

THE NUTRITION PROBLEM IN LATIN AMERICA: DEFINITION, CAUSES, AND REMEDIAL ACTIONS^{1,2}

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Clinical, dietary, and biochemical surveys have shown that on the whole Latin America faces a serious nutrition problem. This article reviews the nature and extent of that problem, especially its effects on maternal and child health, and suggests various approaches for researchers, health professionals, and political authorities that would contribute to its resolution.

Nutrition surveys in many Western Hemisphere countries have demonstrated the severity and magnitude of a Latin American nutrition problem (1-11) that contributes to high rates of morbidity, mortality (12), retarded development (13), reduced working capacity, and consequent higher levels of health expenditure (14,15). The problem influences not only prevailing levels of public health and well-being, but also public capacity for social and economic development.

The present study points out the Latin American countries' most important mal-nourishment problems—principally those affecting mothers and young children—and suggests courses of action to help resolve them.

The Nutrition Problem in Latin America

Although the countries of the region differ markedly in many respects, the results of clinical, dietary, and biochemical surveys indicate that on the whole the people of Latin America have a diet which is notably deficient in calories, proteins, vitamin A, riboflavin, iron, folates and iodine (1-11). These deficiencies are especially important in the population's poor socioeconomic strata, both urban and rural (16-19); but wherever they exist they are likely to have a dramatic impact upon maternal and child health.

Maternal and Child Health Services

In practically all societies a woman is primarily responsible for care of her child and is regarded as an essential link between it and the health services, at least from the child's conception until its fourth or fifth year of age. For this reason maternal and child health services must necessarily be combined.

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Mothers and children in a malnutrition-prone rural setting. Current trends suggest that undernourishment and malnutrition will worsen in Latin America unless major economic and social readjustments are made. (Photo: INCAP)

Home Diet Characteristics

Various studies have been made over the past decade to estimate the intake of nutrients by pregnant women belonging to Latin American population groups with low socioeconomic status (1,20-22). These studies indicate a tendency to increase the intake of food of vegetable origin in the second and third trimesters of pregnancy—a tendency that diminishes after childbirth. Despite this increase, review of all the studies on this subject shows continuing deficiencies in the diets of the pregnant women involved, especially with regard to calories, vitamin A, riboflavin, and iron. For example, Table 1 shows the situation prevailing in a poor rural community where the data indicate that caloric defi-

ciency exceeded protein deficiency. In this community the degree of dietary insufficiency experienced by pregnant mothers and preschool children was similar—in terms of intake levels recommended for both groups—providing added reason for regarding the nutrition problems of pregnant women in a community as indicative of the nutrition problem's seriousness in the community as a whole.

Biochemical Surveys

Of all pregnant women studied, only a small proportion of those from low socioeconomic strata have shown adequate excretion of riboflavin (20,23). Moreover, blood samples have shown low levels of vitamin A, carotenes, and hemoglobin, as

Table 1. Sufficiency of average daily dietary intake in a rural Guatemalan population with a low socioeconomic profile.

Nutrient		Trimester of pregnancy		
		1 (n = 20)	2 (n = 57)	3 (n = 57)
Energy	Intake (kCal)	1,418	1,723	1,819
	Sufficiency (%) ^a	64	72	76
Protein	Intake (g)	39	50	54
	Sufficiency (%) ^a	87	83	90
Animal protein	Intake (g)	8	7	9
Calcium	Intake (mg)	768	967	1,012
	Sufficiency (%) ^a	171	88	92
Iron	Intake (mg)	17	17	20
	Sufficiency (%) ^a	61	61	71
Riboflavin	Intake (mg)	0.68	0.71	0.79
	Sufficiency (%) ^a	57	55	61
Thiamine	Intake (mg)	0.81	0.99	1.07
	Sufficiency (%) ^a	90	99	107
Vitamin A	Intake (mg)	0.47	0.53	0.75
	Sufficiency (%) ^a	36	33	47
Vitamin C	Intake (mg)	36	29	39
	Sufficiency (%) ^a	120	58	78

^aPercentage of the daily intake specifically recommended for pregnant women (1).

Table 2. Levels of valine and glycine, and the valine/glycine quotient, in blood plasma from population groups with different nutritional features.

Group	No. of subjects	Valine (mg/100 ml)	Glycine (mg/100 ml)	Valine/glycine quotient
I. Pregnant women, ^a Guatemala City (UHSEL) ^d	5	1.491	1.210	1.298
II. Pregnant women, San Antonio La Paz, Guatemala (RLSEL) ^e	6	0.998	1.599	0.635
III. Non-pregnant women, San Antonio La Paz, Guatemala (RLSEL) ^e	7	1.447	2.643	0.587
IV. Newborns, ^b Guatemala City (UHSEL) ^d	5	2.392	2.531	0.947
V. Newborns, ^c San Antonio La Paz, Guatemala (RLSEL) ^e	6	2.002	2.970	0.710
VI. Well-nourished children 3-6 years of age	5	1.579	1.606	1.093
VII. Children with kwashiorkor, 2-6 years of age	6	0.275	1.577	0.184
VIII. Children with marasmus, 1 year of age	1 1	0.456 0.584	1.266 1.596	0.360 0.366

^aIn their ninth month of pregnancy.^bSample taken from the umbilical cord of subjects born to mothers in group I.^cSample taken from the umbilical cord of subjects born to mothers in group II.^dUHSEL = Urban, high socioeconomic level.^eRLSEL = Rural, low socioeconomic level.

well as low hematocrits (20). No significant differences were observed in levels of serum proteins (20, 24-26); in all cases a certain tendency toward higher concentrations of serum proteins was observed in women from less privileged groups, a finding attributed to smaller blood volume increases during pregnancy than in well-nourished groups (20). On the other hand, data on free amino acids showed a decline in the valine/glycine ratio. Table 2 illustrates these findings, as well as a parallel pattern detected in blood from newborns' umbilical cords (21, 24, 26). Figure 1 depicts complementary data showing an abnormally high ratio of nonessential to essential amino acids in plasma from pregnant women and newborns in groups with low socioeconomic levels (24).

