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The Potential Role of Processed Complementary Food in Latin America

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Growth retardation is highly prevalent among children in low-income countries. Data collected during the last decade indicate that 32.5% of children under 5 years of age in such countries (about 182 million children) are stunted (1) as defined by a length or height for age less than −2 SD with respect to the World Health Organization/National Center for Health Statistics/Centers for Disease Control and Prevention reference population (2). In Latin America, according to the same source, the prevalence of stunting is 12.6%, which corresponds to more than 6.8 million children. Growth retardation is associated with delayed psychomotor development, decreased immune response, and increased risk of morbidity and death (3–5).

Although a global decline in stunting has been experienced in the last two decades in developing countries, the rate of decline has been slow. From 1990 to 2000, the overall decline in those countries was 0.63 percentage point/year (1). At this rate of decline, almost 45 years would be needed to reduce the current prevalence of stunting of almost 33% to a desired prevalence of less than 5%. It is therefore recognized that governments and international agencies working in the area of public health and nutrition have a role in the planning and implementation of interventions and strategies to improve the nutrition and growth of children in developing countries.

Infection and inadequate food intake are well established causes of growth retardation. Several controlled trials have shown that supplementary feeding during early childhood improves growth in populations where malnutrition is prevalent (3,6–8). The conclusion from these trials is that improvements in dietary intake, both in quantity and in quality, lead to better growth and nutritional status.

These studies have also shown that most of the effect of supplementary feeding occurred during the first 2–3 years of life (9,10), a period of rapid growth, when nutritional needs to sustain the accelerated growth are high and when the incidence of infections is often increased because of an immature immune system and poor hygienic conditions. Infections in turn increase the demands for energy and some nutrients and reduce appetite. During the first 6 months of life, breast milk alone can satisfy the nutrient needs of most infants (11,12). However, after 6 months,

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Despite substantial efforts over the past decades, undernutrition and growth failure remains a major problem in most developing countries. Profound changes taking place in developing countries are influencing eating and physical activity patterns and bringing forth a multitude of chronic diseases of dietary origin. The objective of this workshop is to present new data for the assessment of infant and child growth and to review major causes and consequences of nutrition intervention programs.

Topics cover reviews of several efforts underway to generate new reference data for the assessment of growth, advances in knowledge about the causes of growth failure, and updates on the consequences of poor growth for individuals and societies across a range of functional indicators. Discussions also include review of public health approaches to prevent growth failure and discussions of the nutrition transition and the possible link between growth retardation in early life and risk of chronic disease in adulthood.

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complementary foods are needed in addition to breast milk to meet infant and toddler nutrient requirements (13).

The phase during which other foods or liquids are provided along with breast milk is the period of *complementary feeding*. This period provides a window of opportunity for interventions to improve nutrition and growth of children, inasmuch as growth stunting occurs during this age interval, partly as a result of inadequate complementary feeding practices.

Brown *et al.* (13) define "special transitional foods" as foods provided along with breast milk during the complementary feeding period that are specifically formulated to meet the particular needs of young children with respect to their nutritional requirements and neurophysiological development. These special transitional foods may be either centrally processed or specially prepared at home from family foods for infant and toddler consumption.

In this chapter, we discuss the potential role of centrally processed transitional foods, referred to hereafter as "processed complementary foods," in preventing growth failure in developing countries with emphasis in Latin America. Although we focus on processed complementary foods, we recognize that this is just one of many potential strategies for improving complementary feeding practices among young children. The most appropriate strategy in any given situation will depend on many factors, which must be evaluated before intervening.

INADEQUACY OF COMPLEMENTARY FEEDING IN MANY POOR SETTINGS

Given the accelerated rate of growth during the first 2 years of life, the energy and nutrient requirements per body weight during this period are high relative to other periods of life. On the other hand, the gastric capacity of infants and young children limits the amount of food that they can consume at a given meal; therefore, they need to consume relatively small amounts of food several times a day to satisfy their energy needs. This imposes large demands on the time of the mother or caretaker. In addition, neurological development in infants and young children limits the types and consistency of foods that can be consumed. It is only at about 18 months of age that children can be fully incorporated into the family diet; before that age, special transitional foods should be provided (13). Preparation of those transitional foods may require substantial time and other inputs besides food, such as fuel. Time of the mother or caretaker and availability of fuel and foods may be limiting factors in achieving good complementary feeding practices.

Given the high energy and nutrient requirements, the limited gastric capacity, and the restricted types and consistencies of food accepted by infants and young children, an appropriate mix of frequency of feeding and energy and nutrient density must be reached to satisfy nutritional needs.

Cultural and social factors exert a very important influence in complementary feeding practices and may be key restraining factors. For example, in some cultures, young children are considered not to be ready to eat energy-dense foods or certain

rich sources of micronutrients such as animal products; in some settings encouraging children to finish their serving may be considered inappropriate by some mothers. Working mothers may not be able to cope with the high time demand imposed by the special feeding needs of young children, and poor families may be unable to purchase the food or other inputs required for young child feeding.

ROLE OF PROCESSED COMPLEMENTARY FOODS

For the reasons listed above, processed complementary foods have appeal for use in food and nutrition programs. Centrally processed foods can be designed to require little or no time for cooking as opposed to home-processed foods, can be tailored to the specific nutrition needs of the population, particularly in regard to micronutrient composition and energy density, and can be given desired consistencies and acceptable flavors. The use of flour mixtures, maltodextrose, dry milk, or other dehydrated products as ingredients of processed complementary foods that are later rehydrated at home facilitates transportation, storage, and delivery to large numbers of people, by reducing the volume and weight of the product. Moreover, dehydrated products have a longer shelf life, and the processing and packaging techniques used in production, together with the ease of preparation, which eliminates the need to store a cooked product throughout the day, reduce risk of contamination. These characteristics make the products ideal for large-scale public health programs. In addition, by offering a single, standardized product, large-scale interventions acquire a certain degree of homogeneity. However, as will be pointed out later, a risk of programs based on centrally processed foods is that too much attention is often given to the product design and not enough to logistic aspects to ensure adequate targeting and prompt distribution or to the development of communications strategies to promote the consumption of the product.

