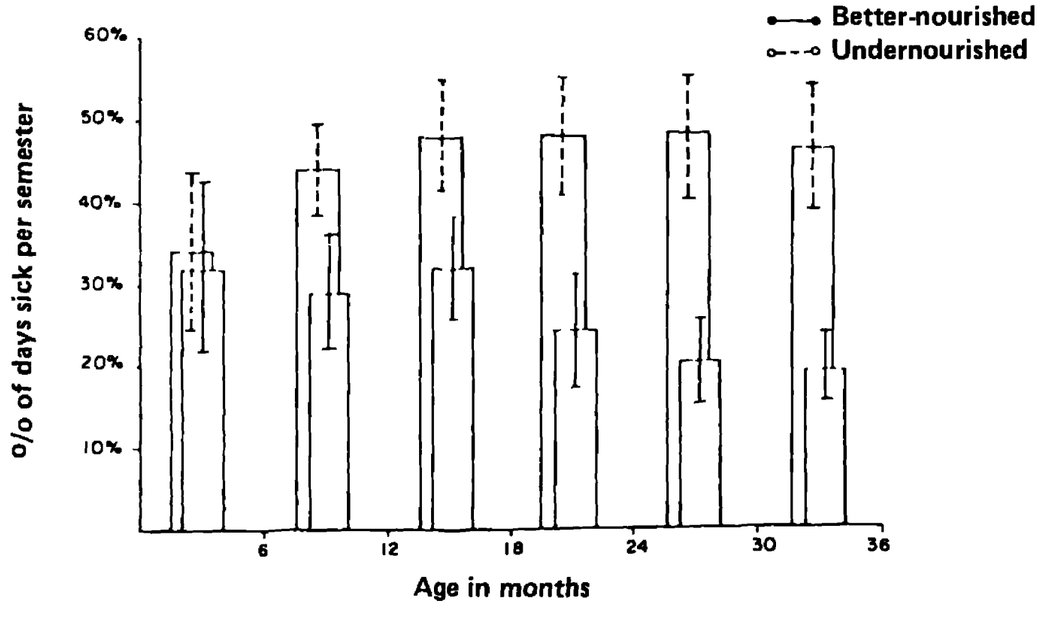
Graph 24. The non-supplemented children (left) have more or less the same frequency of illnesses during the first year (A), more during the second year (B), and especially frequent during the third year (C).

suffered the infectious-contagious virus illnesses characteristic of early childhood. This did not happen among the non-supplemented children; in their case, these illnesses occurred over a more scattered period of time, and sometimes not until the third year of life. Moreover, they were sometimes not as severe, but they did last longer.

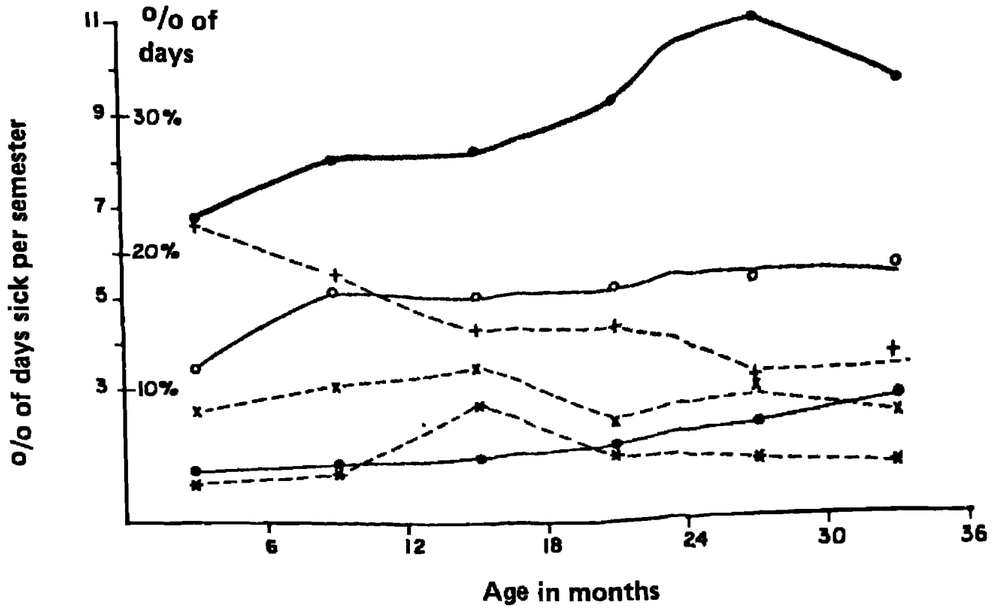
Graph 25 shows the number of days that the children were ill. This is the parameter in which the study best shows the role of nutrition in relation to infections. During the first semester there is no difference between the two groups; however, a very marked difference does appear from the second semester on. The percentage of days ill increases progressively among the undernourished children: 33o/o during the first semester, to 44o/o during the second semester, and to almost 50o/o during the third, fourth and fifth semesters. The tendency is different among the better-nourished children; it would be lineally decreasing if it were not for the small increase during the third semester, that, as was mentioned above, was due to the concentration in the incidence of viral infections.

If, during the second and third semesters, the differences in days ill are important and significant, they are even more so after the age of 18 months, when the better-nourished children are ill less than half of the time that undernourished children are.

The most frequent illnesses were those of the digestive system. It is precisely in this type of illness that the non-supplemented children showed the most difference from the supplemented, to the extent that at the third year of life the non-supplemented were ill with diarrhea twice the amount of time as the supplemented. This is due, above all, because in the non-supplemented children, attacks of diarrhea lasted longer, and these children needed much more time to recuperate. In these children, infectious diarrhea had a more or less rapid acute phase followed by a sub-



Graph 25. The non-supplemented, from the third to the fifth semester, have some illness for as much as half the time.



Graph 26. Among the undernourished children there is a higher frequency of gastrointestinal illnesses (●—●), a little less than respiratory illnesses (○—○), and other illnesses (●—●) than there is among the better-nourished children: gastrointestinal (+— +), respiratory (x — x), and others (* — *).

acute phase that lasted several days, sometimes as long as 10 days. Among the supplemented children, on the other hand, diarrhea usually lasted only one or two days (see graph 26).

As for respiratory illnesses, the difference between the supplemented and the non-supplemented groups is not so great, although it is significant beginning with the second semester. With other diseases, the transmissible viral illnesses (measles, chicken pox, and whooping cough), we found that the supplemented children contracted them earlier, during the second semester, while they occurred in the non-supplemented children later, during the third year of life.

It is not possible that this finding is coincidental with the epidemic exarcerbations characteristic of these ailments that are known to occur cyclically in communities, simply because the children are of different ages. Therefore, in order for the children to contract the disease at a given age, the disease had to be present at a different period of the year.

The lower part of graph 27 shows the differences between both groups regarding more serious illnesses, those classified as grades II and III. They are significant beginning with the second semester: the undernourished now spend twice as many days sick. During the following semester the differences decrease because of what has already been described regarding the viral illnesses of the better-nourished children. During the fourth semester the differences once again become more marked. This factor is very significant for the health of the rural child.

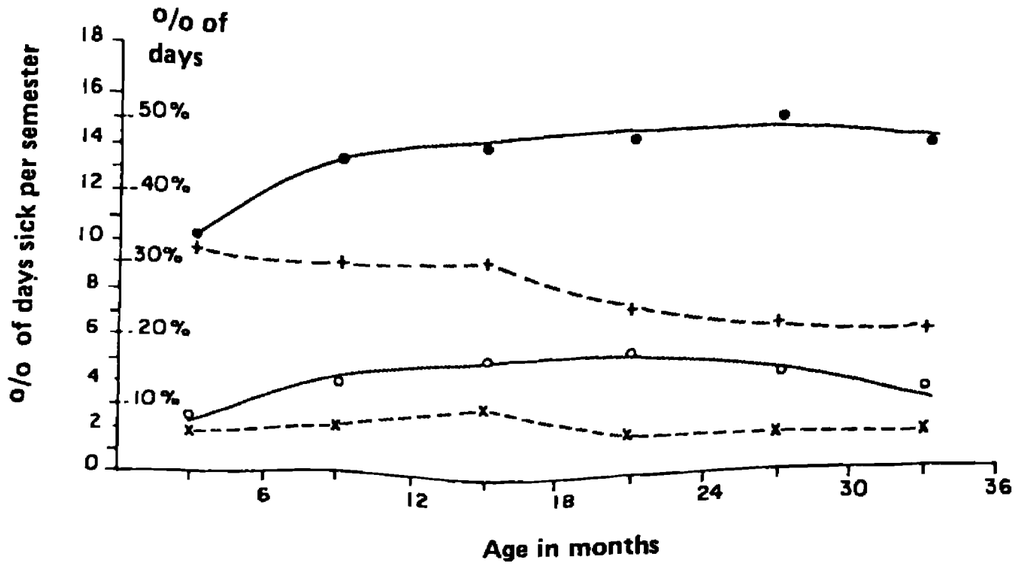
The information given in this chapter shows the influence of nutritional status upon the frequency, seriousness, and type of illnesses. The effect on frequency is little, because the differences between the groups

are not always significant. This situation, to a certain extent, is in accord with laboratory results, which show only small differences in immunity between malnourished and normal children. During the second semester, and above all during the third, the frequency of diarrhea among the non-supplemented children increases greatly.

This is traditionally attributed to the fact that this is when these children begin to receive supplementary feeding in the home. The supplemented children suffer from diarrhea for a fewer number of days in spite of the behavior study showing that this is a period in their lives when they are much more active than the non-supplemented group and, consequently come into more extensive contact with the highly contaminated environment.

There is no doubt that many of the illnesses last twice as long in malnourished children, especially because their period of recovery is longer. After the acute phase, a prolonged period of continuing illness remains; this affects the health of the child quite a bit because it is accompanied by anorexia. This long and distressing phase of recuperation may, in part, be explained by malnutrition itself. We know that the intestinal mucosa among the malnourished is altered, and that the respiratory mucous membrane is stratified, having less mucous secretion and less ciliary movement, which makes recuperation from infections more difficult. We also know that severe malnutrition itself can produce diarrhea because of alterations in intestinal absorption and transit time. It is possible that this mechanism also operates in the case of moderate malnutrition, for example, in the presence of infections.

Whatever may be the explanation for this longer duration of infections, or merely their symptoms, the fact is that the effect upon health is



Graph 27. In the non-supplemented children, days ill according to severity of the illness, with illnesses of grade 1 (●—●), grades 2 and 3 (○—○); in the supplemented with grade 1 (+– +), and grades 2 and 3 (x - -).

magnified by some cultural traits. Among such characteristics is the factor of the mother's restricting the amount of food given the child from the very beginning of an illness until the child no longer manifests symptoms. Thus, if the diarrhea or the cough lasts for five or ten days, the child is kept short of food for that many days.

The effect of malnutrition on the severity of infections was very clear. Practically any infection produces a marked asthenia and anorexia in the malnourished child. Anorexia is an important aggravating mechanism in malnutrition. In malnourished children above the age of six months, practically any illness causes loss of appetite, thus further deteriorating the nutritional status. It is in this way that some children find themselves in a vicious circle that frequently ends in death.

In summary, this part of the study indicates that malnourishment brings about a slight increase in the incidence of illnesses and results in the illnesses being more severe and having a special impact on the general status of the child. Finally, and above all, malnourishment results in illnesses lasting for a longer length of time. All this, combined with cultural factors (especially the fact that the family restricts the food intake of the child during an illness), explains the interaction between malnutrition and infection and the impact of both on the development of the inhabitants in the underdeveloped communities of the world.

CHAPTER 7

Neurological maturation and performance on mental tests

At the present time it cannot be denied that severe malnutrition has important effects upon brain function in most mammals. Yet, this was still often denied just a little over ten years ago, and for three principal reasons: 1) There were defects in the experimental patterns. The tests with which the experimentally malnourished animals had to comply were not very difficult and hunger made the animals more nervous and active. 2) It was not ordinarily taken into account that in several species most cerebral maturation takes place in utero; therefore, malnutrition at a later stage does not affect brain function to any great degree. 3) Due to the great importance of brain function and its small nutritional needs for proteins and vitamins, the brain is the last organ to suffer nutritional damage.

Several recent studies show that the brain is affected, and to a great extent, by malnutrition. The degree to which the brain is affected depends upon the severity of malnutrition and the age at which malnutrition takes place. The damage undoubtedly goes by unnoticed because the brain, especially the human brain, is an organ that has a large functional reserve. In fact, it is rare that the brain is used to its full capacity. Its real functional limit depends more on the learning processes than on its potential physiological reserve. We know it can suffer important damage without showing any deficiency, especially when it is not called upon to function at its maximum capacity.

It has been possible to show that early malnutrition in laboratory animals (either as the result of a malnourished mother or in a malnourished newborn) reduces the size of the brain and the number of brain cells to an important degree, and, in consequence, the cognitive and learning capacities. We know the effects of inadequate diet upon social conduct in several species. Dietetic deficiency in successive generations has brought about a multitude of alterations in brain function among large cohorts of animals.

It has also been shown that seriously malnourished children, suffering from kwashiorkor or marasmus, defectively carry out different mental tests, in comparison with normal children, siblings, or other childrem from the same socioeconomic environment. It has been possible to show, in these children, that the deficiency in the mental tests is greater when there is an earlier appearance and greater severity of malnutrition.

These findings of the effect of severe nutrition on brain function is of little importance because the number of children who reach these grades of advanced malnutrition is relatively small, and particularly because they almost never survive in their natural environment.

From the point of view of health, and perhaps also from the economic and educational points of view, what is important to find out is whether moderate malnutrition, which is being studied here and which affects most of the children in the poverty areas of the world, really leaves neurological, and consequently mental, lesions of importance. This has been difficult to show for several reasons. One is that it has never been possible to isolate the different factors that enter into what is known as intelligence, especially to separate the intrinsic, or cerebral, factors from the extrinsic, or environmental factors, particularly those that relate to learning. That means that a given brain may respond deficiently because it has suffered an anatomical, a chemical, or a functional lesion, or because it has never been taught to respond. Thus, for example, if a child does not perform well on a test of mental capacity there will always be a doubt as to whether he is not smart or whether he may simply not have the background from which he could draw help in problem-solving.

In this respect, we must remember that the malnourished children in the world are almost always found in the most deprived social environments, in very restricted cultural circumstances; their experience regarding a great many objects, geometric figures, and even words in their own language is limited; and, above all, we must remember that, as far as these children are concerned, their experiences are different from those that are part of Western culture.

The mental tests that have been available up to the present moment have been conceived in the developed countries for children of an urban environment whose experiences are obviously different from those of children in other countries and who live in a rural environment. What is more, there are serious problems in translating such tests into Spanish. The translations that have been made are of a literal type, translating into Spanish the meaning of the word and not its "value" in relation to what the mental test wants to determine: for example, the grade of difficulty of a word, the complexity of the concept, the rarity of the object, or one of idiomatic ambivalence.

Based upon the above in spite of the fact that most of the studies done in underdeveloped areas have shown that the majority of malnourished individuals do poorly on mental tests, it is erroneous to interpret this finding as an indication of retardation. The tests used really do not measure the intelligence of children in a rural environment, nor is malnourishment the only factor upon which the test depend.

Malnourished people are also the poorest, the most isolated and ignorant, and of the simplest culture. The researchers who insist that the malnourished are the least smart have accepted as being "good" some tests that are foreign to the way of life in these communities. They have chosen one of the differences between the children from the rural Mexican environment and those from New York –nutritional status– and have identified that difference as being the cause of differences in ability to perform on mental tests. Recently, other authors, with even less adequate criteria, have selected other factors, such as level of education or of

information, as being the most important.

There were some research projects, one, for example, showing that, in a given town, the taller children did better on mental tests than the shorter children, and that this pointed to the nutritional factor as the cause of the differences. The truth is that, even in the same town, the taller children came from a less deprived socioeconomic level with different cultural values, and sometimes even a different genetic background.

The experimental pattern of this research project tried to avoid the errors just mentioned. We succeeded in isolating the variable "nutrition" to a sufficient degree by providing food to one group and not to another, and by leaving unmodified the rest of the ecological variables, such as education, information and culture. We then ran tests that, if not ideal, were in fact the same for both groups.

We are conscious of the fact that the tests are not adequate, but if the supplemented children could pass the tests and the non-supplemented children failed, there is reason to believe that there is a difference and that, in this case, the difference may be attributed to nutrition.

It is appropriate to underline the fact that, in this project, we never speak of "intelligence", but rather only of the ability to do the test, which is not the same thing. We are not sure of what is being measured, given the social, cultural, and educational circumstances of the children of Tezonteopan.

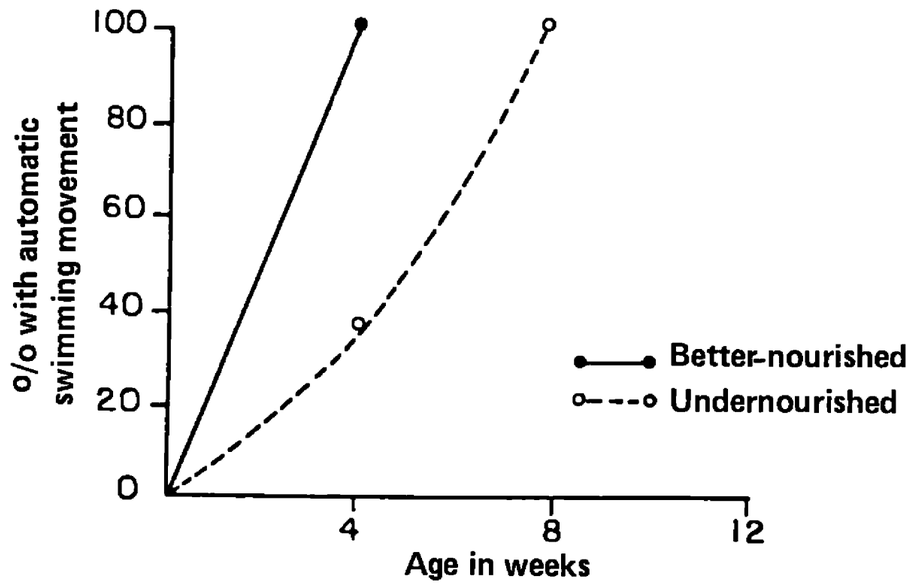
Numerous studies were made. A neurological examination was administered, monthly at first and then once every three months. It included the collection of approximately 50 points of information each time. Also, longitudinally, we administered Gesell-type tests that were well standardized and partly modified by our group of researchers. In addition, we carried out different research activities in the area of the behavior of the children. This last aspect will be discussed in chapter 8.

Neurological study showed some deficiencies among the non-supplemented children in their natural state compared with the children supplemented by our program. Deficiencies were found among the very young, during the first two months, as well as at a later age, about 18 months. This suggests that malnutrition plays a role in the phenomena found because the age at which these phenomena occur coincides with the stages of greatest nutritional deficiency. Malnutrition during gestation is what becomes apparent early in life. Malnutrition that the children suffer as a consequence of prolonged lactation and of the lack of supplementary feeding reaches its maximum at the age of 18 months.

Neurological alterations that appear very early in life went unnoticed in previous studies because of an error in interpretation of some of the reflexes that appear soon after birth and then die out, such as the reflexes for walking and automatic swimming (graph 28).

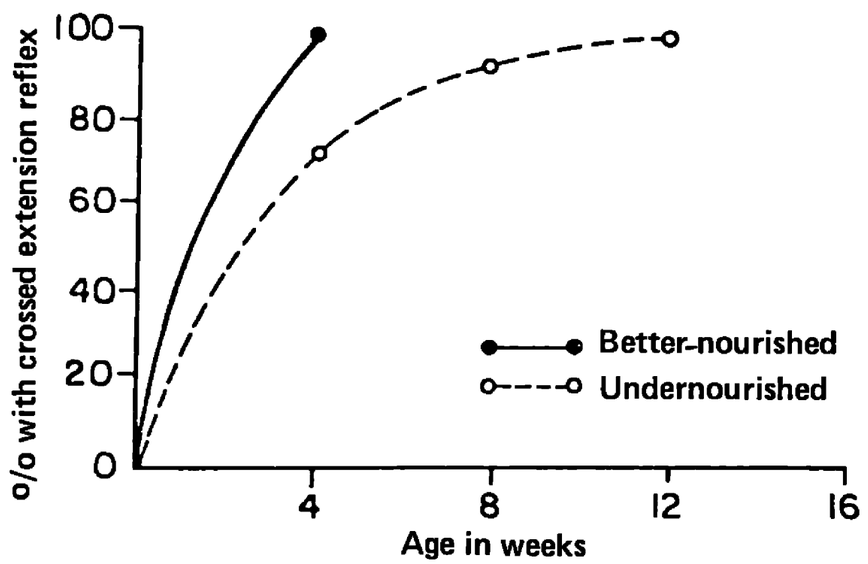
It is easy to show that, during this early stage, the appearance of some reflexes in the undernourished is retarded, for example, the crossed extension reflex in the lower legs (graph 29), the support reaction, and the placement reaction. The retardation in the appearance of the optokinetic reflex was also obvious. On the other hand, the reflexes of crossed extension, of walking movement, and of automatic swimming movement also disappeared later than they did in well-nourished infants.

Some of these differences between supplemented and non-supplemented are not very noticeable, and under the conditions peculiar to a poor town, some of them may be, to a certain degree, beneficial to the undernourished children, particularly the element of persistence of the walking and automatic swimming reflexes mentioned above and commented in the specialized literature over a long period of time.



Graph 28. The automatic swimming movements disappear later among the undernourished.

Some of the deficiencies that were found among the undernourished children in later stages of development, especially at about 18 months of



Graph 29. Half of the undernourished children are retarded in evidencing the crossed extension reflex.

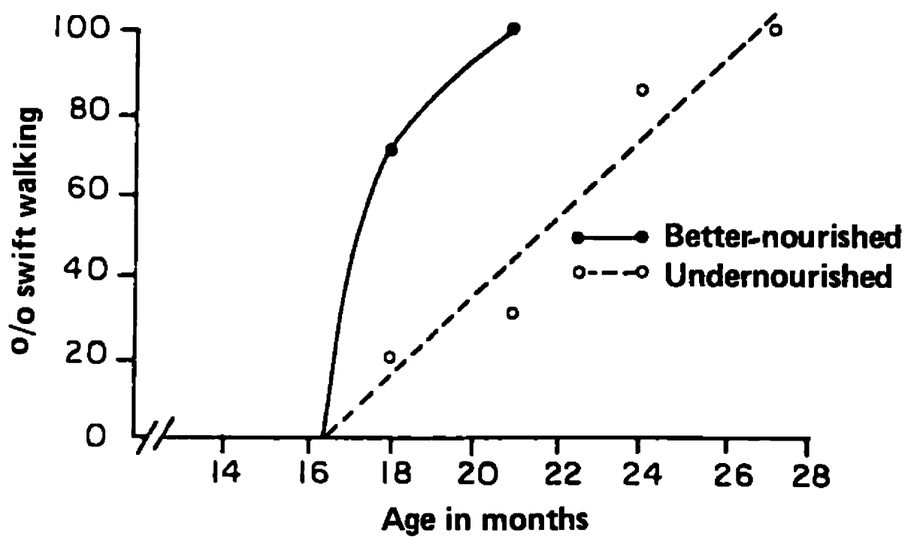
age, were more noticeable than initial retardation. Traditionally, there has been a denial of the possibility that the brain may be damaged by "weaning malnutrition", because when malnutrition sets in at four months of age, 80o/o of the neurons in the children are already present; later, as malnutrition progressively affects the child, the brain matures rapidly. This affirmation does not make sense because it implies that the only thing that matters for cerebral functioning is the histological structure, without taking into consideration chemical maturity and, especially, functional completeness, which depends upon both, as well as other factors which, to date are unknown. It is not known how the brain "thinks", nor how or when it may be affected.