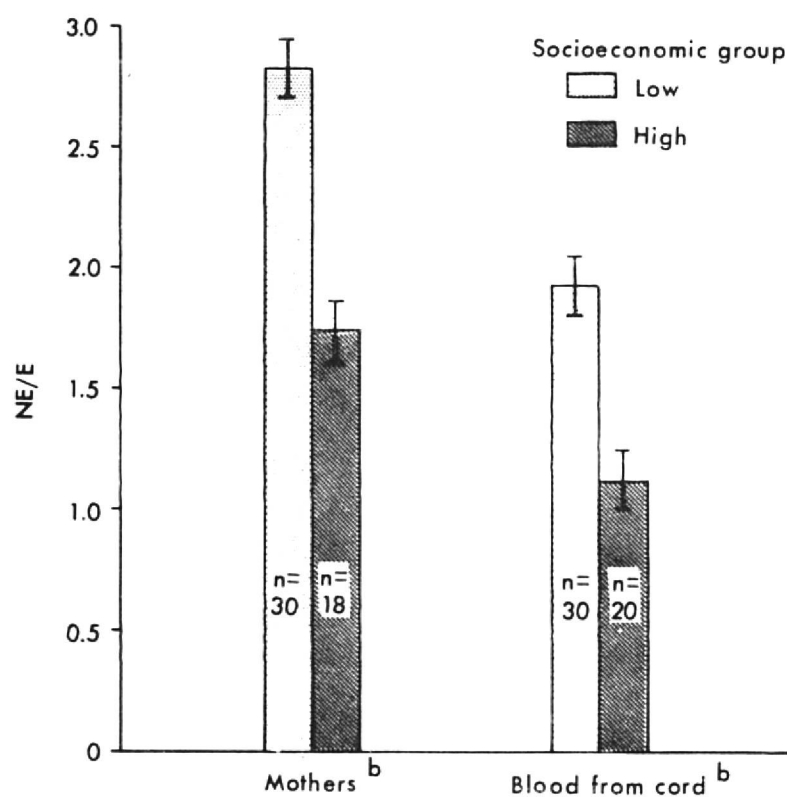
Serum levels of vitamin A follow a similar pattern. As Figure 2 shows, these levels tend to be low in mothers and newborns from groups with low socioeconomic status. The magnitude of the differences, however, is

less for the children (umbilical cord samples) than for the mothers, a fact suggesting that at least in the case of vitamin A there exists a placental mechanism for protection of the fetus (27).

Figure 3 provides information on the magnitudes of iron deficiency in Central America and Panama, as indicated by the proportions of women found to have deficient (less than 15 per cent) transferrin saturation. It is clear that at least 50 per cent of the pregnant women sampled were deficient (1, 28, 29). Folate deficiencies also exist, a fact which becomes more evident when iron is administered to pregnant women. It has been found, for example, that sera from 58 per cent of a sample of pregnant women with low socioeconomic status had low or deficient folate levels (28, 29). This finding merits attention in view of increasing evidence that folate deficiency during pregnancy adversely affects fetal growth (30).

In many poor areas of Latin America

Figure 1. Ratio of nonessential to essential (NE/E) amino acids in the sera of pregnant women^a and in blood from the umbilical cord.

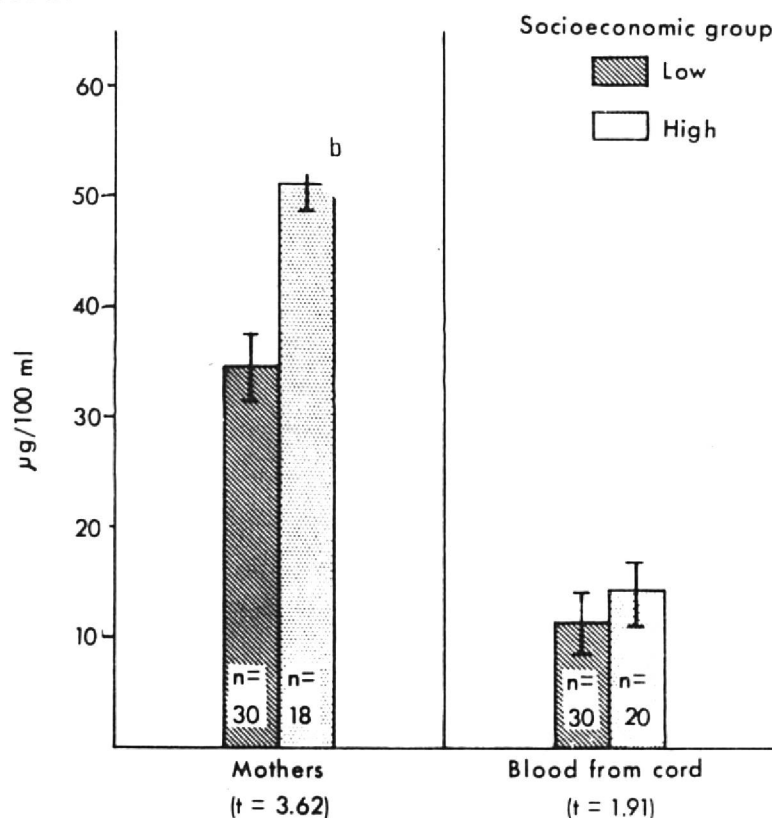


Source: INCAP.

^a Sample obtained at delivery.

^b $p < 0.01$

Figure 2. Serum vitamin A levels found in pregnant women^a and in blood from the umbilical cord.

