Contents

The 1998–2001 Peru Multimicronutrient Supplementation Study (PISA)

Aarón Lechtig, guest editor

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We know much about what to do but little about how to do it: Experiences with a weekly multimicronutrient supplementation campaign

Rainer Gross†, Ursula Gross, Aarón Lechtig, and Daniel López de Romaña

Abstract

Background. *Global population growth is concentrated in urban areas, but there is little understanding of how to implement the necessary interventions to control food and nutrition insecurity. In the urban area of Peru, food insecurity is characterized mainly by micronutrient deficiencies and not by energy deficiency.*

Objective. *To increase the effectiveness and cost-effectiveness of weekly multimicronutrient supplementation programs in poor urban communities.*

Methods. *A series of operational studies were conducted of preventive weekly multimicronutrient supplementation to reduce micronutrient-deficiency anemia in a population consisting of 8,081 children under 5 years of age and 20,082 women and adolescent girls of reproductive age (12 through 44 years).*

Results. *This is one of a series of papers that describe in as much detail as possible the experiences of a multimicronutrient intervention program for poor urban mothers and their young children and summarizes the lessons learned for consideration of future programming.*

Conclusions. *This paper shows that such programs can achieve a high compliance with good training of program staff, involvement of the community, education and motivation of beneficiaries, adequate supplies, and careful monitoring.*

Key words: Food security, multimicronutrient supplementation, under-five children, urban, women

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Introduction

German foreign assistance for development aims to reduce poverty worldwide, build peace, and promote equity in a process of globalization [1]. Within German collaboration policy, food security, with a focus on rural populations and the promotion of agriculture and rural regional development, is a key element [2]. However, it is acknowledged that the right to food must be enforced for the rural as well as for the urban poor.

According to UN Habitat, between the years 1990 and 2000, 71.8% of worldwide population increase occurred in urban areas, and it has been estimated that between 2010 and 2020 practically all population growth (93.4%) will occur in urban areas [3]. By 2020, more than half the population of Africa and Asia will live in urban areas; more than three-quarters of Latin Americans already do.

Urban and rural dwellers are attracted by the promise of a better life in cities, yet the overwhelmingly increasing number of people compromises the ability of the city to meet their basic needs. Urban settlements in developing countries are currently growing five times as fast as those in developed countries. Cities are already confronting the tremendous challenges of lack of shelter, poor infrastructure and services, overcrowded transportation systems, insufficient water supply, deteriorating sanitation, and environmental pollution. As a result, in many developing countries, urban poverty, hunger, and malnutrition are increasing. In Bangladesh, statistics show that although rural poverty rates have declined in the past decade, poverty rates in cities have increased for the first time. Increases in urban poverty are evident across Africa, Asia, and Latin America [4].

National governments, international development agencies, and nongovernmental organizations have much experience with food and nutrition programs in rural areas. However, the urban environment is far more diverse and the urban food and nutrition system is far more complex than in rural settings. Very little scientific literature is available on operational research on scaling-up experiences with such interventions. Without a better understanding of the food and nutrition security situation of urban dwellers and how they cope and organize their livelihoods, it is difficult to design appropriate policies and programs for improving their conditions [4].

The rationale of an urban integrated food security program in Chiclayo

During the last 40 years, Peru, like all Latin American countries, has undergone a rapid process of urbanization. In 1961, 52.4% of the population still lived in rural areas; in 2005, nearly two thirds of Peruvians lived in urban settlements [5]. During the same time span, the nutritional situation has changed remarkably. As shown in **table 1**, between 1975 and 2000 undernutrition, expressed as the prevalence of stunting and underweight, has decreased significantly. However, overweight has become an increasing problem, even in children under 5 years of age [6]. With the data for rural and urban children disaggregated, **table 1** shows further that whereas wasting was reduced at a similar rate in rural and urban children, reduction of stunting occurred mainly in urban child populations. As a result, nutritional inequity between rural and urban areas has increased. However, it would be the wrong conclusion to focus nutrition policy and intervention efforts only on rural children. With the high rate of urbanization in Peru, the majority of stunted children already live in urban areas and the trend continues. This requires adequate food security and public health response.

Recognizing that the high urbanization rate in Peru requires a specific strategy for achieving food and nutrition security for the poor, the governments of Peru and Germany agreed to cooperate in implementing an integrated food security program. The program aimed at helping policy makers, program administrators, and development practitioners to develop and implement sound policy and program strategies to reduce food insecurity and malnutrition in an urban area of Peru. After the joint implementation of a feasibility prestudy, both governments agreed to a program in the coastal area of Peru, where most of the population is concentrated. Because many development programs were being implemented in the low-income belt around the capital, it was decided to offer the program to the municipality of Chiclayo, which accepted the offer.

Objective of the program

The objective of the Integrated Food Security Program (Programa Integrado de Seguridad Alimentaria [PISA]) was to better understand the food security and nutritional situation of a Peruvian urban population in order to design an intervention strategy targeted to aid those most at risk. Since food insecurity in the poor urban population of Chiclayo is characterized mainly by micronutrient deficiencies, the specific objective was to study the implementation and cost-effectiveness of a weekly multimicronutrient supplementation program in children under five and women and adolescent girls of reproductive age (12 through 44 years). Knowledge gained from this experience would be used for possible expansion of German assistance to food security programs from rural to urban areas.

Development of the program

The targeting for the intervention was carried out in a two-step approach. First, a baseline survey was conducted to identify the nature, magnitude, and severity of nutrition problems [7]. The baseline survey was necessary not only to define the intervention areas but also to help map the population in need. The baseline observations were carried out in the three lowest-income areas of Chiclayo. Second, the results of the baseline survey were used to identify geographic target areas, with stunting used as an indicator of poverty.

TABLE 1. Child growth and malnutrition in the last 30 years in Peru expressed as percent prevalence of anthropometric indices[a]

	Wasting			Overweight			Stunting			Underweight		
Year	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
1975	—	—	2.2	—	—	—	—	—	39.7	—	—	16.1
1984	—	—	0.9	—	—	—	—	—	37.8	—	—	13.4
1991/92	1.9	1.5	1.7	4.6	5.8	5.3	41.1	21.6	31.8	18.8	6.1	10.7
1996	1.7	0.8	1.1	5.0	7.8	6.4	40.4	16.2	25.8	13.7	3.9	7.8
2000	1.2	0.7	0.9	—	—	7.6	40.2	13.7	25.4	11.8	3.2	7.1

a. Definitions of anthropometric indices: wasting, < –2 SD weight-for-height; overweight, > 2 SD weight-for-height; stunting, < –2 SD height-for-age; underweight, < –2 SD weight-for-age.
Source: WHO global database on child growth and malnutrition [6].

The entire targeting process and the community-based process of selection and planning of interventions took about one year.

In Peru, micronutrient deficiencies were found to be the main public health nutritional problem in children, women, and adolescent girls, despite mandatory fortification of wheat flour [8]. Following UNICEF's concept of micronutrient supplementation through the life cycle, it was agreed to implement a preventive anemia control program with weekly multimicronutrient supplementation for children under five and for women and adolescent girls of reproductive age (12 through 44 years) from the poorest urban population [9]. Much experience has shown the positive impact and safety of micronutrient supplementation for women and adolescent girls of reproductive age [10]. Recent studies have found that multimicronutrient deficiencies occur in infancy and can be reduced significantly by micronutrient supplementation [11].

On the basis of the Peruvian experience that the consumption of iron supplements distributed by the routine health service to pregnant women was low [12], it was decided that the multimicronutrient supplement should be distributed in two campaigns per year. During each campaign, the children and the women and adolescent girls would take the supplements weekly for 12 weeks. The first campaign was implemented from January to April 2000. Before the fourth intervention started in May 2001, a census was carried out in the 26 identified poor areas to accurately determine the size of the target population.

On the basis of experience in three previous campaigns, it was decided to put special effort into documenting the implementation of the program. In particular, the distribution system [13], the communication program to achieve high compliance [14], the indicators of biological effectiveness [15], and the costs of the program [16] were observed in detail in order to formulate recommendations for future programming [17].

Unlike laboratory research, in which the aim is to control for as many parameters as possible, in a field program, even with the best planning, unpredicted events may severely influence the effectiveness and efficiency of interventions. Therefore, it is not possible to extrapolate from the results of one small-scale study to performance in a large-scale program. Any innovation or intervention requires careful observation and documentation, with milestones for decision-making for further scaling-up in order to reduce the risk of failure in broad implementation. The implementation of this weekly multimicronutrient supplementation program was therefore carefully observed by monthly monitoring of randomly selected small groups. However, the monitoring was designed not to disturb the normal routine of an implementation program, while keeping the researchers informed and prepared for corrective actions, if needed.

Most of the published reports of nutritional interventions describe small-scale studies, and very little literature is available about operational research on the scaling-up of interventions. This series of studies attempts to describe in as much detail as possible the experiences with a multimicronutrient program and to summarize the lessons learned for consideration of future programming.

References

1. Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ). Principles and aims. Bonn, Germany: Federal Ministry of Economic Cooperation and Development, 2006. Available at: http://www.bmz.de/en/principles/index.html. Accessed 23 June 2006.
2. Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ). Food security—a key element of German development policy. Bonn, Germany: Federal Ministry of Economic Cooperation and Development, 2006. Available at: http://www.bmz.de/en/issues/Food/hintergrund/schwerpunktEZ.html. Accessed 23 June 2006.
3. UN Habitat. UN Human Settlements Programme. Human settlements conditions and trends. Nairobi, Kenya: Global Urban Observatory and Statistics Unit, 2002. Available at: http://www.unhabitat.org/habrdd/global.html. Accessed 23 June 2006.
4. IFPRI. Not just where we live, but how we live—addressing urban food and nutrition security. Washington, DC: International Food Policy Research Institute, 2002.
5. INEI. Perú en cifras. Indicadores demográficos. Lima, Peru: Instituto Nacional de Estatística e Informática, 2005.
6. WHO. Global data base on child growth and malnutrition. Peru. Geneva: World Health Organization. Available at: http://www.who.int/gdgm/p-child_pdf/per.pdf. Accessed 23 June 2006.
7. Gross R, Lechtig A, López de Romaña D. Baseline evaluation of nutritional status and government feeding programs in Chiclayo, Peru. Food Nutr Bull 2006; 27(suppl):S115–21.
8. INEI. Encuesta demográfica y de salud familiar 1996. Lima, Peru: Instituto Nacional de Estatistica y Informatica. Available at: http://www.measuredhs.com/pubs/pdf/FR87/00FrontMatter.pdf. Accessed 23 June 2006.
9. Gross R. Micronutrient supplementation through the life cycle. Rio de Janeiro and New York: Ministry of Health, Brazil, and UNICEF, 1999. Available at: http://www.micronutrient.org/idpas/pdf/752MicronutSuppLife.pdf. Accessed 23 June 2006.
10. Huffman S, Baker J, Shumann J, Zehner E. Case for promoting multi vitamin/mineral supplementation for women in reproductive age in developing countries. Washington DC: Academy for Educational Development

and Population Services International, 1998. Available at: http://www.linkagesproject.org/media/publications/Technical%20Reports/multivitamin.PDF. Accessed 8 August 2006.
11. Smuts CM, Lombard CJ, Benade AJ, Dhansay MA, Berger J, Hop le T, López de Romaña G, Untoro J, Karyadi E, Erhardt J, Gross R. International Research on Infant Supplementation (IRIS) Study Group. Efficacy of a foodlet-based multiple micronutrient supplement for preventing growth faltering, anemia, and micronutrient deficiency of infants: the four country IRIS trial pooled data analysis. J Nutr 2005;135:631S–8S.
12. INEI. Encuesta demográfica y de salud familiar 2000. Lima, Peru: Instituto Nacional de Estatistica y Informatica, 2000. Available at: http://www.measuredhs.com/pubs/. Accessed 8 August 2006.
13. Gross U, Valle C, Diaz MM. Effectiveness of distribution of multimicronutrient supplements in children and in women and adolescent girls of childbearing age in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S122–9.
14. Gross U, Diaz MM, Valle C. Effectiveness of the communication program on compliance in a weekly multimicronutrient supplementation program in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S130–42.
15. López de Romaña D, Verona S, Aquino O, Gross R. Protective effect of multimicronutrient supplementation against anemia among children, women, and adolescent girls in lower-income areas of Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S143–50.
16. Lechtig A, Gross R, Paulini J, López de Romaña D. Costs of the multimicronutrient supplementation program in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S151–9.
17. Lechtig A, Gross R, Aquino O, Gross U, López de Romaña D. Lessons learned from the scaling-up of a weekly multimicronutrient supplementation program in the Integrated Food Security Program (PISA). Food Nutr Bull 2006;27(suppl):S160–5.