It is known that the human being begins to integrate language at about 18 months of age and that language is the cornerstone of thought. The human brain thinks using "symbols" by handling "monenes", which are elements derived from language, and if language is not adequately integrated, the handling of the "monenes" is not done well. This function reaches its maximum at the age of 18 months, a moment at which malnourishment also reaches its peak.

Those researchers who suggest that the brain cannot be damaged by second year malnutrition on the basis that it is already more or less established histologically are definitely forgetting how complex cerebral maturation must be, especially in its functional integration, which is not reached until adolescence.

Neurological exploration done during the second year of life showed significant differences, although not accentuated, between the supplemented and the non-supplemented children.

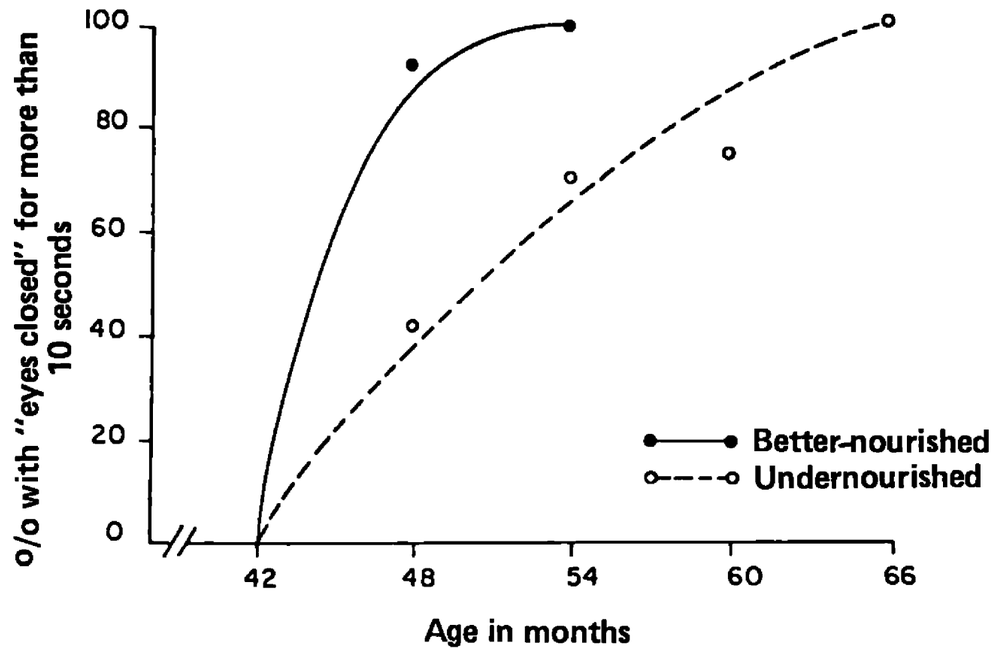
1. It was found that in the non-supplemented child, whose nutritional status is more deteriorated, the retardation in the age at which he begins to walk is more marked. This becomes more obvious when the



Graph 30. The non-supplemented children can walk swiftly 6 months later than the supplemented children.

exploration is done more minutely: swift walking (graph 30), balance, standing on one foot, walking on tiptoe, or jumping with both feet simultaneously.

2. The undernourished children have difficulty in keeping their eyes closed (graph 31) and in lateral conjugated vision.



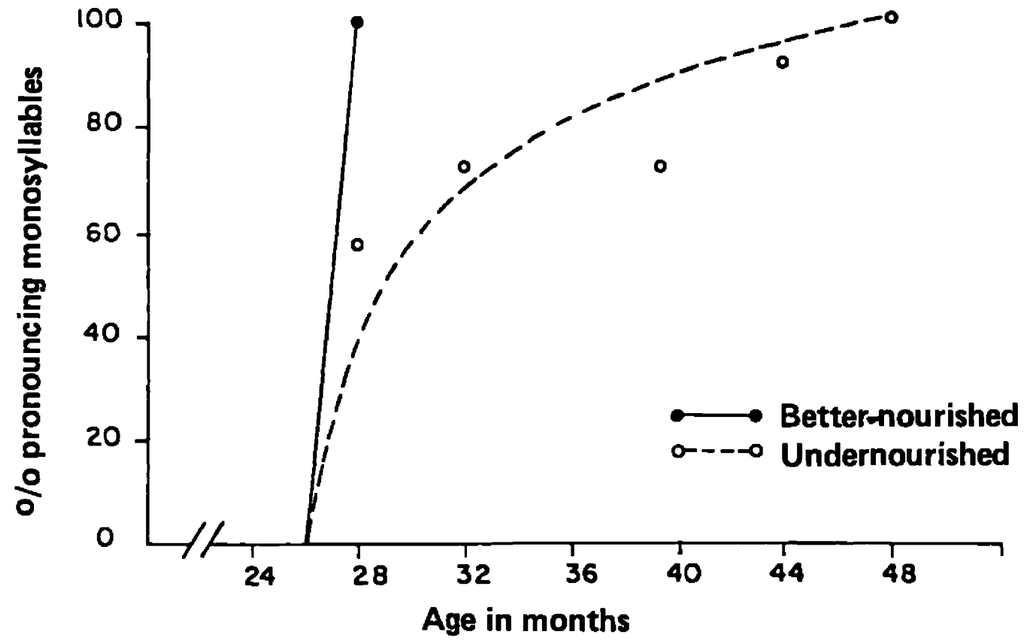
Graph 31. The non-supplemented children cannot keep their eyes closed for 10 consecutive seconds until one year after the supplemented children can do so.

3. It was found that the undernourished children took longer to exert voluntary control over the vesical sphincter, during the daytime as well as during the night.

4. Language retardation in the undernourished children was apparent from the 20th week. Particularly affected was the ability of these children to pronounce some sounds, like "m", several monosyllables (graph 32), the ability to join two, three, or four words, to understand simple orders, or to construct sentences (graph 33).

It would not have been possible to detect the existence of retardation if it were not for proper controls except, perhaps, in the area of language, in which the children were at the border of abnormality. There is no denial of the possibility of the undernourished children having greater alterations; it is simply that the neurological examination, regardless of how detailed it was done, is a rather gross evaluation of brain function. We know that in many cases an important organic lesion is required for a reflex, or various reflexes, to be found abnormal.

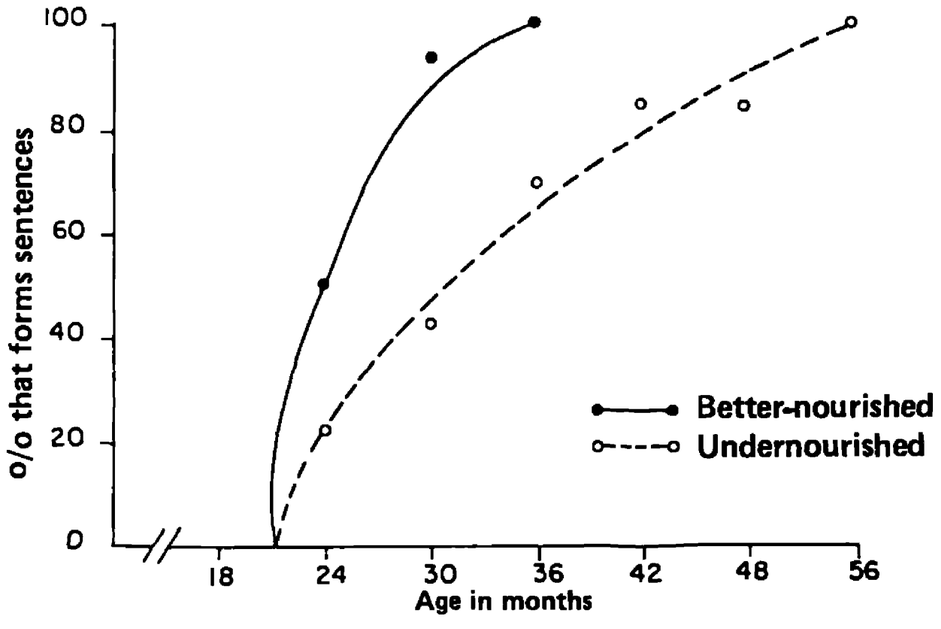
It must be emphasized that only backwardness was found; although late, the reflexes were present and the function was integrated. Besides, in the human being these small delays are not important since, even in a poor environment the child has sufficient protection —mother, family,



Graph 32. The non-supplemented children fall behind as much as a year-and-a-half in pronouncing some monosyllables.

home– to overcome the deficiency. Thus, for example, the fact that the undernourished child begins to walk at a later date is of no great importance as long as the mother continues to provide nourishment.

Language was the area most extensively studied in the project by means of neurological examination, Gesell tests, behavior studies, and



Graph 33. It takes the undernourished children longer to construct three-word sentences.

currently by an intersensorial type of studies. It was observed that integration is a highly complex process, that the undernourished have phases during which retardation is very noticeable and other phases during which there are advances that, in some cases, bring them almost to normalcy. Thus, for example, it was found that the undernourished children took longer to say "mama" and "papa", but suddenly, three or four months later, not only did they say these words clearly enough, but also some more difficult words that were in accord with their age.

It was common to find that after the phases of advancement they again showed periods of retardation and that the phenomenon repeated itself afterwards. In the face of this type of evolution by leaps, it is fitting to ask if the problem is neurological –functional incapacity– or if we are simply dealing with period during which the child lacks will, or whether action on the part of the mother decreases in that she does not provide the stimuli that teach the child to speak. Consequently, we do not know whether the child is backward and recuperates only when he reaches a certain maturity, or whether he only appears to be so, and when environmental conditions are more appropriate and he has the will and the motivation, he learns easily with the result that, at that moment, he almost reaches the language level of the better nourished children.

In spite of limitations operating on the interpretation of the information, it is possible to say that the neurological examination shows that, between 18 and 24 months of age, the undernourished children have several deficiencies in multiple reflex responses; this suggests a retardation in cerebral maturation. In general, the most backward areas were those related to cerebral inhibiting mechanisms that among others, are necessary for maintaining attention on the activities being executed. This finding is important because it may be related to difficulty in concentration manifested by the student who comes from the more undernourished social environment.

In conclusion, the detailed neurological study of both groups of children shows that moderate malnutrition affects but little the maturation of the central nervous system and in such a way that the children are not brought to a clear abnormalcy. Rather, they are indeed brought to a significant condition that is different from that of the better nourished children; this indicated that there is a certain degree of retardation. This latter observation may be of greater importance if we consider that only the really gross reflexes were studied; if these were found to be altered, it is possible that poor nourishment may affect finer aspects of cerebral function, such as memory and intelligence.

Regarding intelligence, a great effort was made to apply different mental tests, among them those proposed by Gesell. These studies were done by specialized personnel and were standardized with other studies of the same type that were being carried out in Mexico at that time. The tests were done monthly during the first year and every three months during the following four years. Our purpose was to keep the study "blind", that is, the psychologists were not told whether the child was supplemented or not. But because there was a wide difference in age between the two groups –an average of more than two years– and because from the beginning a wide difference in behavior was noticeable, this method was invalidated.

In all the graphs in this chapter it is noteworthy that the newly born have high ratings. In fact, they were not placed in their full magnitude so as not to alter the structure of the graph. This fact (which was first described by some researchers in Africa and later by De Licardie and Cravioto in Guatemala and in Mexico) suggest that neurological development at early ages among children in a rural environment is different from that of children in an urban environment. It is said that the former are born more "awake" because in these children some reflexes, especially some of the complex type, are more conspicuous. This has been the basis for proposing the explanation that children in poor environments are born "cleverer" because that is what is required for their survival.

The truth is that the modern patterns of neurological examination, such as those used by the specialists who participated in this study, show that the facts are possibly just the contrary; it seems that the aforementioned complex reflexes are not a sign of advancement or of a greater CNS maturity but rather the very opposite. The explanation is in the philogenetic analysis of these early complex reflexes, which makes it evident that, in many species, they exist as a protective mechanism. Such is the case of the chick that comes running out of its shell, or the baby rhinoceros that runs to the mother dragging its placenta in order to protect itself from carnivores: these things are in accord with non-cortical motor mechanisms, characteristic of certain phases of maturation.

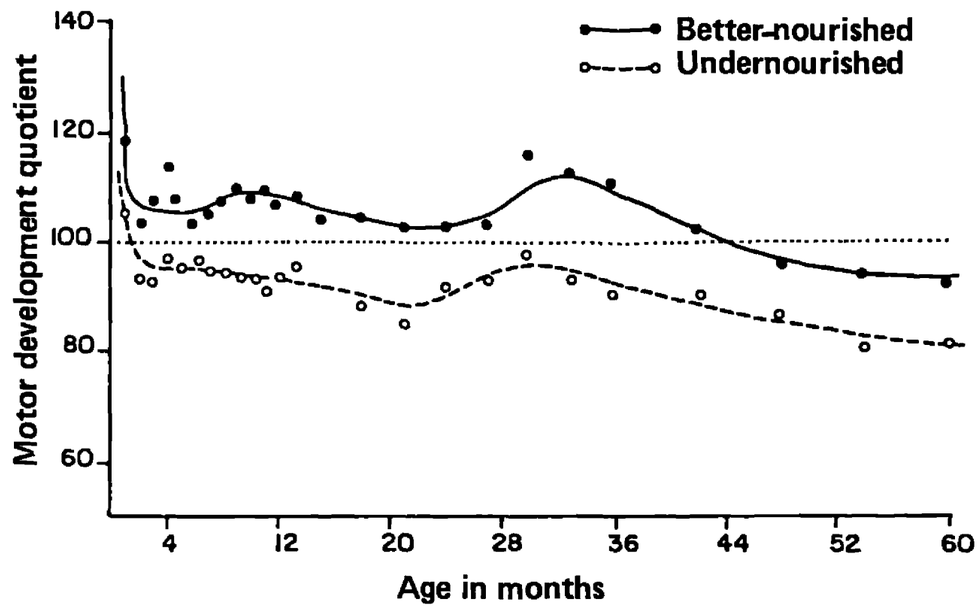
Consequently, the child in a rural environment who tries to walk or run when there is a stimulus, or makes swimming movements when placed in a certain position, or who follows moving objects with his eyes, is not advanced but rather retarded. Therefore, there is no importance, and certainly no significance, in what such researchers have interpreted as a greater capacity for survival among children in a poor environment. Besides, the difference is not so great because it is always reported as percentage of advancement from date of birth, which has little significance since, if an infant three days old were to have a 300o/o advancement, this would mean that he had a motor age, or a language age, of nine days, which is not much.

Other findings that might add to the impression that the child in a rural environment shows greater activity are: the greater activity on the part of the mother, who works until the end of her pregnancy, thus stimulating the child's labyrinth to a greater extent and the fact that during delivery the women in the town are not accustomed to taking any drugs or medications that may have a depressing effect on the newly born.

Graph 34 shows the motor development in both groups of children. The better-nourished maintain a normal level until the age of 40 months; it then drops a little without reaching abnormality. Compared with the better-nourished, the undernourished children are always slightly retarded in development; their average levels are parallel to the better-nourished, but at a point approximately 10 to 15 points lower.

These results support the data obtained through neurological examination. As we know, the Gesell motor development quotient, to a great extent, is in agreement with information derived from a neurological examination.

The results of examination of language development in the children are more or less the same as those in the neurological examination. There are

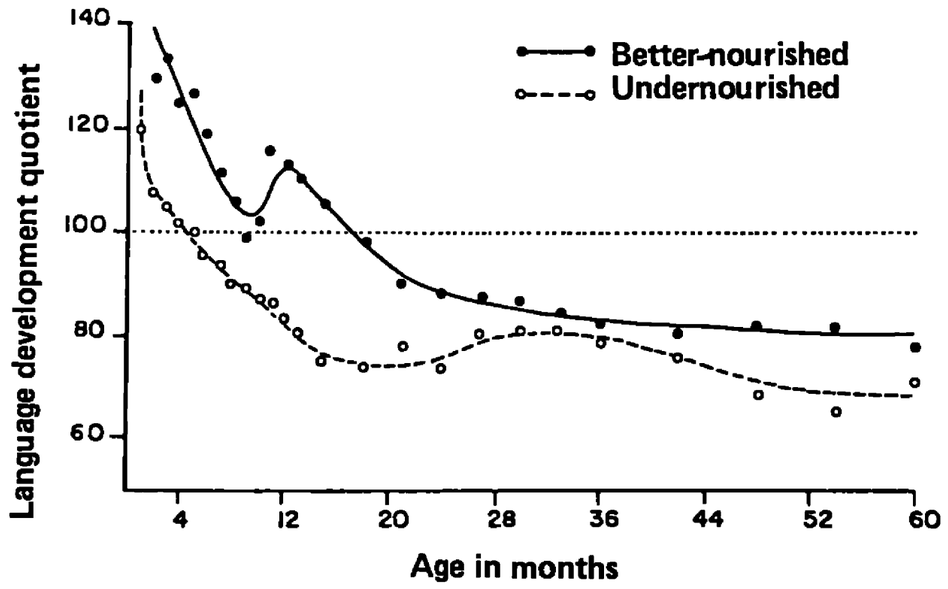


Graph 34. Beginning at 4 months of age, the undernourished children show, comparatively, a certain retardation in motor development.

certain ages in which there are greater divergencies between the better-nourished and the undernourished children, and there are other ages in which the undernourished children appear to be very much retarded, for example, between 10 and 20 months of age, precisely at the beginning of the process of learning to integrate words and phrases, when more is certainly demanded of the brain. Later, at about 30 months of age, there is no longer a difference between the two groups (graph 35).

An important point that deserves comment regarding language is that, beginning with the 12th month of age, the better-nourished children also show retardation while, beginning with the 20th month of age, they almost reach the edge of abnormality. The explanation of this factor is not clear, and it is now being studied. It seems that, in large measure, this is caused by deficiencies in the learning process and by the limited family and social relationship in general. The latter factor is due to cultural factors that have to do with the limited relationship between adults and children: conversation between adults and children is not customary. Another aspect is the limited nature of the communal language, remembering that Spanish it not yet spoken well in Tezonteopan.

In any event, graph 35 shows that the malnourished children are more retarded than the supplemented control groups, and that this retardation becomes more evident during the periods of greater nutritional deficiency. The retardation among the undernourished does not reach a degree such as to allow for the supposition that there may be an important brain lesion or functional alteration. As a matter of fact, the types of alterations found do not warrant discounting the possibility that social factors are as important as organic ones. As will be seen later in the chapter on behavior, it was also found that, at this age, the undernourished children



Graph 35. From the 8th to the 24th month very clear differences are seen in language development, although the undernourished almost catch up with the supplemented after the age of 2 years.

are withdrawn, timid, and not very active; as a consequence, they relate less to the mother and to the environment in general –this translate into a lack of stimuli, in this case of the verbal type, such stimuli being the basis for teaching/learning to speak.

The most significant findings, perhaps, of all those encountered in this study on the carrying out of mental tests are those related to language. Handling language is one of the most difficult tasks that the human brain must deal with, it is the distinctive characteristic of the human brain, and, to a great extent, it is this that establishes the basis for the thought process. The human being thinks symbolically, using a system based on the "monenes" that are derived from the language. Consequently, the measurement of the ability to speak is closely tied to the measurement of the thinking system. This study shows the presence of a large gap in the undernourished children between the ages of 10 and 20 months. Although they recuperate later, the graph shows that quite a bit of what is lost, is lost permanently.

At this time it is not possible to define the ultimate significance (the significance for the future of the child) of this gap that is so important in his development. Some authors suppose that what is lost at the beginning is never recuperated, basing their view on the idea that there are certain critical moments in physiological development. Others suppose that the brain can always learn and, up to a certain point, adapt itself to function, even beyond the usual age at which this function is acquired. Both ideas have support.

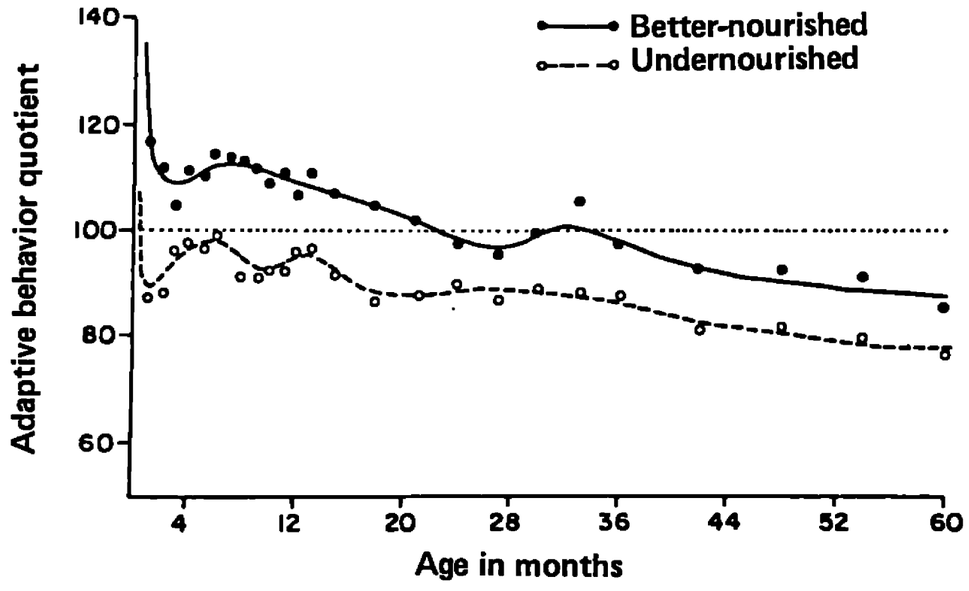
What seems most plausible is that, at a determined age, some stimuli help develop brain function more easily, when they create pathways or systems so that, ultimately, the informational process becomes easier for

the brain. It is also true that once the individual begins to speak, the brain can handle itself with a great deal of ability, practically to a degree beyond known limitation.

The conclusion could be drawn that the lack of nourishment probably by means of the little activity and scanty relationships on the part of the child, renders difficult the early development of language. This reduces the theoretical potential of language function itself and of other functions related to it, such as the thought process. This has little practical significance if we consider that the theoretic potential is much greater than the function necessary for a normal life.

Aptitude for adaptation is an important aspect of what can be called intelligence. It was found that the undernourished children were constantly below the control group in this area.

It is difficult to consider this finding as an artifice of technique, as it seems to be in most of the previous studies in which the control groups were taken from another social level. Our experimental pattern equalized the variables derived from family and social environment. What comes to our attention is the fact that the differences appear practically from the time of birth. This factor (which was also found in the neurological examination and in some other aspects of child behavior) can only be explained on the basis of the hypothesis that different levels of maternal nutrition result in a different degree of cerebral maturation in the child at birth. This finding of the early effect of nutrition, beginning with gestation (when the exterior environment has had no direct effect on the fetus, which has frequently been found in animal research), is more proof than any other of the impact of nutrition upon cerebral function. Moreover, as is shown in chapter 8, there is no difference in stimuli between groups (graph 36).



Graph 36. Adaptive behavior in the undernourished children is parallel to, but at a lower level than the supplemented children.

What is difficult to uphold is whether what Gesell evaluates at these early ages as adaptive conduct is really intelligence. Perhaps it is not until quite some time after four months that it is possible to begin to speak of intelligence.

The variations that the test shows among the undernourished children between the ages of 2 and 16 weeks (which appear to be attempts at recuperation) coincide with the greater availability of milk. In other words, the variations appear during the short period of life in which the children are less undernourished. This information may also indicate the relation between cerebral function and nutritional status.

In the tests carried out with the older children, it was found that the difference between the malnourished and the control group became stabilized at a level of about 10 points less.