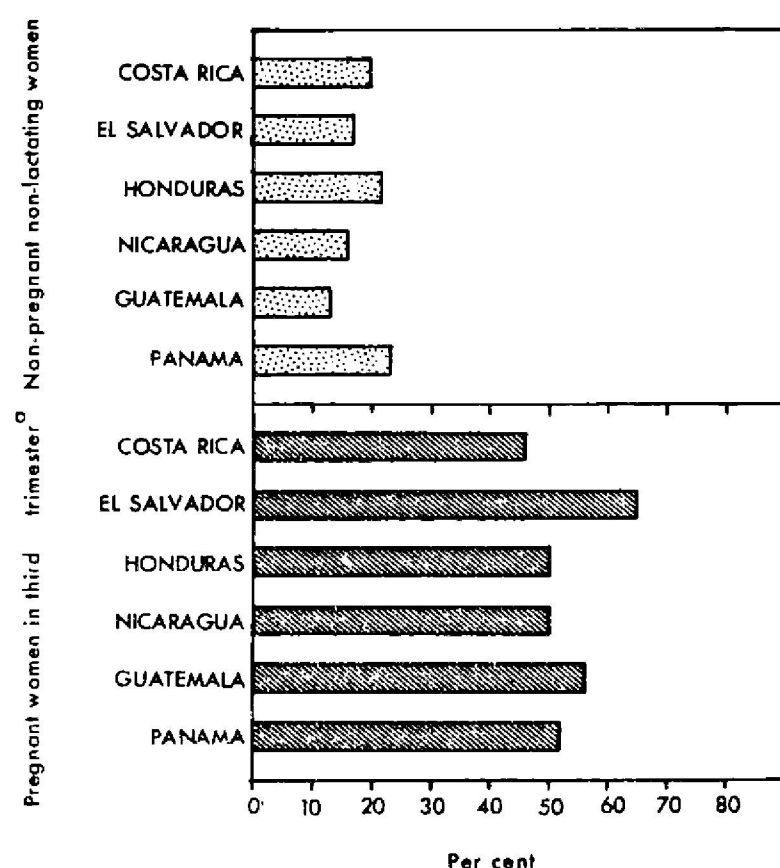


Source: INCAP.

^a At delivery.

^b $p < 0.01$

Figure 3. Percentages of pregnant women from Central America and Panama with deficient (<15%) transferrin saturation (1965-1966)



Source: INCAP.

^aThe Panamanian women were tested in the second trimester.

where malnutrition is prevalent, pregnant women suffer from nutrient deficits that are qualitatively similar but of greater magnitude than those observed in the general population. At the present time the most limiting nutrients are calories, proteins, vitamin A, riboflavin, iron, and folates. Iodine should be added to this list in areas where goiter is endemic. Still more important, the available evidence indicates that in many ways the nutritional status of the fetus reflects deficiencies experienced by the mother.

In sum, maternal nutrition has great public health significance because of its impact, not only upon mothers but also upon their unborn children. Pregnancy brings with it an increased need for nutrients, and this should be kept in mind when planning public health programs.

Causes of the Nutrition Problem

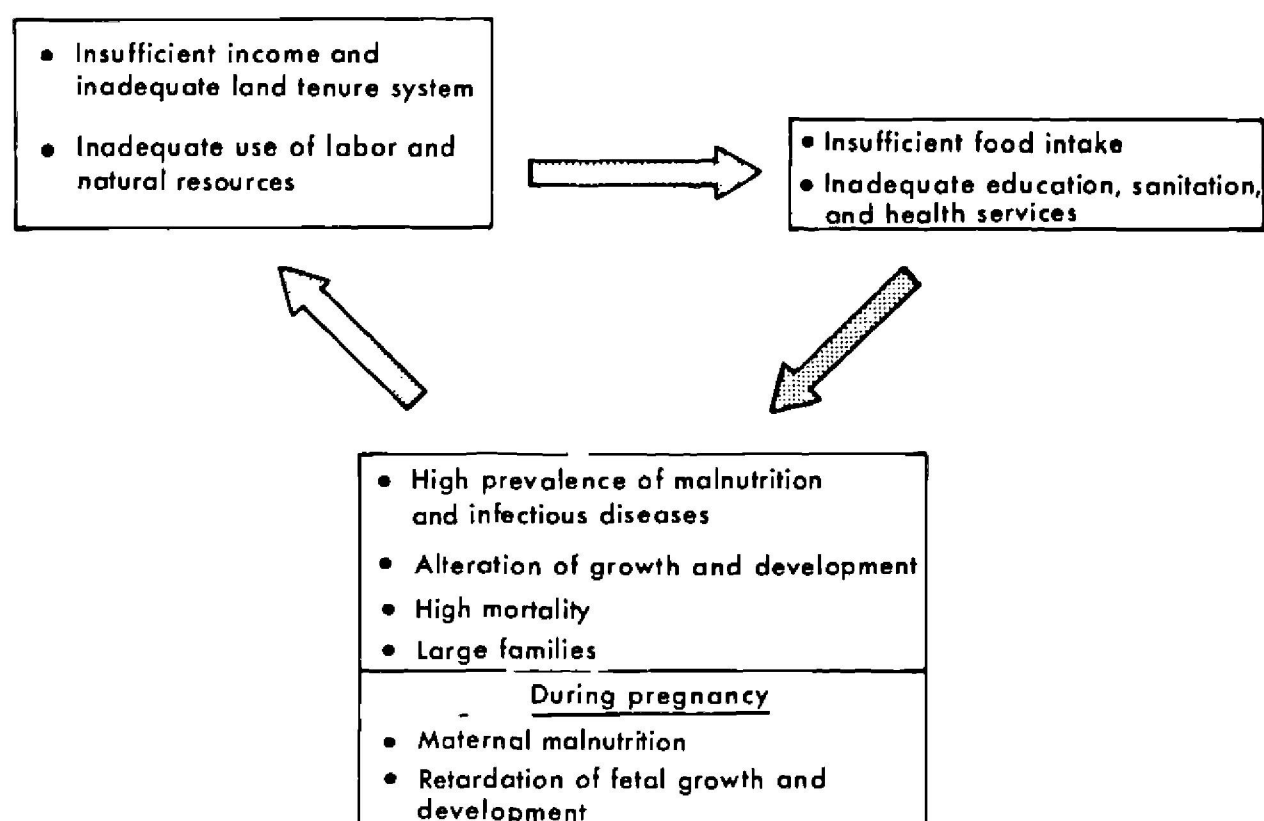
Poverty

Poverty is the principal cause of malnutrition. In the developing countries, as in many other societies around the world, a population's socioeconomic level is closely related to the prevalence of malnutrition in mothers and children (17, 19, 20, 27). Thus, mothers in poor rural populations ingest notably fewer proteins and calories—and have notably less weight gain—than mothers living at relatively high socioeconomic levels. Analogous comparisons in terms of infant birth-weights yield similar results. That is, in the developing countries the proportion of children with low birth-weights is much higher among socioeconomically depressed urban and rural groups than among groups living at high socioeconomic levels (17, 18).

