

Pan American Health Organization

ADVISORY COMMITTEE ON MEDICAL RESEARCH

Seventh Meeting

Washington, D.C., 24-28 June 1968

Special Session on:

Biomedical Challenges Presented by  
the American Indian

Item 6.4

FOOD AND NUTRITION OF THE MAYAS BEFORE THE CONQUEST AND  
AT THE PRESENT TIME

Ref: RES 7/SS/6.4  
3 June 1968

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availability of niacin, favor the development of pellagra in corn-based diets. (10)

We must then ask ourselves how an important civilization like the Maya could develop with such a great dependence on corn as its staple food; and, why the present-day descendants of the Mayas have serious nutritional problems, also because of their dependence on corn.

In this paper we will try to review our unfortunately small store of information on the dietary practices and nutritional status of the Mayan populations before the Spanish conquest of this region. We will analyze the same conditions in their direct descendants, the Guatemalan Indians of today, attempting to determine the main changes that have come to pass. It is our hope that in doing so some general principles, applicable not only to this particular group of American Indians but to others as well, will emerge. I thought this could be more useful than a purely descriptive paper on the nutritional problems now afflicting the American Indian groups.

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"... and grinding then the yellow and the white ears of corn, the goddess Ixmucané prepared nine beverages, and from this food came strength and stoutness and with it they created the muscle and vigor of man..."

"Their flesh was made from yellow and from white corn; from ground and kneaded corn were moulded the arms and legs of man. Only damp, ground corn went into the flesh of our fathers..."

A great civilization developed in Middle-America on the basis of corn. The above quotations from the Popol Vuh, the Sacred Book of the ancient Quiché Maya, emphasize the importance ascribed to this staple grain by the Mayan populations. Nevertheless, our present knowledge of nutrition has demonstrated that corn, if not properly supplemented (17), is nutritionally very poor as a staple. As in most of the cereal grains, its protein concentration is low; in addition, corn proteins have a very low biological value. They are deficient in at least two of the essential amino acids, lysine and tryptophan. (5) Corn is therefore a poor dietary source of protein. Furthermore, the deficiency of tryptophan, plus a low concentration and/or

1. Dietary practices and nutritional status of the pre-Columbian Mayan Indians:

Corn, prepared in many different ways, was eaten at every meal, every day, as the most important food. In addition, the Mayans cultivated and consumed beans, vegetables, fruits, roots, tubers, cacao and spices. (15) Animal products, mainly meat and to a much lesser extent eggs, were apparently not a regular item in their dietary; they were consumed sporadically and on special occasions and obtained mainly by hunting. Very significant in this regard is the existence, in a Mayan dialect of the Guatemalan highlands, of a special word meaning "to eat meat" (tcibex) different from a general word meaning "to eat" (lobex). (14) Only the groups living on the coasts consumed fish. Milk was not used by these populations at all.

Our present knowledge of nutrition indicates that, with such a diet, it is difficult to satisfy the nutritional requirements for at least three important nutrients: protein, calcium and niacin. The deficiency of the last two nutrients (calcium and niacin) was corrected by the way in which corn was processed. For the preparation of "tortilla" and other corn products, the

cereal grain was first soaked overnight in lime water and then cooked in the same water. The purpose of this operation was to remove the husk. As a result, the corn products they prepared were very rich in calcium, for which they had no other adequate dietary sources. This method of processing also yielded products in which the concentration of tryptophane, in relation to the other amino acids, was higher and the niacin more available. (13) In this way, pellagra was prevented. We can only speculate on how this practice was adopted, but it is now evident that it was indispensable for their survival.

We are still left with the problem of how they satisfied their nutritional requirements for protein. As indicated, the main drawback of corn proteins is that they are deficient in some essential amino acids, particularly lysine and tryptophane. However, an amount of 39 g of corn protein per day, which satisfies the average protein requirement in an adult male of 65 Kg. of body weight, (18) does contain the needed amounts of all essential amino acids. (12) This amount of protein is provided by about 370 g of corn, which is not an unreasonable quantity for a man to consume per day.

In fact, Guatemalan Indians now consume around 500 g per day. In spite of the low biological value and low concentration of proteins in corn, it is therefore possible for adults to satisfy their protein needs with this cereal grain as the main staple, provided that sufficient quantities are consumed.

On the other hand, the situation is completely different for small children who have relatively higher protein requirements and in whom the need for essential amino acids is also higher. A two-year-old child, for instance, would need about 18 g of protein per day to satisfy its nitrogen requirements, if the protein has an ideal composition, with a biological value of 100%; in other words, if it is fully utilized. (18) With corn as the source of protein, the child would need 36% of protein, because the biological value of corn protein is about 50%. (4) This means that he would have to consume about 450 g of corn per day, or about 800 g of tortilla, to satisfy his protein needs. This is not only physically impossible but, in addition, the child would be receiving many more calories than he needs.

Small children definitely require sources of more highly concentrated protein with higher biological value. Of course, the Mayans did consume other foods besides corn. From what we know, the other important items in the regular daily diet were beans, fruits and vegetables, roots and tubers. Beans are a more concentrated source of protein, but the remaining food items, although contributing other needed nutrients, reduce the overall concentration of protein in the whole diet. The situation would again be one in which adults can satisfy their nutritional needs with such a diet, but small children cannot.