There is no doubt that these results must be interpreted with care. The tests were well standardized and, to a certain degree, corrected, but we must accept the fact that they are not ideal for evaluating the population that was studied. This lack of adequacy of the tests is reflected in the variations in the results at different ages. The important thing is that this does not differentially affect the groups because both groups are of the same level and of the same socioeconomic status; the latter is the fundamental characteristic in this study.

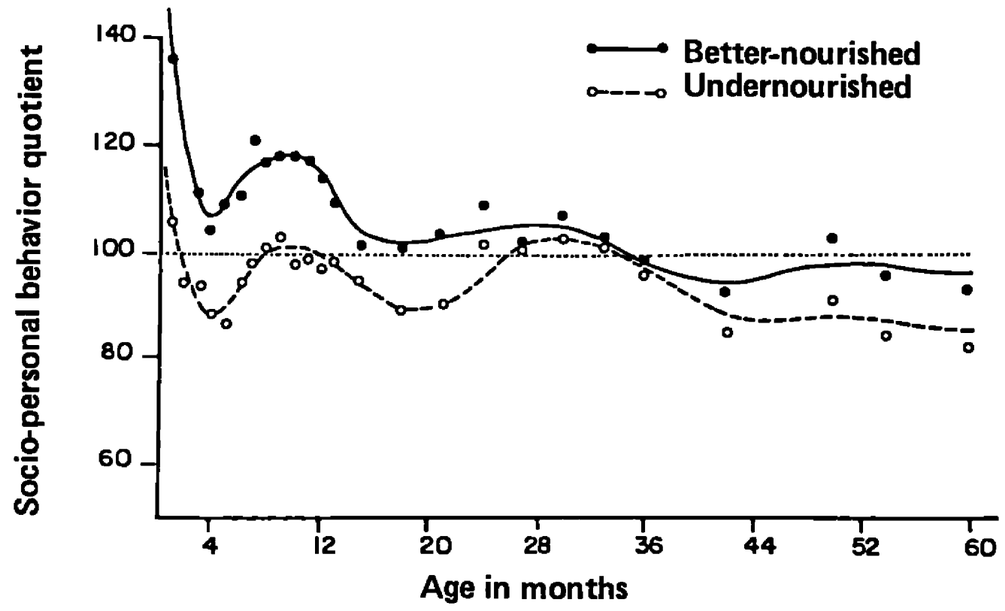
In previous research work, the result achieved on intelligence tests given to undernourished children has been compared to that obtained with children in a different nutritional state as well as in a different environmental and social situation. Under such circumstances, it is not possible to know whether the well-nourished perform on the tests better because they are smarter or because they are from a more favoured socioeconomic and environmental background.

The differences that were found in adaptive behavior are important and consistent. They show that the undernourished children do not do as well on the tests. Because of this, it may be said, theoretically, that their intelligence quotient is lower. At the present time, it is not possible to interpret what this means, because there is no way of maintaining that the acting intelligence quotient is the same as the actual intelligence.

Something similar happens with the development quotient of socio-personal behavior: the two groups are different, a great deal at first and less so after two years of age (graph 37).

In this area, more than in the other, the malnourished children recuperate during the third year of life, at which age there are no longer any differences between the groups. Later, however, differences do appear again. It is difficult to interpret this fact, which is also found in other areas of human development.

Dr. Ramos Galván has called this phenomenon "homeorrhesis", referring particularly to physical development, even though the concept is also valid when applied to behavior. He refers to an adjustment among proportions that can also be here applied to functions which allows the child to achieve a balance in spite of undernourishment. This phenomenon is explained by the undoubted capacity for adaptation in the face of adverse environmental situation which all beings have. As a matter of fact, selection and competition between individuals and between species caused the disappearance, a long time ago, of genetic varieties that did not succeed in achieving a balance in the face of scarcity.



Graph 37. Socio-personal behavior in the undernourished children shows periods of adjustment and non-adjustment compared with the better nourished group, but it tends toward retardation, especially during the first two years of life.

All the mental test results show one fact: more adequately nourished children respond better to stimuli than those who are in a state of moderate malnutrition, and those differences are more or less consistent during the first five years of life. It is not possible to go further and say that the non-supplemented children are not as smart because it is not known just what the tests measure, whether it is intelligence, or other factors such as interest and attention; nor can anything be said with regard to the general importance of the differences. Besides, it is well-known that these differences tend to become reduced and stabilized.

The aspects in which there were greater differences are those that require rapid decisions or those that measure precision in the responses. It is necessary to mention that there are important differences in the attitudes of the children in each group. These will be analyzed in chapter 8.

The fact that there are periods of adjustment in carrying out the tests on the part of both the undernourished and the supplemented children suggests that certain aspects of personality and even of behavior cause the differences. On the other hand, the clear non-adjustment at certain ages suggests the posibility that there may be a direct or indirect effect of food scarcity upon brain function.

In any event, it is important to emphasize that, in spite of having found consistent, persistent, and significant differences, the undernourished children never reach the stage of overt abnormality on testing. Their averages are within the lower limit of normality without conforming to a

clinical picture similar to that of mental retardation.

The system of analysis applied to the Gesell tests is artificial because these tests were handled in a manner different from that for which they were designed. Gesell and the authors before him, especially Piaget, proposed the tests to determine whether a child was normal or not, and not to qualify a case and assign it points. This artificial situation has been created by those who have handled these tests in order to identify something that may be called minimal brain damage. The tests were not designed for this purpose, and there is little significance in speaking of lower limit of normality, which has little to do with the idea of minimal brain damage.

The undernourished children display delayed behavioral development, although the expected behavior never failed to eventually appear in these chronically undernourished children. This means that, different from the mentally retarded, these children always progressed and they still continue to do so.

It is a problem of late appearance of aptitudes, and we do not know to what extent it finally affects the rural dweller. What may happen is what we know happens in the case of physical growth; an undernourished child of nine has the size, the morphology, and the osseous age of a child of seven. It would only be a matter of waiting for him to grow eight years more to reach his full genetic potential, but it does not happen that way. Rather, if we take a given age and go 5 or 6 years beyond that, maturation (perhaps conditioned by genes or by homones) accelerates and the person stops growing rapidly, he fails to achieve his potential height and body morphology, and remains smaller and deformed. But it may also happen that he will recuperate from this "slowness" during puberty. In other words, it is possible that if, for example, an undernourished child reaches the chronological age of 14 with a mental age of 13, at the chronological age of 15 he may reach the maximum mental age of 14 and would be, therefore, completely mature.

The fact that mental tests have been administered to undernourished adolescents in schools in an underprivileged neighborhood and that these adolescents have not recovered an analytical ability does not prove anything because, as has already been mentioned, the tests used are not those indicated for this type of population.

It is advisable to continue studying these people until after puberty in order to clarify the problem. It is necessary to measure the degree of permanent alteration that poor nutrition leaves on total development and to point out its impact on what is most important to the human being: character, intelligence, and social behavior.

In conclusion, it may be said (based on the results of the neurological examinations and on the scanty yield of the Gesell tests) that it is most probable that several factors play a simultaneous part in the retardation found in the analytical ability of the non-supplemented children in our study.

There must be a certain deficiency in brain maturation. This appears to be shown well enough in the neurological examinations and, at early ages, also in the Gesell tests. Several personality characteristics of the undernourished child must also enter into the picture, in accord with the studies on behavior. It is obvious that, as an indirect consequence of

nutrition, several social factors also play a role, especially regarding the limitation of the relationship with the mother and with the environment. Finally, it is possible that, to a certain degree, there are some artifices in techniques, such as not being able to administer the tests "blind".

It cannot be said in what measure each one of these aspects plays a part: After analyzing all the information, and in light of the direct contact with the phenomena and the longitudinal observations of the entire problem, the authors believe that alterations in the development of the character of the child may be of utmost importance; nevertheless, definitely and according to the results. There are no reasons for denying the existence of a certain amount of brain damage. At this time, a detailed and specific study is being made of language and its relation to memory, where the greatest part of the problem seems to lie. Perhaps, by means of this information, it will be possible to define the role of social factors in behavior.

CHAPTER 8

Effects of insufficient food on child behavior

The most important effects of deficient nutrition for human beings are on over-all functioning and behavior, personality and character development on ability to resolve problems to participate in social activity, and, most important, the enjoyment of life.

The behavior of an individual is a complex phenomenon, for it consists not only of personality and intelligence but also of cultural factors, characteristic of the group to which the individual belongs.

In this project small children were studied, and the information gathered covers only the first two years of life. There is no doubt that at that stage there are already external factors that affect child behavior. This is important, since many features of what is described here may already be, to some extent, subject to sociocultural factors.

In spite of the fact that the authors have spent 15 years studying behavior of people in deprived environments, no attempt will be made to interpret it.

It was not the aim of this work to analyze behavior *per se*, but rather to compare behaviors of undernourished children with those who received a better diet.

Behavior was studied by objective methods based on the direct observation of mother-child units, with special attention on their relationship to each other and to their environment. For the most part, the methods were designed without conforming to any previous theories, in particular those of the Freudian type. In part we used techniques characteristic of social psychology, such as the time-sampling method, and often those based on the ethiology of primates.

Much has been said of the behavior of the poor and undernourished. There seems to be an idea prevalent in literature that this type of population, if less capable, is, at the same time, happier. This assertion has never been proven scientifically. Frequently, those in the more developed areas of the world who have this idea are merely projecting emotional attitudes, thereby, consciously or unconsciously, laying the foundation for prolonging injustice and marginalization if not downright colonial domination of the underdeveloped regions.

It is generally true that the inhabitants in poor rural environments behave differently. They seem to have difficulty in comprehending and in communication, and their reactions seem to be simpler and even child-

like. Their apparent slowness and passivity are also noticeable. They rarely display initiative and easily follow the leadership of others; they accept an almost total integration within their community, and before strangers they seem tolerant and non-aggressive, even humble and submissive. It is noteworthy that, by comparison with urban populations, they appear to have a low level of anxiety and tension. A more penetrating observation of these people, in their own environment, making an effort to understand them better, shows that many of these impressions are superficial and unrealistic.

Thus, for example, we find that, in their own homes, the men are intolerant and even aggressive toward their wives and children and there is evidence of significant emotional problems that frequently develop into neuroses.

Little is known about the factors involved in the behavior of rural populations. There are wide differences in cultural values, education, and environment. It is not known whether different behavior can be attributed to these factors, according to habits or cultural repressions, or to personality characteristics. It has not been shown whether the failure of these marginalized people to perform well on mental tests is due to lack of intelligence or to the tests' being unsuited to the environmental conditions under which these people live. Nor has it been possible to define basic character traits or degree of personal maturity.

The objective of this study was to evaluate the effect of nutritional factors on behavior, with special emphasis on the relationship of the child with its environment, as well as the role of environmental stimuli in child development. In the case of a small child, its environment is basically its mother. She is the one who takes care of the child and allows it to mature: food, stimuli, protection, and love. Therefore, in order to better understand the effect of undernourishment, we first tried to observe the mother-infant interaction and then the effect of this relationship upon character manifestations of the child.

Two methods were followed in studying the mother-child relationship and behavior: direct observation in the natural environment and in the very homes, for prolonged periods of three days every two months during the first year, every three months during the second year, and every six months after this age. Measurement of child behavior was made in an open field system designed especially for this purpose.

The observations made in the home were of a qualitative as well as quantitative type. The qualitative type allowed for the classification of the actions in the mother-child-environment system in accordance with closed scales of a progressive and simple type. Included were 37 characteristics related to the condition of the child and environmental position, to the actions of the mother toward the child and of the child toward the mother, and also the attitudes of the father, brothers and sisters and other adults. The qualification of all observations was made after one of the researchers (CM) had been in the home for 72 hours; she evaluated and qualified each of the characteristics.

The quantitative method demands more attention, and it cannot measure everything. It was done by means of a systematic time-sampling method covering 17 aspects of the mother-child relationship. The following is a brief description of the procedure followed.

After one day during which only lactation was studied (this served to have the mother become accustomed to the presence of the researcher in the home), periods of an hour-and-a-half in the morning and an hour-and-a-half in the afternoon were selected for making observations.

The researcher sat in a corner far from, but in from of the child, making believe that she was reading. Every 30 seconds she momentarily raised her eyes to get a sort of photographic image in order to define the family relationship. During the following 30 seconds, with her eyes down, she mentally analyzed the situation and made corresponding annotations. In this way, she made note of whether the mother had spoken to the child, smiled at it, lifted it up, fed it, or whatever other action may have taken place. It was considered that the number of times she noted an action was proportional to the time used for such action.

The same system could not be followed to analyze the actions of the child, or of the father, because they were very irregular during the day; furthermore, the time selected during mid-morning and mid-afternoon was not ideal. For example, in the morning the child might spend the whole hour-and-a-half resting or sleeping. In the afternoon the father was usually out of the house. Alternatively, the method followed consisted of diligently making observations during a period of 10 minutes every hour over a period of 12 hours. Thus, for example, observations were made from 8:30–8:40, 9:30–9:40, 10:30–10:40, etc.

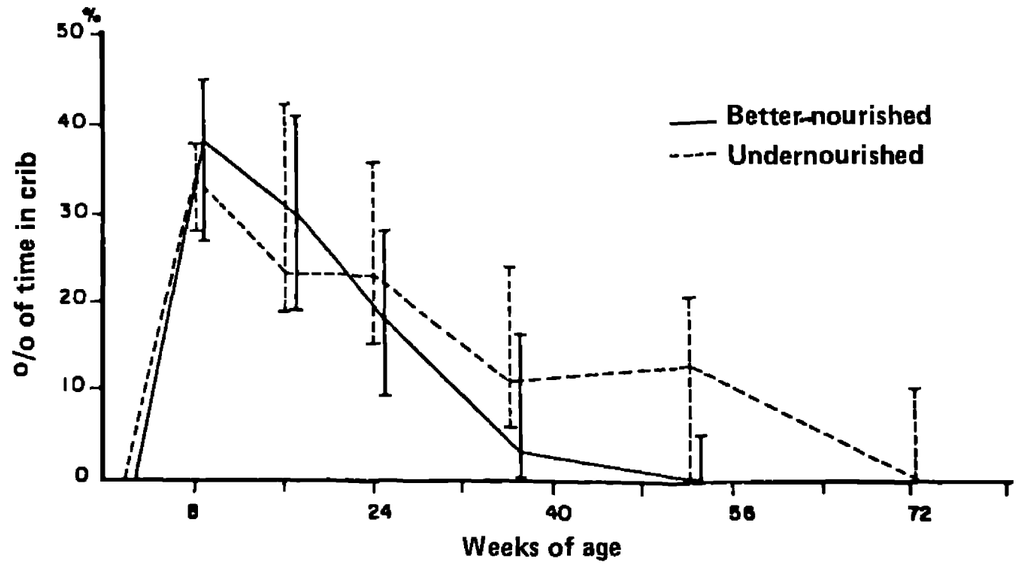
Another method of studying child behavior was to carry out open field tests, for which a sort of "boxing ring" was constructed. The dimensions were 3 meters by 3 meters. Cross lines were drawn every 30 cm, as on graph paper. A 90 cm fence was put up around the square, and the tops were symmetrical. The child was placed in the center of the field. Toys were placed at one end and the mother at another. The child's movements were noted on a sheet of paper containing the design of the floor, measured by the number and direction of crossing lines. This system was constructed to evaluate the activity of the child and its dependence on the mother and, to some extent, to obtain information regarding the child's aggressiveness.

The differences between the two groups were analyzed by using non-parametric statistics of the X^2 type; thus, when the text says that they were significant, the connotation is that these tests were positive.

ACTIVITY OF THE CHILD

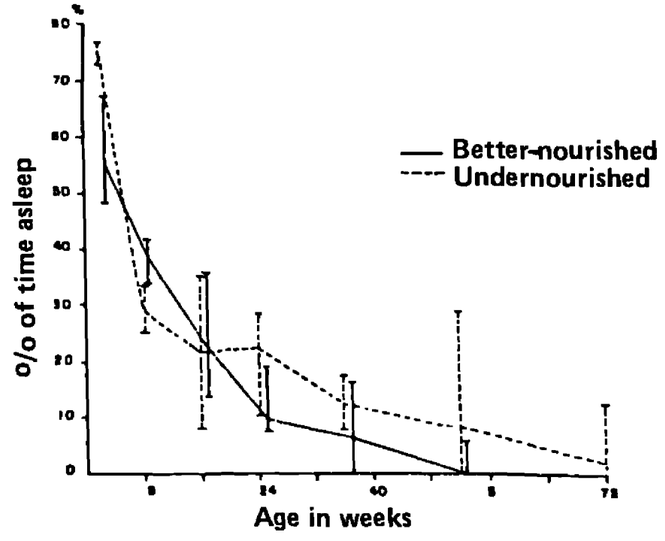
After the age of six months it was clear that the undernourished children were much less active. They slept more (approximately 25o/o more when they reached one year of age), and even when they were awake, they remained in their cribs longer (graph 38).

During the second semester the undernourished children stayed inside their homes for as much as 90o/o of the time; the homes are small and dark, offering the child little possibility to experience environmental stimuli. In constrast, after the 40th week, the supplemented children hardly slept at all during the day (during the sampling periods) and insisted on being taken outdoors. Beginning at this age, they no longer wanted to remain inside the house, whether in or out of the crib (graph 39).



Graph 38. After the 40th week the undernourished child stays in the crib more than 10o/o of the time observed.

These findings concern only the differences in physical activity noted between the two groups of children. The indicator used to measure physical activity was the number of foot contacts with the surface of support. The children fed in the usual manner in the community do not substantially increase their physical activity with age. The line of correlation between observations has little slope and is quite irregular ($Y = 0.44x + 16.3$; $r = 0.88$), while the supplemented group shows a substantial increase in activity; at 18 months of age they are six times more active than the non-supplemented group.



Graph 39. The undernourished child sleeps longer during the day, the differences from the better-fed being significant from the age of 6 months.

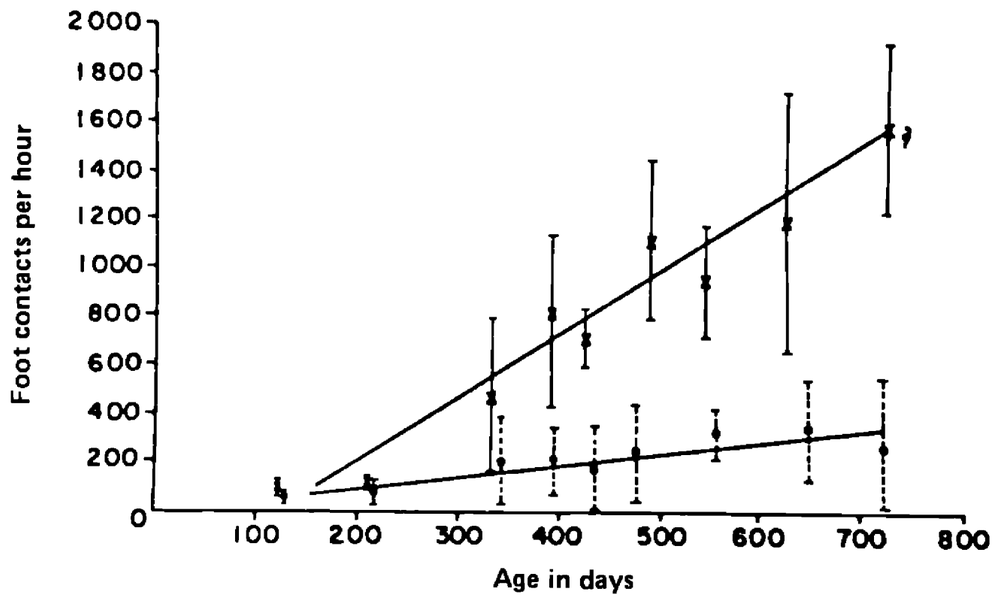
The differences between them are not very significant during the first year of life. However, at 13 months of age the physical activity of the supplemented group is almost four times greater (206.7 steps per hour against 787.5), which is significant to a level greater than 0.001.

We recognize that the indicator "number of foot contacts with the surface of support" is somewhat broad. Nevertheless, it is an objective measure that, applied equally to both groups under strictly standardized conditions, distinguished one group from another quite well. With this method it is important not to affect the behavior of the child in the home. To this end, we used an observer from the town itself, one known to the family, and we located him in a position not readily noticeable to the child (graph 40).

This finding of the effect of nourishment on physical activity is fundamental in explaining many differences that are found between both groups of children, since it undoubtedly affects, in a secondary manner, several other behavior traits in undernourished children.

The relation between physical activity and nourishment is possibly determined by energy intake, since calories are the most deficient part in the diet of children in the community and, perhaps, in the diet in most underdeveloped areas. The child who does not eat enough adapts by reducing activity and sleeping more.

The reduction in physical activity does not explain the ease with which the undernourished children accept remaining within the confines of the house, which is dark and hot, while the supplemented children, at a very early age, insist, by means of movements and crying, on being taken outside. It was thought that the explanation might lie in a difference in body temperature. Therefore, temperature was measured and it was found that (as will be mentioned later), in repose as well as during activity,



Graph 40. The non-supplemented are much less active since they make less foot contacts with the surface of support. At one year of age, the differences between the two groups is already very significant.

the undernourished children had a temperature of almost one half degree less than that of the supplemented children.

Also, the non-supplemented children and the better-nourished control group play differently. The same phenomenon is found in the method of taking samplings in time, as well as in the method of observation and graduation (graph 41).

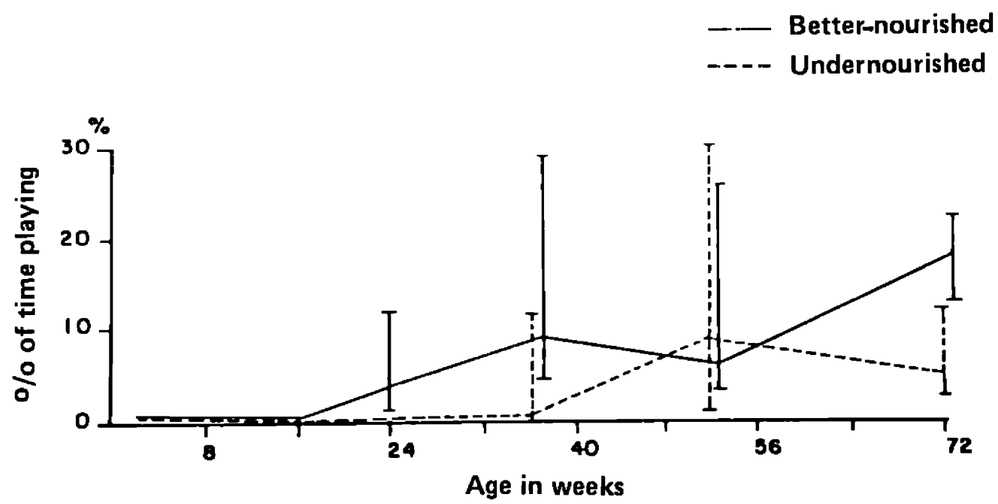
The undernourished children begin to play at an older age, and they devote less time to playing, except at the age of about 36 weeks. This is perhaps because several types of activity were thought of as playing; while the supplemented children discontinued one stage of playing, the non-supplemented children were barely beginning it.