An additional advantage is that processed complementary foods with high nutritive value and adequate organoleptic characteristics can be produced at relatively low prices. For example, the retail prices of 100 g of processed complementary foods produced and commercially distributed in Guatemala (*Incaparina*) and in Colombia (*Colombiharina* and *Solidarina*) range between US $0.11 and $0.19. These prices are very competitive compared with other commercial products available on the market that are used for complementary feeding. For example, the prices of milk, instant cereals, or infant formulas in Guatemala are one to eight times higher than *Incaparina* (14).

Latin America is becoming increasingly urbanized (15); female employment has risen, which in turn has increased female disposable income and has reduced the available time of the mother for food processing and cooking at home. Therefore, the use of purchased foodstuffs is growing along with urbanization.

Processed foods have become important components of the diets of young children. A study conducted in children 9–18 months of age living in a poor semirural community in central Mexico (16) found that among the 20 principal foods, in terms of their energy contribution to the diet, 10 were centrally processed commercial foods

such as milk, soda, cookies, noodles, rice, and yogurt, 2 were locally (community level) processed foods such as bread and biscuits, and 8 were home processed ("tortillas," eggs, and fruits).

Infants in developed countries have consumed commercial processed complementary foods widely for a long time. For example, instant cereals fortified with iron and other micronutrients are commonly used as one of the first foods introduced to children in the developed countries. In fact, those products have become the principal source of iron and other micronutrients in infants between 6 and 12 months, before meat products are introduced into the usual diet. Another example is fortified juices, which are sources of vitamin C for children in developed countries. However, although many of these commercial products are often available in developing countries, their price restricts their use to a small sector of the wealthier population. The challenge for governments and nongovernment organizations is how to bring these products to the poor population in which malnutrition and growth stunting are highly prevalent.

To be successful in promoting growth, processed complementary foods must be nutritionally adequate and must be consumed by target children in appropriate amounts and frequencies to provide the nutrients that limit growth in sufficient quantities. Ideally, the nutrient composition and organoleptic characteristics of the processed foods should be designed to cover at least the nutrient deficiencies of the target population, and appropriate steps should be followed to ensure that the product is accepted by beneficiaries. However, knowledge of nutrient deficiencies is not sufficient in itself. The design of processed complementary foods should also consider the possibility that inappropriate complementary feeding practices lead to dietary deficiencies. Depending on what these inappropriate practices are, the role of processed complementary foods in solving the dietary problem may be more or less important. For example, if the dietary deficiencies are of zinc and iron and the problematic feeding practice is lack of good sources of iron or zinc in the diet because of high prices of sources of those minerals, processed foods fortified with iron and zinc may be an effective solution, provided that the product is accepted and consumed. In contrast, if the problem is low energy intake and the inadequate practice is infrequent feeding, processed complementary foods may or may not be a solution. If infrequent feeding is caused because mothers do not have the time to prepare foods more than two or three times per day, processed complementary foods may be an effective solution. However, if infrequent feeding is due to cultural beliefs and food availability is not a problem, processed complementary foods may not solve the problem.

EFFECT OF PROCESSED COMPLEMENTARY FOOD ON GROWTH IN POOR SETTINGS

The public health effectiveness of processed complementary foods in improving the nutritional status of children at risk of malnutrition has not been clearly documented. Although such foods have often been nutritionally complete, not enough attention has been paid to their cultural acceptability and behaviors around their use or to issues of production, cost and financing, social marketing, and targeting and distribution. As a result, processed complementary foods have often failed to reach the poorest households, or when they have reached these households, they have not been successful in improving nutritional status because breast-feeding practices and other important feeding behaviors have not been simultaneously improved (17).

However, as expected, effects on growth have been clearly documented in controlled trials when processed complementary foods are consumed regularly and in adequate amounts. The well known supplementary feeding trial conducted by the Institute of Nutrition of Central America and Panama (INCAP) in rural Guatemala (18) is a good example of the effects that can be achieved when the target population consumes a processed complementary food. The study took place between 1969 and 1977 in four rural Guatemalan villages where stunting was highly prevalent. It included the provision of a beverage (*Atole*) rich in energy (91 kcal/100 ml) and protein (6.4 g/100 ml) to children less than 7 years of age in two randomly selected villages. The remaining two villages received a low-energy, no-protein beverage. *Atole* was one of the precursors of *Incaparina*, a processed complementary food that is currently on the market in Guatemala. The drinks were offered daily, free on demand, for the 7 years of the study. Daily consumption of the drinks was recorded for participating children. The diet and the nutritional status of children in the four villages were similar at the onset of the study. Children in the communities who received *Atole* had a net improvement in dietary intake, while those who lived in the other two communities did not improve their diet substantially. As a result, children in the villages that received *Atole* during gestation and the first 3 years of life grew on average 2.5 cm more than children in the nonsupplemented villages (8). Supplementation also reduced the prevalence of malnutrition, and severe stunting (length for age less than −3 SD) in children less than 3 years of age declined in supplemented villages from 45% in 1969 to about 18% in 1977 (3).

The results indicate that under controlled situations when children consume processed complementary foods, effects on growth are important. However, often too much attention is given to the development of an adequate processed complementary food, while little effort is given to the development of a communication strategy to promote the consumption of the product.

NEED FOR A COMMUNICATIONS STRATEGY

To ensure sustained consumption by target children, processed complementary foods must be delivered as part of a program that should include a communications component. For a specific product to be introduced into the diet of children, demand should be generated through social marketing, which has been used successfully in the promotion of specific products such as oral rehydration solution, contraceptives, and vitamin A capsules (19). Moreover, incorporation of the processed complementary foods into the diets of children always requires changes in complementary feeding practices. Therefore, the communications component that will promote the de-

mand and will ensure consumption of the product through behavioral changes is as important as the design of the appropriate processed product. It is often the case that the greatest effort is given to the design and development of a processed food and little or no effort is devoted to the communication strategy to promote the product and to produce changes in feeding behaviors. An intervention based on a processed complementary food is unlikely to be successful if it is not part of a broader program that includes an effective program of communication aimed at changing behavior.

ESSENTIAL ROLE OF PROCESSED COMPLEMENTARY FOODS TO MEET MICRONUTRIENT NEEDS

Micronutrient deficiencies are an important public health problem in developing countries. It is estimated that 42% of children less than 5 years of age in developing countries have anemia, mostly as a result of iron deficiency, and that 3.3 million children less than 5 years of age have clinical signs of vitamin A deficiency (1). Although less information is available about zinc deficiency, it is becoming evident that large numbers of children consume diets that do not satisfy dietary zinc recommendations or that have important amounts of elements in the diet that reduce the bioavailability of dietary zinc.