Baseline evaluation of nutritional status and government feeding programs in Chiclayo, Peru

Rainer Gross†, Aarón Lechtig, and Daniel López de Romaña

Abstract

Background. *Because of the rapid growth of the urban population in Peru, food and nutrition insecurity will occur increasingly in this population. For appropriate policy setting and programming, the food and nutrition situation of the urban poor requires better understanding.*

Objective. *To gain information about the nature, magnitude, severity, and causes of the nutritional problems of the population in low-income areas of the city of Chiclayo, Peru.*

Methods. *A cross-sectional nutrition survey was conducted in 1,604 households, covering children under 5 years of age and their parents.*

Results. *The prevalence rates of stunting, wasting, overweight. and anemia in children were 15.4%, 1.3%, 4.6%, and 65.7%, respectively; one third of adults were overweight, and one tenth were obese; 2.1% of the mothers were underweight; and 34.3% of mothers and 12.2% of fathers had anemia. Governmental feeding programs did not address these problems adequately.*

Conclusions. *Interventions must have adequate targeting; address appropriate responses at the household, community, and national levels; and reduce stunting, obesity, and iron-deficiency anemia.*

Key words: Anemia, children, overweight, stunting, urban, wasting, women

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Introduction

Despite numerous efforts in the past decades, more than 800 million people still suffer from various forms of nutrition insecurity [1]. Nevertheless, the nature and causes of food and nutrition insecurity are changing. Although the pace of change varies across regions, common trends can be identified throughout the developing world.

The world's population is becoming increasingly urban, and the urban poor are becoming the majority of the poor in most countries. According to the latest United Nations estimates, between the years 2000 and 2030 almost all of the world's population growth will be concentrated in urban areas in developing countries. As a result of growth trends as well as rural to urban migration, the world's urban population will equal its rural population around 2017, and by the year 2030 almost 60 percent of the world population will live in cities [1]. In the year 2002, 76% of the population in Latin America was urban, and the rate of growth for the following years has been approximately 2.2% per year. This rapid increase in urbanization is transforming food systems and the scope and nature of the nutritional challenges these populations face [2–4].

A more sedentary lifestyle of the urban population and an increased dietary energy intake have led to a steady increase in the prevalence of overweight and obesity in children and adults in many developing countries. In some Latin American countries, such as Chile, Costa Rica, and some areas of Brazil, the prevalence of overweight and obesity has surpassed that of stunting [5]. By the year 2030, the average daily caloric intake in developing countries is expected to increase by nearly 200 kilocalories, in part due to increased intake of vegetable oils, meat, sugar, and wheat. Net imports of these commodities by developing countries have increased by a factor of 13 over the past 40 years and are expected to grow by more than three times (345%) by the year 2030 [6].

In most developing countries, the prevalence of stunting has decreased somewhat over the past 10 years.

In Latin America the rate of decrease is approximately 1% per year [7]. The prevalence of iron-deficiency anemia in children and women has remained somewhat constant over the last decades. Iron-deficiency anemia is by far the most common form of malnutrition, affecting more than 3.5 billion people in the developing world, according to the World Health Organization (WHO) [8].

As a result of changes in the nature and causes of malnutrition, those paradigms that in the past led to the successful control of stunting may not be very useful in this new context [9]. However, there is a serious lack of information regarding the patterns and determinants of malnutrition in urban areas, the interventions that work and do not work, and the design and implementation of programs and policies in order to address the real needs of the urban poor [10, 11].

The causes and severity of food insecurity and malnutrition, encompassing both undernutrition and overnutrition, and the groups at risk differ between rural and urban populations. Furthermore, the most influential determinants of food insecurity and malnutrition may also vary not only between countries but also within countries. As a consequence, well-designed evaluations are required to understand the specific conditions of a population in order to develop succesful interventions aimed at improving nutrition and household food security.

To provide the necessary understanding, a baseline survey was conducted with the following objectives: to stimulate dialogue among community groups, nongovernmental organizations, government authorities, donor agencies, and program operators regarding food and nutrition security issues; to identify the nutritional, income, and employment problems in the target population; to identify the most affected groups; to develop a specific causal framework; to identify the appropriate interventions; to identify the best indicators for program monitoring and evaluation; and to propose any necessary additional studies.

Subjects and methods

Subjects

The present cross-sectional study was conducted between October and November 1998 in three urban, lower-income areas of Chiclayo (Chiclayo, La Victoria, and Leonardo Ortiz), a coastal city in the north of Peru. Organized poor urban slums are legally acknowledged as "young townships" by the Government of Peru. The subjects were children under 5 years of age and their parents. The selection criteria for families to participate in the survey were residency in the preselected areas and having a child under 5 years of age.

Households were selected by a randomized cluster survey. A sample size of 1,600 was calculated based on the assumption of a prevalence of nutritional deficiencies in children of 50% and a recommended survey design factor for urban population of 4 [12]. In the end, 1,604 households and 4,194 persons, including mothers, fathers, and children, participated in the baseline survey (**table 1**). If there were two or more children under five in the same household, one child was randomly selected for data collection. The guidelines of the Council for International Organizations of Medical Sciences were followed for ethical considerations [13].

Methods

A structured questionnaire was developed following established guidelines [12]. The questionnaire collected information regarding household demographics; the main problems perceived by the parents; socioeconomic characteristics of the household, including economic expenditures; dietary intake patterns; household participation in food-supplementation programs; household participation in social activities; children's illnesses; child-feeding practices; and health services for the children.

Once the questionnaire was completed, the fieldworkers measured the weights, heights, and hemoglobin concentrations of the children and their parents. The weights of the children and adults were recorded to the nearest 0.1 kg with an electronic weighing scale (Model 730, SECA, Hamburg, Germany). After the mother was weighed, her child was given to her and she was weighed again while standing on the scale holding the child; the child's weight was calculated by subtracting the mother's weight from the combined weight of the mother and child. The children and their parents were wearing light clothing during the weighing process. The WHO-recommended length-measuring board for infants (Ahrtag, London)[14] was used to measure the lengths of children under 2 years of age to the nearest 0.1 cm with the child lying down. From the age of 2 years on, the stature of children was measured with a microtoise (CMS Weighing Equipment, London)

TABLE 1. Participants in baseline survey of poor urban areas in Chiclayo, Peru

Unit sampled	Total	Chiclayo	La Victoria	Leonardo Ortiz
Settlements	71	42	21	11
Households	1,604	743	339	522
Individuals				
Mothers	1,597	739	338	520
Fathers	993	465	211	317
Children	1,604	743	339	522
Total	4,194	1,947	888	1,359

according to WHO recommendations [14]. Blood samples were obtained by finger pricking, and the hemoglobin concentration in one drop of whole blood was measured with a portable photometer (HemoCue; AB Leo Diagnostics, Helsingborg, Sweden).

Rate of adequate targeting and coverage of government food-distribution programs

The Peruvian government implements several types of food-distribution programs grouped into two main interventions: the National Program of Food Assistance (Programa Nacional de Asistencia Alimentaria [PRONAA]) [15], which is administered by the central government, and the Glass of Milk Program [16], which is administered by local municipalities. The adequacy of targeting and the coverage of these programs were estimated from the results of the survey. Targeting was defined as the percentage of all houses covered by at least one food-distribution program that were in fact moderately poor or extremely poor (household expenditure < US$200/month or < US$100/month, respectively). Coverage was defined as the percentage of all moderately poor or extremely poor households that received food from at least one of the distribution programs.

Statistical analysis

The SPSS software package (Windows version 10, SPSS, Chicago, IL, USA) was used for all statistical analyses, and a p value ≤ .05 was considered to indicate statistical significance. All measures and determinations were checked by a systematic quality assurance system at data entry. In order to test each variable for normal distribution, the Kolmogorov-Smirnov goodness-of-fit test at $p \leq .05$ was used. Cross-tabulation was conducted and chi-square tests were used to analyze the statistical associations between population groups and socioeconomic indicators. Analysis of covariance (ANCOVA) corrected for age was used to explore statistical relationships between nutritional status and socioeconomic indicators.

Anthropometric indices were calculated from weight, height, age, and sex according to the reference data of the National Center for Health Statistics (NCHS) using Epi Info version 6.0. Stunting and wasting in children were defined as < –2 SD z-scores for height-for-age and weight-for-height, respectively. Overweight in children was defined as > 2 SD z-scores for weight-for-height. Underweight, overweight, and obesity in adults were defined as body-mass index (the weight in kilograms divided by the square of the height in meters) values < 18.5, 25.0 to 29.9, and ≥ 30, respectively. Analysis of covariance (ANCOVA) corrected for age was performed.

Results

Selected personal characteristics of the participating mothers and fathers are shown in **table 2**. Nearly half were born in the city of Chiclayo, the capital of the department of Lambayeque, around 15% came from other areas of Lambayeque, and 20% came from the neighboring Andean department of Cajamarca. Although there were no significant differences between fathers and mothers in the place of birth, fathers had lived in the city significantly longer than mothers ($p < .001$). Fathers had more years of education than mothers, but the difference was not statistically significant. Almost all of the fathers and most of the mothers were working for income (97% and 77%, respectively). Both mothers and fathers perceived the same four major problems regarding quality of life, but there was a significant difference between the sexes in the order of importance in which they ranked these problems ($p < .001$); 67% of the mothers placed the highest importance on the lack of job opportunities and 68% of the fathers on insufficient income.

The participating households had an average of 3.6 ± 2.1 rooms and 6.9 ± 3.2 persons (**table 3**). The number of persons per household was significantly lower in Leonardo Ortiz than in the two other municipal areas ($p < .001$). Approximately half of the houses

TABLE 2. Personal characteristics of mothers and fathers in poor urban areas in Chiclayo, Peru

Characteristic	Mothers (%)	Fathers (%)
Place of birth		
Chiclayo	46	44
Lambayeque	14	15
Cajamarca	18	20
Other	22	21
Years of residence in Chiclayo[a]		
≥ 10	50	68
5–9.9	22	17
< 5	28	15
Formal education		
None (0)	5	2
Primary (1 to 5)	25	19
Secondary (6 to 10)	50	55
Superior (more than 10 years)	20	23
Working for pay	77	97
Perceived problems[a]		
Lack of job opportunities	67	57
Lack of safety	47	48
Insufficient income	42	68
Insufficient food	37	30

a. $p < .001$ (χ^2 test).

had clay walls, but the proportion of houses with clay walls differed significantly among municipal areas ($p < .001$). Most households had access to a public water supply and electricity (67% and 74%, respectively), but only half of them had access to a public sewage system. There were significant differences among municipal areas in the percentage of households with access to a public water supply ($p < .001$), electricity ($p = .007$), and a public sewage system ($p < .001$). Only 35% of the families owned their houses; Leonardo Ortiz had a significantly lower percentage of homeowners than the other municipal areas ($p < .001$). Approximately 60% of the households were classified as moderately poor and 8% as extremely poor, with monthly expenditures of less than US$200 and US$100, respectively). Interestingly, Leonardo Ortiz had a higher proportion of households classified as extremely poor and a lower proportion classified as not poor than the two other areas ($p = .005$).

The mean prevalence of stunting among children was 15.4% (**table 4**). There were differences in the prevalence of stunting and wasting among the three municipal areas, with Leonardo Ortiz having higher percentages of both ($p = .009$ and $p = .09$, respectively). There was a significant relationship between household economic expenditure and the prevalence of stunting among children ($p < .001$, χ^2-test) (**fig. 1**), which was confirmed by analysis of covariance ($p = .011$). Economic expenditure was also significantly negatively associated with wasting in children ($p = .011$). ANCOVA also indicated a significant negative association between the level of formal schooling of the

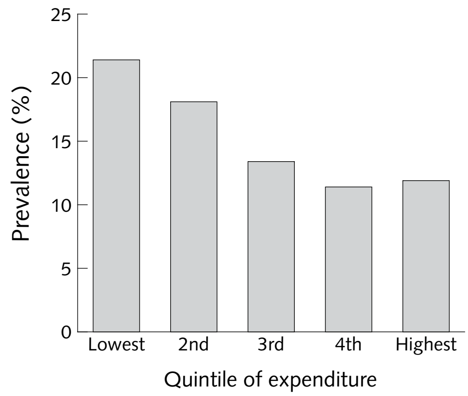

FIG. 1. Prevalence of stunting in urban children under 5 years of age according to quintile of household expenditure ($p < .001$, χ^2-test)

TABLE 3. Socioeconomic indicators of households in poor urban areas of Chiclayo, Peru

Indicator	Total (n = 1604)	Chiclayo (n = 743)	La Victoria (n = 339)	Leonardo Ortiz (n = 522)	p
No. rooms per household (mean ± SD)	3.6 ± 2.1	3.7 ± 2.2	3.8 ± 1.8	3.1 ± 1.8	.12
No. persons per household (mean ± SD)[a]	6.9 ± 3.2	7.0 ± 3.4[b]	7.0 ± 3.2[b]	6.7 ± 2.9[c]	< .001
Clay walls (%) [d]	56.0	5.7	74.3	51.5	< .001
Public water supply (%) [d]	66.8	71.2	61.7	64.0	< .001
Waste disposal (%) [d]					< .001
Public sewage system	48.3	62.0	55.2	24.1	
Latrine	38.2	26.8	40.4	53.1	
Electricity (%) [d]	74.2	76.2	72.3	72.6	.007
Housing (%) [d]					< .001
Owned	34.6	39.6	31.9	29.3	
Rented	11.7	10.4	9.7	14.8	
Borrowed[e]	53.4	49.4	58.1	55.9	
Goods owned (%)[d]					
Color television [d]	34.7	37.3	37.2	29.5	.009
Radio [d]	56.5	56.9	58.7	54.6	.47
Refrigerator	26.6	32.3	23.9	20.1	< .001
Monthly household expenditure (%) [d]					.005
Not poor ≥ US$200	33.3	37.3	32.8	28.0	
Moderately poor < US$200 to ≥ $US100	58.8	56.8	59.0	61.7	
Extremely poor < US $100	7.8	5.9	8.2	10.4	

a. Analysis of variance (ANOVA).
b, c. Means with the same superscripts are not significantly different ($p > .05$, Tukey's test).
d. Pearson chi-square test
e. "Borrowed" housing here refers to a house that is not owned or rented but loaned by the owner for short-term use by a family.