A Model of Interrelationships

Most of the Latin American countries share a number of common features: Low per capita gross national product, total dependence on external markets for primary products, inefficient systems of land tenure, and rudimentary technology. Their societies are also characterized by marked differences between upper and lower socioeconomic strata, especially in terms of purchasing power, access to foods, and conditions of environmental sanitation. For these reasons, malnutrition and infectious diseases are very prevalent, especially among mothers and young children. Figure 4 shows a simplified model of the relationship between socioeconomic factors, malnutrition, infection, and retarded development. Maternal malnutrition, whether caused directly by dietary deficiencies or indirectly by progressive nutrient losses (owing to physical activity or infectious diseases), is a major cause of retarded growth and development from the fetal period onward—

Figure 4. Socioeconomic determinants of maternal nutrition and fetal growth in pre-industrial societies.



Source: INCAP.

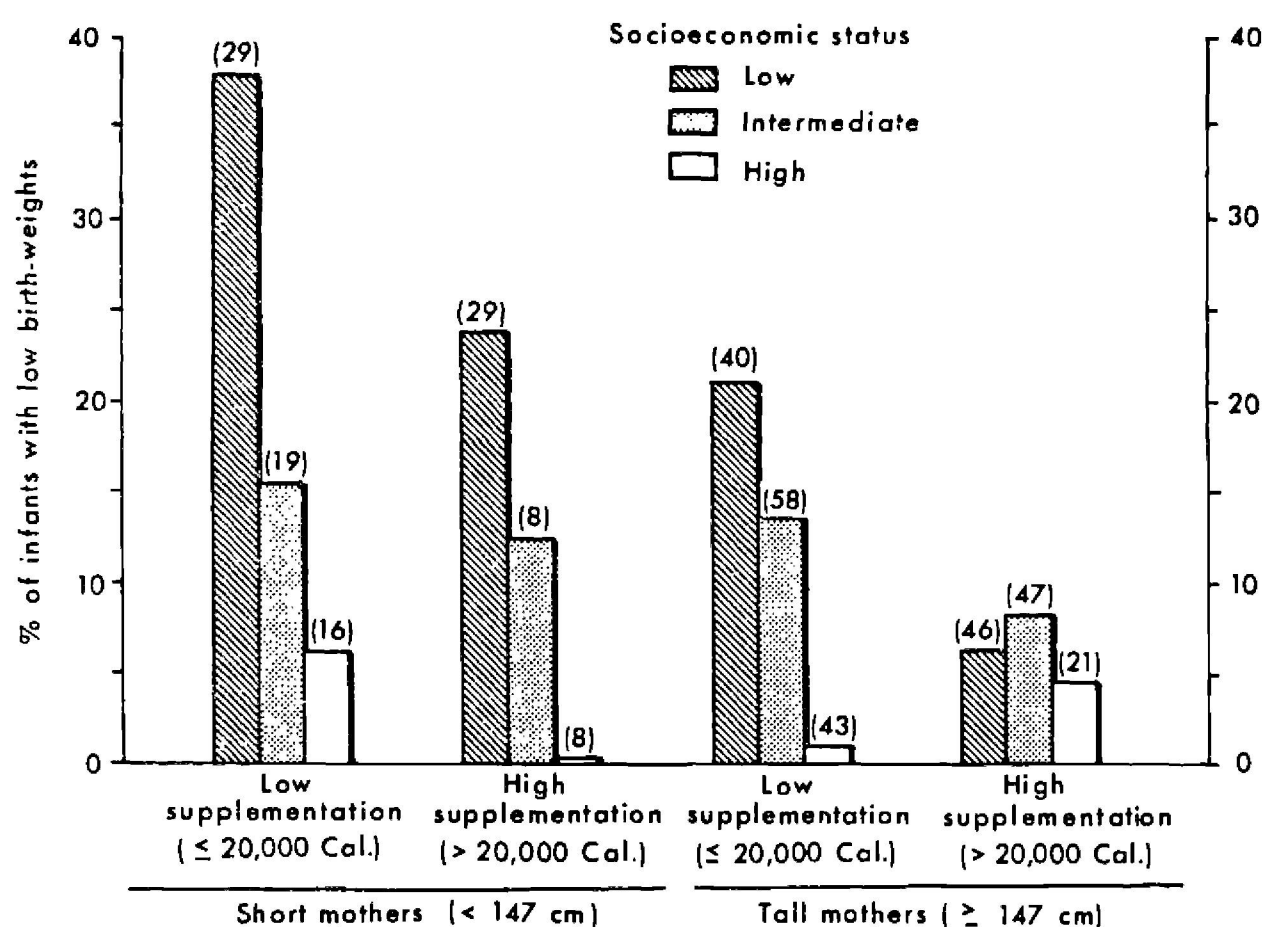
retarded growth and development that tends to perpetuate itself from generation to generation in a vicious circle of poverty—malnutrition—poverty.

What is more, the dynamics of the demographic variables and the manner in which economic activities evolve suggests that present conditions of undernourishment and malnutrition will worsen unless major economic and social adjustments are made in the developing countries (31, 32). Modification of economic, social, and political factors bearing directly upon the interrelationships just described will depend on particular circumstances prevailing in each country. But this much is clear: So long as these factors are not modified, more than 100 million Latin Americans will continue to suffer the consequences of malnutrition at a cost that is unjustified in human terms and that constitutes a formidable obstacle to social development of the region.