CLOSENESS OF THE MOTHER

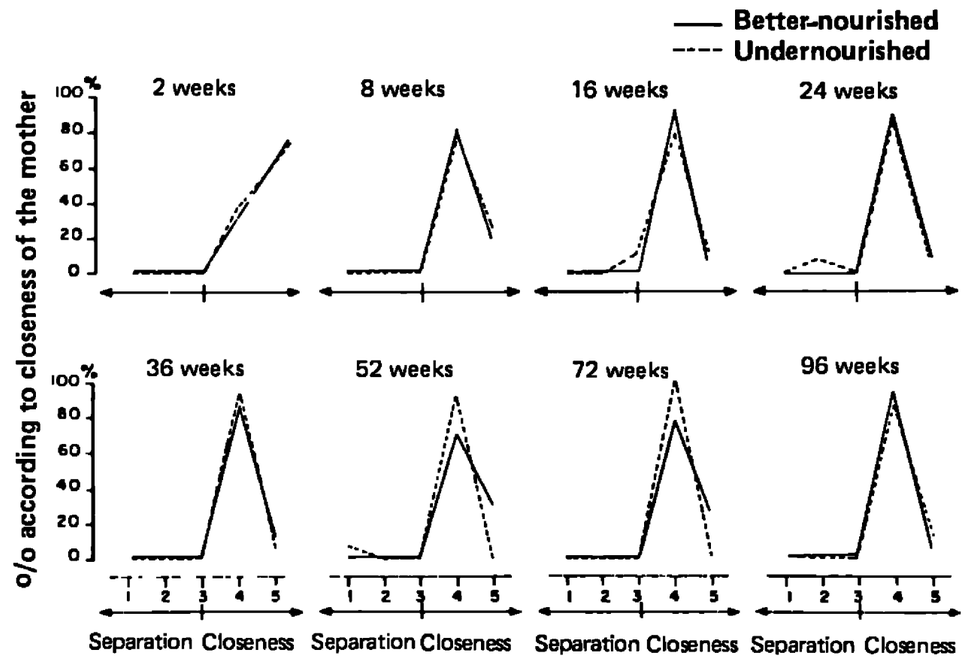
When the distance from the mother to the child is measured in a general way, almost no difference is found between the two groups during the first year of life. In both groups, the mother is near the child at least 35o/o of the time during the day (graph 42).

It is customary in the community for the mother to provide everything for the child. The father does practically nothing. The siblings take part in child care, especially the females, but only at a later date. In graph 43 we see that the mother begins to receive help beginning with the 24th week, however, the amount of help is significant only after the 96th week, when the child is almost 2 years old. In the case of the supplemented children, there is greater participation in the care of the children by the rest of the family. As will be seen later, these children become more independent, they depend less on the mother, and they show preference toward the siblings (graph 43).

The time curve showing the child in the arms of the mother very much resembles that of the time curve for lactation. This means that the mother holds the child in front of her basically to give it the breast, whether it be to provide the child with milk or for the child to play with the breast. This situation explains the differences between the two groups



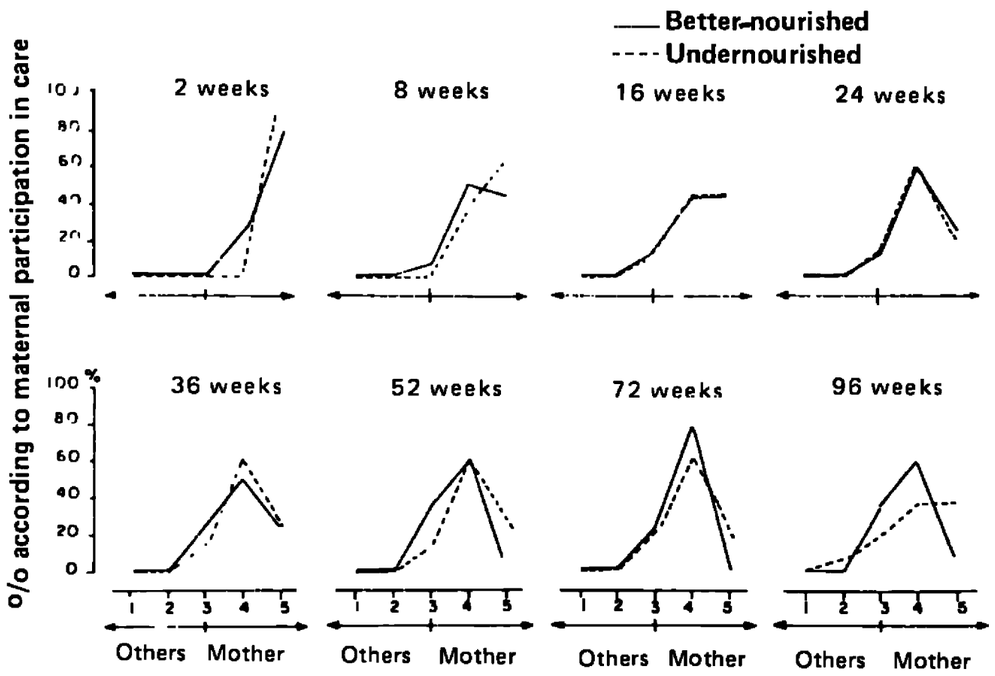
Graph 41. The non-supplemented children begin playing almost six months later. There is also a delay in the appearance of a more elaborate form of playing.



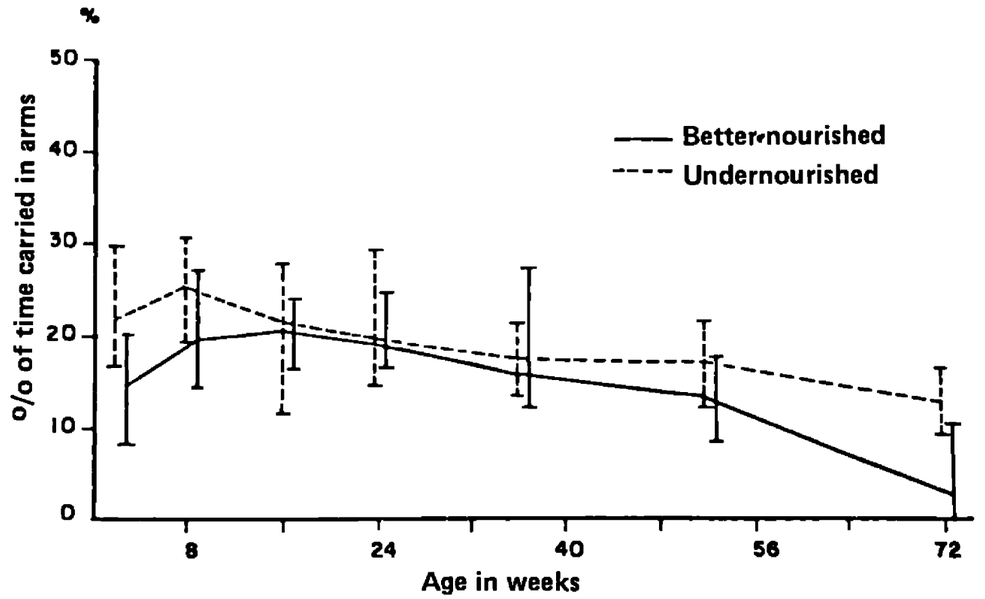
Graph 42. In both the supplemented and the non-supplemented units there is a great deal of closeness between mother and child.

during the second year, when the breast is given only to the undernourished children (graph 44).

The pattern of the mother carrying the child wrapped in a shawl on her back is quite different between the two groups. During the second



Graph 43. It is not customary for mothers to receive aid in caring for the children at early ages. The situation is the same in both groups.

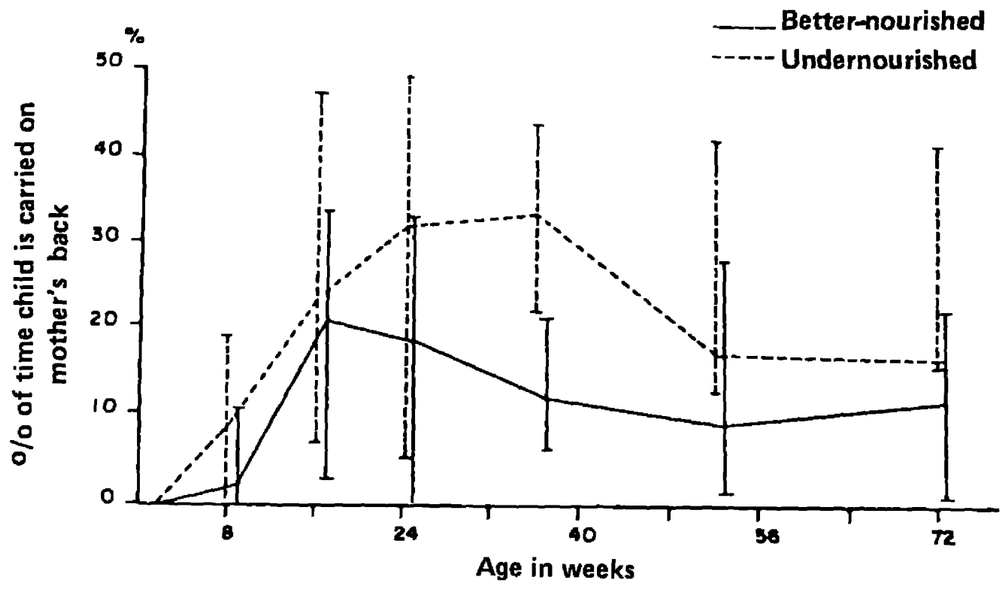


Graph 44. The undernourished children are carried in the mother's arms longer during the first three months as well as after one year.

semester, the non-supplemented child spends 30o/o of its time in that position, frequently asleep, whether the mother is walking or working. On the other hand, the supplemented child, after the 16th week, does not accept being carried on the mother's back; he often kicks and moves around so that the mother is obliged to put him down on a small straw mat. As previously discussed it is possible that this difference is related to the changes in physical activity and temperature as well as the tendency toward independence. The difference in the weight of the respective children also enters the picture; the supplemented children weigh more, especially in relation to the weight of the mothers (an average of 44 Kg). It is thus more difficult for the mothers to carry the children, especially when the mothers do housework or work in the fields (graph 45).

ACTIONS OF THE MOTHER TOWARD THE CHILD

In general, the mothers in the community are quite passive in their relationship toward the child. Practically speaking, they lack the initiative to change the cultural patterns of attention or care. Graph 46 shows that with the method of taking time samplings there are virtually no observations of certain types of activities on the part of the mother toward the child: neither possitive ones, such as talking to it, smiling at it, playing with it, or caressing it, or negative reactions such as scolding it, striking it, or showing some signs of annoyance. The behavior pattern is the same in the mothers of both non-supplemented and supplemented children. Possibly this method of taking time samples is inadequate for registering momentary activities. It must be remembered that the samples were taken one second out of each thirty seconds; therefore, it is easier to note a longer action, even though it may be sporadic, than a rapid action

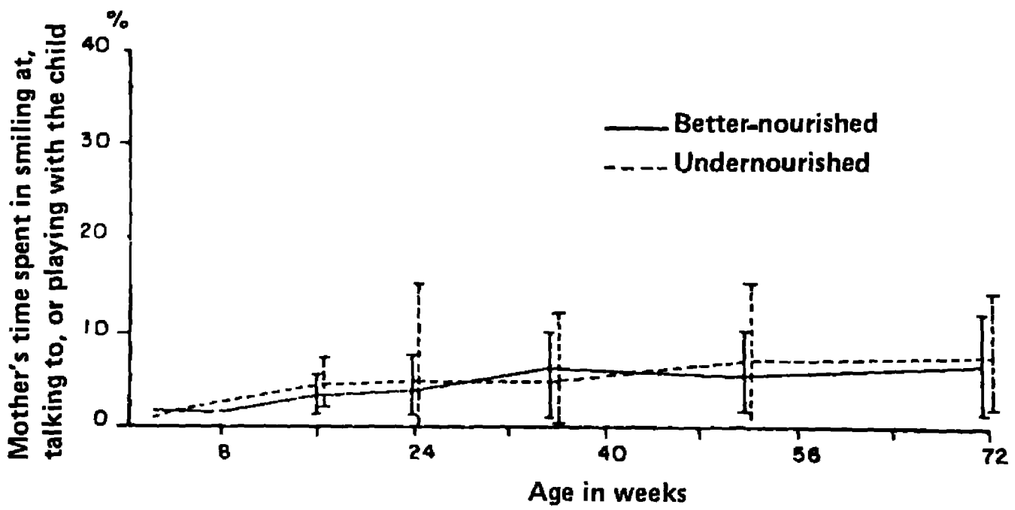


Graph 45. During the second semester of life, the undernourished child is carried on the mother's back for a longer time. The differences are very noticeable at 8 months of age.

thay may be more frecuent.

This does not mean that the mother shows no devotion for the child. Rather, it is simply that, in accordance with community habits, the mothers are not accustomed to displaying attitudes of love or stimulation toward small children.

The women in this community are very much subject to the will of the husband and of the mother-in-law, both of whom in general, have a



Graph 46. It is not customary in the community for the mother to stimulate the child with caresses, smiles, or words. This is true for the supplemented as well as for the non-supplemented.

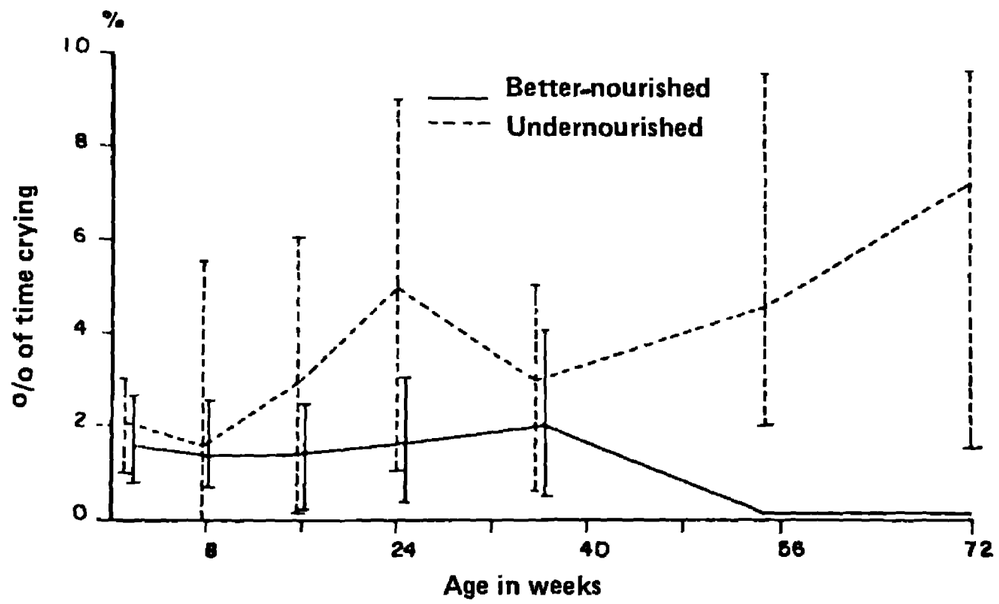
restrictive attitude toward maternal initiative in type and amount of food offered or kind of child care and stimulation. The means by which the mother is restricted is to attribute the cause of any illness whatsoever to such innovations she may apply. For example, if the child develops diarrhea, the mother-in-law criticized the child's mother severely for any change from usual custom she may have introduced.

ATTITUDES OF THE CHILD

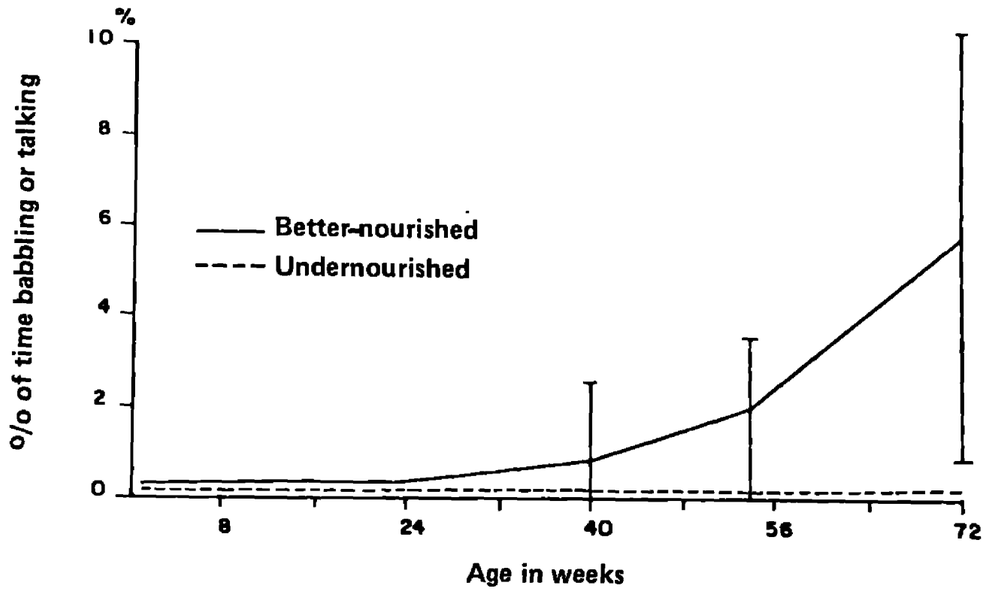
At the outset, the child communicates with the mother by crying and then, progressively, by the use of other types of signs and sounds. In graph 47 we see that in this area there are differences between the groups: the undernourished children cry more.

It is noteworthy that the crying time of the undernourished children increases greatly between the 8th and 24th weeks. This coincides with the progressive lack of milk shown in the studies on lactation. Subsequently, the child calms down a bit, but only transitorily. This decrease may be due, in part, to the introduction of other foods that although not much in quantity, do manage to placate the child, and also in part to the fact that it is during this period that malnutrition sets in and the child loses its appetite.

The resumption of crying during the second year is probably the result of personality upsets, to which reference will be made later. The suplemented children stop crying at eight months, and they progressively communicate with the mother by means of other sounds. This very marked difference could be shown with the time sampling method. This reflects not only a different type of relationship with the mother, but also a difference in character traits between the two groups (graph 48).

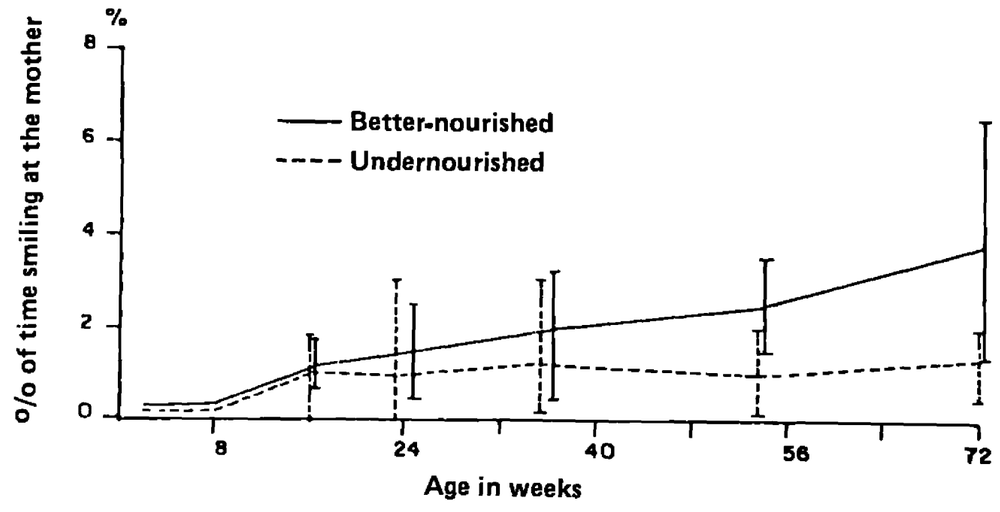


Graph 47. The non-supplemented children cry more after the 8th week and especially after the 36th week.



Graph 48. The undernourished children practically do not babble or talk while the supplemented children do so increasingly from the 40th week on.

A very low level was found in other areas of communication, perhaps because with the use of this method it is not easy to detect momentary actions such as smiles, caresses, etc., because this type of communication is not frequent in this culture. Graph 49 shows some differences that were observed regarding smiling. They are not significant until the second year.



Graph 49. The undernourished children do not increase the time spent smiling at the mother while the supplemented children do.

CARE SHOWN BY THE MOTHER

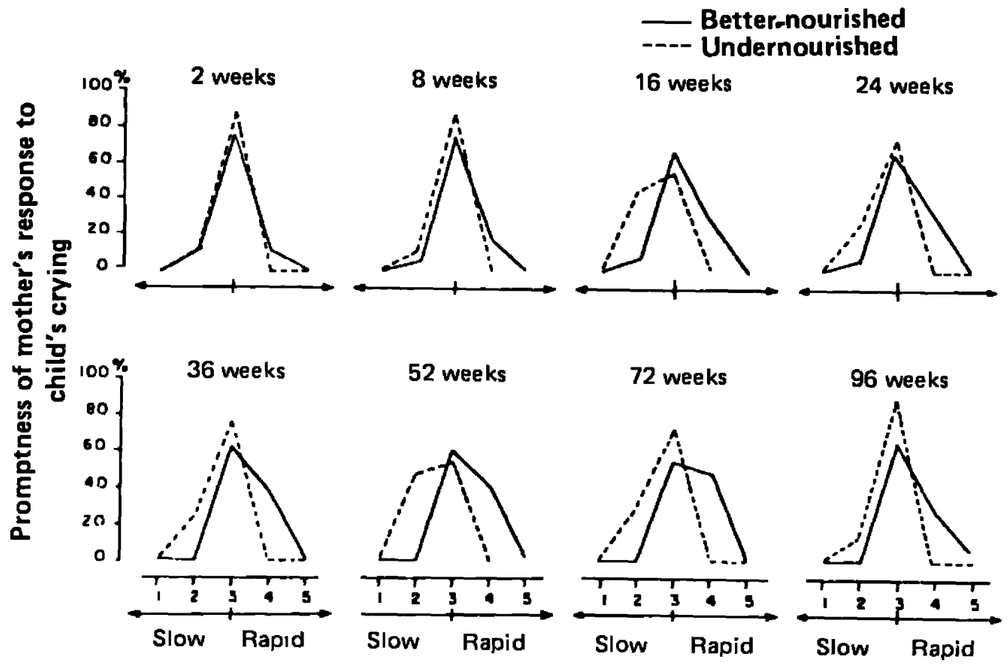
The women in the town do not make much effort to protect their children, nor do they spend much time cleaning and changing them. Each time the child cries they go to it more or less promptly, but their responsive attitudes are simple (graph 50).

Generally, the mothers give the children the breast to calm them whenever they cry. When the child rejects the breast, they also respond in a simple manner, they rock the child or take it in their arms to put it to sleep. It is rare for the mothers to try to find out whether anything is bothering the child, such as an insect bite, a pain, or some other thing.

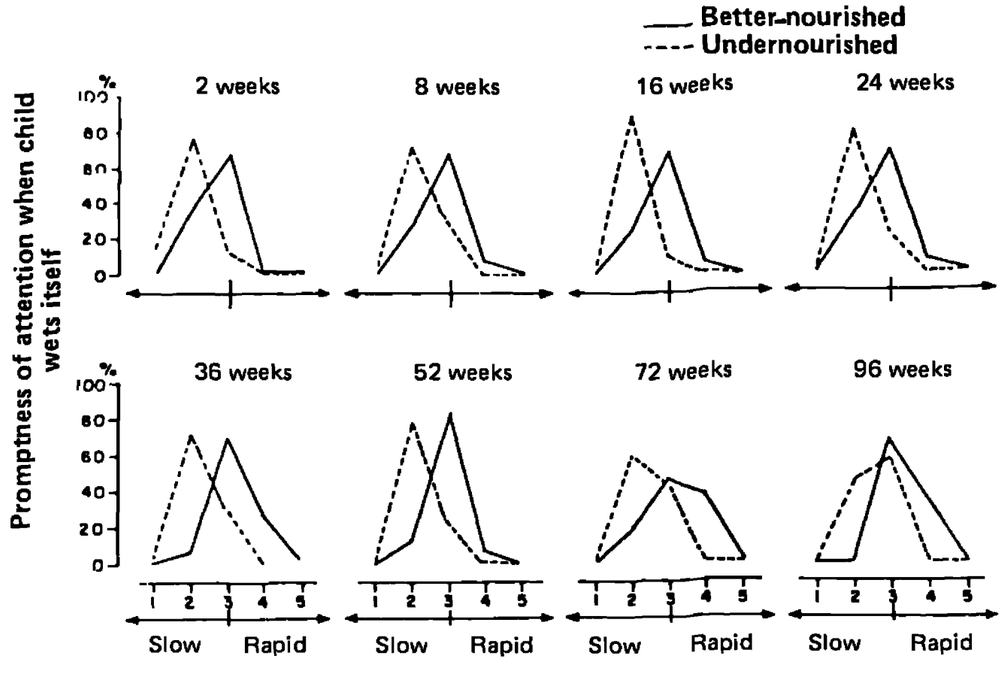
The promptness with which the mother attends the child is different in each group. It may be that the supplemented children cry louder, and demand more, or that the supplemented mothers are more active and have a greater capacity for response.