The specific role of micronutrient deficiencies in the etiology of growth retardation has been attracting attention. Brown *et al.* (20) published a meta-analysis of 25 trials in children 0–13 years who were supplemented with zinc for an average of about 7 months. They reported an average effect size of zinc supplementation of the order of +0.22 SD in height for age, which was highly significant ($p < 0.001$). The greatest responses to zinc supplementation were found in children with the most stunting and the lowest initial plasma zinc levels. Other supplementation trials using single micronutrients have been less conclusive. For example, the results of iron studies are conflicting and there appear to be little or no effect of vitamin A on growth, except in children with severe deficiency. The effect of other micronutrients has been less studied. However, it is possible that more than one micronutrient may be limiting growth, and hence the correction of a single deficiency may not be enough to improve growth substantially. It has been suggested that latent deficiencies of other micronutrients besides zinc can suppress the growth response after zinc repletion (21,22). For this reason, multiple micronutrient supplementation trials have been conducted in Mexican (23) and Chinese infants and young children (24). The results of both these studies indicate that other deficiencies besides zinc were suppressing growth, and that improving micronutrient intake alone, without provision of macronutrients, can lead to improved growth. The study in Mexico found that the effect of multiple micronutrient supplementation was larger in children less than 12 months of age at baseline. In this age group, the effect of supplementation on length was a 0.3 length-for-age z score. These results reinforce previous findings about the larger effects on growth of dietary improvements during infancy, when complementary feeding is very important, than during older ages. The results suggest that fortified processed complementary foods may have larger effects on growth than nonfortified products.

The principal natural sources of highly bioavailable iron and zinc are animal products, particularly meats. In an analysis of recent demographic and health survey datasets from Latin America, Ruel (15) found very low intakes of eggs, fish, and poultry, particularly in rural areas. These results are not surprising, given the high prices of meats in the market that prohibits their consumption by poor families. In addition, in some cultures, meat is not considered an appropriate food for infants and young children. As mentioned earlier, even in developing countries, meats are not the principal source of iron during infancy.

After a thorough review of dietary intakes of poor children in developing countries and the available complementary foods in these settings, Brown *et al.* (13) concluded that "it is practically impossible to supply enough iron from unfortified complementary foods to meet the iron requirements in young children in developing countries." They also conclude that the situation is similar for zinc, which has been shown to be associated with linear growth.

OPTIMAL CHARACTERISTICS OF PROCESSED COMPLEMENTARY FOODS

We have stated that the design of processed complementary foods to be promoted in a nutrition intervention should consider the nutrient deficiencies in the target population. However, the design of a processed complementary food provides an opportunity to develop a product that is nutritionally balanced and is accepted by the population. According to Brown and Lutter (25), optimal characteristics of processed complementary foods include the following:

Adequate energy density for a given feeding frequency (*i.e.*, for a frequency of three or more meals a day, energy density should be at least 0.8 kcal/g)
Appropriate nutrient profile
Adequate micronutrient/energy ratios
Suitably low renal solute load
Appropriate viscosity (children require semisolid preparations until about 12 months of age)
Desirable sensory properties
Processed, if necessary, to avoid the presence of antinutritional factors
Resistant to microbial contamination
Easy to prepare
Low cost
Fun to eat

It is also important that processed complementary foods are developed and marketed in compliance with the international code of marketing of breast milk substitutes and the *Codex Alimentarius* standards for processed cereal-based foods for infants and children (26).

Given the importance of processed complementary foods as vehicles for micronutrients that are deficient in the diet, special attention should be paid to the bioavailability of the micronutrients added to the product. Different forms of fortificants have

different absorption rates; for example, iron sulfate and sodium–iron ethylenediaminetetraacetate are more bioavailable than elemental iron. In addition, some foods that can be used as ingredients have high contents of inhibitors for the absorption of certain micronutrients. For example, corn is rich in phytate, which inhibits iron absorption. Other considerations are the cost of the fortificants and their undesirable organoleptic effects on the product. For example, sodium–iron ethylenediaminetetraacetate is very expensive compared with ferrous sulfate; however, the latter can produce changes in color and flavor of the products. Elemental iron is less bioavailable but is cheaper and more stable than ferrous sulfate.

In summary, the choice of the form of micronutrients used for fortification should consider bioavailability, cost, and stability issues.

PROCESSED COMPLEMENTARY FOODS FOR THE VERY POOR

Role of Governments in the Region

The prevalence of growth stunting is very high in developing countries. As mentioned earlier, it is estimated that about 182 million children under 5 years of age in such countries are stunted (1). How can governments improve the nutritional status of such large numbers of children? Processed complementary foods can play an important role in broad public nutrition programs, provided that they contain limiting nutrients in adequate amounts, that they are well accepted by the target population, that they are delivered by programs that are targeted to the right population (young children and infants of poor families), that their logistics ensure adequate and timely distribution, that the products are free of charge or have an affordable price, and that they include as a central component an effective communications strategy to promote the consumption of the product. Because such foods can be produced inexpensively and require minimal time for preparation and cooking, they are also likely to alleviate other economic and time-related constraints to improved child feeding.

Role of Private Industry

The role of the private food industry in the production of processed complementary foods in the region can be diverse. The first model is a research or technical institution commissioned by a government to develop the product, and private industry—through bidding—produces the complementary food for large programs. A variant of this model is when a government generates technological specifications for the development of the product, and private industry then develops the product, using ingredients that may or may not be defined in the technical specification. The food is then purchased by the government for distribution to program beneficiaries at little or no cost. Within this model, it is important that the private industry deliver the product as close to the distribution centers as possible.

A second model is when private industry produces complementary foods on the basis of government specifications or formulation and then sells it on the market at the same time as the government purchases the product and distributes it to program beneficiaries. The advantage of this model is that a product sold on the market is likely to have higher prestige and hence may be more likely to be consumed than donated food that is not sold on the open market. This model also has the advantage that the product is available for purchase to those who do not qualify for a government program, and hence it can reach a wider customer base. Last, commercial marketing of the product, assuming that there is sufficient demand, will ensure its continuation once the government program has ended.