The Poverty Cycle

The information in Figure 5 is based on a study conducted in four rural Guatemalan villages (17). The cited findings help to bring out relationships between low birth-weight and three other variables: maternal height, caloric supplementation during pregnancy, and socioeconomic status. As indicated, the association between relative socioeconomic level and low infant birth-weight was very marked among mothers of short stature with low caloric supplementation. On the other hand, there appears to have been no association between relative socioeconomic level and low infant birth-weight among tall mothers with high caloric supplementation. The two middle groups (tall mothers with low supplementation and short mothers with high supplementation) experienced intermediate de-

Figure 5. Proportions of low birth-weight babies in different maternal groups, defined by socioeconomic level, supplementation received during pregnancy, and maternal height.



Source : INCAP.

No. of cases in parentheses.

$p < 0.05$

degrees of association between low infant birth-weight and socioeconomic status.

A reasonable interpretation of these data would be to infer that the score on the socioeconomic scale reflects cultural and economic conditions that cause malnutrition and disease in the mother, and that these, in turn, cause retarded fetal growth. In other words, both a mother's nutritional history and her current nutrition are important factors that mediate the causal relationship that exists between socioeconomic level and retarded growth.

Political Action

In the same way that factors causing malnutrition originate in diverse sectors, so

many different groups are affected by the consequences of malnutrition. It must therefore be recognized that the greatest obstacle to improving the state of nutrition in Latin America is the insufficient degree of effective political will to implement the required multisectoral actions. This is the result of insufficient understanding of the problem and its various possible solutions, as well as frequent apparent incompatibility between the interests of those responsible for governmental authority in a country and those affected by the problem.

Recommended Courses of Action

The remainder of this article will focus on courses of action that we regard as

important and that we believe would help alleviate the nutrition problem in Latin America.

Socioeconomic Development

Malnutrition is primarily attributable to poverty, but social and economic development in the Latin American countries tends to be rather gradual; therefore, improvement of the population's nutritional status cannot be left exclusively to this process. It suffices to point out that if current economic trends continue, none of the Central American countries will have solved its nutrition problem by 1990 (31), and that many countries elsewhere in Latin America are in a similar position. At the same time, although a majority of the Latin American countries have developed plans for their health, education, and agriculture sectors, few countries enjoy effective intersectoral coordination; the plans that do exist rarely spell out nutrition goals; and the logical result is that insufficient emphasis is placed on the nutritional aspects of the development programs involved.

It follows that besides accelerating the social and economic development process, vital steps to improve nutrition must be taken; for without such measures it is unlikely that the development levels specified will be achieved (33). This course of action would be feasible if an effective political decision imposing coordinated planning on the different sectors were made at the highest level. Such planning, however, should be regarded as an activity which only acquires significance once it reaches the stage of effective application and evaluation.

These circumstances make it advisable to establish an ascending set of goals for improvement of nutritional status in the Latin American countries, with special emphasis on the poorest population strata—these being goals that must be achieved progressively before an advanced stage of socio-

economic development can be reached. Attaining these goals will naturally involve expense and, in many cases, a reduction of other programs' budgets. Nevertheless, the cost is justified by the favorable impact that nutritional improvement will have upon the rate of acceleration of the development process (31). Viewed in this light, measures to raise the population's nutritional status become an integral and vital part of each country's plans for socioeconomic development.

Role of the Health Sector

The health sector must promote the intersectoral planning of nutrition programs and must participate in their implementation. In addition, it must be responsible for diagnosis and surveillance of the population's nutritional status and for formulation of recommendations on food consumption and nutrient requirements. Such recommendations should include food ration models for both individuals and groups (34,35), simple norms for food quality control, and practical guidance on the prevention and treatment of specific deficiency diseases.

For example, in the preparation of nutrition recommendations for pregnant women, it should be clearly understood that the maternal diet must provide the nutrients needed to keep both mother and fetus in good health, to permit adequate maternal lactation, and to maintain maternal health in the interval between pregnancies (36). It is also worth remembering that satisfactory early nutrition of a future mother—from conception to adolescence—plays a key role in satisfactory intrauterine development of her future child (26).

Table 3 shows how pregnant mothers in a rural Guatemalan village can satisfy their need for additional nutrients by using food products available in the community. The figures cited indicate that if locally avail-

Table 3. Daily dietary "cost" of pregnancy in an indigenous rural community of the Guatemalan *altiplano*, 1972.

Nutrient	Beans 4 tablespoons (cooked)	Tortillas (yellow) 2 units	Cheese 15 g	Tomatoes 1/2 unit	Cabbage 1 leaf	Total	Recommended increase during pregnancy ^a
Energy (kCal)	108	186	65	5	6	370	350
Protein (g)	7	5	4	0.2	0.4	16.6	15.0
Calcium (mg)	28	142	341	1	10	522	650
Iron (mg)	2.4	2.2	0.2	0.1	0.2	5.1	0
Thiamine (mg)	0.2	0.1	0.05	0.01	0.01	0.37	0.20
Riboflavin (mg)	0.06	0.04	0.01	0.01	0.01	0.13	0.2
Niacin (mg)	0.6	1.0	0	0.1	0.1	1.8	2.3
Retinol (vitamin A, ug)	0	14	29	13	2	58	150
Cost (U.S. cents)	1.3	1.0	1.0	0.5	0	3.8	

^aINCAP, 1973.

able foods are used, the additional investment required is some 4 cents per day, i.e., US\$7.20 for each pregnancy, assuming the increased intake occurs during the last two trimesters alone. A further significant point is that vitamin A is the only nutrient that could not be obtained in sufficient quantity from those locally available foods. Other strategies—such as provision of additional foods, supplementation, or fortification—would be needed to ensure adequate vitamin A intake for pregnant women in this population (37).

The health sector should also promote and participate in evaluation of all measures aimed at improving public nutrition. Such evaluation is essential for determining the effectiveness, efficiency, and side-effects of the programs selected and for deciding what changes are needed.