The response to the child who wets itself is greater in the mothers of the supplemented children; since these children have a greater intake of milk and food, it is possible that they urinate and defecate more often (graph 51).

The differences in habits of cleanliness were very clear. Beginning at a very early age, the better-nourished children required that they be cleaned; they gave the impression that they felt bothered with dirtiness and that they liked water and enjoyed being bathed. Just the opposite was true with the non-supplemented children, some of whom displayed an absolute horror of water. This may bear a relationship to their lower body temperature; it is possible that they feel water to be too cold and

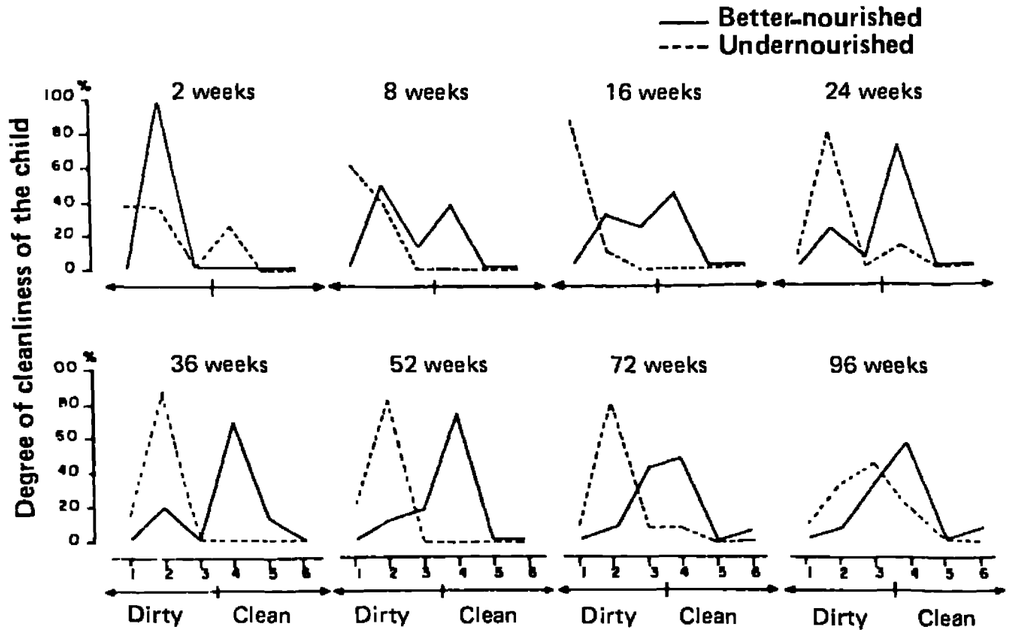


Graph 50. There are some differences in the promptness with which the mother responds to the child's crying. The mothers in the supplemented units do so with greater promptness after the child reaches the age of 8 months.



Graph 51. The mothers of the supplemented children also act more rapidly when the child wets itself.

that it lowers their body temperature even more. Water helps cool the supplemented children, whose body temperature and amount of perspiration are greater (graph 52).

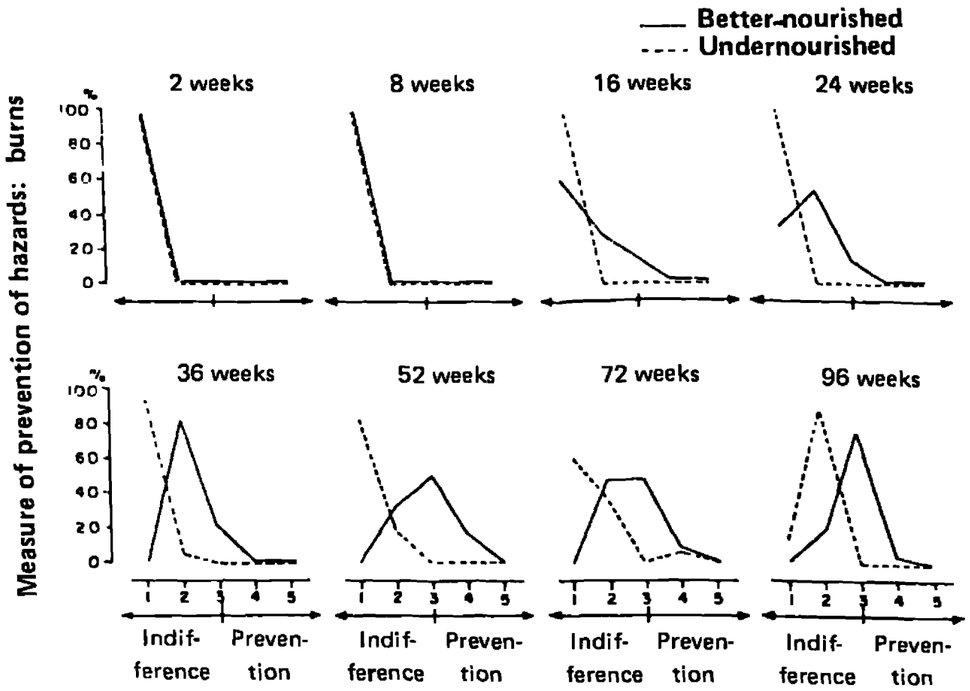


Graph 52. Habits of cleanliness were very different from a very early age. The supplemented children were cleaned, bathed, and fixed up much more.

In the area of care on the part of the mother, two factors stand out: 1) many actions on the part of the mother are initiated by the child; the demand for care is as important as the offer, or more, and 2) the child makes demands in accordance with his physiological conditions, his energy, his activity, his temperature, his health, and his personality characteristics. This means that poor nutrition depresses many of the child's physiological functions, thus lowering his demand level; consequently, the care given by the mother is of a lesser degree and simpler.

This is also seen in the precautions against danger. It is not customary in the community to take any measures against the child's falling from the crib or being burned by fire (which is at floor level). This is possibly related to the fact that the undernourished child (the usual child in his community) is not active and spends most of its time in the crib or close to the mother and is therefore not in any great risk of accident. In effect the small hut is quite ample for the child. However, the situation is different with the better-nourished child since he is more active and more curious; he moves around in his crib, he crawls and tends to move away from the mother. Therefore, the mother must watch this child constantly, and she must even take certain measures to avoid accidents (graph 53).

It is seen that in the homes of the supplemented children some measures are taken beginning with the 16th week and that by the 36th week definite precautions are applied. The risks to which the children are exposed are high, since a normal house in this community is hazardous to



Graph 53. The mothers of the better nourished children begin to take preventive measures against burns in the home from the time the child is 6 months of age.

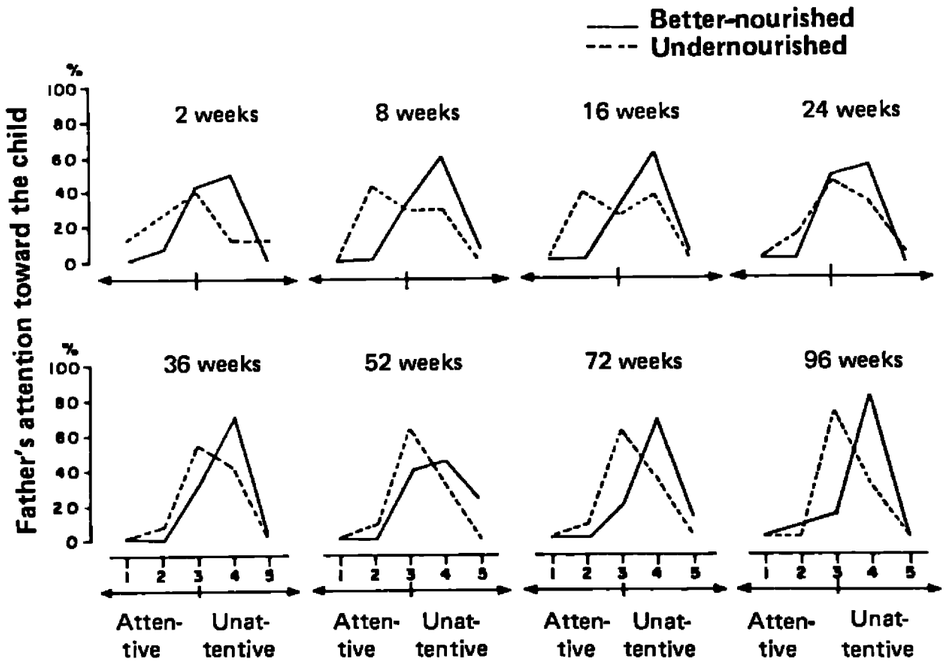
an active child to the extent that during the study there were three serious accidents. One child went out to the patio and was stepped on by horses, another fell from the crib. The third was jumping on the cover of the well, the cover broke, and the child fell into the well and drowned.

PARTICIPATION ON THE PART OF THE FATHER

In the community's culture, the fathers take little part in giving care and attention to the child —these are exclusively feminine obligations. It is considered that a man loses his manliness if he carries or feeds a child. It was noticed that from a very early age in the life of almost all the better nourished children, the father felt somewhat concerned and displayed attitudes toward the child that, up to that moment, had not previously been displayed. Graph 54 shows the difference between the groups; the difference is not always significant, and it varies according to the ages. The distribution curve of the fathers of the supplemented children is similar to the curve of fathers who showed greater participation.

Graph 55 shows the number of activities in which the father helps. The fathers of the non-supplemented children occasionally participate in one or two activities, and at that, the simplest. At the lowest level, we tried to determine whether the father sometimes looked at or touched the child, and next, if he sometimes rocked the crib or picked the child up in order to help the mother a little. In the case of the supplemented child, the father quickly reached our third level of study, which included playing with the child and giving it instructions.

The custom in the community of the father's not participating in



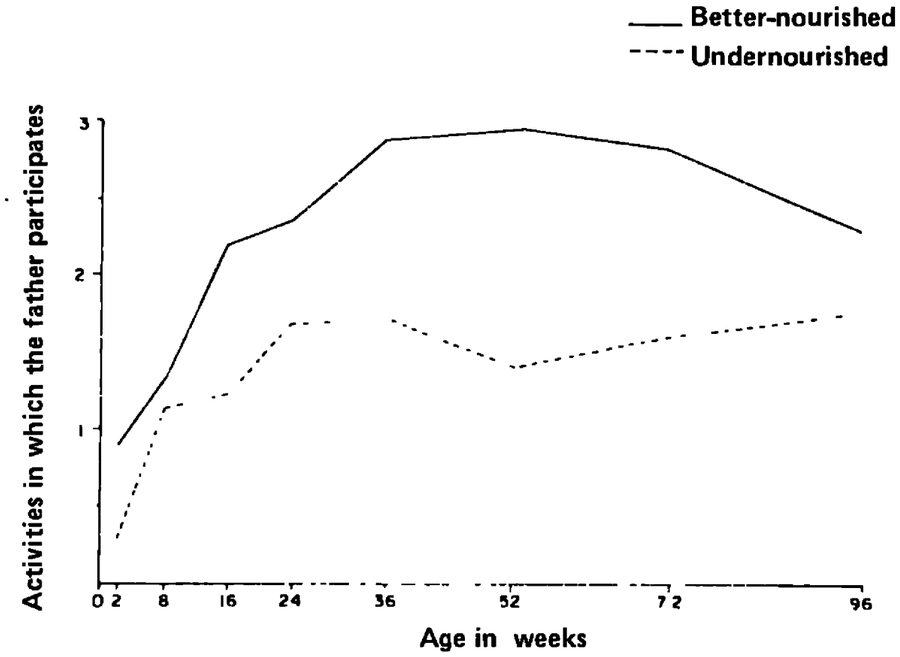
Graph 54. The father pays little attention to the child. In the case of the supplemented child, the father pays a little more attention to the child especially at a later period.

children-care during the first year of life reaches such a degree that only two of the fathers of non-supplemented children were observed playing with th child at some time during the 72 hour study period. The fathers of the supplemented children were observed playing with the child at least ten times, beginning at a very early age.

It was observed that some fathers of supplemented children carried the child in their arms and walked along the streets of the town so that neighbors and friends could look at it; in other words, the father was boasting about the child. What is more, some of these fathers frequently went beyond the levels of our study to participate in bathing the child and changing its diapers and clothing. It was never thought that this would happen in this town so it was not included among our classification on the questionnaire.

It is believed that these attitudes on the part of the father were also possibly responses to the child's attitude. The supplemented child is heavier, more active, more demanding, tires the mother more, and makes it difficult for her to carry on her chores; this, perhaps, impels the father to help sometimes. For this reason, too, the child is more aggressive, more open, and more independent; it seeks out other persons and initiates a certain positive relationship with the father. The latter factor not only calls for responses on the part of the father, but also a general change in attitude and an emotional reaction of love that, with time, becomes stronger.

In the case of the undernourished child, especially a boy, the opposite frequently occurs. It is not rare that, beginning with the 52nd week, there is the beginning of a certain negative relationship with the father. This may be the result of timidness in the child and its extreme dependence



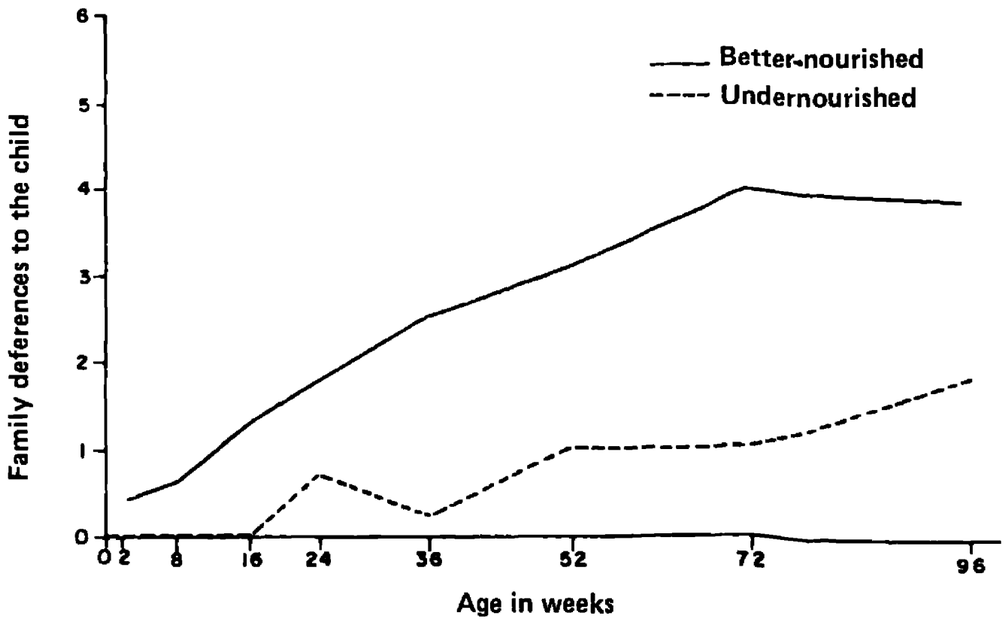
Graph 55. The father of the undernourished child participates very little in the care of the child. The father of the supplemented child, when the child is one year of age, participates in the three activities studied.

upon the mother; this clashes with the desire of the father who wants the child to cry less and be more independent. Thus, the father unleashes aggression while the child displays a timorous attitude that is even more noticeable at an older age, when the father is clearly trying to separate the child from the mother so that the child can become braver, or more "macho". The result is an aggravated relationship between father and son.

MANIFESTATIONS OF AFFECTION ON THE PART OF THE FAMILY

In the community it is not customary for parents to display affection toward children. The parents are not accustomed to kissing them, praising them, or saying that they love them. No special effort is mate to provide them with attention, toys, or rewards. It was observed that, beginning in the 16th week, the parents of supplemented children began to show them some attention. Graph 56 shows the little amount of attention that the family pays to the child.

This area, more than any other, shows the low level of relationship between mother and child, which is characteristic of this community's culture. There is a lack of initiative on the part of the mothers as well as in the role played by the child in improving this relationship. It is probable that the supplemented child, because it is more active, more restless, and more demanding, draws the attention of the family to a greater extent. The result is a greater preoccupation for everything concerning



Graph 56. The family displays a lesser number of deferences to the undernourished child. The differences are large from the beginning.

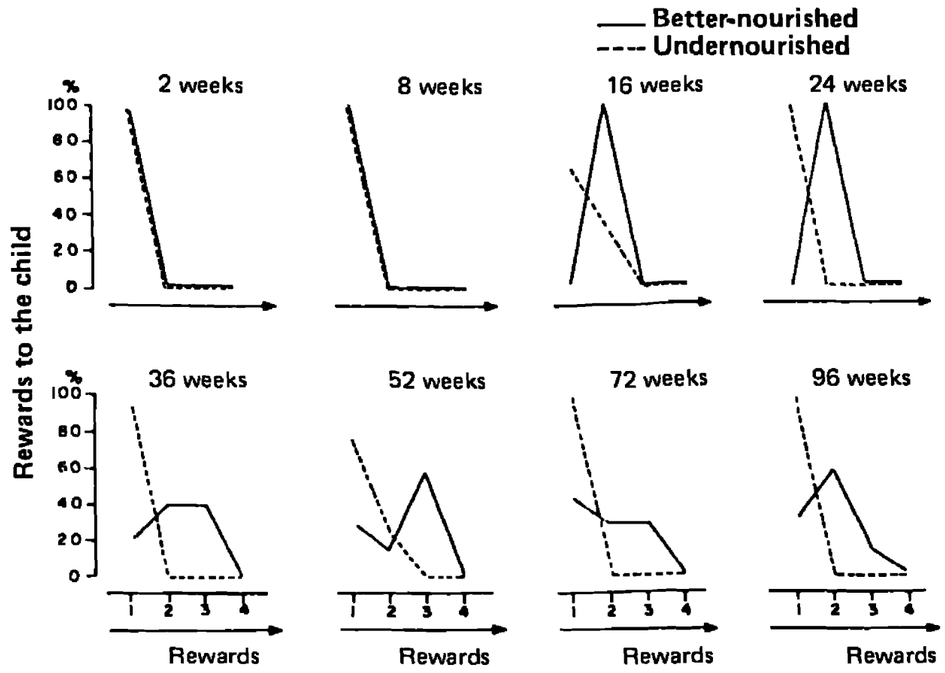
the child, and the necessity of setting up systems of rewards and punishments (graph 57).

The people in the community are not accustomed to give the children presents or rewards, as is seen in the curves in graph 57 for the non-supplemented children. This group practically never rises above the first level, with the exception of two children who received presents at the age of 52 weeks. Beginning with the 16th week, the supplemented children were more coddled; at that age they were always given toys, clothing, and rewards for good behavior. This was an unexpected effect of supplementation.

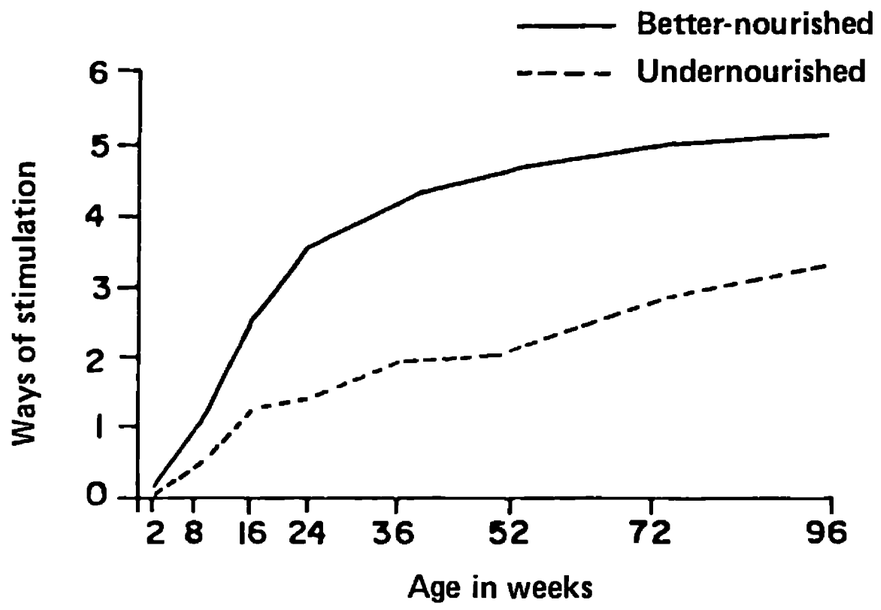
FAMILY STIMULI

Graphs 58 and 59 show the differences that exist, beginning at age one year, in the ways that the family stimulates the child. It is very simple with the undernourished: moving the child in its crib, carrying it in the arms, giving it the breast, the mother carrying it on her back. It is not until the second year of life that some other forms of family stimulation are instituted, such as direct instructions, upbringing, playing, and discipline.

In some ways and even before beginning to receive supplementary feeding, the better-nourished children, at an early age, had greater stimulation, a situation that at about the age of 36 weeks, became complex, the families included some activities that were of an educative and instructional type, related to behavior.



Graph. 57. It is not customary in the community to give rewards to the children. The supplemented children, however, do begin to receive rewards at the 16th week of age.



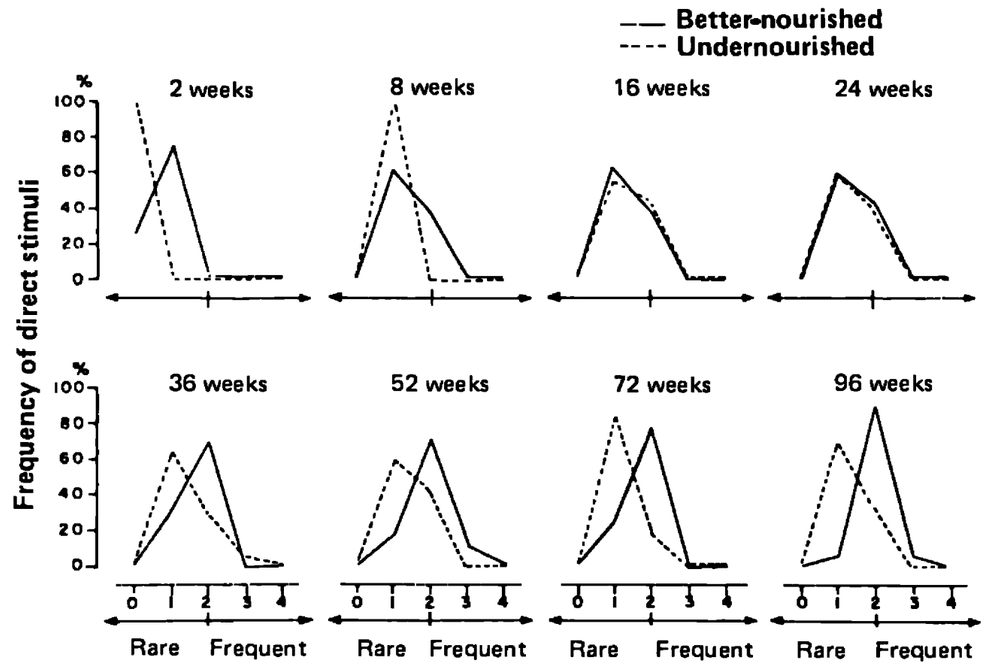
Graph 58. A lesser variety of direct stimuli are offered to the non-supplemented children.