A third model is private industries producing their own products that compete in the market. Governments may decide that instead of distributing the product, beneficiaries may receive cash to purchase it on the market.

In all cases, a communications strategy is required to promote consumption. However, if beneficiaries receive cash, the communications component becomes even more important to ensure that beneficiaries employ the money to purchase the products. The food industry has the potential to be an important collaborator in improving the nutrition and health of the population in Latin America.

POTENTIAL RISKS ASSOCIATED WITH THE USE OF PROCESSED COMPLEMENTARY FOODS

Processed complementary foods should be considered to be products that complement breast milk and traditional foods between about 6 months and the time when children become fully integrated into the family diet. However, if feeding with these products begins before 6 months of age, it is likely that breast-feeding will be displaced, with negative consequences for the nutrition and health of the baby. It is recommended that babies not be fed these foods before 6 months of age. After 6 months, it is important to continue promoting breast-feeding and employing these foods as complements to breast milk.

The provision of liquid processed complementary foods should be discouraged because it could lead to bottle-feeding and may displace breast milk. The preferred consistency of the foods, after hydration, should be semisolid.

Another risk involved is contamination. Ready-to-eat products usually require the addition of water. When the quality of water is poor and it is not boiled before rehydrating the product, contamination can occur. It is important to include messages about the need to use potable water for rehydrating the product and advising that the leftovers should be discarded to avoid proliferation of microorganisms that can produce gastrointestinal infections.

Another important issue to consider when processed complementary foods are promoted is the sustainability of the intervention. Creating dependency on a food that is not processed at home may have negative effects on nutrition if the distribution of the product stops after it had been integrated into the child's diet.

Other strategies such as nutrition education can improve complementary feeding through the use of locally available foods and resources, without creating dependency from external products and resources that may not be sustained. However, their disadvantage is that the foods available at affordable prices may not provide

certain nutrients that are limiting growth. Also, foods and resources may vary substantially among regions in a country, and therefore recommendations to improve feeding practices may also vary widely. As stated in the introductory section, it is important to recognize that there are many strategies to improve complementary feeding and that there is no single approach that can be applied universally.

EXAMPLES OF PROCESSED COMPLEMENTARY FOODS IN LATIN AMERICA

Latin American countries have created a number of processed complementary foods in the last four decades. The nutrient composition of such products has changed over the years, reflecting the nutrient deficiencies of concern during this period. In the 1960s and 1970s, concerns were primarily about protein and energy deficiencies. This concern is reflected in the formulation of products developed during that period. In contrast, as concern about micronutrient deficiencies grew, processed foods incorporated them as key ingredients. One of the better known products is *Incaparina*, a high-quality protein/vegetable mix developed by INCAP in Guatemala in the 1960s. The ingredients of the original formula were maize flour (65%), cottonseed flour (25%), and soybean flour (10%). The product was based on *Atole*, a traditional beverage consumed in Central America and Mexico that is considered culturally appropriate for infants and young children. The vegetable mix has to be cooked for at least 15 minutes. The energy density of the dry product is 3.67 kcal/g, and it contains 23 g of protein/100 g. The beverage was not particularly rich in micronutrients, and the bioavailability of minerals is low. After the introduction of *Incaparina* into the market, INCAP licensed a private company to manufacture and sell the product in the local market. The product concepts of *Incaparina* were used in several countries, notably in Colombia, to develop similar foods. The original formula is still used in a commercial product currently in the market in Guatemala. INCAP has recently developed a new version of *Incaparina*. The protein quality has been improved, and iron, vitamin B, zinc, and calcium were added. The cost of the new *Incaparina* is still very competitive.

Colombia has been particularly active in the development of processed complementary foods. As mentioned earlier, *Incaparina* was used as a model for the development of several products (e.g., *Colombiharina*). Three of such foods are produced today: *Bienestarina*, *Colombiharina*, and *Solidarina*. All three use soybean flour and either corn, rice, or wheat flour and nonfat dry milk or a combination of these. The energy density per unit dry weight of the products ranges from 3.7 to 3.8 kcal/g. The protein content ranges between 21 and 26 g/100 g of high-quality protein. All three formulations are fortified with the following micronutrients: vitamins A, B_1, B_2, and C, niacin, iron, calcium, and phosphorus. Only *Colombiharina* is fortified with zinc (27).

In 1993, Peru produced a product called "*Alli Alimentu*," a precooked (extrusion) instant complementary food with high nutritional value. It was designed to cover 33% of the energy requirements, 100% of the iron, zinc, iodine, vitamin A, and vitamin C requirements, and 60% of the other micronutrient requirements of 6- to 36-month-old children living in a region of the country with high prevalence of malnutrition and poverty. The reconstituted product has a semisolid consistency (3,000–6,000 cp) with an energetic density of 1 kcal/g. The product was developed by the Instituto de Investigacion Nutricional. Presently, it is used in several programs implemented in the country, which are estimated to cover more than 2 million beneficiaries a day (28).

Some of the products described above were not developed for a specific project but were conceived as foods with high nutritive value to be used by different programs and strategies or to be sold on the market. That was the case for *Incaparina*. Other products such as the Peruvian *Alli Alimentu* were developed as part of an ambitious governmental program. Today, *Incaparina* is sold on the market in Guatemala. *Bienestarina*, *Colombiharina*, and *Solidarina* are currently distributed by government-funded programs ranging from nurseries, daycare centers, schools, youth clubs, and maternal and child programs that altogether cover an estimated 4.2 million children and women (27). Finally, *Alli Alimentu* is used in several programs implemented in Peru, which are estimated to cover more than 2 million beneficiaries a day. An interesting feature of *Alli Alimentu* is that it was produced by private companies chosen through public bidding. To participate, each company acquired the technical specification produced by the Instituto de Investigacion Nutricional and developed its products according to this specification, which did not require specific raw materials but rather a particular nutrient content and composition. Afterward, each company sent a sample of their product to a public notary selected by the Instituto de Investigacion Nutricional, where the technical information of the product and the product samples were coded. The program involved community participation activities designed to promote community participation (28).

Despite the vast experience in the development and use of processed complementary foods in Latin America, little is known about the effects of the products or programs that distribute them on the growth and nutritional status of beneficiaries, because low priority is usually given to monitoring and evaluation activities. One of the exceptions was the program that distributed *Alli Alimentu* in Peru, which was carefully evaluated by the Instituto de Investigacion Nutricional. Evaluation included process and impact. Results of the process evaluation showed that program implementation was satisfactory. Impact evaluation documented improvements in the dietary intake and micronutrient status and an important reduction of anemia. However, no effects were documented on growth (28).