TABLE 4. Prevalence (%) of malnutrition in children and adults in poor urban areas in Chiclayo, Peru

Nutritional status	Total	Chiclayo	La Victoria	Leonardo Ortiz	*p* value[a]
Children (n = 1,598)					
Stunting (HAZ < –2 SD)	15.4	12.9	14.8	19.3	.009
Wasting (WHZ < –2 SD)	1.3	0.9	0.6	2.1	.09
Overweight (WHZ > 2 SD)	4.6	4.7	5.6	3.7	.39
Mothers (n = 1,589)					.65
Underweight (BMI < 18.5)	2.1	2.6	1.8	1.7	
Overweight (BMI 25.0-29.9)	33.3	33.1	36.5	31.5	
Obese (BMI > 30)	9.5	9.7	8.0	10.3	
Fathers (n = 983)					.38
Underweight (BMI < 18.5)	1.3	0.9	1.5	1.9	
Overweight (BMI 25.0–29.9)	32.8	31.6	30.6	35.9	
Obese (BMI > 30)	8.7	8.0	11.7	7.9	

HAZ, height-for-age z-score; WHZ, weight-for-height z-score; BMI, body-mass index
a. Pearson chi-square test.

mother and father and the prevalence of stunting in children ($p < .001$).

The average prevalence of overweight among children was 4.6%, and there were no significant differences among the three municipal areas ($p = .39$). The overall prevalence of overweight and obesity in mothers was 33.3% and 9.5%, respectively, with little variation among the three areas ($p = .65$). Similar results were observed in fathers, with 32.8% of them being overweight and 8.7% obese, but with no differences among areas ($p = .38$). The prevalence of overweight among mothers and fathers was significantly higher in the households with the lowest monthly expenditures (**fig. 2**).

As expected, the prevalence of anemia was highest among children (65.7%), followed by mothers (34.3%) and fathers (12.2%) (**table 5**). There were no significant differences among municipal areas in the proportion of children, mothers, or fathers with anemia ($p > .05$). However, among children there was a significant association between area of residence and mean hemoglobin level ($p = .013$, ANCOVA corrected for age); children living in Leonardo Ortiz had lower hemoglobin concentrations than children in Chiclayo and La Victoria.

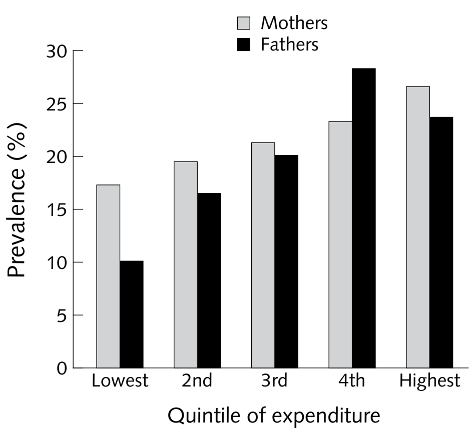

FIG. 2. Prevalence of overweight in urban mothers and fathers according to quintile of household expenditure. The differences within mothers and fathers are significant ($p < .001$, χ^2-test)

In general, the rates of both adequacy of targeting and the coverage of government food-distribution programs were low (**table 6**). In fact, the rates were lower in extremely poor households (25.4% targeting and 26.3% coverage) than in poor households (19.7% and 54.1%, respectively).

Discussion

The prevalence of stunting observed in this study among children under 5 years of age in selected poor urban slums of Chiclayo was about two-thirds of the national prevalence of 21.7% in 2000 [17]. In 1992, 1996, and 2000, the national prevalence of stunting in children decreased from 29.0% to 22.7% to 21.7%.

TABLE 5. Prevalence (%) of anemia in mothers, fathers, and children in poor urban areas in Chiclayo, Peru[a]

Subgroup	Total	Chiclayo	La Victoria	Leonardo Ortiz	*p*
Children (n = 1,564)	65.7	64.6	62.3	69.4	.09
Mothers (n = 1,576)	34.3	34.2	33.5	34.8	.97
Fathers (n = 961)	12.2	12.3	9.5	13.7	.50

a. Anemia in children, mothers, and fathers is defined by hemoglobin levels less than 110, 120, and 130 g/L, respectively.

TABLE 6. Rates (%) of targeting and coverage of urban moderately poor and extremely poor households by government food-distribution programs[a]

Variable	Moderately poor households	Extremely poor households
Targeting	19.7	25.4
Coverage	54.1	26.3

a. Targeting was defined as the percentage of all houses covered by at least one food-distribution program that were in fact moderately poor or extremely poor (household expenditure < US$200/month or < US$100/month, respectively). Coverage was defined as the percentage of all moderately poor or extremely poor households that received food from at least one of the distribution programs.

A similar trend has been reported for other Latin American countries [7]. The prevalence of anemia in children (65.7%) was higher than that reported nationally for the year 2001 (49.6%). It is difficult to ascertain the cause of the higher rates of anemia in our study. However, a dietary intake study conducted in a subgroup of children and adults (not reported here) found very low iron intakes, only 30% to 60% of the recommended daily allowance. In contrast to these deficiencies, the high prevalence of overweight and obesity in adults indicated an excessive intake of energy, which has also been reported in other populations of the Peruvian coast [17] and in several other Latin American countries. With a low prevalence of stunting in children, a high prevalence of anemia compared with the national average, and a high prevalence of overweight and obesity in adults, this population illustrates the typical problem of the double burden of malnutrition (under- and overnutrition), which is also found in other populations of Latin America.

The city of Chiclayo has considerable socioeconomic diversity. The prevalence of stunting is highest in households in the lowest quintile of household expenditures and decreases gradually by quintile, reaching a plateau in the two highest quintiles at approximately 12% to 14%. A similarly shaped curve was reported for the city of São Paulo [9]. The authors stated that the reduction of growth retardation in households in the higher quintiles of income could not be achieved by increasing income alone and suggested that at higher incomes, access to high-quality health and environmental community services such as water and sanitation becomes the limiting factor for a further reduction of undernutrition.

The analyses of covariance also found a significant negative association between the level of formal schooling of the parents and the prevalence of stunting among their children. This observation reinforces prior findings on the importance of education as an intervention and its potentially powerful nutritional impact [18, 19]. Experience from successful nutritional programs has shown that improved services in the community, such as potable water, sewage systems, health facilities, access to the most limiting micronutrients, good-quality care, early stimulation, and education, are essential as well. Geographic targeting is particularly needed for the improvement of social infrastructure and services.

Household economic expenditure was significantly correlated with the prevalence of overweight among adults, but not with the prevalence of underweight among adults. The prevalence of overweight among adults was already significantly higher in households in the first two quintiles of expenditure, suggesting that even in the poorest segments of the urban population, there are emerging conditions leading to positive energy balance (lower expenditure and higher intake of energy).

During the past four decades, different Peruvian governments have implemented feeding programs with the aim of assisting poor families to eradicate food insecurity and hunger. For many years these programs have been targeted to urban populations in general and to Lima and other main cities of the coast in particular. Since 1990, these programs have been expanded to cover the poorer populations of both urban and rural areas [20].

The survey showed the poor targeting of government programs. The coverage rate of feeding programs was low in moderately poor households (54.1%) and even worse in extremely poor households (26.3%). This suggests that there was neither an effective selection process nor a specific inclusive approach to target those most at risk. The iron–folate supplementation program for women had little coverage, as has also been reported at the national level [20].

The findings of the baseline survey resulted in several meetings with community representatives, nongovernmental organizations, government authorities, donor agencies, and program operators to develop a causal framework for appropriate interventions based on UNICEF's framework of malnutrition [22]. As shown in **figure 3**, four vertical thematic areas were identified as key interventions: nutrients, hygiene, care, and purchasing power. In addition, three horizontal, crosscutting areas were selected to support the thematic areas: communication, organization (community empowerment and capacity strengthening), and extension services.

At the household level, multimicronutrient supplementation was identified as an important strategy to control micronutrient deficiencies of the poor. Opening a savings and credit program to improve purchasing power is another strategy that could be used to improve the nutritional status of the present population, in particular the extremely poor households. However, it was also acknowledged by all participants in the program that the improvement of community services such as water and sanitation is another important strategy to improve the nutrition situation.

Horizontal areas \ Vertical areas	Nutrient intake			Hygiene			Care	Purchasing power	
	Supplementation	Fortification	Diet	Water	Sewage	Garbage	Kindergarten	Income	Services
Communication									
Organization									
Extension									

PISA working groups

FIG. 3. Framework of a food security intervention strategy for Chiclayo, Peru

In summary, the poorer urban dwellers in the coastal region of Peru require interventions that will not only reduce the risk of stunting and anemia but also address the emerging problem of obesity. Food-assistance programs working in Chiclayo did not reach those at risk or address the nutritional needs of the population. Furthermore, inadequate targeting may even increase the risk of obesity and thus the risk of chronic diseases in later stages of life. Therefore, other measures need to be identified that will reach the poorest and support them by providing jobs and cash opportunities (income and employment programs).

References

1. Food and Agriculture Organization. Food insecurity in an urban future. Available at: http://www.fao.org/newsroom/en/focus/2004/51786/article_51797en.html. Accessed 23 June 2006.
2. Musgrove P. Basic food consumption in north-east Brazil: effects of income, price, and family size in metropolitan and rural areas. Food Nutr Bull 1988; 10:19–37.
3. Aguirre P. How the very poor survive—the impact of hyper-inflationary crisis on low-income urban households in Buenos Aires, Argentina. Geojournal 1994; 34:295–304.
4. Arambulo P 3rd, Almeida CR, Cuellar J, Belotto AJ. Street food vending in Latin America. Bull PAHO 1994:28,344–54.
5. Atkinson SJ. Urban-rural comparisons of nutrition status in the Third World. Food Nutr Bull 1993;14: 337–40.
6. Drewnowski A, Popkin BM. The nutrition transition: new trends in the global diet. Nutr Rev 1997;55:31–43.
7. UNICEF. The state of the world's children. New York: UNICEF, 1998.
8. World Heath Organization Regional Office for the Western Pacific. Micronutrient deficiencies. Available at: http://www.wpro.who.int/health_topics/micronutrient_deficiencies/general_info.htm. Accessed 23 June 2006.
9. Gross R, Monteiro CA. Urban nutrition in developing countries: some lessons to learn. Food Nutr Bull 1989;11:14–20.
10. Esrey S, Feacham RG, Hughes JM. Interventions for the control of diarrhoeal disease among young children: improving water supplies and excreta disposal facilities. Bull World Health Organ 1985;63:757–72.
11. Esrey SA, Potash JB, Roberts L, Shiff C. Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. Bull World Health Organ 1991;69:609–21.
12. Gross R, Kielmann A, Korte R, Schoeneberger H, Schultink W. Guidelines for nutrition baseline surveys in communities. Jakarta, Indonesia: South East Asian Ministry of Education Organization–Tropical Medicine (SEAMEO-TROPMED) and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Version 1.2, 1997. Available at: http://www.nutrisurvey.de/baseline/baseline.htm. Accessed 23 June 2006.
13. CIOMS. International guidelines for ethical review of epidemiological studies. Geneva: Council for International Organizations of Medical Sciences, 1991.
14. WHO. Measuring change in nutritional status. Geneva: Word Health Organization, 1984.
15. Programa Nacional de Asistencia Alimentaria (PRONAA). Ministerio de la Mujer y Asistencia Social. Lima, Peru, 2006. Available at: http://www.pronaa.gob.pe. Accessed 23 June 2006.
16. Gajate G, Inurritegui M. Impacto del programa de Vaso de Leche sobre el nivel de nutrición infantil. Economia y Sociedad 2003;50:63–70.
17. INEI (Instituto Nacional de Estatística e Informática). Encuesta Nacional de Demografía, Educación y Salud. Lima, Peru: ENDES, 2001.
18. Behrman J, Wolfe BK. More evidence on nutrition demand. Income seems overrated and women's schooling underemphasized. J Dev Econ 1984;14:105–28.
19. Behrman J, Wolfe BL. How does mother's schooling affect family health, nutrition, medical care usage, and household sanitation? J Econometr 1987;36:185–204.
20. Lechtig A. Sistema de Seguridad Alimentaria y Protección Social. Plan Estratégico. Lima, Peru: Presidencia de la República del Perú, PRONAA, 2003.
21. UNICEF. Nutrition strategy. New York: United Nations Children's Fund, 1991.