In this respect as in others, it is noted that there are some differences present even before the child is started on direct supplementary feeding. There is no clear explanation for this. It may be that a mother supplemented during pregnancy and continuing to be supplemented after the birth of the child enjoys better health, is less apathetic, and takes some initiative to which the community is not accustomed. However, this phenomenon seems to be relatively limited. It may also be that the infants' better nutritional state began during gestation.

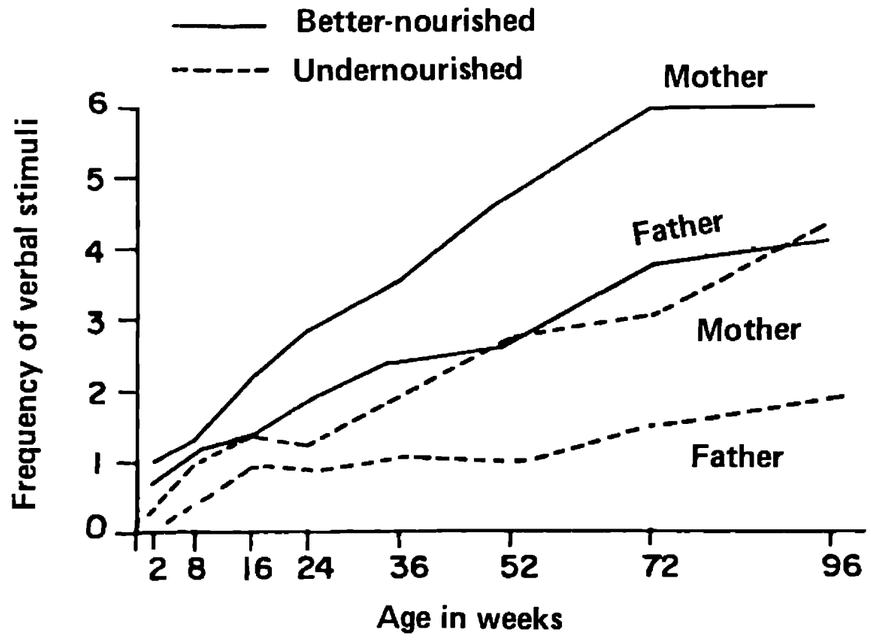
The most important stimuli for the human being are the verbal ones that provide the basis for communication, understanding, and thinking. Graph 60 shows that the parents are sparing in their use of language with their children. Its functional explanation may be that it is not considered important to expose the child to speech in order to achieve an adequate relationship as well as to accelerate the process of learning.

The method of time sampling shows that the number of phrases spoken by the parents to the children is practically zero during the first semester, and from that period on the increase is very slow. In the case of the supplemented children, the increase is more constant; at one-half year it is already different from the community norm; it later reaches a significantly greater level than that achieved by the non-supplemented group.

It is not common in the community to give instructions directly to the child regarding his behavior, especially when the child is small. Undernourished children are very passive, and perhaps this results in the parents rarely attempting some educative procedures. Graph 61 shows that the non-supplemented children receive practically no instructions from



Graph 59. According to this method of observation, both groups are show to be different only after 8 months of age. The undernourished children are rarely stimulated.



Graph 60. The parents of the undernourished children speak to them less from an early age on.

parents, since the scanty modifications that the curves follow after one year are not significant.

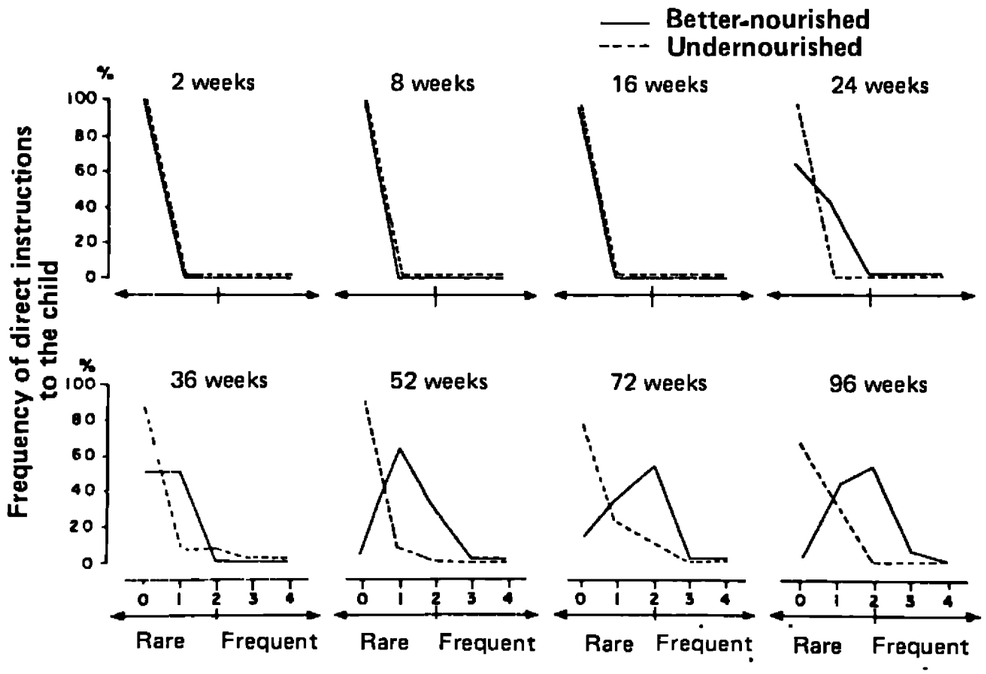
It cannot be claimed that instructions to the supplemented children were common, but they were indeed given to them to a greater extent beginning with the 36th week. This is perhaps directly related to the greater activity of the child who, possibly, induced the parents to attempt some type of instruction for the purpose of establishing norms of behavior.

ENVIRONMENTAL STIMULI

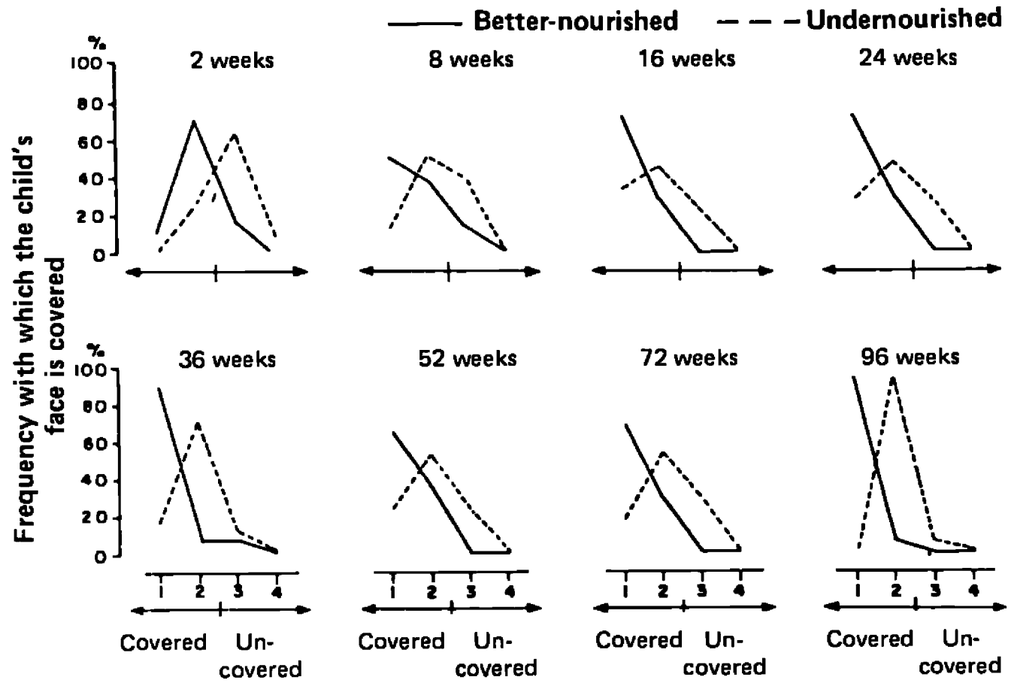
The environment of the child in this community is not very stimulating, the houses are small and dark and have no windows, and few objects are there for the child to look at. Since the custom is for the mother to carry the child on her back in an uncomfortable position with its face almost covered, it is unusual for the child to see anything (graph 62).

The undernourished child accepts being heavily clothed and having its face covered not only when it is asleep but during the daytime when it is awake; this is the usual custom in this country as well as in other underdeveloped countries. The supplemented child does not tolerate these things, and at a very early stage it constantly tries to uncover itself. This may be related to other similar findings to which we well now refer.

During the first semester, the non-supplemented children tend to remain in the crib most of the time. Even during the second year they remain quiet and restricted in their environment. The better-nourished



Graph 61. It is rare in the community for the mother to give any instruction to the child; the supplemented children begin to receive some instruction at the age of 8 months.



Graph 62. It is customary to cover the child's face even at a late age; this is always done to a lesser extent with the supplemented children.

child is significantly different: he soon tends to play with the animals and with his brothers and sisters, and he is much more interested in his surroundings. He plays with objects, is curious, more willful, and he takes more initiative.

Graph 63 shows that at an early age, at a maximum of 8 months, the supplemented child is outdoors more of the time. The difference is very noticeable at that age. The malnourished children are indoors 90o/o of the time, while the supplemented children are indoors only 50o/o of the time.

The difference is due to the fact that they feel too warm. In addition, they try to remove their clothing and enjoy baths (the opposite of what happens with the undernourished children). All this resulted in our research group taking the children's temperature and, in some cases, measuring their perspiration by using a plastic sleeeve around the arm.

As already mentioned, the undernourished children have a lower basal temperature that is accentuated during activity, when the difference can be as much as half a degree. Also, perspiration is 30 or 40o/o lower during repose.

This finding is another piece of information on the close relation between some biological characteristics and different behavior traits. The better-nourished children have a higher metabolic rate that, together with greater physical activity, results in a higher body temperature; as a consequence, perspiration is more abundant. Thus, these children feel uncomfortable indoors, they uncover themselves, and ask to be moistened, cleaned, and bathed. The undernourished children, because of their

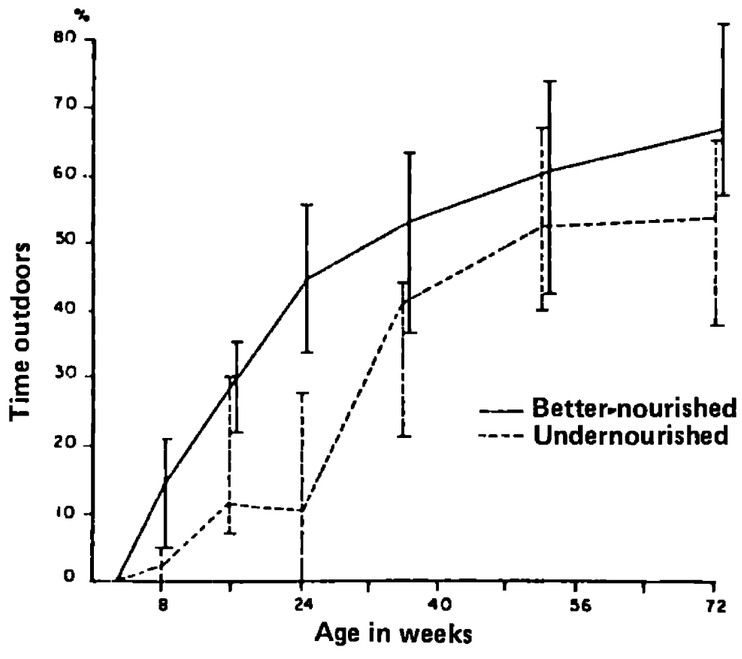
opposite characteristics, feel better well-clothed, in their cribs, and indoors.

The method of scalograms showed that, beginning in the 36th week, there was a great difference in how much the children moved about. There is also reference to the desire of the better-nourished child to be moved from place to place, certainly because it becomes bored being in a single place. The undernourished child wants to follow the mother, while the better-nourished child, on the contrary, always asks to be moved or forces the mother, or whoever is taking care of him, to follow him (graph 64).

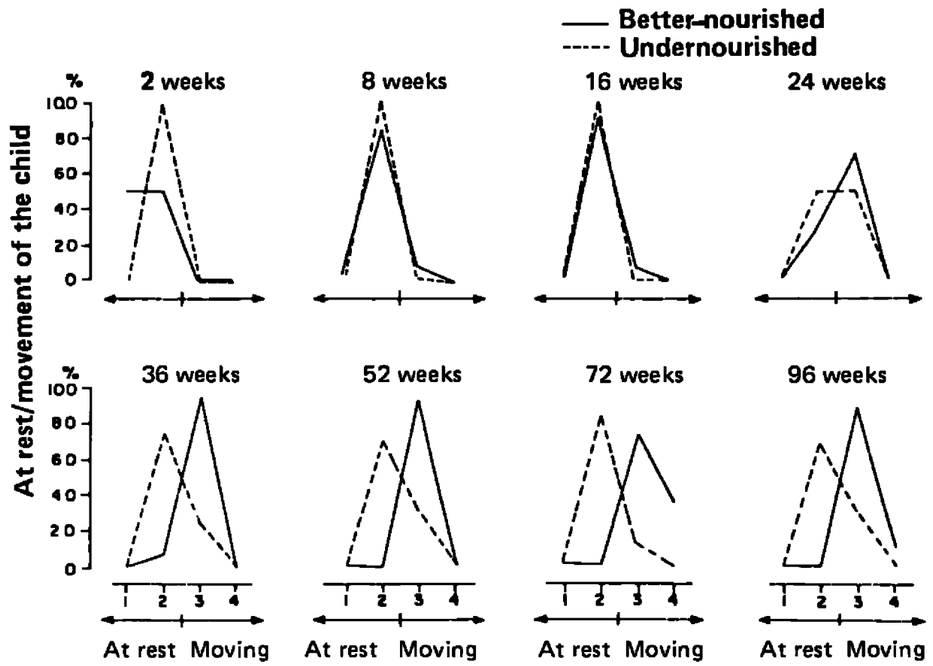
CHARACTER OF THE CHILD

There is no doubt that many of the behavior characteristics of the undernourished child can be attributed to scant physical activity. Nevertheless, it is clear that not everything relates to this factor. The undernourished child is overtly withdrawn and timid,to the extent that in many cases he comes to fear all people except the mother. At the same time, he is very passive and lacking in imagination, so it is difficult for him to make choices. In general, his principal reaction is a form of mindless crying, thereby putting pressure on the mother to interpret his desires.

It is commonly thought that this type of behavior might be due, in part, to the fact that children in a rural environment are strongly repressed by the father. This study proved just the opposite. It was rare in the community to find mistreatment of children under two years of age, or repressive measures taken against such children. As a matter of fact, children of this age are not even given directions. The parents adopt a



Graph 63. The undernourished child stays indoors more time, especially at about age 6 months

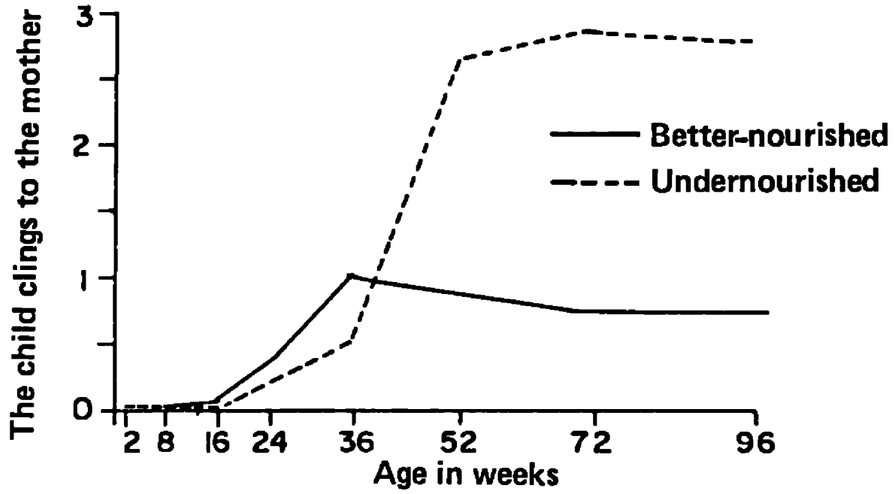


Graph 64. The undernourished children are at rest for a longer time, especially after the 8th month, when the supplemented children do not accept being in a single place.

tolerant, complacent attitude, but at the same time they do not grant the child any special attention and, even less, privileges.

Most of the changes in the behavior in the undernourished child can be categorized in three ways: apathy, insecurity, and limited expression of emotion. Apathy is manifested in negative attitudes and in the incapacity to make or follow initiatives, thus leading to a high degree of passivity. Many communities interpret this by saying that the child is sad; there are communities that sum up the symptom characteristics of undernourishment by using the word "sadness" either in Spanish or in the local language, if one exists. It would seem that this type of child does not want to use up any energy; this is evidenced by the fact that he sleeps a great deal, he remains quiet in his crib most of the time, he does not like to walk, and he does not like to go outdoors. This apathy is possibly related to inadequate diet and is a direct adaptation to lack of foods.

The undernourished child is very insecure, which explains his timidity fear, and dependence on the mother. This is shown by classifying some of the child's actions under the heading of "clinging to the mother", as shown in graph 65. The malnourished child between the ages of 16 and 36 months does not want to be separated from the mother: he holds on tightly to the mother's breast, hand, or skirt. The supplemented child stays at the level of maternal dependence classified as grade 1. The non-supplemented child stays at grade 3, which is characterized as almost complete clinging, sometimes accompanied by a strong manifestation of anxiety and even of desperation.



Graph 65. The undernourished children, as soon as they can, cling to the mother more strongly and for a longer period of time.

This symptom is more difficult to explain. However, it is possibly because the insecurity is related to a feeling of weakness a child may feel when it is not well-nourished. If the child feels weak and perhaps unprotected as well, it is logical for him to seek out the mother.

This behavior complex, especially holding on tightly to the mother, is what leads to calling the child "chípil" in Mexico, particularly among the groups in the high plains area. In the Náhuatl language, this word means "jealous". This word is used because it is believed that, in some way, the child becomes aware of the fact that the mother is pregnant; the child therefore anticipates that a new brother or sister will present competition and will take away protection and the mother's milk. This syndrome, according to the description of the people in the community, indicates that the child cries a lot, suffers anorexia, becomes sad and frightened, and his hair becomes stiff. What probably happens is that, upon becoming pregnant, the mother's supply of milk drops even more, while malnutrition and the behavioral disorders, discussed here, become more accentuated.

These character traits in the undernourished child are manifested at a very early age, and they probably constitute the basis for a defective relationship with the mother. The child becomes more helpless and seeks overprotection. The result is that the mother responds by giving in and becoming passive.

During some circumstances of emotional tension, as when the mother or child is undergoing a medical examination, a kind of peculiar emotional communication was noted between the two: when the child displayed anxiety and perspired, the mother did the same, and vice-versa; also, when the child relaxed and began to play, the mother did the same. This was observed under many other emotional circumstances. It happens so quickly that we may be dealing here with communication by means of fero-hormones, as has been shown in most other animal species. There are times when this integration of components in the mother-child unit is detrimental. It makes them susceptible to environmental hostility of

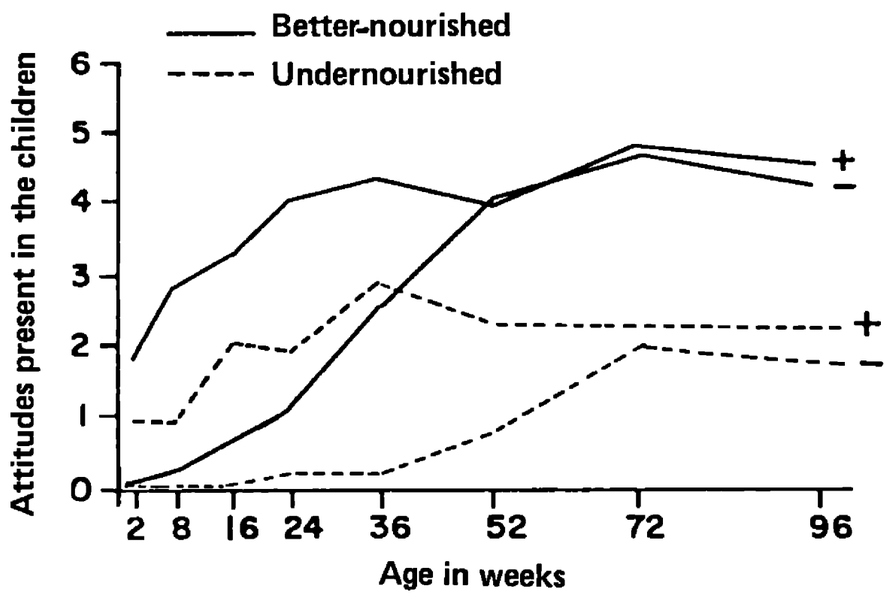
every kind, including that of the husband-father; it is not rare for him, too, to become emotionally charged but in a negative way so that he exploits the vulnerability of his wife and child.

The expression of feeling is very limited in the undernourished child. His attitudes and general behavior are both passive. Graph 66 shows the response of undernourished children to environmental stimuli. This was studied by observing the presence or absence of: 1) six character traits that were considered positive: cooperation, playfulness, enthusiasm, amiability, serenity, and attention span, these were applied to specific circumstances and were well standardized; 2) six character traits that were considered negative: silliness, bad temper, excessive demands, aggression, selfishness, and lack of cooperation; these, too, were well defined and standardized in the same manner.

It was clear that the better-nourished children displayed more complex behavior. At certain times, when they were in good humor, they exhibited several traits of a positive type, although under other circumstances they could be silly and aggressive, especially in the relationship with the mother, or at times with brothers and sisters.

Contrariwise, the undernourished children displayed few positive *or* negative traits. It was found that during the second year of life, on average, they showed only one or two positive traits, generally amiability toward others and, on occasion, playfulness and cooperation. They also displayed the same number of negative traits, especially contrariness, which was constant and distintive throughout.

In addition, the study of behavior shows that the undernourished child is slower in his responses and is clearly unable to communicate by any means, including language. It is not rare to find that when this type of child wants something, even at an advanced age, during the second year,



Graph 66. The undernourished children show a simpler behavior since they display less positive attitudes (+) as well as less negative attitudes (−).

for example, he will spend half an hour crying and whining without the mother being able to learn what it is the child wants.

Limitation of expression is more difficult to interpret. It may be affected, in part, by other factors, such as lack of activity, which could deprive the child of the information necessary to feed his memory, which would make it difficult for him to establish a stable pattern of behavior for adaptation. To a certain degree, his timidity and fear always make him react negatively so that he does not face problems.

There are other factors that damage his ability to express himself possibly, related to the findings in the other area of functional cerebral ability (neurological examination and Gesell tests) that show a certain retardation as the result of organic or functional damage.

The undernourished child is simple in his reactions, selfish toward the mother, self-absorbed, and not very friendly toward the other members of the family. In other words, his emotional development is retarded.