One of the latest processed complementary foods developed is a product currently distributed in Mexico as part of a federal program called Progresa. Mexico has a long tradition of food and nutrition programs and policies, including macro-level economic and food policy, social sector support programs for human development, and food distribution programs. Between the decades of 1950 and 1980, a mixture of food price control, food subsidies to basic foods in government-owned retail stores, generalized subsidies to staple foods, school lunch programs, and the distribution of food

baskets to poor families was implemented. During this decade, the food and nutrition policies and programs have been reviewed in terms of their cost-effectiveness. The substantial investment in food and nutrition programs and activities has been judged to be of poor effectiveness because the benefits have not been targeted at the vulnerable population. Therefore, a substantial proportion of the subsidies went to a population that was not vulnerable in socioeconomic or biological terms. This low effectiveness was in part the motivation behind Progresa, the acronym for *Programa de Educación, Salud, y Alimentación* (Program for Education, Health, and Food) that the administration of President Zedillo implemented as its main social program. As the title of the program indicates, there are three main components: education, health, and food. Progresa also includes several activities aimed at improving the nutritional status of children less than 5 years of age and of pregnant and lactating women. The following is a description of the program, with emphasis on the nutrition subcomponent (29).

THE MEXICAN PROGRESA

Progresa was designed as a program that emphasizes adequate targeting. The goal of the program is to reach the estimated 4.2 million families (over 25 million people) who, according to government estimates, are below the extreme poverty line. The program has as its ultimate objective the improvement of the human capital of those poor families through investments in their education, health, and nutrition.

The first stages of the program have been directed to rural areas. The beneficiaries up to February 2000 were over 2.3 million families selected in a two-stage fashion. In the first stage, rural communities with the poorest conditions on the basis of infrastructure, education, and economic opportunities were selected. In addition to the condition of poverty, two other conditions were required for the communities to be included in the program: a population between 50 and 4,999 and access to health and education services. Although these two conditions certainly exclude poor people from the program (probably the poorest people), the low population limit was set because the cost of providing services to communities of less than 50 persons is prohibitive; the condition of access to health and education services is required given the nature of the program, which offers as its main benefits services provided by the health and education sectors.

The identification of communities was followed by the selection of individual families within those communities. The selection of families was made through surveys in which the socioeconomic condition of the families was evaluated. Those classified as in extreme poverty were chosen as beneficiaries. To receive the benefits, selected families must comply with health care visits, and school-age children must attend school regularly.

The program includes the following benefits for participating families:

- A monetary transfer for food purchases to all families. Every family receives a fixed monetary transfer regardless of the number of family members and their age. The purpose of the transfer is to improve the diet of the family; therefore, it is intended for food purchases. As mentioned earlier, to receive the money transfer, the family members must comply with scheduled health care visits and mothers or those in charge of child care must attend health education sessions.
- Grants to families whose children attend school. One of the principal obstacles to human capital formation is dropping out of primary or secondary school, which often results from the need for parents to increase the family income. The cost of education and the opportunity cost of having a child at school who can generate income are factors that stimulate dropping out of school. The objective of this component is to provide enough incentives for families to keep their children in primary and secondary school.
- For each child attending school between third grade of primary school and third grade of secondary school, the participating families receive a grant. The amount of the grant increases as children move to the next upper grade. Because girls drop out of secondary school at a faster rate than boys, the amount granted to girls is larger between the first and the third grade of secondary school. The difference in the amounts granted to girls was defined on the basis of economic information about the differences between boys and girls in the opportunity cost of remaining in school. In addition to these benefits, families receive small amounts of money to cover school supplies. Benefits are not provided if children do not attend school regularly.
- Adding the monetary equivalent of the food and the educational grants results is a substantial increase in income over that normally received by the target families. An average family participating in the program receives about US $27 from the monetary transfer for food and the education grants. This amount is adjusted for inflation every 6 months and is equivalent to about 30% of their monthly income.
- Health care for all family members. All members of the families selected as beneficiaries of the program have free access to health care in the government health clinics. A primary health care package, including basic preventive and curative services, is offered in health clinics serving Progresa communities. The infrastructure and equipment of clinics in their communities have been improved substantially. In addition, personnel attending those clinics receive special training and supervision. Physicians attending those clinics receive salaries that are substantially higher than those received by physicians attending clinics in communities not included in Progresa.

In addition to the care provided, participating mothers or child care providers must attend health education sessions. There are 25 topics covered by health providers that include subjects on nutrition, hygiene, infectious diseases, immunizations, and chronic diseases, among others. Mothers must attend those sessions to qualify for program benefits.

The most vulnerable family members from the nutrition point of view receive food supplements as part of a nutrition component described below.

Nutrition Component of Progresa

Food supplements are provided to children less than 2 years of age, regardless of their nutritional status, to pregnant or lactating women, and to underweight children between 2 and 4 years of age in participating families.

The supplements were specifically designed by an advisory committee which included nutritionists, food scientists, and public health specialists, brought together by the secretary of health. A detailed description of the products and the process of their development has been published (30). A brief description of the products follows.

Both supplements contained the following ingredients: whole dry milk, sugar, maltodextrin, vitamins, minerals, and artificial flavors and colors. Both are distributed in 240-g packages as products that are ready to eat after they are hydrated.

Once hydrated, the supplement for children has the appearance of a pap or puree (a thick liquid suspension). The product is called "*papilla*," the Spanish word for pap, and is produced in three different flavors: banana, vanilla, and chocolate. A daily ration contains 44 g of the dry product, which after hydration weighs about 70 g. This amount contains 194 kcal, 5.8 g of protein, and approximately 1 recommended daily allowance of the following micronutrients: vitamins A, E, C, and B_{12} and folic acid, iron, and zinc. The energy and nutrient composition of 1 ration of the pap is presented in Table 1.

The supplement for pregnant and lactating women is consumed in the form of a beverage. The beverage, called "*suplemento alimenticio*" (food supplement), is produced in three flavors: banana, vanilla, and natural (without flavor). A daily ration (52 g of the dry product or 200 g of the beverage) contains 250 kcal, 12.0 g of protein, and the following micronutrients: vitamins E, C, and B_{12} and folic acid, iron, zinc, and iodine. The energy and nutrient composition of 1 ration of the beverage for women is presented in Table 1.