Effectiveness of distribution of multimicronutrient supplements in children and in women and adolescent girls of childbearing age in Chiclayo, Peru

Ursula Gross, Claudia Valle, and Marita Mamani Diaz

Abstract

Background. *There is a need to better understand the coverage of scaled-up multimicronutrient supplementation programs.*

Objective. *The coverage of the distribution of multimicronutrient supplements in 26 urban communities among women and adolescent girls 12 through 44 years of age and children under 5 years of age was evaluated for purposes of scaling-up.*

Methods. *Formative research and descriptive statistics were used to analyze the distribution of supplements.*

Results. *Despite a delayed memorandum of understanding with the health sector and delayed delivery by the producer of the supplement, a high coverage rate of supplement distribution to the children (88% on average during the 3 months of supplementation) was still achieved as a result of the strong commitment of the community and the Integrated Food Security Program. The lower coverage rate among women and adolescent girls (47% on average) was the result of too short a period of enrollment in the program. There was no decrease of coverage during the 3 months of supplementation in both groups.*

Conclusions. *Effective, sustainable, large-scale micronutrient supplementation programs require broad partnerships with commitments of governmental and nongovernmental organizations, communities, and the private sector. Availability of the supplements and communication materials must be secured well ahead of the supplementation campaign and distribution of the supplement.*

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†Dr. Gross died on September 30, 2006.

Key words: Childbearing age, community distribution, micronutrients, supplementation, under-five children, urban

Introduction

Drugs and nutritional supplements are widely used for disease control, particularly where routine services are weak. However, their effectiveness is often limited because of low adherence by the target population [1]. The reasons for noncompliance are inadequate program support (lack of political commitment and financial support), insufficient delivery of services (poor provider–user dynamics; lack of supplies, access, training, and motivation of health-care professionals); and patient factors (misunderstanding of instructions and adverse side effects, among other factors).

In the case of iron supplementation, Galloway and McGuire [2] and Schultink et al. [3] found that unavailability of the tablets was the most common reason that women did not take iron–folate supplements. This observation has been confirmed by a study of iron-supplementation interventions in eight countries [4] that found that the major reason for the effectiveness of supplementation programs is adequate supply. In addition, inadequate counseling of women, difficult access to and poor utilization of prenatal health-care services, and fear of taking medications during pregnancy may be factors contributing to the low effectiveness of supplementation programs. Experience in developing countries indicates that often the poorest women with the most deficient food intakes are the least likely to receive iron supplements during pregnancy [5]. Yip [5] concluded that communication efforts must be expanded to increase understanding of the importance of taking supplements and to address any fears or misconceptions related to supplementation. Overall, the capacity of individuals and communities to define, analyze, and act to address their own health needs must be considered.

The objective of this operational research study was to evaluate the coverage of multimicronutrient supplements in adolescent girls and women aged 12 through 44 years and in children under 5 years of age at the household level using the health-sector distribution channel combined with community participation.

Methods and materials

Study populations

The Integrated Food Security Program (Programa Integrado de Seguridad Alimentaria [PISA]) began coordination and negotiation with the Regional Health Directorate of Lambayeque (Dirección Regional de Salud Lambayeque [DIRESA]) in 2001 to implement a joint campaign for the prevention of anemia and micronutrient deficiency in 26 low-income townships of Chiclayo, Peru. Adolescent girls and women aged 12 through 44 years and children under 5 years of age were targeted to receive weekly doses of micronutrient supplements [6]. To achieve high compliance, a comprehensive program strategy was developed. This supplementation-promotion program targeted a primary, a secondary, and a tertiary group.

The primary target group (beneficiaries) consisted of adolescent girls and women 12 through 44 years of age and children 6 months through 4 years of age from the 26 selected townships of Chiclayo. According to a census conducted in the townships, a total of 20,082 adolescent girls and women of childbearing age and 8,081 children were entitled to participate in the supplementation program.

The secondary target group (facilitators) consisted of individuals who had close contact with the beneficiaries. They had influence on practices and choices of the potential beneficiaries because the primary group trusted them. The supplementation campaign was built on the active participation of communities. Thirty-two supplementation committees were formed to cover the 26 townships geographically. The committees were in direct contact with the beneficiaries and took over all duties of the supplementation campaign. The facilitators consisted of 32 presidents of the supplementation committees and 255 members, all volunteers. A total of 287 persons worked as facilitators of the campaign.

The tertiary target group (health professionals) consisted of personnel of DIRESA (directors and chiefs of the health facilities) and professionals who were designated by the health authorities to implement the supplementation campaign. These professionals generally were in charge of the Regional Program of Micronutrients (Programa Regional de Micronutrientes [PREDEMI]) of DIRESA and were responsible for the supplementation of pregnant women and children 6 to 12 months of age with iron sulfate.

Strategy

Supplementation with micronutrients

The overall objective of the supplementation program was to improve and secure the micronutrient status of women and children. In particular, the program aimed to provide weekly multimicronutrient supplementation of girls and women 12 through 44 years of age and children 6 months through 4 years of age, and to provide nutritional education to adolescent girls, women, and mothers of small children to inform them about the health and nutritional problems they faced, the need to improve their health status, and how they could change their behavior.

To accomplish these two aims, the following strategy was developed:

- *Involvement of the health staff.* Professionals from the health sector were informed about the supplementation campaign and motivated to participate in developing the educational materials as well as to take over responsibility for the supplementation campaign.
- *Training of facilitators.* The developed educational material was used to train the facilitators in groups of 8 to 10 in sessions of about 3 hours once a month, at the beginning of the campaign and subsequently each month. The training took place 2 to 5 days before the new supplements and educational materials were distributed to the beneficiaries by the facilitators.
- *Coaching of the adolescent girls and women.* The facilitators informed the beneficiaries about the nutritional topics during supplement distribution once a month.

The distribution of supplements was accompanied by a communication strategy, in which the women and adolescent girls were informed why they should take the supplements and how they could participate in the campaign. At monthly meetings held during the campaign, the facilitators not only distributed the supplements but also informed the primary audience on nutritional topics to initiate long-term improvements in the micronutrient status of the population. The communication strategy is described in detail by Gross et al. [7].

Since PISA was looking for sustainable ways to improve the nutritional situation of the population, the project decided to collaborate with the regional directors of DIRESA. PISA and DIRESA prepared a memorandum of understanding for the micronutrient supplementation campaign describing the accountabilities of both sides.

As shown in **figure 1**, the health professionals of PREDEMI should have been responsible for dissemination of information about the campaign, training of the supplementation committee members (facilitators), distribution of the supplements to the 13 health centers

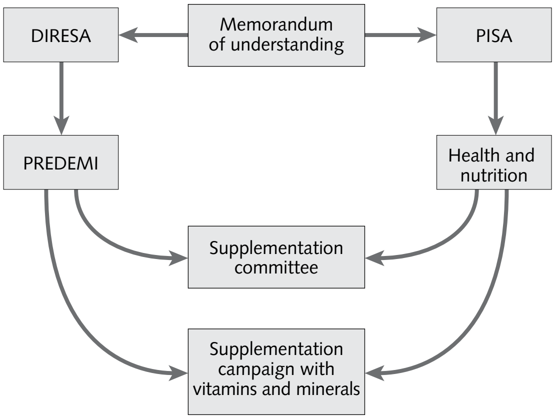

FIG. 1. Relationships among the main stakeholders of the supplementation program as described in the memorandum of understanding between the Regional Health Directorate of Lambayeque (Dirección Regional de Salud Lambayeque [DIRESA]) and the Integrated Food Security Program (Programa Integrado de Seguridad Alimentaria [PISA]). DIRESA is represented by the personnel of the Regional Program of Micronutrients (Programa Regional de Micronutrientes [PREDEMI])

and monitoring of campaign logistics. It was planned that PISA would support the health sector in all these activities through its health and nutrition section; however, PISA had to assume the operational responsibility for program implementation.

Supplements for adolescent girls and women of childbearing age

Two types of supplements were manufactured by HERSIL Laboratories, Lima, which had received the premix from Roche Laboratories, Lima. The micronutrient content of the supplements is described by López de Romaña [8]. During the campaign, both types of supplement were called Nutrivit. One type of Nutrivit was a capsule containing vitamins and minerals for the adolescent girls and women. The health staff received blister packs each containing 10 capsules. The packs were cut and each woman received four capsules each month.

Supplements for children 6 months through 4 years of age

The other type of supplement, called a “foodlet” (a combination of food and tablet), was especially developed for small children. It was not a tablet, because it could be diluted or masticated by the child, nor was it an ordinary food, because of its high micronutrient contents, form, and packaging. The micronutrient contents were based on the recommendation of an international expert group that two recommended daily allowances (RDAs) should be administered once per week [9]. The foodlet was white and tasted like milk and vanilla. Each mother received a blister containing four foodlets for her child once a month.

Distribution strategy

According to the memorandum of understanding between PISA and DIRESA, the execution of the supplementation program was to be carried out in “cascades,” in which the health professionals of PREDEMI would hand over the materials of the campaign to the presidents of the supplementation committees. All facilitators distributed the supplements and communication materials to the beneficiaries.

Before the first phase of distribution started, information about the supplementation program was to be disseminated to adolescent girls and women of childbearing age and to mothers to inform them about the benefits of the micronutrient supplements, where to enroll, and when the distribution of the supplement would begin. Information was to be disseminated by interpersonal communication, posters, and loudspeakers. Persons interested in receiving the supplements were invited to enroll at the facilitators’ houses, which had been marked by blue flags on the roof or the door. A specific form was used for enrollment.

The distribution cascade was to have five phases. In phase 1, PISA, in collaboration with PREDEMI, were to develop and purchase materials for the supplementation campaign to be passed to PREDEMI on a monthly basis. The quantity of materials to be handed over depended on the number of women and adolescent girls and children enrolled in the 26 townships. In phase 2, the personnel of the 13 health centers, who were responsible for the supplementation campaign, were asked to pick up all the material from the PREDEMI office once a month. In phase 3, the presidents of the 32 supplement committees were to collect the materials once a month from their corresponding health centers. In phase 4, the presidents of the 32 committees were asked to hand out the materials to the facilitators according to the numbers of persons enrolled (women, adolescent girls, and children). In phase 5, the facilitators were to distribute the supplements (one blister pack of four capsules or four foodlets, one for each week) and communication materials to the enrolled persons. Each of the five phases was to be monitored by a delivery form to be filled out. Additional communication material was used to motivate the primary audience to pick up the supplements on a monthly basis [7].

Community participation

Broad community participation was achieved through the formation of supplementation committees for the program. The facilitators were either elected by the community or confirmed specifically for the campaign by the president of the supplementation committee. The aims of the supplementation committees were to produce a multiplication effect, increase the coverage rate at low cost, and strengthen the role of community organizations in health care.

Training of the supplementation committees

Training started about one and a half weeks before the initiation of the campaign and took place in the house of the president or one of the committee members. At this initial stage, two topics were covered (**table 1**): the development of the "Nutritional Campaign with Vitamins and Minerals" and the management of the printed materials of the campaign. First, all facilitators were well informed about the supplementation campaign itself, the supplements and how to take them weekly, and possible positive and negative side effects. They learned about the importance of vitamins and minerals, the causes and consequences of deficiencies, and how to avoid them. Second, all facilitators had to be trained on how to fill in the forms for reception of the supplements as well as how to distribute the communication materials to the beneficiaries. In addition, they learned how the beneficiaries should mark the intake of the supplements on the calendars that each participating family received.

Responsibilities of the supplementation committees

The main responsibility for the campaign lay in the hands of the supplementation committees (facilitators), who performed the dissemination and motivation activities so that adolescent girls and women with their children enrolled themselves in the homes of the committee members (**table 2**). In compliance with phases 3 to 5 of the supplementation strategy, the supplements and the communication materials were picked up by the presidents of the committees at the health centers every 4 weeks, and the facilitators distributed them at the monthly meetings of the beneficiaries. In addition to advice on how to take the supplements, new information on better nutrition was disseminated, accompanied by new communication materials [7]. Thus the beneficiaries were motivated to participate in all monthly meetings. Specific forms were completed to monitor the distribution pathway from the health centers to the beneficiaries.