Although there are great differences in the scope and type of nutrition problems faced by the Latin American countries, they are everywhere most urgent among the poorest segments of the population. It follows that nutrition activities should form an integral part of primary health services and community development programs for least-favored population groups. In this regard, active participation by community members is vital to the effectiveness of such

programs; therefore, all community actions should go hand in hand with educational activities that are based on the cultural patterns of each community and are oriented to practical solution of community problems.

The physician, the nurse, and the health auxiliary all have important roles to play in development of such activities, so it is imperative to motivate and educate these personnel, and to provide them with a sound background in practical nutrition.

In addition, the nutritionist should be considered a key member of the team responsible for coordinating intersectoral activities. This professional should act as an agent for change, encouraging wider understanding of the nutrition problem in all sectors of government—including the health sector.

Research Priorities

The principal efforts in this area should be devoted to applying existing knowledge for the benefit of the population, in a manner best suited to conditions in each country.

It should be recognized that the national nutrition surveys made over the past two decades have generally proved of little value in planning action programs. That is, in

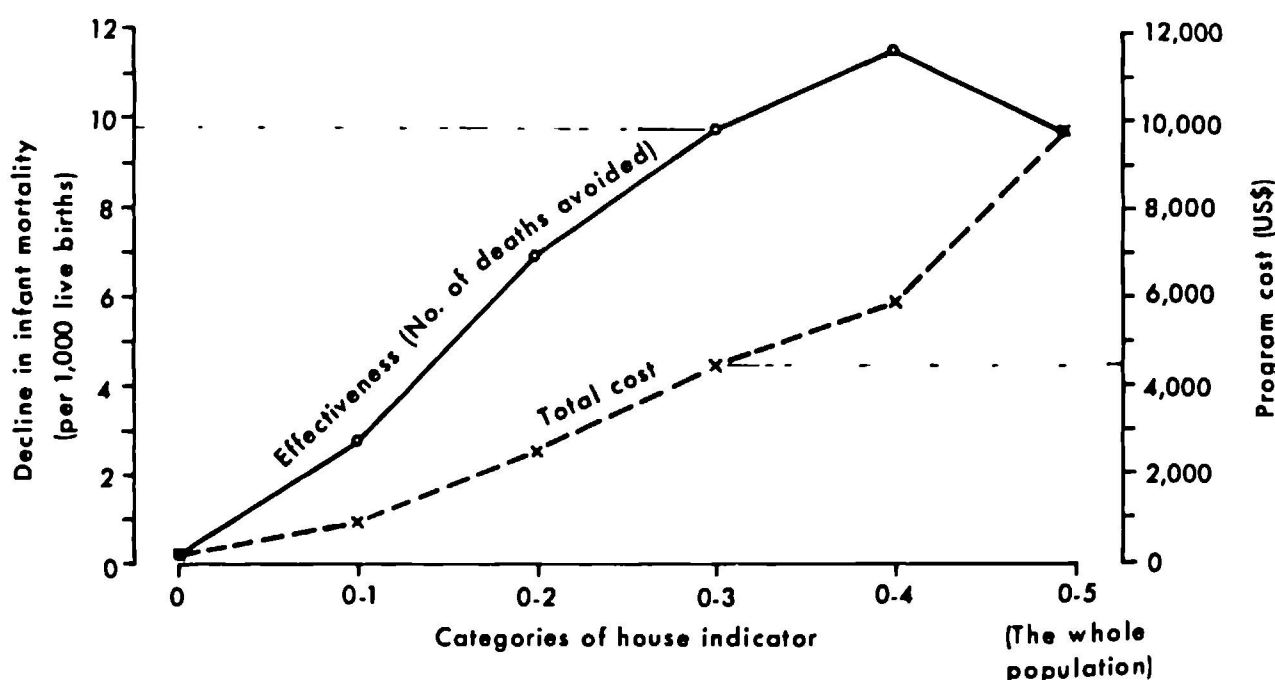
each specific case they have often failed to provide an understanding, in concrete terms, of the problem's magnitude, the population segments at highest risk of malnutrition, and the most important conditioning factors involved. Moreover, the data have generally been presented in the form of national averages. This can lead to serious error, since the intakes of individuals tend to vary greatly from this average figure. The essential thing is to show what is happening in the different socioeconomic categories in each country. It is this information that provides the policy-maker and planner with the knowledge needed to qualitatively and quantitatively identify the large disparities that exist between social classes in different geo-economic zones, to point out the importance of certain basic foods for groups with low socioeconomic levels, and to take the most appropriate decisions in each case. All of this makes it essential to develop simple nutrition indicators and to use them as regular components in conducting continuous surveillance of each country's nutrition and health status.

A further important priority for any research undertaking is the need to evaluate action programs and their cost in terms of benefits derived.

Figure 6 shows how indicators can be employed to help measure cost-effectiveness, using a program designed to reduce the prevalence of low birth-weight and infant mortality as an example. This example assumes that a total of 1,000 pregnant women participated, that home characteristics were used as the risk indicator, and that the program's impact was measured in terms of reduced infant mortality.

Each mother's house indicator score was based on the materials used to make the floor, walls, and ceiling, as well as on the number of rooms in the family home and the relative quality (within the village) of the home environment. For example, a score of "0" reflected very rudimentary conditions (walls made of straw, only one room, a ceiling made of palm fronds), while a score of "5" indicated a home of top quality by the standards of the village (floors, walls, and ceilings of brick and

Figure 6. Variations in the effectiveness and cost of a program^a projected according to the house categories used to identify women likely to bear infants with low birth-weights.



Source: INCAP.

^a Estimated for a group of 1,000 women.

cement, and more than three rooms—including a kitchen, bedroom, and dining room—in relatively adequate condition).