The supplements are distributed to beneficiaries in the health clinics every month. The family receives a 1-month supply of supplements for each family member who qualifies as a beneficiary.

TABLE 1. *Energy and nutrient content of one ration of Progresa supplements*

	Content of one ration[a]	
Energy and nutrients	Pap (children)	Beverage (women)
Protein	5.8 g	12–15 g
Energy	194 kcal	250 kcal
Iron	10 mg	15 mg
Zinc	10 mg	15 mg
Vitamin A	400 µg	—
Vitamin E	6 mg	10 mg
Vitamin C	40 mg	70 mg
Vitamin B_{12}	0.7 mg	2.6 µg
Folic acid	50 µg	100 µg
Iodine	—	100 µg

[a]Ration, (dry basis): pap, 44 g; beverage, 52 g.

As part of the health component, mothers or child care givers must attend health education sessions. Four of those sessions deal with the following specific topics in nutrition: the Progresa supplements, diet and health, nutrition during pregnancy and lactation, and breast-feeding.

The topic about the Progresa supplements provides motivational messages that encourage adequate child feeding and the administration of the supplements to the intended beneficiaries and provides practical information about the preparation, administration, and storage of the supplements.

Evaluation

As part of the development of the supplements, sensory evaluations were conducted (31). In addition, a study to assess the acceptability and the intake during 2 weeks of both supplements at the community level was carried out (29). Process and impact evaluations are currently ongoing and will be completed by the end of the year 2000.

The objective of the process evaluation is to assess the performance of the program. This is done by contrasting the norms, procedures, and goals of the project as stated in the program plan with the way the program actually works. Interviews with the providers of services and with beneficiaries are conducted to learn about program implementation. At the end, it will be possible to determine the degree to which the goals of the program are met.

The purpose of the impact evaluation is to assess the effects of the program on the nutritional status of children. Two study strategies will be used: a cross-sectional design to estimate the impact on prevalences of malnutrition and micronutrient deficiencies and a longitudinal design to assess the impact on growth and changes in micronutrient status in a cohort of infants that will be followed during 2 years. For both types of strategy, a design with intervention and control communities will be used.

Cross-Sectional Design Strategy

Three cross-sectional surveys were proposed in the course of 2 years. Each survey will be conducted in an independent sample of children residing in 224 communities (Progresa communities), randomly selected among those that were selected to participate in Progresa in six states. The same number of communities that will participate in Progresa by the end of the year 2000 will be selected as controls. The control communities were selected individually to match each Progresa community in terms of population, indicators of community infrastructure, wealth, and geographic location. The control communities had to be in the same *municipio* (county) as the matched Progresa community.

Three cross-sectional surveys were planned to be applied to both Progresa and control communities: a baseline survey conducted in August 1998 and two follow-up surveys, one that took place in August 1999 and one conducted at the end of 2000.

In each Progresa community, 10 families with children under 5 years of age selected to participate in the program were randomly chosen for participation in the survey. In each survey, an independent sample was obtained. Trained personnel also used the questionnaire applied in Progresa communities for the selection of beneficiaries in control communities. Families from the control communities that would qualify as beneficiaries of the program were the population from which 10 families per community were selected for participation in the survey. Therefore, families selected for the survey in control communities were supposed to be similar in socioeconomic conditions to those selected for the survey in Progresa communities.

The information and measurements obtained on the children and their families were as follows: age, anthropometric measurements (weight and length or height), hemoglobin (using a portable photometer), dietary intake (using a 24-hour recall questionnaire), and a venous blood sample for determination of vitamins A, E, C, folic acid, as well as zinc and iron status (n a subsample).

The principal outcome variables of the cross-sectional design are prevalences of malnutrition, anemia, and micronutrient deficiencies. Other variables that will be used as co-variates are socioeconomic conditions, satisfaction with the program, and intake of the supplements.

Longitudinal Design Strategy

The group of children between birth and 12 months of age studied at baseline will be followed 1 and 2 years apart to assess the impact of the program on growth and micronutrient status. Children will be 12–24 and 24–36 months during the second and third follow-up examinations. The information and measurements obtained will be those described for the cross-sectional surveys. However, the outcome variables will be the evolution of the nutritional status over time. The principal outcomes will be as follows: linear growth and changes in length-for-age z score, weight gain and changes in weight-for-age z score, changes in weight-for-length z score, changes in the mean values of micronutrient status (vitamins A, E, C, and folic acid, zinc, and iron), and changes in the prevalences of wasting, stunting, underweight, anemia, and micronutrient deficiencies.

Results from evaluation are expected to be available during the year 2001

CONCLUDING REMARKS

Stunting and micronutrient deficiencies continue to be a public health problem in Latin America. Dietary improvements during the first 2–3 years of life can improve growth and micronutrient status. Breast milk alone is generally sufficient to achieve adequate nutrition during the first 6 months of life. Thereafter, micronutrients and energy often become limiting. Therefore, adequate complementary feeding along with breast-feeding is the key to the prevention of stunting and micronutrient malnutrition.

The use of processed complementary foods is one strategy being employed in Latin America to improve complementary feeding practices and to reduce the prevalence of stunting. Centrally processed foods require little or no time for cooking, can be tailored to the specific nutrition needs of the population, particularly with regard to micronutrient composition and energy density, and can be given desired consistencies and well accepted flavors. They can also be stored and transported easily and have a long shelf life. The processing and packaging techniques used in production and the ease of preparation that eliminates the need to store a cooked product throughout the day reduce the risk of contamination. In addition, the products are easy to store and transport because they are often dehydrated. These characteristics make the products ideal for large-scale public health programs. The process of urbanization in the region, the rising numbers of working mothers, and the increasing use of industrialized foods in the diets of infants and young children all make processed complementary foods attractive for many mothers in Latin America.

To ensure consumption of processed complementary foods by the target population, it is important to use social marketing techniques for the design of the product and to build a communications component as part of the project to promote it.