TABLE 1. Topics for training of the community facilitators of the supplementation program in Chiclayo, Peru

Development of the Nutritional Campaign with Vitamins and Minerals
» Concept of supplementation
» Weekly consumption
» Positive and negative effects
» Dissemination of information
» Distribution of the supplement to the beneficiaries
Management of the printed materials of the campaign
» Manuals for facilitators
» Calendars
» Supplement distribution forms
» Handouts and pamphlets for adolescent girls and women of childbearing age
» Posters
» Blue flags to indicate facilitators' houses
Nutritional topics
» Importance of vitamins and minerals
» Importance of vitamin A, vitamin C, folic acid, iron, and zinc
» Causes and consequences of deficiencies of these five micronutrients
» Alternatives for prevention and cure of these deficiencies
» Foods rich in these five micronutrients
» Breastfeeding
» Complementary feeding from 6 months
» Balanced food intake

Monitoring

Each of the steps of the supplementation program and their weaknesses were monitored by different small groups of participants. The aim was to be informed about what went right or wrong so that rapid decisions and interventions could be made by PISA, if necessary. Information to be used for future supplementation programs and possible scaling-up was to be collected without compromising implementation of the program by too much interference.

The monitoring system of PISA (internal monitoring) included a review of the administrative sheets to be filled in by the health professionals for supervising the reception and distribution of the supplements and the communication materials during the campaign. A similar sheet was filled in by the facilitators to keep track of how many supplements reached the beneficiaries and on what dates. Three weeks after the supplementation campaign ended, PISA evaluated the increase in knowledge of 180 beneficiaries (180 women and adolescent girls, randomly selected from the list of participants) by questionnaires and observation.

Additional external monitoring was carried out by an independent scientific institution during the first, second, and third months of the supplementation program. Sixty randomly selected families that were participating in the campaign were questioned each month (including an average of 75 women, 25 adolescent girls, and caretakers of 83 children 6 months through 4 years of age. On the average, information from 183 persons was available for monitoring purposes each month. The monitoring covered consumption of the supplement, the well-being of the beneficiaries, and increase of knowledge about micronutrients.

The information sources used to measure the effectiveness of supplement distribution came from the facilitators' reports of distribution.

Statistical analysis

Data were entered with the use of SPSS software for Windows, version 10.0.5 (SPSS, Chicago, IL, USA).

TABLE 2. Detailed responsibilities of the community facilitators of the supplementation program in Chiclayo, Peru

Activity	Description
Dissemination and motivation	The facilitators were responsible for disseminating information about the campaign by hanging posters in strategic places, communicating with neighbors about the beginning of the campaign, and loudspeaker announcements. Dissemination was carried out 1 week before the campaign started
Enrollment	Persons who were interested in participating in the campaign enrolled in the facilitators' houses using special enrollment forms
Distribution of supplements	Only the facilitators distributed the supplements to the beneficiaries. Each beneficiary received one blister pack containing four portions of Nutrivit (one for each week) over a 3-month period
Information about micronutrient deficiencies	Before the beneficiaries received the supplements for 1 month, the facilitators explained to them the problems of deficiencies of micronutrients (iron, zinc, vitamin A, vitamin C, and folic acid), especially in women and adolescent girls of childbearing age and children under 5 years of age, and how to cure or prevent these deficiencies
Motivation to take the supplement	The facilitators explained how to take the supplement once a week. Every time the beneficiaries came back to get a new blister pack of the supplement, they were reminded how important it was to take them every week
Explanation of the printed materials and how to mark the calendar	The facilitators explained the pamphlets the beneficiaries had received and the importance of marking in the calendar the day they took the supplement
Information about the nutritional topics and distribution of the corresponding printed materials	During the monthly meetings, the facilitators gave additional information about breastfeeding, complementary feeding, and nutritious food for the family. Each topic was accompanied by printed materials; its distribution was used as a motivator for the beneficiaries
Logistics of reception and distribution of the supplements and educational materials	The facilitators had to fill out specific forms after receiving the materials of the campaign and distributing them to the beneficiaries

Descriptive analysis (cross-tabulation) was mostly used for statistical evaluation. The chi-square test was used to explore for significant differences in cross-tabulations. The independent *t*-test was used to compare the coverage of the supplements in women and adolescent girls and in children during the 3 months of supplementation.

Results

As shown in **figure 1**, DIRESA and PISA should have shared all activities of the supplementation campaign, whereby the responsibility should have been on the governmental side. However, due to a delay in signing the memorandum of understanding between the two institutions, PISA had to take over the full responsibility for the campaign. It developed the communication materials, took over the training of the supplementation committees (facilitators), distributed the materials directly to the health centers, and monitored all activities.

Implementation

All components of the campaign had to be postponed because of the delay in delivery of the supplements by the manufacturer. Because the manufacturer confirmed only the supply of the capsules and gave no clear confirmation about the foodlet, it was decided to begin the supplementation campaign for women and adolescent girls of childbearing age as soon as possible, because PISA did not want to interrupt the twice-yearly campaign and lose the confidence of the population. Otherwise, a subsequent supplementation campaign during the second half of the year would have been jeopardized, because all supplementation activities would have clashed with school holidays and Christmas preparations in the community. As a result, supplementation of the women and adolescent girls started 1 month later and supplementation of the children started 2 months later than was originally planned.

As mentioned above, a delay in signing the memorandum of understanding between DIRESA and PISA forced PISA to take over activities that were to have been performed by the ministry. DIRESA initiated formation of the supplementation committees by sending out letters inviting people to volunteer for the campaign activities, but only 4 of the 13 health centers or posts complied with all of their responsibilities. The task most often completed by the health centers or posts during the 4 months was the distribution of the supplements to the leaders of the supplementation committees, an intramural activity. Extramural activities such as monitoring were not carried out, although payment for transportation was offered by PISA.

Training of members of the supplementation committees (facilitators)

The initial training of the 287 facilitators was carried out by PISA. Training was based on a manual for facilitators and included the use of pictures of foods and of Nutrivit capsules and foodlets, as well as examples of the forms to be filled in. The training covered the concept of the nutritional campaign, Nutrivit capsules and foodlets, and the importance of vitamin A, vitamin C, folic acid, zinc, and iron. The facilitators also underwent participatory training on how to use the visual materials, since a summary of these three topics had to be presented to the beneficiaries at the first meeting.

After the training, a post-test was conducted on a randomly selected group of 40 percent of the facilitators. The results showed that 98% to 100% of the facilitators knew how many Nutrivits had to be distributed to the beneficiaries at the monthly meeting, how many supplements the beneficiaries had to take per week, and how to take the capsules.

However, at this point only 84% of the facilitators knew how to record the date of intake of the capsule on the calendar, and the facilitators were retrained during the following session. After retraining, all the facilitators knew how to mark the calendar. In addition, 91% of the facilitators knew how to advise the women and adolescent girls on what to do if they forgot to take the supplement, and 98% of them knew where the supplements should be stored. Retraining was provided during the subsequent monthly meeting to those facilitators who were still insecure. Training placed emphasis on education and on participatory practicing of new topics (see **table 1**).

Information about the supplementation campaign

Because the campaign had to be postponed for 1 month, dissemination of information about the supplementation program began in the last 2 weeks of the presidential election campaign. Posters of candidates and parties were placed wherever possible, and many cars with loudspeakers were on the roads. Thus, the perception of the population of anything beyond the election was limited. In addition, the week before the election was declared a "silent week," in which no public announcements were allowed. Because the activities and announcements of the supplementation campaign were classified as public announcements, all of these actions had to be omitted. As a result, the information campaign had only one 1 week to attract and inform possible participants. As shown in **table 3**, under these circumstances, most community members learned about the supplementation campaign from the facilitators. According to external and internal monitoring, 61% and 54%, respectively, of the primary audience reported they had heard about the campaign from the facilitators, 19% and 21% from loudspeakers, and 2% and 8% from friends and neighbors.

Distributor-reported supplementation coverage rate

Because of the time constraints on the campaign, the rate of coverage of women and adolescent girls was not as high as expected (**fig. 2**). Many women and adolescent girls showed up in the days after enrollment was closed, but they had to be rejected by the facilitators, who were strictly instructed not to allow later enrollments because it would not be possible for them to receive 12 weeks of treatment. At least 9 of the 12 doses were required for minimal efficacy. During the distribution meetings, all beneficiaries received information on the supplements, when and how to take them, and what foods should be consumed by the whole family (see **table 2**; described in detail by Gross et al. [7]). This informational and educational system would have broken down if enrollment had been allowed in the following weeks; the facilitators would have been overburdened, and more trained staff would have been required. Despite all these circumstances (**fig. 2**), the rates of coverage of the women and adolescent girls of childbearing age and of the children did not change during the 3 months of the supplementation campaign. The coverage rates varied from 46.9% to 48.0% (average, 47.4%) for the women and adolescent girls and from 86.6% to 88.2% (average, 87.8%) for the children. However, there was a significant difference between the coverage rates for women and adolescent girls and for children ($p < .001$, *t*-test).

TABLE 3. Principal sources from which beneficiaries ($n = 180$) reported obtaining information about the supplementation campaign according to internal and external monitoring[a]

Source	Internal monitoring (%)	External monitoring (%)
Facilitators	61	54
Loudspeakers	19	21
Neighbors or friends	2	8

a. The difference between the results according to internal and external monitoring is significant ($p < .001$, χ^2 test).

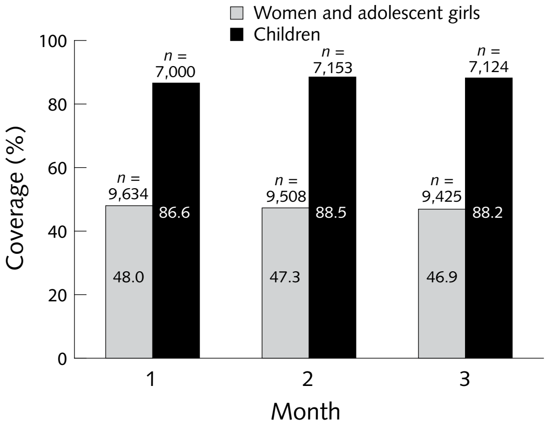

FIG. 2. Distributor-reported coverage rates of supplementation in all women and adolescent girls of childbearing age ($n = 20,082$) and under-five children ($n = 8,081$) during the 3 months of supplementation. All differences are significant ($p < .001$, *t*-test)

Distribution of nutrition educational materials

To increase knowledge of nutrition and to induce a sustainable change in nutrition-related behavior, nutrition educational materials and related recipes were distributed during the monthly pickups of the supplements [7].

Discussion

The distribution suffered from several constraints. Delayed delivery of the supplements by the manufacturer caused a 1-month postponement of the supplement campaign for women and adolescent girls of childbearing age and a 2-month postponement of the campaign for children. Because of the 1-month delay, the time available for promoting the campaign to women and adolescent girls and enrolling them was too short, only 2 weeks. In addition, the election campaign distracted the community. All of these factors resulted in lower coverage rates in women and adolescent girls. Because the enrollment period for children started after the election, later than the enrollment period for women and adolescent girls, and lasted for a whole month, the coverage rate of children was high (88%).

It was evident from these constraints that supplements and communication materials should be ordered much earlier and delivered at least 3 months before distribution to the beneficiaries. This would require a shelf life of the supplements of at least 9 months. Compliance can be significantly improved by making sure that iron supplements are available at all times, as stressed by Galloway and McGuire [2]. Also important is an appropriate timely agreement between all partners before the program starts. It is obviously wise to have an alternative plan for what to do and who will take over if one of the partners fails to comply. The time allowed for promotion of the supplements and enrollment of beneficiaries should be at least 1 month, and the period should be selected at a time when no other big campaigns that could distract the target population are taking place. Since it was planned to have two supplementation campaigns per year, scheduling of the campaigns should have taken into account the considerable time span between the two campaigns, as well as school vacations and important national holidays (such Christmas as Independence Day).

In this project, the health sector complied mainly with intramural activities such as distribution of materials to the presidents of the committees. As a consequence, activities involving direct contact between this key sector and the communities, such as training facilitators and monitoring program activities, were rare. Therefore, PISA had to take over many additional activities, which resulted in overburdening their limited number of health and nutrition professionals.

Despite these constraints, the women and adolescent girls showed a strong interest in the supplements. The high degree of motivation to receive the Nutrivit was confirmed by the consistent coverage rate over the 3 months. The relatively high participation of the health professionals at the training sessions for the facilitators (50% to 75%) may have been due to the facts that the communication materials had already been prepared by PISA and that the training itself was mainly implemented by PISA nutritionists, so that no additional extramural efforts were needed from the health professionals.