OPEN FIELD TESTS

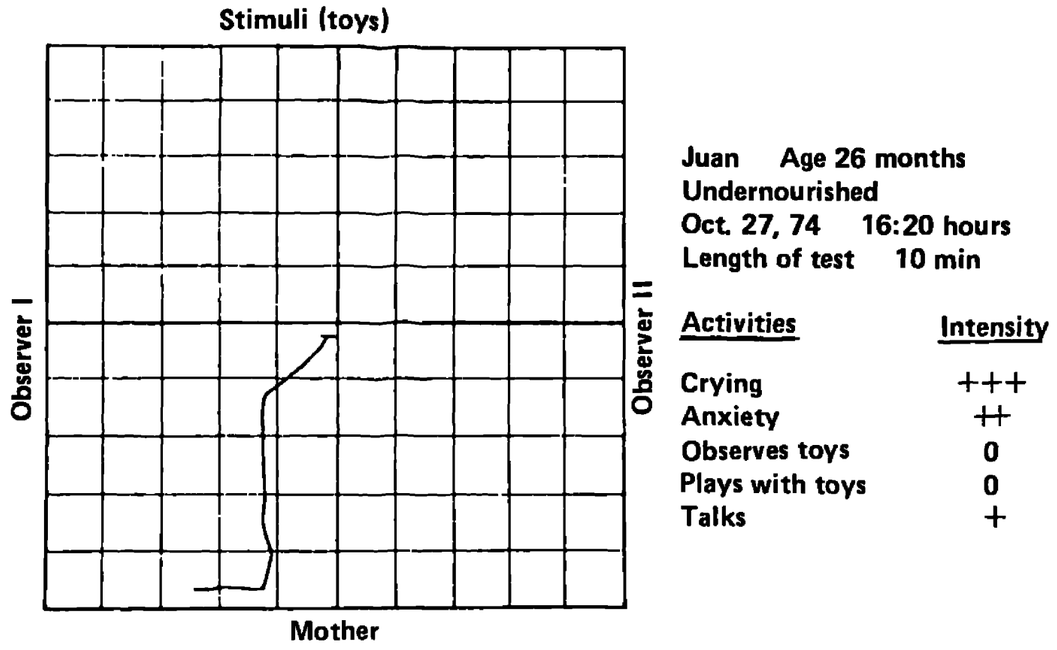
This part of the study was designed to test experimentally, in a controlled situation, the differences in that behavior trait found in the homes that was judged to be the most important: dependence and independence in the mother-child units.

As indicated in the description of general methodology in the behavior studies, the child was placed in the center of a lined quadrilateral. The mother was on one side, several toys to attract the child's attention were on the opposite side, and stationed on the other two sides were two observers who followed the child's movements and traced a corresponding line on a sheet of paper on which was drawn a copy of the lined quadrilateral (graph 67).

Althoug it was not possible to conclude this part of the study because of economic limitations, and therefore, the analysis was only cross-sectional, not longitudinal, it remained clear that the undernourished children behaved differently from the better-nourished. Even at a later age, between two and three years, the only thing that the undernourished children did was go toward the mother, cry, and demand to be picked up and taken away. They were afraid of the strange environment, they did not become interested in the toys, and their movements within the quadrilateral did not carry them beyond the area of the mother.

The better-nourished children, at times beginning at a very early age, felt more confident, frequently went toward the toys, picked them up and carried them to the mother and to the observers, and moved all around the quadrilateral.

We do not know what aspects of child characteristic this "dependence-independence" system measures, but it most certainly is complex. The fact that the undernourished children tend to go toward the mother directly and fast, ignoring or even fearing the environment, is very probably due to apathy, timidity, fear, and insecurity. If they have been accustomed to clinging closely to the mother, have had little contact with other people or the environment, it is logical that they should feel anxiety when placed alone in a strange place. Therefore, the reaction of this type of child depends not only on its condition at the time of the experiment



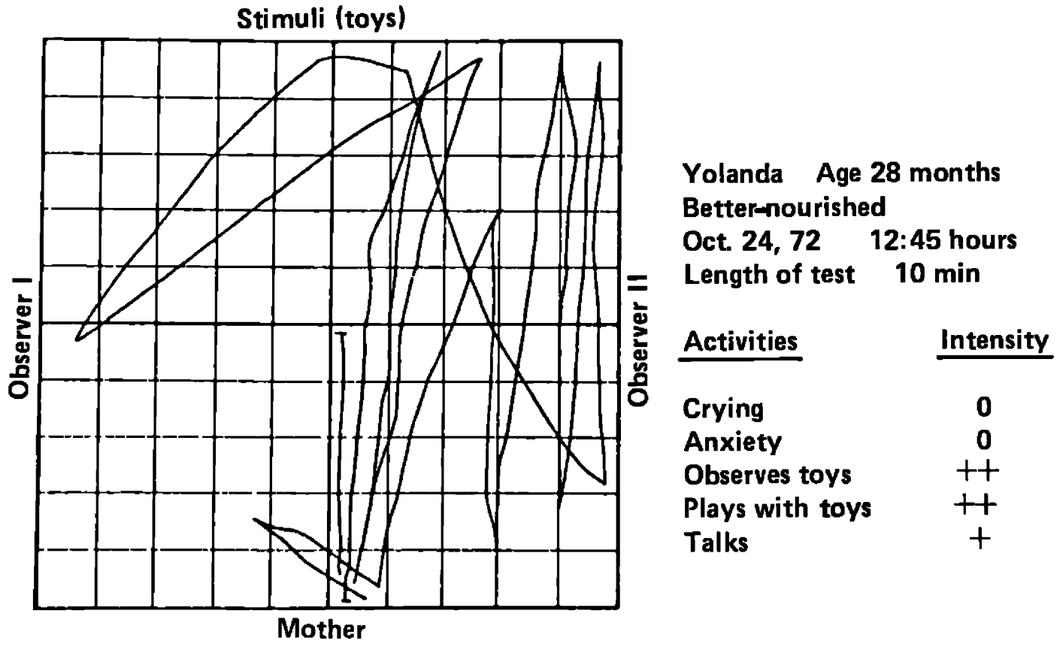
Graph 67. The undernourished children go toward the mother, they do not explore the environment, and they cry.

but also on its background.

The better-nourished children, on the other hand, were seen to be more "centered", many of them without fear, most of them daring to go toward the toys, and above all, they moved around the whole quadrilateral showing a greater sense of security and command of the situation (graph 68).

This method is relatively simple. Perhaps it should be tried in other environments in order to learn more about its diagnostic possibilities. The most difficult thing is the construction of the system. It must be completely symmetrical and regular so as to avoid the child's "sideslipping" for other reasons. Only by putting it to use in other environments can we come to know to what extent it measures the intrinsic characteristics of the child or of the mother-child unit, and to what extent it depends upon cultural conditions.

This open field system made it clear that poor nourishment affects behavior a great deal, to the extent that perhaps, of all the methods used, this is the one that best makes distinctions between the groups. The results evolved as they did because, in accordance with the data gathered in the homes, the procedure measures what is most affected by malnutrition: physical activity, independence, security, and deductive capacity. Therefore, the procedure proves the hypothesis that was set forth when the study was designed, namely, that the undernourished child is insecure and dependent, conditions that are closely tied to immaturity of character. Consequently, it may be said that malnutriton, more than anything else, retards emotional maturity.



Graph 68. The better-nourished child is more active, he seeks the toys, and he talks with the observer.

COMMENTARIES AND CONCLUSIONS

The observations made in the time sampling method indicate the low level of relationship in the non-supplemented mother-child units throughout the first two years of the child's life. The mother takes few inititatives and, in general, limits herself to three types of actions: 1) to give the child her breast as an immediate response to crying, doing so for as long and as often as the child wants; 2) puts the child in its crib and rocks it, or has one of the other children in the house rock it, which is a way of freeing herself a little in order to do the daily chores; and 3) carries the child on her back when she is grinding maize or when she has to go out of the house.

Few signs of affection are manifested toward the child, and direct or intentional stimuli are rare. The father helps only a little; the mother members of the family, especially the other children, do so at a later date.

This situation shows such a great passivity in the mother-child relationship that even the researchers themselves were surprised. The child demands only the breast; at times, when the child seems to want something else, the mother interprets it solely as hunger and, consequently, only gives the child her breast.

A comparison with the supplemented children shows that this passive relationship can be broken simply by providing better nourishment. In the better-nourished units, the mother-child relationship increases rapidly until it reaches a level that is quite higher than is customary in the community, but not, of course, to the level that is seen in urban families.

These differences may be attributed only partially to the mother, who, perhaps, being better-nourished, had more energy and was able to initiate some changes. A large part may be attributed to the child, who, upon being better fed, was more active and made greater demands; this resulted in the mother having to respond more often, and to establishing a progressive system of interaction.

The mechanism according to which foods act is not as simple and clear as one may think at first sight. In principle, foods are an additional source of stimuli by themselves, not only because they stimulate the senses of taste and smell, but also because, in that poor environment, they clearly offer an alternative to the mother's breast. From a very early age, the supplemented children learned that the breast, and to some extent the mother, is not the only gratifier and that there may be other things. This undoubtedly induces them to seek alternatives and, above all, to ask for alternatives in a different manner. Foods also affect the child by adding to his weight and this, in turn, establishes a variable in the mother-child relationship. Thus, it was more difficult for the mother to carry the baby and take it with her. Also, the supplemented child was sick 30o/o less time during its second year; this presents another variable that may affect conduct, not only in the sense that the child feels better, but also that it has an influence on maternal attitudes. All these factors are consequences of nutrition, as direct as in their influence on body energy and in feeding the organism, and they should not be neglected when interpreting the findings.

Nevertheless, the central line in the sequence of events that explains the influence of malnutrition upon behavior, begins with a lack of energy intake that restricts the activity of the child and renders him passive and less demanding. Hunger dominates the child, he asks only for the breast, and the mother only offers him the breast, which means that the child establishes very little relationship with the mother or with the rest of the family. Whatever relationships he does establish are very simple and offer him very few stimuli for mental and social development, thus, restricting his capacity for self-expression.

This sequence can also explain the differences that were found in carrying out the mental tests. They do not perform well on these tests not only because of their timidity and lack of interest, but also because they do not have the background information to do so. In turn, they lack the information because of the scarcity of stimuli they receive as a result of the poor relationship between the child, the environment, especially with the mother. This brings us back to the importance of physical activity in the development of the child.

Particularly in light of the neurological disorders, the mental tests, and certain of the results in the behavior study, it cannot be denied that the child may have some retardation in some cerebral functions, specifically in those functions that refer to his adaptive behavior and to language. This, in turn, further reduces his relationship to the environment, his learning skills and his intellectual abilities. This insufficiently nourished child does not originate stimuli himself, nor does he contribute substantially toward creating his own environment. Physically and emotionally, he is just another being in a private family environment. The basic question is whether or not this child can recuperate some of

the retardation at a later period in his life. There is no doubt that an undernourished child establishes fewer relationships, receives less stimulation and, perhaps undergoes retardation in brain maturity; but there is always the possibility that he may receive stimuli at a later period in his life and recuperate everything that was lost.

The neurological examinations showed that the recuperation of reflexes is total; the function is recovered at a later date, and completely. What is known up to now, regarding the mental tests, indicates that there is a great probability of his achieving a balance; even though he may not reach the level of the control group, he does parallel the control group at a level about 10o/o lower. This suggests that there is the possibility that, at adolescence, he will reach normal levels or will remain with only a slight deficit.

The differences in behavior are large, and their consequences are more noxious for the individual. Some of the studies done in subsequent years have shown that, in many aspects and at some ages, the undernourished child catches up with the better-nourished control child; however, this does not happen in several important areas. For example, during the third year, and especially during the fourth, the undernourished child becomes more active and begins to relate to the parents at a level similar to that which the supplemented child did at two years of age. Some facets of language are learned very rapidly, thus, making the child appear normal but younger than he really is. Other character traits are not totally modified, for instance, insecurity, timidity and, especially, the passive, restricted behavior. They are children who, at school age, are considered "very good" because they are obedient, they cause no great problems for their parents or teachers; but they do not learn sufficiently well, and they have no great interest in doing so.

This means that the "chípil child" syndrome, as serious as it may be, is basically transitory; it leaves results that, to a degree, may be considered advantageous to the survivor who wants to lead a tranquil life in a poor and limited community. His passivity and inactivity allows him, when he is small, to live in a small house and with little protection. When he is older, the same behavior traits make it easy for him to adapt to a simple, stereotyped culture in a small community, to being without work, or entertainment, and to having few opportunities.

In the same way, the home is adequate for the undernourished; the community culture and economy are also, to a certain extent, created by and for malnutrition. From the social point of view, malnutrition has a depressing effect on individual initiative; it is the cause and consequence of the community in general, being limited in knowledge and in cognitive capacity. In the same measure that a quiet and submissive child accepts limitations more easily and adapts better to that type of life, so it is with the adult, too. From very early in life, the "chípil child" syndrome opens the way for the human being to follow a process of adaptation to his environment of underdevelopment, it helps him accept living in filth in passive resignation, elements that are the very essence of the culture of poverty in the rural world.

All of this forms a complex by which adaptation to malnutrition explains underdevelopment, and underdevelopment, in turn, explains malnutrition. In all this, the personality of the malnourished is

a manifestation of processes of adaptation that reduce human expression to a minimum so as to be able to survive amidst poverty.

CHAPTER 9

Implications for health

THE IMPACT OF NUTRITION ON BIOLOGICAL FUNCTIONS

The longitudinal focus of this study has clearly shown a close interaction between nutrition and almost all aspects of human development. The intake of food acts upon cells, tissues, and organs even before birth and establishes limits to potential development.

The common mechanism in these phenomena is adaptation, which allows the child to survive by enduring scarcity. At an early age there is an organic adaptation that limits the number and size of each one of the units of which the human being is made up: the 3×10^{14} cells of the organism. Also, and to a more important degree, there is a functional adaptation that reduces the expenditure of energy; there is also an adaptation in individual and social behavior. Throughout the study it became clear that there are several areas of interaction between the mechanisms of adaptation to malnutrition,and the function of the mother-child units. By way of summary, we shall describe the principal interactions that were found.

Nutrition and fertility

It was shown that human reproduction is one of the functions most affected by insufficient consumption of the principal nutrients. The study showed a delay in the time between deliveries, resulting in women having half the children they might have had. Biologically, this is an important functional disorder, since nothing can limit the survival of a specie more than alteration in fertility. However, this does not appear to be decisive for the human because there are other mechanisms that the homo sapiens species can use with more success. The effect of malnutrition is clearly adaptive because it balances the number of people against nutritional resources. This was not shown in these community studies, but it probably manifests itself in other communities that are in more precarious conditions.

Nutrition and lactation

Lactation appears to be a function that maintains itself in spite of severe nutritional restriction in the mother. This study showed that this is true only in part. In all the mothers in our sampling there was alteration in the pattern of secretion. Approximately half of the mothers began to produce milk quickly and in a large quantity. However, after two months, their production dropped off sharply, with milk solids falling by almost 30o/o within a short time. The other half began secreting milk very slowly; it was very difficult for them to produce significant quantities, and never enough to meet the demands of the child. Even though these two effects cut down the total volume or milk solids only moderately for feeding the child, an important impact on the child's development was indeed shown.

Nutrition and development of the fetus

The differences in weight at birth between the children of undernourished mothers and the children of supplemented mothers were definitely significant, showing that maternal nutrition affects the growth of the unborn child. This has been popular as well as medical knowledge. It has been made obvious by the recommendations of obstetricians who advise the mother not to eat too much so that the child does not grow too large thus, avoiding problems during delivery.

There are only some researchers who deny the effect of maternal nutrition on fetal growth giving as their reason that it has not been scientifically proven that nutrition is a principal factor. Considering the experimental pattern that was followed in this study, the fact remains clear. The improved nutrition of the better-nourished mothers brought about a difference in weight at birth that does not seem too very large in magnitude (only 180 g, that is, a little less than 10o/o), but the differences is indeed very important to the future of the child.

Nutrition and infections

The study shows that an improved nutrition helps only partially in preventing illnesses, but it definitely does render them less serious and of shorter duration. The latter means less damage to the functional status of the tissues and hastens recuperation after infection and inflamation The malnourished children older than 18 months spent from 40 to 50o/o of the time ill, while the figure for the better-nourished was only 15o/o.

This finding helps define more clearly what the malnutrition-infection complex represents in impoverished countries, not only in the sense that poverty is the substratum of both, and that infection promotes malnutrition, but also, what is most important, in that sense is that, undeniably, malnutrition favors infections.

Nutrition and defects in growth

Deficient growth of the malnourished has been well-known for a long time. Proof of this can be shown by merely observing the height of the

people affected, the height differing according to development and nutritional level. This study shows that the problem begins *in utero*, and that, after birth, the differences in growth are evident in the various body measurements. The malnourished child, from the time it is born, has a smaller thoracic perimeter, and the legs are shorter. There is also a progressive deficiency in total height. These are basic characteristics in the physical growth of the undernourished.

Nutrition and the consumption of foods

The first thing that the organism of the malnourished learns is: not to eat. It is adaptation epitomized. If food is lacking, the organisms reduces its necessity for energy and other requirements by means of a smaller body mass, a decrease in the rate of growth, a reduction in physical activity and, probably, also by a metabolic adjustment. All the children in our sampling who did not receive supplementary feeding quickly lost the feeling of hunger, they slept more, they were very inactive, and their body temperature was half a degree lower. It was a surprise to find that, between 12 and 18 months of age, these children were able to live on a total of less than 500 calories and 10 g of protein a day, while the children who were already accustomed to eating better were hungry and consumed more than twice the amount of energy and up to five times more protein.

Nutrition and adaptation by sex

The boys grew more than the girls on the same amount of milk, as happens with other primates. Also like other primates, the boys were more labile and susceptible to infections. This means that the female is less efficient metabolically but more resistant, and that she survives better under precarious circumstances. While she may assure the continuity of the species, she also brings about an element of deterioration of the species by perpetuating a form of malnutrition that can be called congenital and that has transgenerational effects. A mother who has survived malnutrition is small in size, she begets small children who can adapt more easily to scarcity and yet survive, and thus, the species become biologically smaller and more limited.

Nutrition and physical activity

Low levels of physical activity in malnourished children is certainly another very direct mechanism of nutritional adaptation. If there were some easy way of measuring it, it would be the most precise indicator of the nutritional status of a child. The implications of this finding are great. On the one hand, there is the effect, also direct, that malnutrition can have on the capacity for work and on productivity, which was not measured in this study. On the other hand, there are important indirect effects, which this study did show, on the interaction of the child and its environment (especially with the mother) and the feedback of stimuli for development. The brain needs stimuli in order to learn and, very possibly, also needs it to establish the structural connections for function. The study was very clear: an inactive body leads to an inactive mind.

Nutrition and retardation in organic maturation

Following this study, the possibility is left open (more open than ever) to the idea that malnourishment retards the maturation of some organs, the most important of all, and one that is included in this study, being the central nervous system. The neurological examination was conclusive: there are differences between the two groups. The undernourished children are definitely retarded in severall reflexes, and more markedly so during the ages of maximum lack of nutriments. Of course, the retardation does not reach the level of overt abnormality, but it is there, showing that if functions such as the reflexes are retarded, others that are finer and more difficult to integrate can also be affected.

Another possible tissue effect is the relationship between malnutrition and aging. It was shown that menopause comes early and that in the families in our sampling there were clear manifestations of premature aging. This was not directly proven, and this relationship is left as a hypothesis for future studies.

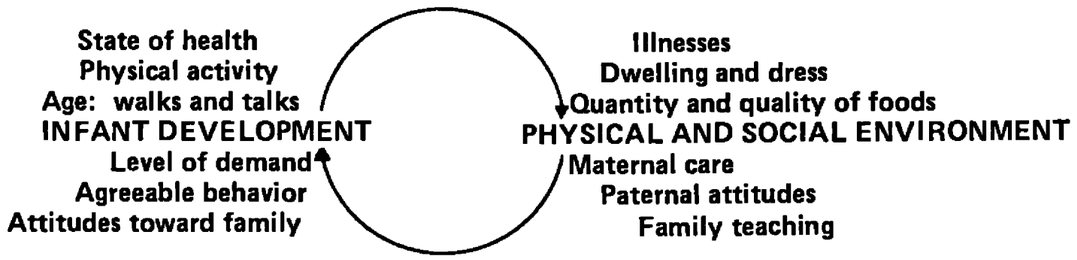
Nutrition and mental development

There were clear and important differences in mental development between the supplemented and the non-supplemented groups. In all the areas explored, especially in language and in the capacity for adaptation, the undernourished children scored lower. This means that they were deficient in the solution of problems. The implications of this finding are not easy to interpret. If the tests used were not ideal, it should be indicated that they were the same for both groups. It may, therefore, be concluded that poor nutrition does affect the ability to resolve the problems that are set forth in the Gesell test and, consequently, the poorly-nourished children are retarded when compared with the better-nourished children.

THE IMPACT OF NUTRITION ON BEHAVIOR

This area is the richest in original results and the most important in defining the effect of malnutrition on human development. This study makes evident a great deal of information suggesting that the possibility of progress in the human being depends in great measure on the initial impulse toward development. The first months are the period in life in which a sound and active child can create its own proper environment, one in which to seek the stimuli that will allow for the formation of intelligence.

The human being is perhaps the only animal that can substantially modify its own environment, not only physically, but mentally and socially as well. This is shown very clearly in the crucial result indicating that the undernourished small child does not relate adequately to the mother and thus, does not receive sufficient stimuli for this behavior to evolve satisfacforily.



Graph 69

Graph 69 shows how the child modulates his environment and how the environment, in turn, modulates the child.

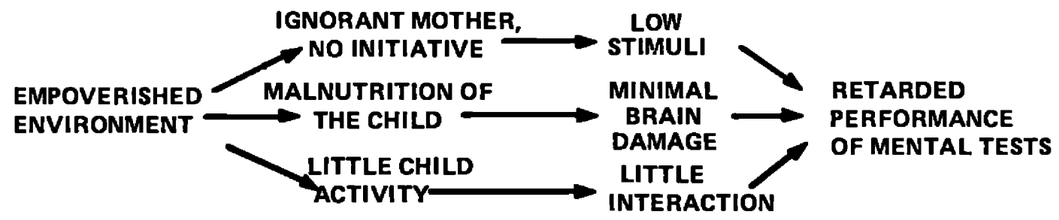
This means that a better-developed child is active and healthy, has positive attitudes and complex behavior patterns, modifies its environment, suffers fewer illnesses, asks for more food, and causes his family to provide him with more care and teaching; thus, he is constantly receiving stimuli. All this, benefits his nutritional status, which, in turn benefits his development.

This situation is just the opposite in poor communities: the child shows little activity, he is often sick, and he has negative attitudes that isolate him and reduces his contacts with his environment. All he wants is the mother, and not even all of her –just the breast or physical contact so that he may feel a sense of security. This environmental poverty does not provide him with any stimuli for the development of his mind or his behavior.

To some extent, the human brain can be compared with a computer, with the unique characteristic, however, of being able to "program itself" and, even more to "construct itself". The complex of environmental stimuli and the responses to them progressively create response systems that in a simple fashion, were described at the beginning of the century as conditioned reflexes. A malnourished child whose life is deprived of stimuli, whose relationship with mother, father, brothers and sisters is deficient, whose information is very limited, and who has, therefore, a poor ability for integrating responses, becomes retarded in the accumulation of experiences; it is for this reason that learning becomes difficult for him, as does performance on intelligence quotient tests.

Ever since studies were begun on the impact of nutrition on human intelligence, two hypotheses were proposed. The first is that environmental deprivation (let us call it poverty) causes malnutrition which, in turn, through lack of nutriments, damages the brain, and this damage is manifested by poor mental capacity. The second hypothesis does not accept the possibility of brain damage; it proposes that an environment limited by the lack of food causes malnutrition and, because of the reduction of stimuli, results in poor mental capacity. This hypothesis does not relate malnutrition to the intelligence quotient directly, but rather through a common factor: deprivation.

This study provides data that show that both hypotheses are incorrect, or that they are only partially correct. It is most probable that, as we find in biology and even more in sociology, what occurs is a phenom-



Graph 70.

enon that has multiple causes with several components at work. What was found may be seen in graph 70.