Optimal characteristics of processed complementary foods include the following: adequate energy density for a given feeding frequency (*i.e.*, for a frequency of three or more meals a day, energy density should be at least 1 kcal/g); appropriate nutrient profile; adequate micronutrient/energy ratios; suitably low renal solute load; appropriate viscosity (children require semisolid preparations until about 12 months of age); desirable sensory properties; processed, if necessary, to avoid the presence of antinutritional factors; resistant to microbial contamination; easy to prepare; low cost; and fun to eat.

Processed complementary foods should be considered products that complement breast milk and traditional foods between about 6 months and the time when children become fully integrated into the family diet. To interfere as little as possible with breast-feeding, complementary feeding should not start before 6 months of age, and after that age, it is important to continue promoting breast-feeding and employing these foods as complements to breast milk. Also, to reduce risk of breast milk displacement, liquid products and the use of bottle-feeding should be avoided.

Despite the many processed complementary foods that have been used in Latin America, only a few of the programs that promote these products have been adequately evaluated. It is recommended that a monitoring and evaluation component be included as an integral part of programs that promote and distribute processed complementary foods.

RECOMMENDED RESEARCH ACTIVITIES

Various research questions regarding the potential role of processed complementary foods are still unanswered. Biomedical, epidemiological, programmatic, and operational research is needed in the following areas:

- The bioavailability of different mineral salts and compounds—particularly those that contain iron and zinc—in processed foods that employ different macronutrient composition and different ingredients, especially in those foods that use ingredi-

ents that interfere with the absorption of minerals. As a result of this research activity, recommended micronutrient densities for processed foods that use different fortificants, macronutrient composition, and key ingredients should be set.

- Effects of energy density, viscosity, and consistency of complementary foods and the frequency of their intake on satiety, substitution of the diet, and displacement of breast milk.
- Impact evaluation of supplementation with processed complementary foods on growth, anemia, micronutrient status, morbidity, and other outcomes.
- Effectiveness, cost-effectiveness, and process evaluation of current public health programs involving processed complementary foods, including evaluation of the communications component.
- Comparison of effectiveness of programs that distribute donated processed foods *versus* programs that distribute cash and promote processed foods available in the market.
- Risk of contamination and proliferation of pathogens in processed complementary foods under different preparation techniques and handling and storage conditions found among beneficiaries of programs that distribute such processed foods.
- Evaluation of the sanitary quality of processed foods as prepared and used by mothers in the context of current programs that distribute such foods.
- Qualitative research on mothers to identify concepts and behaviors regarding the use of processed complementary foods in the diet of their infants and young children in different cultures.

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DISCUSSION

Dr. Castillo: I think the Progresa program is very interesting. How do you know that papilla is used only by the target children and the pregnant women and not by other members of the family, for example, other children?

Dr. Riveras-Dommarco: One of the issues that we addressed in the process evaluation that I mentioned was precisely that: to try to find out if the product has been used only to feed children or to feed other family members. We do not have results from that analysis yet, but it's a very important question. In a few months, we will have some answers.

Dr. Guesry: You recommend delaying the introduction of processed complementary foods until after 6 months, but many investigators—including Waterlow in Thailand, Whitehead in the Gambia, and many others—have shown that energy

intake deficiencies start between the third and the fourth months and that growth faltering also starts during that period. This means that you apparently accept such growth faltering, for reasons I don't understand. Could you explain?

Dr. Rivera-Dommarco: In my opinion, there are sufficient data now to indicate that if a child is breast-fed–which is almost universally the case in these communities—you probably do not need to introduce any complementary foods before 6 months. There are risks involved in the introduction of such foods, and as long as the mother is breast-feeding, I believe we should delay introducing them until after 6 months. I know that there are many differing opinions on this, but that is my point of view.

Dr. Endres: Could you explain the discrepancy between your recommendation not to introduce solid foods before the age of 6 months and the fact that in your Progresa program, you provide papilla for infants from 4 months of age?

Dr. Rivera-Dommarco: I've based my preference for 6 months mainly on studies like the ones done by Dewey in Honduras, showing that breast milk alone provides sufficient nutrients up to 6 months. In fact, when those investigators compared a group of exclusively breast-fed infants with infants receiving complementary foods, there were no differences in growth by 6 months. I know this is an unresolved issue. However, the current official recommendation in Mexico is to start complementary foods between 4 and 6 months, so that's why the program starts at 4 months.

Dr. Flores: When we reviewed the issue of introducing complementary feeding for the Fourth Report (1), we found that field studies show that complementary foods introduced between 4 and 6 months of age replace nutrients from breast milk and confer no advantage for growth or development.

Dr. Haschke: A short comment on the weaning age. We all agree that the WHO recommendation is between 4 and 6 months, but I think we should recognize that all children are different. One child may need complementary foods earlier than another. Science rather than politics will give us the answer to this.

Dr. Guesry: I don't have any experience with *Incaparina,* but I do have experience with *Labdamine,* which is a similar product made in France for North Africa. In my experience, this product is rarely used by mothers for feeding their infants during the weaning period because the packaging is poor and because the texture, appearance, and taste of the product are not optimal. Have you assessed the actual usage of this type of product?

Dr. Rivera-Dommarco: I agree that it is very important to do sensory testing before putting a product into such a program. We did compare our product with popular industrially processed products, and it ranked very favorably. It is a high-quality product in terms of texture, flavor, and appearance. The packaging is also similar to that of commercial products. I agree with you that many programs have failed because they have not paid enough attention to this issue. Industry usually pays a lot of attention to such matters, so we should draw on their experience in making good products that appeal to children and mothers.

Dr. Brunser: Chile has a very long experience with complementary feeding. We have learned, at enormous cost, from our mistakes. One of these mistakes was a problem that nobody foresaw, that is, the image of the complementary foods distributed by the government through its various programs. For many years, the government distributed skimmed milk became food for the poor, and the fat from milk, you accelerate gastric emptying while increasing the relative proportion of lactose. When we did a study of lactose intolerance in the Chilean infants, we found that by 2 years of age, about 15% of them already had some degree of lactose maldigestion. Thus, it was true when mothers said that skimmed milk produced diarrhea in their children.

The concept of "food for the poor" is an important one. Skimmed milk became food for the poor because it was badly packaged, pilfered, contaminated, and so on; in a word, it was not attractive, and because it was free, it had no perceived value. To combat this, one of the tactics that the ministry of health introduced rather early on, and after losing enormous amounts of money, was to release these products first on the open market in the smartest supermarkets. Only after that, and after a careful advertising campaign, was it then distributed through the national health service. To combat the black market for these free products, the government-distributed product has a different package size from the supermarket product, though the contents are the same.