As Winichagoon [10] observed in Thailand, whatever governmental institution is to be involved in a supplementation campaign, a strong community commitment must be achieved to secure high compliance.

In this program it became clear that health sector personnel could and would perform mainly intramural activities, such as distribution of materials that were picked up by the presidents of the committees, that did not require them to leave their institutions. Because of this, all activities that involve contacts with the beneficiaries should be taken over by trained facilitators who are selected and organized by the community. Khan et al. [11] described a similar experience in Vietnam, where the existing system of distribution of supplements to pregnant and nonpregnant women was inconvenient. To overcome this constraint, local members of the Women's Union, who knew their village colleagues, were trained to distribute the supplements.

In addition, a good monitoring system is indispensable. The pathway from the supplier of the supplements to the beneficiaries must be monitored to avoid mismanagement and frustration. Furthermore, the supplement distribution program must always be accompanied by a comprehensive communication program. Although these requirements will increase the costs of the supplementation program, as shown by Lechtig et al. [12], fulfilling them will be indispensable to secure participation and continued compliance.

To achieve strong governmental ownership and commitment, two other governmental institutions were contacted to explore whether they could cover part of the target group (women and adolescent girls and children). The National Program of Food Assistance (Programa Nacional de Asistencia Alimentaria [PRONAA]) is responsible for distribution of food to the *comedores populares* (people's canteens or soup kitchens). The infrastructure of their distribution channel could be used for distribution of the supplement to women, adolescent girls, and children. The other governmental institution contacted was the Directorate of Education (Dirección Regional de Educación). If the secondary school system were used for supplement distribution and additional nutrition education by trained teachers, female adolescent students could improve their nutritional status. Increased awareness and demand for iron–folic acid supplementation of the secondary school girls was described by Garcia et al. [13] in the Philippines and by Kanal et al. [14] in Cambodia.

Two small trials were conducted to explore the possible use of these two institutions, with recognition that the institutions cannot replace the role of the Ministry of Health. Nevertheless, they could be helpful additional partners in micronutrient campaigns. Both trials were too small to provide representative data but were promising.

References

1. Rosenberg MJ, Burnhill MS, Waugh MS, Grimes DA, Hillard PJ. Compliance and oral contraceptives: a review. Contraception 1995;52:137–41.
2. Galloway R, McGuire J. Determinants of compliance with iron supplementation: supplies, side effects, or psychology? Soc Sci Med 1994;39:381–90.
3. Schultink W, van der Ree M, Matulessi P, Gross R. Low compliance with an iron-supplementation program: a study among pregnant women in Jakarta, Indonesia. Am J Clin Nutr 1993;57:135–9.
4. Galloway R, Dusch E, Elder L, Achadi E, Grajeda R, Hurtado E, Favin M, Kanani S, Marsaban J, Meda N, Moore KM, Morison L, Raina N, Rajaratnam J, Rodriquez J, Stephen C. Women's perceptions of iron deficiency and anemia prevention and control in eight developing countries. Soc Sci Med 2002;55:529–44.
5. Yip R. Iron supplementation: country level experiences and lessons learned. J Nutr 2002;132(4 suppl): 859S–61S.
6. Gross R, Lechtig A, López de Romaña D. Baseline evaluation of nutritional status and government feeding programs in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl): S115-121.
7. Gross U, Diaz MM, Valle C. Effectiveness of the communication program on compliance in a weekly multimicronutrient supplementation program in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S130–42.
8. López de Romaña D, Verona S, Aquino O, Gross R. Protective effect of multimicronutrient supplementation against anemia among children, women, and adolescent girls in lower-income areas of Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S143–50.
9. Gross R. Micronutrient supplementation in the life cycle. New York: UNICEF, 2002.
10. Winichagoon P. Prevention and control of anemia: Thailand experiences. J Nutr 2002;132(4 suppl):862S–6S.
11. Khan NC, Thanh HT, Berger J, Hoa PT, Quang ND, Smitasiri S, Cavalli-Sforza T. Community mobilization and social marketing to promote weekly iron-folic acid supplementation: a new approach toward controlling anemia among women of reproductive age in Vietnam. Nutr Rev 2005;63(12 pt 2):S87–94.
12. Lechtig A, Gross R, Paulini J, López de Romaña D. Costs of the multimicronutrient supplementation program in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl): S151–9.
13. Garcia J, Datol-Barrett E, Dizon M. Industry experience in promoting weekly iron-folic acid supplementation in the Philippines. Nutr Rev 2005;63(12 pt 2):S146–51.
14. Kanal K, Busch-Hallen J, Cavalli-Sforza T, Crape B, Smitasiri S, and the Cambodian Weekly Iron-Folic Acid Program Team. Weekly iron-folic acid supplements to prevent anemia among Cambodian women in three settings: process and outcomes of social marketing and community mobilization. Nutr Rev 2005;63(12 pt 2):S126–33.

Effectiveness of the communication program on compliance in a weekly multimicronutrient supplementation program in Chiclayo, Peru

Ursula Gross, Marita Mamani Diaz, and Claudia Valle

Abstract

Background. *Compliance with daily micronutrient supplementation is usually poor and the question arises whether compliance with a weekly regimen would be better.*

Objectives. *The inputs (messages and channels), output (increase of knowledge), and outcome (behavior changes) of a communication campaign in a micronutrient supplementation program for women and adolescent girls 12 through 44 years of age and children under 5 years of age (primary audience) were analyzed.*

Methods. *The communication program addressed not only the primary, but also the secondary (facilitators) and tertiary audiences. Formative research and descriptive statistics were used to analyze the communication campaign.*

Results. *Nearly all women and adolescent girls (89%) and children (91%) took at least 75% of the supplements over the 3-month period. The incidence rates of reported negative side effects of supplementation in children and in women and adolescent girls were less than 10%. Knowledge of micronutrient nutrition among facilitators of all ages and education levels increased significantly* ($p < .001$).

Conclusions. *A thoroughly planned and implemented nutrition communication program can secure high compliance of the beneficiaries of micronutrient supplementation programs. The necessary supplies should be available at least 3 months before program implementation. With an adequate communication program, supplementation programs can be used to foster food-based approaches for the target audience.*

Key words: Communication, community, micronutrients, supplementation, under-five children, urban, women

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Introduction

Within the Integrated Food Security Program (Programa Integrado de Seguridad Alimentaria [PISA]) in Chiclayo, Peru, the overall objective of the multimicronutrient supplementation program was to improve and secure the micronutrient status of women, adolescent girls, and children, the most vulnerable groups in the population [1]. Micronutrient supplementation is a widely used nutritional intervention to reduce micronutrient deficiencies. However, despite its proven efficacy, supplementation often shows little effectiveness [2, 3]. Distribution problems and low compliance are the main causes of limited effectiveness. Weekly supplementation is increasingly being recommended to reduce the amount of effort required for distribution of the supplements with a satisfactory level of availability at the consumer level [4]. Since compliance with daily supplementation programs is usually poor, the question arises whether compliance with a weekly regimen would be better.

In 1996, the World Health Organization (WHO) [5] stated that a supplementation campaign should be accompanied by an effective communication effort, as suggested by Yip [2]. According to the United Nations Sub-Committee on Nutrition [6], the major reason for the lack of compliance with iron supplementation is the lack of appropriate training of health staff. In such cases, a proper demand for the supplements has not been created within the target group. Griffiths [7] stated that demand must be created, the tablets or food supplied in an acceptable form, and education about proper use be carried out to ensure demand. Independently of the frequency of administration of supplementation, factors such as motivation, supervision, and communication with the target audience play a crucial role [7]. Mason et al. [8] described community participation as an important feature of health programs, because it increases the motivation of community workers and their effective communication within the community. Women's Union collaborators were used to expand the opportunities for communication and education beyond the capacity of health personnel in Vietnam [9].

On the basis of these experiences and recommendations, a nutrition communication program was developed to maintain high compliance with multimicronutrient supplementation in children 6 months through 4 years of age and in adolescent girls and women 12 through 44 years of age. The objective of this study was to measure the effectiveness of the nutrition communication program.

Materials and methods

Strategy of the communication program

The micronutrient supplementation program had two components: the distribution of the supplement [10] and an accompanying communication program. **Table 1** shows the logical framework of the communication program in which the input, output, outcome, and impact are related to the target audiences. According to the framework, transfer of knowledge about the importance of micronutrient nutrition and the way micronutrients should be distributed should lead to increase of knowledge in the target audiences. This should influence their practices and choices and result in improvement of the nutritional status of the primary target audience. According to these principles, information, education, and communication (IEC) [11] should increase the knowledge of all audiences. In consequence, improved knowledge and understanding should lead to high participation and compliance in the program. Finally, high compliance should result in the reduction of anemia and other symptoms of micronutrient deficiencies. This study describes the chain of input, output, and outcome of the communication program. Implementation, monitoring, and evaluation of the distribution of the supplements, leading to a high availability of supplements in the primary target audience, are described by Gross et al. [10]. The supplementation campaign resulted in an improved micronutrient status, as reported by López de Romaña [12].

Responsibilities within the communication program

Figure 1 shows the planned distribution chain of the communication materials. Initially it had been agreed that PISA would purchase the multimicronutrient supplements and hand them over to the Regional Health Directorate of Lambayeque (Dirección Regional de Salud Lambayeque [DIRESA]). The supplements would then be distributed to local community facilitators who would pass them to the beneficiaries. The distribution of the supplements is described in detail by Gross et al. [10].

Target audiences

Table 2 shows the strategy of the communication program according to its inputs (messages, materials, channels, communication strategies, and monitoring), considering the primary, secondary, and tertiary audiences. PISA selected 26 townships of Chiclayo, Peru, to participate in a micronutrient supplementation program. The townships chosen were poor, as judged by several social, economic, and health indicators [12]. A memorandum of understanding was prepared between PISA and DIRESA as the governmental institution, which implemented related programs to improve the nutritional status of the population. It was agreed to involve the professionals of all 13 health centers of the 26 townships in the supplementation campaign. The strategy and tasks are described by Gross et al. [10].

Primary audience (beneficiaries)

During the design of the supplementation campaign in 2001, PISA conducted a census that found that 20,082 women and adolescent girls of childbearing age (12 through 44 years) and 8,081 children 6 months through 4 years of age lived in the projected area. This primary audience was entitled to receive the supplements,

TABLE 1. Logical framework of the communication program

		Target audience		
		Primary	Secondary	Tertiary
Input	Knowledge transfer	Information	Education (training)	Communication
Output	Knowledge increase	Micronutrients Program implementation	Micronutrients Program implementation Monitoring	Micronutrients Program implementation Monitoring and evaluation
Outcome	Practices and choices	High participation	High participation	High, sustained compliance
Impact	Nutritional status	Reduced anemia		

nutritional materials, and advice once a month during the campaign.