As may be seen, the number of deaths the program could prevent increased as the upper limit of the "house" standard used to select high-risk groups was raised, until finally no further increase in program effectiveness was observed. If no such procedure were followed, the total cost of the program might continue increasing steadily, even after its effectiveness had levelled off. More specifically, if we use categories 0 to 3 on the "house" axis to identify women at high risk of malnutrition and apply the program exclusively to this group, the effect on the entire population would be similar to that obtained if the program itself were applied to the whole population. As the cost of applying the program exclusively to the high-risk group is only half of the cost of covering the whole population, the use of the "house" indicator in this case should

make it possible to obtain about twice the anticipated benefits at the same cost (38).

There is also a need for researchers to examine ways that simple and easily applied technological developments can improve food availability and nutritional quality, employing knowledge drawn from genetics and the agricultural sciences.

Overall, nutritional research in Latin America should place more emphasis on activities that can furnish the various government sectors with information needed to diagnose the nutrition problem, with recommendations on food intake that will serve to guide policies affecting food availability and acquisition, and with simple techniques for evaluating the effectiveness of current programs. Such contributions, in our judgment, will facilitate the adoption and implementation of decisions helping to improve the nutritional status of the Latin American population.

SUMMARY

Results of clinical, dietary, and biochemical surveys indicate that on the whole the people of Latin America have a diet notably deficient in calories, proteins, vitamin A, riboflavin, iron, folates, and iodine. These deficiencies are likely to have an especially strong impact on maternal and child health, especially since pregnant women in poor areas often suffer from nutrient deficits that are qualitatively similar but larger than those observed in the general population. Equally important, available evidence indicates that in many ways the nutritional status of the fetus reflects deficiencies experienced by its mother.

A close relationship also exists between poverty and malnutrition. Thus retarded growth and development stemming from maternal malnutrition tends to perpetuate itself from generation to generation in a vicious circle of poverty-malnutrition-poverty.

Current economic and demographic trends in Latin America suggest that present conditions of undernourishment and malnutrition will wors-

en unless major economic and social adjustments are made. What specific modifications of economic, social, and political factors are needed will of course depend on each country's particular situation, but this much is clear: So long as these factors are not modified, over 100 million Latin Americans will continue to suffer the consequences of malnutrition at a cost that is unjustified in human terms and that constitutes a formidable obstacle to social development of the region.

Social and economic development tends to be a rather gradual process in the Latin American countries, and the development programs involved tend to place insufficient emphasis on nutrition. It therefore follows that besides accelerating this development process, vital steps to improve nutrition must be taken; for without such measures it is unlikely that the development goals specified will be achieved.

Within this context, the health sector must promote intersectoral planning of nutrition programs and must participate in their imple-

mentation. It should also work to ensure that nutrition activities form an integral part of primary health services and community development programs for least-favored groups.

Regarding nutritional research, greater emphasis should be placed on work that can furnish governments with information needed to diagnose the nutrition problem, with recommenda-

tions on food intake that can help guide policies on food acquisition and availability, and with simple techniques for evaluating current programs. For it is contributions in these areas that will facilitate adoption and implementation of decisions helping to improve the nutritional status of the Latin American population.

REFERENCES

- (1) Instituto de Nutrición de Centro América y Panamá (INCAP); Oficina de Investigaciones Internacionales de los Institutos Nacionales de Salud (EEUU); ministerios de salud de los seis países miembros. *Evaluación nutricional de la población de Centro América y Panamá: Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua y Panamá* (six volumes). INCAP, Guatemala, 1969.
- (2) Flores, M., M. T. Menchú, and G. Arroyave. Ingesta de micronutrientes en las áreas rurales de Centro América y Panamá. *Arch Latinoam Nutr* 19:265-278, 1969.
- (3) Institute of Nutrition of Central America and Panama (INCAP), and Nutrition Program, U.S. Center for Disease Control. *Nutritional Evaluation of the Population of Central America and Panama: Regional Summary*. DHEW Publication No. HSM-72-8120; U.S. Department of Health, Education, and Welfare; Washington, 1972.
- (4) Interdepartmental Committee on Nutrition for National Defense. *Bolivia: Nutrition Survey*. U.S. Government Printing Office, Washington, 1964.
- (5) Pan American Health Organization. *The National Food and Nutrition Survey of Guyana*. PAHO Scientific Publication No. 323, Washington, 1976.
- (6) Interdepartmental Committee on Nutrition for National Defense. *Peru: Nutrition Survey of the Armed Forces, February-May 1959*. U.S. Government Printing Office, Washington, 1960.
- (7) Interdepartmental Committee on Nutrition for National Defense. *Colombia: Nutrition Survey, May-August 1960*. U.S. Government Printing Office, Washington, 1961.
- (8) Interdepartmental Committee on Nutrition for National Defense. *Chile: Nutrition Survey, March-June 1960*. U.S. Government Printing Office, Washington, 1961.
- (9) Interdepartmental Committee on Nutrition for National Defense. *The West Indies, Trinidad and Tobago, St. Lucia, St. Christopher, Nevis, and Anguilla: Nutrition Survey, August-September 1961*. U.S. Government Printing Office, Washington, 1962.
- (10) Interdepartmental Committee on Nutrition for National Defense. *Venezuela: Nutrition Survey, May-June 1963*. U.S. Government Printing Office, Washington, 1964.
- (11) Interdepartmental Committee on Nutrition for National Defense. *Ecuador: Nutrition Survey, July-September 1959*. U.S. Government Printing Office, Washington, 1960.
- (12) Puffer, R. R., and C. V. Serrano. *Patterns of Mortality in Childhood: Report of the Inter-American Investigation of Mortality in Childhood*. PAHO Scientific Publication No. 262, Pan American Health Organization, Washington, 1973.
- (13) Lechtig, A., H. Delgado, R. Martorell, C. Yarbrough, and R. E. Klein. Effect of maternal nutrition on infants' growth and mortality in a developing country. In: *Perinatal Medicine* (Fifth European Congress of Perinatal Medicine, Uppsala, Sweden, 9-12 June, 1976). Gosta Rooth and Lars-Eric Bratteby (eds.), Stockholm, Sweden, Almqvist and Wiksell International, Stockholm, Sweden, 1976, pp. 208-220.
- (14) Piñera, S., and M. Selowsky. *The Economic Cost of the "Internal" Brain Drain: Its Magnitude in Developing Countries*. World Bank Staff Working Paper No. 243, The World Bank, Washington, 1976.
- (15) Selowsky, M., and L. Taylor. The economics of malnourished children: An example of this investment in human capital. *Economic Development and Cultural Change* 22(1), 1973.
- (16) Arroyave, G., A. Méndez, and W. Ascoli. Relación entre algunos índices bioquímicos del estado nutricional y nivel socio-cultural de las familias en el área rural de Centro América. *Arch Latinoam Nutr* 20:195-216, 1970.