We have mentioned the fact that the Mayans did not consume milk, and that other animal products (meat and eggs) were not only eaten irregularly, but it is also very unlikely that they fed meat to infants and small children, as they had not developed the required processing facilities. There was only one solution, and they applied it; that is, prolonged lactation. The information that is now available indicates, in fact, that Mayan mothers breast-fed their children for at least three years, and frequently even longer. (16)



Our present knowledge indicates that breast milk can satisfy all the nutritional requirements of a baby up to approximately six months of age. It is probable that from about that age Mayan mothers started to give their children the regular family food items, but they continued to feed them breastmilk as an indispensable protein supplement. By the time they were completely weaned, after the age of three, they were already able to eat enough of the family food preparations to satisfy their nutritional requirements without the use of any special product, such as milk in the case of western civilization. It is also probable that during this transitional period, from about six months to 3 or 4 years of age, they did not grow to their full genetic potential. This could be the main reason for the small size of the adults, which is well documented. This reduction in body size, a consequence of environmental conditions and particularly of nutrient availability, can also, I believe, be considered as a mechanism of adaptation to those environmental conditions. In fact, with reduction in body size resulting in a similar reduction in nutrient requirements, they were better able to meet these requirements with available food items.

Unfortunately, we have not found information on the health conditions of children in those populations. Data on infant and early childhood mortality could be particularly illustrative. The information available indicates that, in general, the children were healthy - de Landa says in reference to this situation: "They grew wonderfully handsome and fat during the first two years. Later, their skin waxed dark with continuous bathing by mothers and many suns; they were nonetheless bonny and mischievous throughout childhood, never ceasing to wander about carrying bows and arrows and frolicking among themselves and thus they grew until they began to adopt the ways of the youths and to acquire a more exalted self-concept, and to leave behind the things of childhood." (15) We cannot say the same about the majority of pre-school children of Mayan descent today; they are usually apathetic and very frequently sick.

Another important deduction which we can make from the information on late weaning, that is, after three years of age, concerns birth spacing. The mothers probably had that much time at least between one birth and the next. To

what extent prolonged lactation contributed to this situation we still do not know. However, it was definitely very convenient, because only in this way could the mothers breast-feed their children as required. Accurate information on the nutritional condition of the adult population of the pre-Columbian Mayans is also non-existent, but all known facts indicate that, although small, they were in general strong and healthy. We can thus conclude that, in terms of nutrition, they did not have serious problems and were well adapted to environmental circumstances and the degree of their cultural and technological development. They did, however, undergo acute crises, and there is information on famines which they suffered when natural disasters (draughts or locust invasions) interfered with their corn crops.

2. Dietary Practices and Nutritional Condition of the Guatemalan Indians of Today

The dietary practices of the Guatemalan Indians of our time have not changed very much from those common to their ancestors, the pre-Columbian Mayas. The changes that have occurred, however, have gradually brought about the deterior-

ration of their diet and have upset the balance under which they lived.

Corn, processed in the same way, is still the main staple. It provides up to 80% of the calories and 70% of the proteins in the diet of the adult population. (9) Beans, vegetables and fruits complement their basic diet. (8) These products, however, now have a market value for which the more affluent non-Indian groups in the population are better able to compete. This factor applies even more to animal products. Wild animals have practically disappeared and hunting is no longer an important means of obtaining precious foods.

Domestic animals are now the only important source of animal products, and their market is very competitive. The majority of the Indian families raise some animals in their homes, mainly poultry and pigs. They are, however, more a source of badly needed cash than a source of food. These animals and their products are consumed only on very rare occasions; most of the time, they are sold. The meat most frequently consumed is beef, which has to be obtained from the market and therefore is one of the luxury items for which cash is needed.

The Indians have not only lost the sources of food which they could formerly obtain from the wild forests, but, in addition, the land which was available to them for cultivation has been drastically reduced in extension. Before the conquest, they had all the land they needed to produce their corn. Although the method of cultivation they used could not be considered very efficient today, its relative inadequacy was compensated by the availability of sufficient land for a system of rotation. They did not need to produce cash crops, which now compete with food crops for the best lands.

Under the present circumstances, the Indians are frequently forced to buy even their corn, which they had always produced before. Owing to their present poverty, this greater dependence on the market to satisfy food needs has caused their diet to deteriorate. Another change in the adult diet is the introduction of coffee, which has replaced the more nutritious corn and chocolate beverages which they used to drink. Distilled alcoholic beverages have also been incorporated into their consumption habits, with deleterious

effects from the nutritional and even more from the economic points of view.