Secondary audience (facilitators)

The micronutrient supplementation campaign was based on the active participation of the population in the activities of the supplementation committees. Each of the 32 supplementation committees formed in the 26 townships consisted of a president, a secretary, and the other members. A total of 287 persons, all volunteers elected in general assemblies of the population of each township, served on the committees. The committee members showed high dedication to helping the population and identified

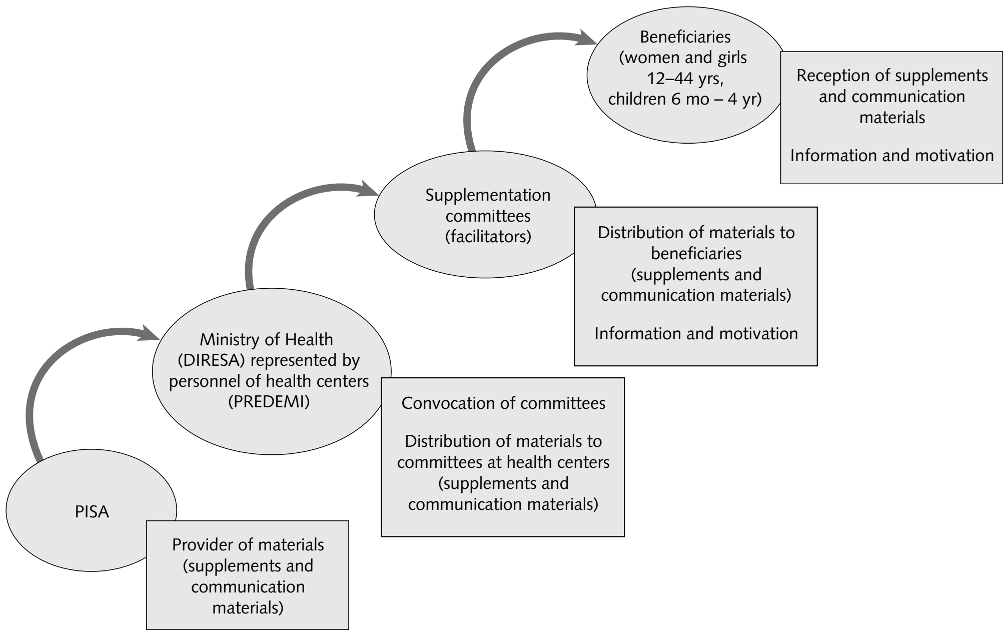

FIG. 1. Communication channels. DIRESA, Regional Health Directorate of Lambayeque (Dirección Regional de Salud Lambayeque); PISA, Integrated Food Security Program (Programa Integrado de Seguridad Alimentaria); PREDEMI, Regional Program of Micronutrients (Programa Regional de Micronutrientes)

TABLE 2. Strategy of the communication program according to its inputs

	Target audience		
	Primary	Secondary	Tertiary
Population	Girls and women 12–44 yr Children 6 mo–4 yr	Facilitators	Ministry of Health (DIRESA) professionals
Input			
Messages	Specific messages “Supplementation with vitamins and minerals” “Put health and energy in your life” “Healthy and energetic family” “Be an active and energetic teenage girl” “It doesn’t cost you anything” Nutrivit logo (capsules and foodlets) Different messages on food habits		
Channels	Interpersonal communication Printed materials Loudspeakers	Interpersonal communication Printed materials T-shirts Blue flags	Interpersonal communication Printed materials
Monitoring	3 external monitorings 1 internal monitoring	Internal monitoring of facilitators’ performance	Agreement on internal monitoring of Ministry of Health professionals’ performance

DIRESA, Regional Health Directorate of Lambayeque (Dirección Regional de Salud Lambayeque) themselves with problems in the community. They were trained as facilitators to work directly with the primary audience. Once trained, the committee members established contact with the primary audience (adolescent girls, women of childbearing age, and small children), with the following tasks:

» Informing the primary audience about the importance of micronutrient nutrition and improved health;
» Explaining the opportunity to register for the supplementation program;
» Distributing the supplements and communication materials;
» Monitoring the program.

This paper focuses on the activities related to the communication aspect of the supplementation campaign. The activities related to the distribution of the supplements and their impacts are described in more detail in Gross et al. [10].

Tertiary audience (health professionals)

DIRESA and PISA prepared a memorandum of understanding to implement the micronutrient supplementation campaign jointly. It was agreed that professionals from the health establishments of the townships would be responsible for the distribution of the campaign materials. PISA assisted in all activities, starting with the development of communication materials, training of the facilitators, and monitoring. Each health establishment designated one professional to participate directly in the execution of the campaign. These professionals were mainly personnel from the Regional Program of Micronutrients (Programa Regional de Micronutrientes [PREDEMI]).

Messages

In general, messages (verbal or nonverbal, pictorial, or gestures) are tailored to arouse reactions in the target audience. Messages were developed for the supplementation campaign to inform and motivate the target audiences (women and adolescent girls) to participate in the program and take the supplements over a period of 3 months. The supplementation campaign was called the "Nutritional Campaign for Vitamins and Minerals." The term "vitamins" was chosen because it was known by the primary audience and had positive associations, whereas the term "micronutrients" was unknown, as a pretest had shown.

Messages for the primary and secondary audiences

The development of the messages took into account the nutritional problems, characteristics of the audiences, communication objectives, and channels of transmission for the messages.

In order for the primary and secondary audiences to identify themselves with the messages, cartoons showing members of a family were developed, as well as a Nutrivit logo showing the two types of supplements used in the campaign (**fig. 2**). The cartoons were used in all communication and training materials to awaken curiosity and break up the texts without disturbing the flow of information, creating a content environment and easy understanding.

To position the supplement for the primary and secondary audiences, the following five key messages were chosen:

» "Supplementation with Vitamins and Minerals." All audience members should know what the campaign was about and become aware of the need for vitamins and minerals.
» "Bring Health and Energy into Your Life." This slogan was used in all materials distributed at the beginning of the campaign to motivate the primary audience to improve their health and thus their energy level for their daily life.
» "Healthy and Energetic Family." This message was directed toward adult women and mothers to create awareness that the family needs energy for daily activities.
» "Be an Active and Energetic Teenage Girl." Qualitative investigations conducted in preparation for the campaign found that the adolescent girls could not identify with materials and messages developed for adult women. Therefore, this specific message with a

FIG. 2. Communication materials distributed to primary and secondary audiences during the supplementation campaign. Top left, pamphlet for women: "It doesn't cost you anything to have a healthy family full of energy. Top middle, pamphlet for adolescent girls: "It doesn't cost you anything to be an active girl full of energy." Top right, manual for facilitators: "Nutrition campaign with vitamins and minerals." Middle center, blister pack of foodlets. Bottom left, nutrition manual: "Good nutrition provides health and energy to the entire family." Bottom right, economical and nutritional recipes: "Good nutrition is the basis for family well-being"

separate pamphlet for that age group was developed and disseminated.
» "It Doesn't Cost You Anything." To increase participation, the population was informed that the supplements would be free of financial costs.

Social costs include going to get the supplements, remembering to take them every week, experiencing possible side effects, and being aware of possible barriers within the social environment (e.g., uninformed husbands, friends, teachers, or even auxiliary health-care staff). To lower the social cost, information about the benefits of the supplements was provided by the facilitator, and related communication materials were distributed.

Communication channels

Channels of interpersonal communication and mass media may be needed to convey specific messages to the target audiences. Channels should be selected according to their credibility and interest, affordability, and accessibility to the target audience. As shown in **table 2**, the following communication channels were used for dissemination of the messages:

» *Interpersonal communication*. As found in prior campaigns, the most important channel for all three audiences was interpersonal communication. Because interpersonal communication leaves much room for different interpretation or presentation of the topics, standardization of the messages was strived for by the distribution of printed materials.
» *Posters*. Posters were positioned at strategic places, such as in shops and on trees, to inform the population about the campaign.
» *Loudspeakers*. Cars with loudspeakers drove through the roads of the 26 townships to inform the communities about the campaign.
» *Blue flags*. The facilitators' houses were marked with blue flags to show the people where they could enroll themselves in the campaign and from whom they could get the supplements and the printed communication materials.
» *T-shirts*. The facilitators received T-shirts to be worn during the campaign to identify them as the resource persons. Since the facilitators did not even receive an expense allowance for their work with the beneficiaries, the T-shirts were appreciated as a sign of recognition that gave them prestige in the communities. The slogan "Bring Health and Energy into Your Life," as well as the Nutrivit logo, was printed on the back of the T-shirt.

Printed materials

As shown in **table 3**, different printed materials were developed for the three audiences to inform them about why and how they should participate in the campaign. To give the materials a consistent, specific identity, they all used the same slogan, "Bring Health and Energy into Your Life," and the same cartoon characters. The same cartoons of family members were used in the nutrition education manual and the recipe booklet.

All printed materials were pretested according to the recommendations of HealthCom [13]. Low-cost, nutritious recipes were developed by the Nutrition Division of PISA, portion sizes were checked with mothers of small children, and the nutritional values of the recommended recipes were calculated with the use of Erhardt's software [14] on the basis of the Peruvian Food-Composition Table [15].

Printed materials for the primary audience

The first objective of the printed materials for the primary audience was to inform them about the importance of micronutrient nutrition. At the beginning of the campaign, the target audience received a handout to reinforce the loudspeaker campaign to encourage them to enroll in the supplementation program. Furthermore, two separate pamphlets (one for adolescent girls and the other for women) were distributed that explained why micronutrients are important and what can be done to improve micronutrient status. To reinforce the message on balanced diets, a nutrition manual and a related recipe booklet (**fig. 2**) were developed and distributed at the monthly meeting to change food-consumption habits. All printed materials were designed to reinforce, complement, and complete the messages presented by interpersonal communication.

The second objective was to inform the community how the micronutrient campaign could help improve micronutrient status. Each family was given a calendar on which to mark the day for supplement intake (**fig. 3**). The calendars were valued in the community for the decoration of homes, offices, and shops.

Printed materials for the secondary audience

A manual was developed for the facilitators to ensure that they transmitted the message correctly to the primary audience and to provide additional information about micronutrients in local food. The manual included illustrations of local foods that were high in vitamins and minerals. To standardize the implementation of the communication campaign, the manual also contained information for the facilitators about how the supplementation program would be implemented. The facilitators were also given forms on which to record when the beneficiaries received the printed materials and the supplements. The beneficiaries were told how to mark the calendar when they first received the supplement.

Printed materials for the tertiary audience

The manual for facilitators was also used by the health professionals to train the facilitators. Visual materials, such as pictures of the main local foods and the sup-

TABLE 3. Printed materials related to micronutrient nutrition and supplement distribution given to the primary and secondary audiences

Material	Micronutrient nutrition	Supplement distribution
Primary audience		
Handouts		Information about the micronutrient campaign together with the loudspeaker announcements
Pamphlets	Information about the importance of improving micronutrient status Importance of vitamin A, vitamin C, folic acid, iron, and zinc Causes and consequences of deficiencies of these 5 micronutrients Alternatives for prevention and cure of deficiencies of these 5 micronutrients Foods rich in these 5 micronutrients Additional information about the supplementation campaign	
Nutritional manual	Information on Breastfeeding Complementary feeding Balanced food for the family Manuals are given to the beneficiaries each time they pick up the supplements	
Booklet of nutritious and economical recipes	Recipes for the corresponding themes (complementary feeding and healthful food for the whole family) to be picked up with the nutritional manual	
Calendar		Each family receives one calendar on which to mark the day of supplement intake; serves as reminder for the weekly intake
Secondary audience		
Facilitators' manual	Concept of the campaign; basic information about micronutrients, food sources, and administrative handling of the campaign, including all training topics	
Poster		Information and motivation for the primary audience to take part in the supplementation campaign
Administrative forms		For enrollment of the beneficiaries, reception and distribution of supplements and communication materials

plements, were also developed for the participatory training of the facilitators. These materials were kept by the facilitators to be used to instruct the beneficiaries at the monthly meetings.

Monitoring

External and internal monitoring and evaluation systems were established.

External monitoring and evaluation by an independent institution

External monitoring and evaluation focused on compliance to the supplement regimen. Monitoring was conducted at months 1, 2, and 3 of the supplementation program. As already described by Gross et al. [16], a small sample size was chosen in order to minimize the additional burden on project personnel. Sixty families were randomly selected each month from the lists of participants and questioned. An average of 25 adolescent girls, 75 women of childbearing age, and 83 caretakers of children were chosen each month. The participants were asked whether they had received any information from the campaign, seen the printed materials, been given explanations about how to use the calendars, and read the materials. For monitoring of compliance, the beneficiaries were asked in detail how many supplements they had taken and the reasons for noncompliance, if relevant. All answers were unprompted. Compliance was evaluated after the end of the supplementation period. Recalled compliance was defined as reporting having taken at least 9 supplements out of 12. The beneficiaries were also asked if they liked the supplements and if they felt any effects (positive or negative) from the supplements. All unprompted answers were recorded.

FIG. 3. Calendar distributed to primary audience during the supplementation campaign to mark the day of intake of the supplement

Internal monitoring system within the PISA project

Internal monitoring focused on compliance with the distribution of the materials and supplements. The forms filled in by the health professionals to supervise the reception and distribution of the supplements and communication materials during the campaign were reviewed. A similar form was filled in by the facilitators to keep track of how many supplements reached the beneficiaries and when. A detailed description is given by Gross et al. [10].

Three weeks after the supplementation campaign ended, PISA evaluated the increase in knowledge of 180 randomly selected beneficiaries by questionnaires and observations. It was also determined which printed materials were kept by the beneficiaries as an indicator of their interest in the messages.

To monitor the knowledge of the secondary target audience (facilitators), a questionnaire with 26 questions (14 related to micronutrient nutrition and 12 related to the delivery mechanism) was developed, based on the manual for facilitators. The questionnaire was applied before and after the training. Forty percent of the facilitators were randomly selected for monitoring of their increase in knowledge.

Statistical analysis

Data were entered with the use of SPSS software for Windows, version 10.0.5 (SPSS, Chicago, IL, USA). Descriptive analysis was mostly used for statistical evaluation. The independent *t*-test was used to compare the knowledge status of the secondary audience (facilitators) before and after the training.

Results

Program implementation

According to external monitoring, most of the primary audience interviewed (94%) indicated that they had received one or more of the printed materials (pamphlets, nutrition manual, or recipes), and 89% had kept some of them. Most of them (95%) reported receiving the calendars, and 82% were able to show them during the monitoring session.