- (17) Lechtig, A., H. Delgado, R. E. Lasky, R. E. Klein, P. L. Engle, C. Yarbrough, and J-P. Habicht. Maternal nutrition and fetal growth in developing societies: Socioeconomic factors. *Am J Dis Child* 129:434-437, 1975.
- (18) Lechtig, A., H. Delgado, R. Martorell, C. Yarbrough, and R. E. Klein. Relación entre aspectos socioeconómicos y peso al nacer. In: *Problemas perinatales del parto prematuro y del retardo de crecimiento intrauterino*. O. Althabe and S. Schwarcz (eds.), Editorial "El Ateneo," Buenos Aires, Argentina (In press).
- (19) Arroyave, G. Nutrition in pregnancy: Studies in Central America and Panama. *Arch Latinoam Nutr* 26:129-160, 1976.
- (20) Arroyave, G., W. H. Hicks, D. L. King, M. A. Guzmán, M. Flores, and N.S. Scrimshaw. Comparación de algunos datos bioquímico-nutricionales obtenidos de mujeres embarazadas procedentes de dos niveles socio-económicos de Guatemala. *Rev Col Méd* (Guatemala) 11:80-87, 1960.
- (21) Beteta, C. E. *Embarazo y nutrición (estudio longitudinal en mujeres embarazadas pertenecientes al grupo rural de bajo nivel socio-económico de Guatemala)*. Graduate thesis in medicine and surgery, School of Medical Sciences, San Carlos University, Guatemala, November 1963.
- (22) Lechtig, A., J-P. Habicht, E. de León, G. Guzmán, and M. Flores. Influencia de la nutrición materna sobre el crecimiento fetal en poblaciones rurales de Guatemala: I. Aspectos dietéticos. *Arch Latinoam Nutr* 22:101-115, 1972.
- (23) Arroyave, G., S. Valenzuela, and A. Faillace. Investigación de deficiencia de riboflavina en mujeres embarazadas de la ciudad de Guatemala. *Rev Col Méd* (Guatemala) 9:7-13, 1958.
- (24) Arroyave, G. Nutrition in pregnancy in Central America and Panama. *Am J Dis Child* 129:427-430, 1975.
- (25) Beaton, G. H., G. Arroyave, and M. Flores. Alterations in serum proteins during pregnancy and lactation in urban and rural populations in Guatemala. *Am J Clin Nutr* 14:269-279, 1964.
- (26) Lechtig, A., M. Béhar, G. Arroyave, J-P. Habicht, C. Yarbrough, F. E. Viteri, L. J. Mata, H. Delgado, J. Filer, and R. E. Klein. Influence of maternal nutrition on the characteristics of the placenta and fetal growth. Paper presented at the Symposium on Effects of Inadequate Nutrition on Human Development, Continental Meeting of Science and Man, Mexico City, 20 June-4 July, 1973.
- (27) Arroyave, G., Y. M. de Moscoso, and A. Lechtig. Vitamina A en sangre de embarazadas y sus recién nacidos de dos grupos socioeconómicos. *Arch Latinoam Nutr* 25:283-290, 1975.
- (28) Viteri, F. E., V. de Tuna, and M. A. Guzmán. Normal haematological values in the Central American population. *Brit J Haematol* 23:189-204, 1972.
- (29) Viteri, F. E., and M. A. Guzmán. Haematological status of the Central American population: Prevalence of individuals with haemoglobin levels below "normal." *Brit J Haematol* 23:725-735, 1972.
- (30) Iyengar, L., and K. Rajalakshmi. Effect of folic acid supplement on birth weights of infants. *Am J Obstet Gynecol* 122: 332-336, 1975.
- (31) United Nations Food and Agriculture Organization (FAO). *El estado mundial de la agricultura y la alimentación*. FAO, Rome, Italy, 1974.
- (32) FAO-SIECA. *Perspectivas para el desarrollo y la integración de la agricultura en Centro América* (Volumes 1 and 2). FAO-SIECA, Guatemala, 1974.
- (33) Beghin, I. Políticas nacionales de alimentación y nutrición, 1976. INCAP, Applied Nutrition Division (MS in preparation).
- (34) Flores, M., M. T. Menchú, M. Y. Lara, and M. Béhar. *Dieta adecuada de costo mínimo para la República de Costa Rica*. INCAP, Guatemala, 1970.
- (35) Flores, M., M. T. Menchú, M. Y. Lara, and M. Béhar. *Dieta adecuada de costo mínimo para la República de Nicaragua*. INCAP, Guatemala, 1970.
- (36) Pan American Health Organization. *Maternal Nutrition and Family Planning in the Americas*. PAHO Scientific Publication No. 204, Washington, 1970.
- (37) Arroyave, G., and A. Lechtig. Nutrición materna en una sociedad de bajo nivel socio-económico. In: *Aspectos perinatales del parto prematuro y del retardo de crecimiento intrauterino*. O. Althabe and S. Schwarcz (eds.), Editorial "El Ateneo," Buenos Aires, Argentina (In press).
- (38) Lechtig, A., H. Delgado, C. Yarbrough, J-P. Habicht, R. Martorell, and R. E. Klein. A simple assessment of the risk of low birth weight to select women for nutritional intervention. *Am J Obstet Gynecol* 125:25-34, 1976.