Another problem arose when we developed a corn/soy milk blend. The corn was bought rough as grain and was then finely milled into cornmeal. When you do that with a spinning mill, the corn becomes heated. This makes the tryptophan unavailable and gives the product a peculiar smell. Because of the smell, the product was rejected. To solve this problem, we had to go to industry and ask for help. The moral is that you need to go to the people who have the knowledge and ask them to lend a hand in developing and marketing these products.

Dr. Lejarraga: I'm glad Dr. Rivera stressed the importance of the nutritional components of complementary foods. In Argentina, we are concerned about the increasing use of juices for children. These are becoming very fashionable now, and advertising pressures are leading to their increasing use in very young children. I now often see children aged from 1 to 2 years with first-degree malnutrition whose mothers are buying as much as 1 liter of juice a day for them. This is expensive and prevents the purchase of more valuable foods.

Dr. Amigo: What is the role of the state? You talked about the role of the private sector, but I think it is important to define the role of the state. In many countries, the state seems to play no role. I'm also worried about the strategy of the World Bank, which appears to prefer to give money than to support feeding programs.

Dr. Rivera: The role of the state differs according to the country, but in Mexico, for example, where there is such a high prevalence of stunting, the government role is very important. In fact, the government is producing food products through a government-owned company. The government distributes these products and is in charge of the programs. There may be other countries where the role of private industry is more important.

About the strategies of poverty alleviation, I agree that simply transferring money will not solve the problem, particularly in young children and in pregnant and lactating women. In Mexico, a group of public health nutrition workers was consulted by the government on this matter, and our opinion was that there was a need for a nutritional component in government aid, which is why we have our nutrition program now.

Dr. Haschke: I have two short comments. The first relates to the fortification level in your supplements given to pregnant women. You provide a folic acid supplement of only 100 µg/day, which contradicts the present recommendation to give 400 µg/day. Second, about your request for more research on bioavailability: Most of the

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problems of bioavailability have already been solved. For example, here at Instituto de Nutrición y Tecnología de Alimentos (INTA) in Chile, much work has been done on iron bioavailability from cereals. We now know there are many products on the market with low-quality iron and poor bioavailability, as a result of neglect of present knowledge.

Dr. Rivera-Dommarco: With regard to folic acid level, unfortunately this was a decision made by a committee of scientists in Mexico, but I agree with you that it should be higher. About bioavailability, I know we now have many answers, but there are still many questions. For example, numerous products still use reduced iron as a fortificant, and we know it is not easy to study the bioavailability of reduced iron. Products that have been shown to have very high bioavailability, such as iron–sodium ethylenediaminetetraacetate, are quite expensive. These are the reasons why I think there is still the need for more research, particularly in the context of local foods.

Dr. Frongillo: The state of Mexico has obviously made a particular commitment to nutrition, and one can envisage that commitment continuing for a long time. But at some point, one imagines that the state will not sustain that role and market forces will take over. There is nothing inherently against commercial products being on the market, but if our goal is to reduce health disparities, I worry that if the market is allowed to take over completely, without the state, we may be in a situation where there are increasing disparities again.

Dr. Rivera-Dommarco: Your question is very appropriate for Mexico because there will soon be a new government. The big question is: Will they sustain the program? Our communities are now very conscious of the benefits of the program, and there is a widespread demand for it to continue. We have not yet had any experience of what will happen to these programs when there is a change in government in Mexico. Chile, on the other hand, has experienced this, and it appears that when people receive a benefit, their demand for the benefit to continue is so strong that it cannot be ignored, even by a government that is reluctant to continue with such programs. It appears that they don't have any alternative, because the demand is so strong. Your question is very pertinent, and I'm worried about what will happen.

Dr. Uauy: What is the technical group in Mexico going to do to ensure that this program continues? The tradition, not only in Mexico but in Latin America as a whole, is for new governments to introduce change—new programs, new ideas, new teams. In Chile, for better or for worse, the program was built into law in 1937 as part of the Social Security Act for workers, so it has a legal framework that cannot be changed or dismantled by a new government.

Dr. Rivera-Dommarco: To be honest, there is no consensus among the scientific group as to what to do now. But I really think that it is important at least to promote the idea in society that malnutrition is a public health problem and that something should be done.

Dr. Vázquez Garibay: Reduction in stunting is not a simple linear effect in Mexico. It is now clear from various studies that to achieve a reduction requires improving the education of the mother, improving the *per capita* income, decreasing the prevalence of digestive and respiratory diseases, decreasing family size, and promoting more breast-feeding. In many of our states, especially in suburbs of the cities, no more than 20% of infants receive breast milk after 6 months of age. It seems to me that the food program is useful but is not really reaching the population that needs it. I believe there are 40 million people in Mexico who can be classed as poor, 60% of whom receive less than $40 a month. We need to know what is happening to the communities that are not involved in the Progresa program. What changes in stunting have occurred in those children?

Dr. Rivera-Dommarco: I agree that my linear projection was optimistic. In the best-case scenario, we will have to wait 28 years, and maybe even more. I accept that many people in Mexico believe there are more than 26 million poor people in the country, perhaps as many as 36 million. That is a debate between government and opposition. Maybe more people should be receiving the program, but at least the poorest people are beneficiaries.

Dr. Ruel: I want to make a more global point about the presentation. I found it highly biased toward Latin America. I think it is important to remember that the arguments for this approach in Latin America do not necessarily apply in other regions. Dr. Gibson could certainly give us examples of how difficult it is to do this kind of intervention in Africa. What are the potential solutions and what other approaches do we have to think about in regions where we do not have these facilities?

Dr. Rivera-Dommarco: I agree that Latin America is, on the whole, very well developed, governments tend to be strong, and there is a good infrastructure. Also, the rates of malnutrition are lower than in other places. But I was giving a Latin American view.

Dr. Ruel: This type of experience in other regions raises totally different points. For example, when you say "distribution is easy," "costs are low," "marketing is easy," such things just do not apply to other regions. Maybe you should change the title of your report and add "in Latin America."

REFERENCE

1. UN Administrative Committee/Sub-Committee on Nutrition (ACC/SCN). *Fourth report on the world nutrition situation.* Geneva: ACC/SCN with International Food Policy Research Institute; 2000.