Changes in dietary practices concerning small children are even more important, and they have been mainly the effect of cultural influences. In the first place, the period of weaning has been shortened. In pure Guatemalan Indians, prolonged lactation is still indispensable for the children's survival. Complete weaning in these populations now takes place at the age of two to two and one half years approximately (11). This time, already shorter than it used to be before the conquest, is being progressively reduced as the process of integration into the "ladino" culture advances; that is, as the Indians gradually adopt Western civilization. (11) This situation is very dangerous and it has caused acute nutritional problems, as these populations adopting earlier weaning most frequently are not prepared culturally and economically to feed their children properly during the critical post-weaning period. Their general ignorance in matters of hygiene, and their lack of the most elementary physical facilities in their homes, renders the

use of milk very dangerous. Furthermore, in the majority of cases they cannot afford to feed milk to their children.

The situation is further aggravated by the introduction, by foreign civilizations, of refined products with a much lower nutritive value than the foods they replace. This is particularly true and deleterious for the child during the post-weaning period. An example of this problem is the introduction of pure starch preparations from corn or manioc, now frequently used in the form of gruels for small children, instead of the more nutritious whole corn gruels of old. The Guatemalan Indians of today, therefore, seem to be in a less favorable balance with their environment than their ancestors used to be. Furthermore, their dietary practices have deteriorated. Food intake at the present time is barely adequate for adults and frequently inadequate for children. As a result, the environmental stresses, particularly the heavy burden of frequent infections in early childhood, have caused poor nutritional conditions for the general population, with frequent and severe cases of nutritional deficiencies found particularly in early childhood.

Briefly, the nutritional problems now affecting the Guatemalan Indians are the following: the most important is, by far, protein-calorie malnutrition (20). As indicated, it is the result of the synergistic effect of an insufficient and inadequate dietary intake and frequent infectious episodes, particularly diarrheal processes and the common diseases of childhood. (3) This condition contributes very significantly to the high mortality rates in infancy and early childhood. (2) It causes a relatively high prevalence of severe cases of protein-calorie malnutrition (kwashiorkor and marasmus) (1), usually fatal if not properly treated in a hospital. Even more important from the public health point of view are the chronic, subclinical forms of malnutrition, which usually go unrecognized. They are affecting the large majority of the population, both children and adults. (19) The consequences of this condition are not yet clear but there is information which suggests that it may be an important factor interfering with mental development in children (6) and with work performance in adults. (21) If these observations are confirmed, and studies are now underway to test this hypothesis, it is easy to understand the tremendous



significance of the problem in terms of the general well-being of these populations and of their participation in the social and economic development of their societies and countries.

Among the other nutritional problems, we can mention vitamin A deficiency, primarily the result of diets in which the sources of this vitamin are vegetable products with low biological activity, consumed in insufficient amounts. (8) This deficiency results in problems as serious as kerotomalacia, ending in complete blindness during early childhood. Riboflavin deficiency is among the most prevalent of the vitamin deficiencies (8). It is closely interrelated with protein deficiency, since the adequate dietary sources of both are frequently the same. Mucosal and cutaneous lesions, characteristic of this deficiency, are frequently seen. Its possible general effects are not clearly understood. Nutritional anemias are also highly prevalent; the deficiencies of iron and folic acid are the most frequently responsible factors, but again protein malnutrition also contributes

to their development (22). Anemias may also be important in restricting work capacity. Endemic goiter was also highly prevalent in Guatemala, but fortunately it has now been controlled with salt iodization in this country.(7)

The nutritional problems herein summarized are not affecting the Indian population in Guatemala specifically or preferentially. They are associated with low educational and economic levels and poor sanitary conditions. There are non-Indian populations in similar conditions, but practically all the Indian populations fall into this category. It is for them a problem of difficulty in proper integration and adaptation to new ecological and cultural conditions and social structure.

In my opinion, the situation described in relation to the Mayan Indians, and the changes that have come to pass, are applicable to a lesser or greater extent to other Indian groups now living with the realm of western civilization in the Latin American countries. On the other hand, many

Indian groups still living in isolation from the western culture and from the present Latin American societies have less serious nutritional problems; some of them seem to be living under excellent conditions in this regard. These groups are still very dependent on hunting and fishing to satisfy their food needs, and still follow the "primitive" practice of raising their children at the mother's breast for as long as possible. They do not have at their disposal the "benefits" of civilization, such as the practice of bottle feeding and very inadequate weaning foods. We must consider the situation of these groups of primitive Indians as they are being incorporated into our societies, with the hope that we will find the means to prevent or minimize the possible deterioration which, in terms of nutrition, they may be exposed to in the process of integration.

SUMMARY

An analysis of the dietary pattern and the nutritional condition of the Mayan populations, before the conquest and at the present time, indicates that although corn constitutes the main staple for both population groups, the pre-Columbian Mayas were probably better adapted to ecological conditions. The availability of game/or hunting, a greater availability of land for cultivation, the lack of competitive markets, prolonged lactation of their infants and the lack of industrialized products were among the factors that favored the diet and resulted in better nutrition of the Indians at that time. The socio-cultural and economic changes that have taken place after the conquest have deteriorated the diet of the present Indians and resulted in serious nutritional problems, among which protein deficiency, particularly in small children, is the most important. This experience should be considered both in trying to solve the nutritional problems of this and other American Indian groups now living with populations of western culture and in preventing similar changes that could occur as the still primitive and isolated Indian groups are incorporated into the present Latin American culture.

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