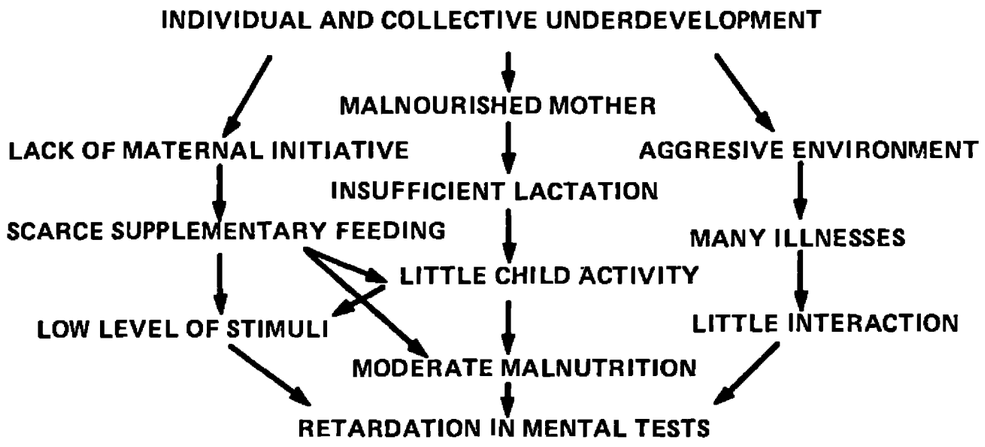
Graph 70 does not dwell on the most important factor, which is the relation among the different factors and the manner in which they reinforce each other. Thus, as has been stated several times, the mother takes no initiative, largely because the child makes no demands; for this reason, the mother does not offer the child food, and this results in malnutrition in the child. A more complex picture of the situation is shown in graph 71.

In this scheme, nutrition is the axis of the problem. It acts through poor maternal malnutrition, first through the placenta and then throught the breast; this does not favor infant development and results in a passive, undemanding child. Add to this the fact that the mother does not give the child other foods and that the child suffers many illnesses, and thus, malnutrition becomes even more serious. This directly affects brain capacity, which indirectly leads to poor relations to the environment and deficient stimuli. These latter factors are the most important; they are the consequence of malnutrition and not directly of poverty. The environment near the child is very limited: the mother and what she gives the child –her breast, other foods, stimuli, contamination. This small environment is neither static nor unidirectional; the child and its condition are very much involved in the dynamics of malnutrition.

Characteristic of the behavior of the undernourished child is his timidness when confronting different environmental stimuli, his passive attitude, and his markedly slow responses. All this fits his immature character and limits his potential for intellectual growth. In this sense, we are speaking of an interaction between character, or personality, and intelligence, which is really very important, not only with reference to children. We do not know to what extent the character of the malnourished influences intelligence and performance on mental tests. Nor do we know to what degree the tests measure personality and not real analytical capacity. We do not know to what extent malnourished children make no effort, are not interested, or find it of no importance to do well on the tests, or to what extent they really cannot do them.

METHODOLOGICAL COMMENTARIES

The experimental pattern presents some methodological innovations in social research. The most important was the introduction of one



Graph 71.

variable, by means of a system of intervention, into a population group in its own natural environment.

This type of pattern had not been attempted in human studies because it is difficult; but is obviously offers many possibilities. In this case, it was based on the previous experience of the authors, and in view of the great need there is for valid and incontrovertible information upon which to base the programing of activities for improving rural well-being. It was known from the beginning that even though the planning and execution of the study were done carefully, it would not be possible to arrive at the same level of accuracy as achieved in laboratory experiments. It is not the same thing because it is necessary to respect the free will of the people. Therefore, in no way was it thought that the standardization of the variable would be perfect. Limits were established for the socioeconomic levels of the families and for the health characteristics of the child and the mother; they were observed carefully so as to watch for any changes in the family. If any changes were found, the most that could be done was to remove the family from the study, but by no means modify the family.

The main problem that we faced was that foods were soon proved to be a multiple-action variable. Not only were they an accumulation of nutrients, but a gratifying source in themselves and, therefore, an important stimulus. Furthermore, as nutrients they had many effects. Not only did they nourish the cells, thereby leading to greater organic development, they also had psychological benefits, leading to a child who was more active and who had a more positive outlook; this permitted the child to relate to and modify its environment. In this situation, the methodology ran into a problem: only one variable was supposed to be changed, and while this was possible, the variable turned out to be complex. Because of this, comments are frequently made as to what aspects of nutrition are involved in each specific case.

This method has been criticized on the grounds that when controlling all of the variables and modifying only one, the action of this one is magnified and, therefore, appears more important than it really is. In accordance with this, nutrition proved to be so valuable for human development only because it is "isolated". This is not true, because the system of standardizing conditions and modifying one variable has been used in general biomedical research for a long time, particularly in the laboratory, where it has shown valid results. What is certain is that when the intermediate variables are suppressed, the impact of the variable that is introduced does become magnified. In this study, though, there was no suppression of the intermediate variables such as the impoverished environment, infections, and the ignorance of the family; rather, they were equalized; in other words, they were the same for both groups. What the experimental pattern did, was correct a nutritional deficit in order to find out which other variables were, as a result of improved nutrition, corrected and thus learn what alterations were associated with the deficiency.

Another original procedure in social research was the time sampling system of observing family behavior, something that had not been previously done in the homes of the subjects. The method proved to be very useful because, in addition to showing the differences brought about by malnutrition, it also showed little-known patterns of rural behavior. Although this material is almost complete, it will not be further discussed here. It will provide an opportunity for some interested specialist to do an appropiate analysis.

Another original method was the open field study of children. This is an old technique in animal research recognized to be highly productive; this technique should continue to be explored by specialists in human behavior.

The most original of the methods was prolonged observations within the homes, obtaining the information by seeing it and feeling it rather than asking about it. This was extremely valuable in the matter of mother-infant interaction. This method, too, has been criticized on the basis that the presence of the researcher modifies the behavior of the family. This study made use of all the experience and technology that the research group has accumulated throughout many years of work in the rural Mexican environment, which certainly made it possible for us to largely overcome this objection. Previous visits were always made in order to establish a relationship with the family; attention was distracted by focusing the study on lactation; the visiting periods were long (3 days each time), but only three hours were used for taking samplings of behavior. Finally, and most important, only one of the researcher (CM) was involved in this aspect of the study.

It is recognized that the number of mother-child units were few, and that the experimental design was at the limit of significance of the statistical systems; but information from larger samplings would have been superficial, and fortunately the results proved that the procedure chosen was good enough, because very clear differences were always found between the two groups. Nutrition affects human development to such an extent that if the number of cases had been even fewer, the results would still have been evident. Moreover, it must be remembered that, since the study was longitudinal, the number of observations was large; this makes the significance of the findings stand out.

This monograph gives information covering the period from the first two to five years of life. This is a poorly explored period and is only the start of development. Consequently, if one uses only the findings

extracted during this period, it is difficult to confirm that alterations found in development are permanent. But it is inappropriate to think only about the value of the knowledge gathered in terms of the future of the child. A child, during the time that he is a child, must also be the subject of concern on the part of researchers in the field of human health and well-being.

There are two working hypotheses regarding the possibility that moderate malnutrition may be the cause of several problems in the school child and, especially, in the adult. There are those who feel that, after the initial effect of malnutrition, when the organism has achieved homeorrhesis, there is time for correction of the alterations in development, for achieving balance and normalcy.

On the other hand the mayority of researchers believe that at least part of what is lost will not be recovered depending on the timing, severity and duration of malnutrition. The discussion is ironic at the present time because, in poor environments, there is no possibiblity for improvement. Diet continues to be deficient throughtout the rest of the life of those involved. The problem will only be solved when there is an investment of sufficient resources that are really directed toward a solution of the problem.

The child who survives has already learned to eat less and has adapted to inadequate ecological conditions that he will have to face in subsequent years; he is, therefore, most suited to survive in an impoverished and limited environment. However, he is less capable of developing in a dynamic environment in which competition is more important. There is no doubt that he will lack the ability to change and that he will thus find himself in a vicious circle: a deficient diet will reduce his hopes for improving his life, while poverty will prevent him from obtaining better nutrition.

What is most probable is that some may be able to recuperate and some not. That is why it is important to extend this study for as long as possible and to continue to determine this complex problem longitudinally. The situation is such that not all functions are affected equally and, therefore, each one will follow a different course. Thus, it should be possible to find out which alterations that appear at an early age tend to correct themselves, which leave a scar on development or on behavior, and which persist or become worse and thereby prevent the individual from achieving complete health.

IMPLICATION FOR CLINICAL PRACTICE

The fundamental finding of this study was that poor nutrition results in adjustments at different levels (in the cells and tissues, in individuals, and in societies), that these adjustments are mechanisms of adaptation for survival, but that they significantly affect function to the degree that they constitute an illness: chronic moderate malnutrition.

At the present time, this form of malnutrition is certainly the main social problem in most of the underdeveloped countries.

The manifestations are insidious, it undermines the child little by little, and reduces abilities without causing any pain or annoyance. That is why the medical field has not entirely accepted it as a nosological entity, ignoring the fact that it is certainly the oldest illness, and that,

quietly, it has done more to limit the quality of life of the human species.

The medical field has not recognized it, perhaps, because it occurs mostly in those people who do not go to doctors. In any event, it is difficult to identify its manifestations, scarce and barely perceptible as they are, during a clinical examination of the traditional type. As has been discussed, clinical signs appear only when the subject should be functioning but is not functioning well. In order to note the manifestations, what is necessary is a dynamic examination rather than the customary static examination.

Moderate malnutrition limits the individual's capacity for action, his social relationship, his relationship with his environment, and his possibilities for progress and self-improvement. Moreover, chronic moderate malnutrition is not cured with medication; rather, it requires action of a preventive type. The basis is a better diet. The probability of the individual's achieving a better diet depends more on social conditions than it does on a prescription. That is why all the members of a society must participate in the treatment of this illness, especially community workers: teachers, health promoters, agricultural extensionists, nurses, aides, social workers, and others. In one way or another all these people can help prevent the newborn rural children from falling victims to this adaptation to low nutritional levels, to his apprenticeship to poverty –in effect, to this chronic, moderate malnutrition. Once the child has "fallen sick", it is necessary to rapidly increase his consumption of foods so as to enable him to recuperate as much as possible of the development that he has lost.

One may ask: How do we diagnose moderate malnutrition? The answer is that a diagnosis is not necessary, because practically all children in poor environments suffer from it, are going to suffer from it, or have already survived it. The whole population in such areas requires measures to be taken: 1) *prevention:* give the mother supplementary foods during pregnancy, and give it to the child between two and four months of age; 2) *curative:* feed the child extra food between four and twenty four months of age, 3) *rehabilitation* –to the extent that rehabilitation is possible: give dietary supplements to all children over twenty four months of age. If there are any children that do not require such measures, it would certainly do them no harm to receive attention along with the rest.

A specific diagnosis only has to be made in an environment that has better educational and economic resources and in which there is a heterogeneous population, there is, for example, in urban health centers or in social welfare units. What is most necessary is to determine the nutritional status of the child – undress him and give him a thorough examination; under these conditions diagnosis is easy because malnutrition is always obvious.

It is necessary to insist upon this point because it is quite common in public health medicine for the doctor not to look for complications; if the patient, or the mother, complains of some symptom, it is common for the doctor to pay attention to that symptom only in order to finish the session more rapidly. The diagnosis of nutritional deficiency always imposes the necessity for communication, attention, education, follow-up, and evaluation of results. This is complex and difficult, especially in view of the fact that, unfortunately, it is not solicited by the patient, nor

by the authorities, nor even by the prevalent social milieu.

In arriving at a diagnosis, it is also useful to know the condition of the child at birth, particularly the weight and length of gestation, diet during the past and especially during the weaning period, present dietary intake and the care, frequency, and types of illnesses that the child has had. The child should be weighed and measured to see if there is any retardation in physical growth. There should be an effort made to understand and to integrate functional disorders, body morphology, alterations or indications of malnutrition, attitudes, relationship with the mother, the child's nature and several other data that are more difficult to quantify if methods that are used in this study are not employed.

IMPLICATIONS FOR COMMUNITY HEALTH

Several key facts in communal health are derived from this study: poor nutrition affects all human development, and the earlier malnutrition begins, the more serious its consequences can be; malnutrition can be prevented only by the consumption of more foods, and the earlier complementation of the diet begins, the better the results achieved. These statements open wide possibilities for analytical action because they clearly show that to prevent malnutrition is not as difficult as was previously thought.

It is possible to think of a population suffering from chronic moderate malnutrition as walking along the edge of a cliff: some fall off the precipice, while others continue moving ahead under precarious conditions. If we can succeed in moving them onto firmer land, or at least a short distance from the edge, then, disproportionate to the small improvement, the number of those who fall will decrease greatly and the condition of the survivors will be more adequate. A small, but significant improvement in food consumption, especially for children, is not really onerous for the family.

If we accept that the malnutrition problem is susceptible to preventive measures, the following priorities should be considered.

1. Begin earlier supplementary feeding of the child; in other words, at the age of three months give him the same foods as will be given him at the age of eight months. Even though it may seem paradoxical, the rural child is more resistant to contamination at an early age because he is better-nourished, he still has maternal anti-bodies, and he is voracious: he eats everything that is given to him. In accord with our study, this action would be extremely valuable, and it would not significantly overburden the family's economy.

The study of lactation clearly showed a fact important for nutrition and one that is new within the field of preventive medicine: perhaps half of poorly-nourished mothers do not produce enough milk right from the beginning, with the consequence that the child undergoes immediate nutritional deficiency. Like every new finding, this needs confirmation; if it is positive, then the advice must be given to supplement the breast beginning at a very early age, and this could prove to be dangerous if the foods are contaminated. In any event, our National Institute of Nutrition has begun to recommend earlier supplementation with only fruit juices and purees. These foods have the advantages of supplying complementary

calories, water that is so necessary in tropical countries, and some vitamin C that may also be lacking. Further study is needed in this regard.

2. *Give the child practically any food until he is full.* This measure is based on the knowledge that: a) the problem is fundamentally caloric, and the milk from the breast is so good a food that it can complement any other, including sugar or maize; b) the digestive capacity of a three-month-old child is complete; it can eat everything, provided that the foods are either ground or finely chopped.

The study did not satisfactorily prove that energy is the limiting nutrient, but it did provide a great deal of information to indicate that this is probably true.

The two measures just mentioned would be more beneficial if the supplementary foods were administered under better technological conditions: products that were ground, strained, and recently cooked. Hygiene is very important but not indispensable. It would not do to be overly anxious about it to the point of arousing fear in the mothers and in the personnel working on community health improvement. The environment is already so contaminated that, in any event, the child will be overriden with bacteria because fingers are put into his mouth, he is left on the floor in contact with the animals, and there are many other similar exposures.

3. *Improve the nutrition of pregnant women.* It is important because of the demonstrated fact that nutrition during pregnancy has an influence on the weight of the child at birth and, therefore, on the possibility of the child's survival and better development. This measure was not placed as the first priority, as apparently it should have been done, because it has less possibility of success: a) the mothers are more easily convinced about giving the child foods than about consuming foods themselves; b) it would be more expensive because what the rural mother needs is more a change in dietary quality than in quantity; c) based on the information gathered in this study, the efficiency of this action in child development would probably be half of what it would be if the foods were administed directly to the child. Nevertheless, we must remember the problem of congenital, or transgenerational malnutrition in the sense that if the condition of the women is not improved (their size and morphology), they will continue to beget small children, thereby delaying the definitive solution (see figure 6).

4. *The improvement of maternal nutrition during lactation* also has effects on the development of the child. As previously indicated, supplementing the mothers resulted in the body weight of the child being one kilogram more at the end of the first year, in half of the children, and half a kilogram more in the other half of the children. Of course, this program is less efficient than direct nutrition of the child because a great number of foods are required to achieve the increase in the child's weight. But we must also remember that the mothers, too, need health programs.

5. Watch the development of the child, using weight as an indicator in order to discover cases of hypogalactia which, in poor environments, is not as rare as commonly believed. It is probable that one mother out of every twenty may not be able to increase her production of milk much above the initial level; therefore her child will tend to fall into a state of malnutrition with a high probability –almost a certainty– of death. How many mothers this involves cannot be stated with certainty because

the studies of milk production are relatively scarce. But if it is one out of 20 mothers this implies that hypogalactia is a serious problem in community health and that it is one of the main causes of infant death. It could be the underlying cause of deaths that are frequently recorded, as "congenital weakness", "poorly defined cause", "prematurity", and others, attributed to the child that could instead be caused by low milk production in the mother.

6. There are two other measures not strictly in the field of nutrition that this study found to be very important: a) *The prevention of transmissible illnesses,* that contribute about 20% of the poor growth syndrome in this type of population, mainly through fever that alters metabolism, anorexia, and food prejudices in the mother; and b) *spacing between children.* In this respect, the study shows that it is harmful for the new child when the mother becomes pregnant while she is still breast-feeding the last child. The lactating child is affected because the secretion of milk drops off and the mother decides to wean him abruptly. The mother, too, is seriously affected because of the tremendous nutritional load imposed upon her.

7. *Lend decided support to infant nutrition so as to enable the child to reach a weight of 8 Kg in the shortest possible time.* This should be a goal rather than a program, and it can be achieved through a combination of the previous recomendations: maternal nutrition during pregnancy so that the child may be born at a normal weight (at least more than 3 Kg); maternal nutrition during lactation so that the mother may produce milk more regularly; early and decisive supplementation of the child so that there is no interruption in growth, watchfulness in order to prevent illnesses and major nutritional disorders.

The limit of 8 Kg is established by integrating all the variables in development, that show that this weight can be the transition point between what may be called an extrauterine fetus (having little capacity for defense and being very dependent upon the mother) to an independent individual who can crawl around and ask for food, thus permitting it to be more or less autonomous. Children must break this barrier at the eighth month; if not, their possibilities for optimum development are weakened. The later they reach this point, the less they can expect of a future. It would be like being born again: their opportunities depend upon the physical, mental, and social conditions in which they begin.

This goal of 8 Kg in eight months would not be difficult to reach using the systems of mother-infant health if all batteries available to community health were adopted. This would be particularly true if the most important tool of all were better applied, i.e., education. Education is hardly even used in the underdeveloped countries, while in the developed countries it has produced such good results.

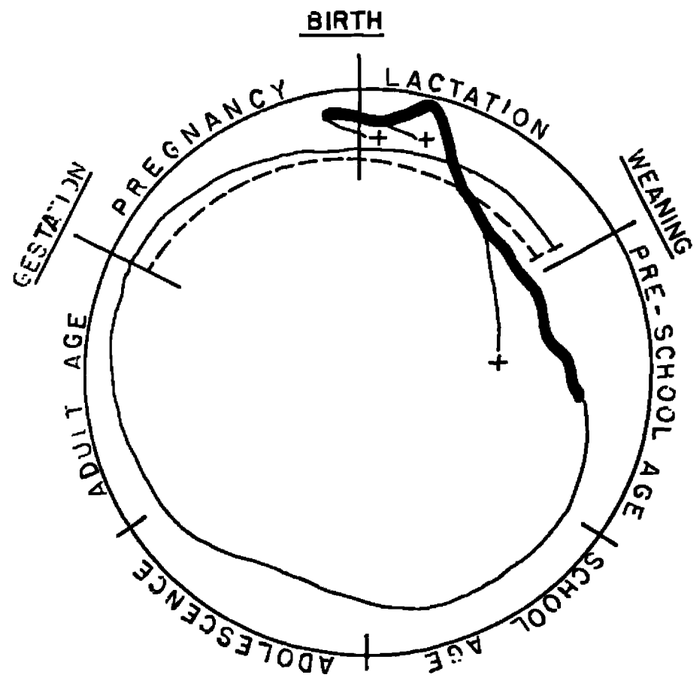
The mothers in Mexico are in the process of change, but they do not know in which direction. The mass communication media invite the people to use products that are both bad and expensive, while there is passivity on the part of the public health personnel who do nothing to provide the low-income groups with better information and direction.

Nutritional education is a very effective tool because it can cover a wide area of topics at low cost. But it must be directed at the priority

topics in a very definite and concise manner, and it must attack the problem at its roots —nutrition of the mother-child units.

CONCLUSIONS ON NUTRITION AND HUMAN DEVELOPMENT

Graph 72 expresses the changes that the level of nutrition undergoes in persons who live in a poor environment. The outer circle would be the maximum in accord with genetic condition; the inner line would be the evolution that is most commonly found in less developed areas. The children are born below optimum status because of intra-uterine undernourishment. Some, indicated by the first line ending with a cross because of major problems, are born with still lower weight and have a greater probability of dying soon afterward. Later, the quality and quantity of initial lactation bring them very close to a healthy state for the first and last time in their lives because once milk is inadequate as a source of food, they drop weight sharply and reach their worst condition only a few months later. In the second line ending with a cross we see the cases in which the mother suffers from hypogalactia, and the child enters into a state of malnutrition and dies. The third line ending with a cross represents those children who die because the mother does not complement breast-feeding with other foods; these children are especially prone to many infections. Those who survive recuperate only partially and do not reach normalcy.



Graph 72. The life cycle in a rural population. The outer circle is the norm and it shows the ages at which most is contributed.

Up to this point, the discussion has been based on information from this study. From this point on, according to other data of a cross-sectional type, we know that the individuals remain at a low level of unstable balance; we know, too, that they again suffer malnutrition during adolescence, when the deficiencies become aggravated by the great needs of growth.

The study once again comes back to a problem directly related to the mothers who were studied (many of them still in puberty) when they became pregnant and have another nutritional burden imposed upon them. Their nutritional status deteriorates and it is difficult for them to reach equilibrium. Pregnancy represented a heavier nutritional burden than lactation did for the mothers studied, in spite of the fact that, from the physiological point of view, the contrary has always been considered to be true. The occurence of a succession of pregnancies, deliveries, and periods of lactation (which has been called the syndrome of "uncontrolled" maternity) affects the status of the woman, as is seen in the graph, reducing the possibilities of the subsequent siblings being normal. It is frequent that a mother in these circumstances will give birth to progressively smaller children and will also have lactation performances with more abrupt decreases in milk production after the peak.

To this, there are added problems of greater susceptibility to illnesses, probably throughout the rest of her life. There is also premature aging, brought out in this study by the indication of early menopause in the women and, during the community study, by the small survival rate, that is, those who do not reach old age.

This life cycle results in individuals who are limited in their individual development and who, in their totality, perpetuate communities and societies that are low in socioeconomic development. Basically, this type of persons make up societies that are at the limit of survival, controlled in number by availabiblity of food, and who are always near the critical level. This situation in the human being constitutes a peculiar phenomenon within the development of the species. All other species are in ecological balance with recources, thus, keeping the individuals apt and sound. Among human beings in poor areas, such as in this community, such a balance does not exist; a greater number of people in relation to resources means more deterioration, what is more, the environment frequently deteriorates progressively along with the people in it.

Behind this problem, couched in hardly perceptible but none less, the less determinant circumstances, is a system of community control that is the basis of social injustice prevalent in the poor communities of most rural areas. The people in small communities do not get to see even half of the fruits of their labor. They are always in financial debt to the community merchant-cacique (strong-man). They are under constant pressure from social, religious, and political demands. They are constrained in their opportunities for achieving better conditions for the future. They lack resources for the consumption of foods, and they also suffer a greater lack of resources for reinvestment that would enable them to produce under better conditions or to avoid ecological deterioration.

The situation must change, and, in fact, it is already changing in most of the world. The problem has a solutionn, even within the social context that prevails in most rural areas; the solution lies in merely using existing

knowledge, such as that offered by this study. There is no doubt that it is necessary to establish a hierarchy of steps to be taken and to work under a system of priorities. If resources are scarce, it will be necessary to select a package of minimum actions but one that will fully cover basic needs so as to once and for all do away with the presence of citizens whose conditions of life are physically, mentally, and socially limited by chronic malnutrition.

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