A postevaluation of the availability of the printed materials was carried out about 3 weeks after the end of the supplementation campaign. The primary audience (180 persons) were asked to show the nutrition education materials they had received at the same time as the distribution of the supplement. As shown in **table 4**, the printed materials that were most often kept by the beneficiaries were the nutritional manual and the booklet of economical recipes. Sixty-four percent of the primary audience had kept the entire nutritional manual, and 75% had kept the complete collection of recipes. All of the adolescent girls had kept the complete collection of recipes, but only half had kept the entire nutritional manual. Sixty-one women in the primary audience reported that they had tried a recipe from the balanced food intake booklet a total of 112 times. The complementary feeding recipes had been prepared 55 times.

TABLE 4. Number (percentage) of primary target audience who could show part or all of the nutritional manual or the recipe booklet to the interviewer 3 weeks after the end of the supplementation campaign (internal evaluation)

	Nutritional manual			Recipe booklet		
Beneficiaries	Entire manual	Complementary feeding	Balanced food intake	All recipes	Complementary feeding	Balanced food intake
Women ($n = 170$)	109 (64)	99 (58)	124 (73)	128 (75)	139 (82)	128 (75)
Adolescent girls ($n = 10$)	5 (50)	9 (90)	9 (90)	10 (100)	10 (100)	10 (100)

Schedule of activities

Table 5 summarizes the schedule of activities. Six months were needed from the convocation of the facilitators until the internal postevaluation. Activities involving development of materials, pretesting, production of the communication materials and the supplements, and their distribution to the health centers are not included.

Increase in the primary audience's knowledge of micronutrients

During the internal postevaluation interviews by

TABLE 5. Schedule of activities

	Mo 1				Mo 2				Mo 3				Mo 4				Mo 5				Mo 6			
Activity	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Convocation of facilitators	■	■																						
1st training of facilitators (supplementation campaign)		■	■																					
Communication campaign (posters, loudspeaker cars, and handouts)				■	■																			
Enrollment supplementation campaign for women and adolescent girls 12–44 yr				■	■																			
Internal monitoring (distribution of communication materials and supplements)						■																		
1st supplementation of women and adolescent girls 12–44 yr (supplement distribution for 4 weeks, 1 pamphlet for adult women and mothers, 1 pamphlet for adolescent girls, 1 calendar per family)							■	■	■	■														
Announcement of enrollment of children 6 mo–4 yr for supplementation (facilitator, loudspeaker cars, and handouts)							■	■	■	■														
1st external monitoring											■													
2nd training of facilitators (retraining on supplementation, marking calendar, nutrition manual; 1st theme: exclusive breast-feeding)									■	■														
Internal monitoring (distribution of communication materials and supplements)										■			■											
1st supplementation of children 6 mo–4 yr (distribution of supplements)											■	■	■	■										

continued

PISA, 87% of the 170 adult women and 9 of the 10 adolescent girls reported having read the nutritional manual. When they were specifically asked about food sources with high micronutrient content, 60% named liver and meat.

According to the results of the third external monitoring, 83% of the primary audience reported that they knew how to mark the calendar. Furthermore, 88% indicated that they had received information about the advantages of the supplements, and 75% could recall having been informed about the possibility of negative side effects of the supplements. Only 49% of the interviewed persons knew how long they would receive the supplements.

Increase in the facilitators' knowledge of micronutrients

A questionnaire was developed to measure the increase of knowledge of the facilitators. In addition to questions about the administration of the campaign, there were 14 questions related to micronutrient nutrition

TABLE 5. Schedule of activities *(continued)*

	Mo 1				Mo 2				Mo 3				Mo 4				Mo 5				Mo 6			
Activity	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
2nd supplementation of women and adolescent girls (distribution of supplements and 1st theme nutritional manual)											■	■	■	■										
2nd external monitoring															■									
3rd training of facilitators (nutrition manual 2nd theme: complementary feeding and recipes)													■	■										
Internal monitoring (distribution of communication materials and supplements)														■										
3rd supplementation of women and adolescent girls (distribution of supplements, 2nd theme nutrition manual and recipes)															■	■	■	■						
2nd supplementation of children 6 mo–4 yr (distribution of supplements)															■	■	■	■						
3rd external monitoring																			■	■				
4th training of facilitators (nutrition manual 3rd theme: nutritious family foods and recipes)																	■	■						
Internal monitoring (distribution of communication materials and supplements)																		■						
3rd supplementation of children 6 mo–4 yr (distribution of supplements, nutrition manual 3rd theme: nutritious family foods and recipes)																			■	■	■	■		
Internal evaluation																								■

(knowledge of vitamin A, vitamin C, iron, folic acid, and zinc; their importance for the body; examples of micronutrient-rich foods; signs of iron and vitamin A deficiency and anemia [terminus, prevention, and cure]). The secondary audience on average responded correctly to 50% of the 14 questions before training and 76% of the questions after training. Many facilitators had heard about vitamin A, vitamin C, and iron but had no knowledge of folic acid and zinc (**fig. 4**). The percentage of facilitators who responded correctly to questions about folic acid and zinc increased highly significantly after training ($p < .001$).

The number of correct answers to the 14 micronutrient-related questions increased significantly after training ($p < .001$, *t*-test) in all age groups by nearly the same percentage (**fig. 5**). The youngest facilitators had the lowest level of knowledge before training and the greatest increase in knowledge after training. About 3% of the facilitators had only 1 to 3 years of primary education, 27% had finished primary school, 60% had had 1 to 6 years of secondary education, and 10% had had higher education). The number of correct answers increased significantly ($p < .001$, *t*-test) in all groups (**fig. 6**). There was no significant relationship between increase in knowledge through training and either age or educational level.

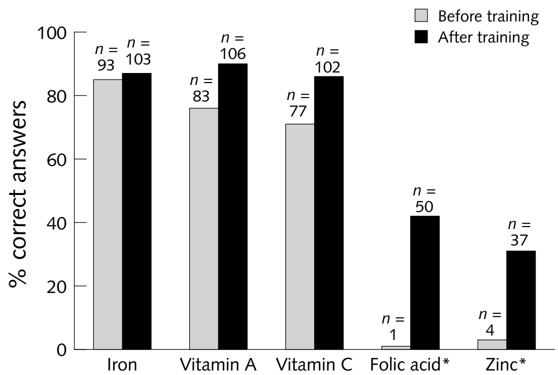

FIG. 4. Percentage of facilitators who could name foods rich in iron, vitamin A, vitamin C, folic acid, and zinc before (n = 109) and after (n = 118) training.
*Differences are significant ($p < .001$, *t*-test)

Behavior change among the primary audience

Beneficiary-reported compliance

Printed materials were distributed to motivate the beneficiaries to return to the monthly meetings. According to internal monitoring, participation remained about the same throughout the 3 months, as indicated by the facilitators' distribution sheets [10]. Nearly 90% of children in all communities and about 48% of women and adolescent girls in all communities consumed the supplements during the 3 months.

Beneficiary-reported compliance was defined as having taken at least 9 supplements out of 12. The average beneficiary-reported compliance for the three groups (women, adolescent girls, and children) over the 3 months was 90%. At the third monitoring compliance was reported to be between 91% and 95%, indicating that there had been no fatigue effect (**table 6**).

Acceptability of the supplements

As shown in **table 7**, the acceptability of the supplements by women and adolescent girls increased from 89% to 100% from the first to the third monitoring. In the third month, 61% of the interviewed women and adolescent girls reported an increased appetite, and 72% of mothers reported that their children's appetite had increased. The mothers and adolescent girls also claimed to be more lively and less tired and ill. The caretakers of the children reported an acceptability rate

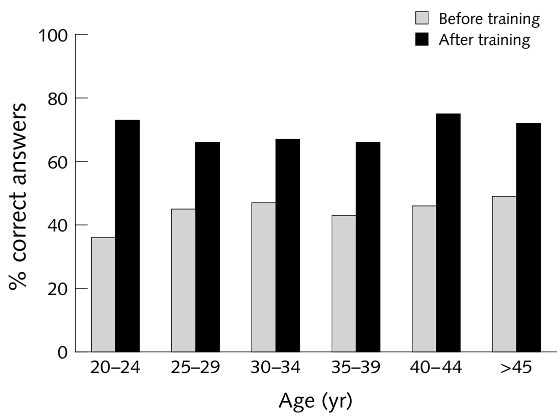

FIG. 5. Percentage of correct answers to 14 questions about micronutrients before (n = 109) and after (n = 118) training of the facilitators (randomly selected) according to age group All differences are significant ($p < .001$, *t*-test)

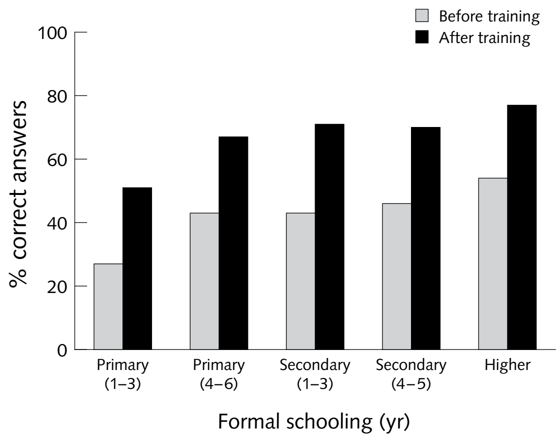

FIG. 6. Percentage of correct answers to 14 questions micronutrients before (n = 109) and after (n = 118) training of the facilitators (randomly selected) according to educational level. All differences are significant ($p < .001$, *t*-test)

TABLE 6. Beneficiary-reported compliance with supplementation by randomly selected women, adolescent girls, and children measured by external monitoring on a monthly basis

Response	Month 1	Month 2	Month 3
No. in sample			
Women	82	74	69
Adolescent girls	23	30	21
Children	82	85	75
No. (%) reporting compliance[a]			
Women	73 (89)	64 (86)	63 (91)
Adolescent girls	NA	25 (83)	20 (95)
Children	79 (96)	79 (93)	69 (92)

NA, information not available

a. Beneficiary-reported compliance was defined as having taken at least 9 supplements out of 12.

TABLE 7. Acceptance of the taste of the supplements and positive and negative side effects determined by external monitoring

Response	Month 1	Month 2	Month 3
No. in the sample			
Women and adolescent girls	105	104	90
Children	82	85	75
Acceptance of the supplements (%)			
Women and adolescent girls	89	94	100
Children	92	95	90
Positive side effects (%)[a]			
Increased appetite			
Women and adolescent girls	41	60	61
Children	49	68	72
Less tired, more active			
Women and adolescent girls	5	—	7
Children	2	2	7
Negative side effects (%)[a]			
None			
Women and adolescent girls	75	87	84
Children	93	99	89
Nausea/vomiting			
Women and adolescent girls	4	9	2
Children	1	1	4
Black stool			
Women and adolescent girls	0	0	3
Children	0	0	4
Headache			
Women and adolescent girls	7	5	—

a. Reports of side effects were unprompted.

of about 90% over the 3 months.

On average, over the 3 months of supplementation, more than 80% of the women and adolescent girls reported they had not experienced any negative side effects, and more than 90% of the mothers reported that their children had had no negative side effects. The most frequently reported negative side effects were nausea, black stool, and headache, but the incidence of these effects was low, as shown in **table 7**.

Discussion

Program implementation

Despite the original commitment of the Ministry of Health to take the lead in the campaign, it became evident during implementation of the program that the public sector was not meeting its responsibility. As a result, PISA had to take over full responsibility, including the active involvement of the community. According to the findings of the MotherCare project [17], community participation is an important factor for success in communication and supplementation activities. In this Peruvian intervention, the supplementation campaign needed an alliance with the governmental sector, but it was also crucial that a nongovernmental organization (PISA) take the lead in the program, with full involvement of the community. A similar experience was reported by Griffiths for iron interventions [7].

As previously described, this supplementation campaign was coupled with nutrition education to ensure an improvement and maintenance of micronutrient status, as recommended by Ahluwalia [18]. However, the postevaluation of this study revealed that the women and adolescent girls were more interested in the practical application of good nutrition than in learning about its theoretical background. More women and adolescent girls kept the entire recipe collection than the entire nutritional manual. This difference was more pronounced for the adolescent girls than for the women. The high interest in the recipes was confirmed by the fact that nearly two-thirds of the primary audience had used the recipes, some of them repeatedly. Thus, although nutrition education plays a crucial role in successful supplementation campaigns, improving theoretical knowledge is not enough. Practical implementation, motivation, supervision, and communication with the target audience are essential for an effective campaign.

For communication to succeed, the strategy must combine the art and the science of communication. The art is the creative element, i.e., the expression of an idea, a symbol, or an action that captures attention because it is meaningful and memorable [18, 19]. In line with this recommendation, cartoon characters depicting members of a family were created to arouse interest and promote identification of the primary audience with these characters. All materials developed were pretested, as recommended by HealthCom [13], and the resulting recommendations were incorporated. The technical content of the materials was developed according to the target audiences' needs, background knowledge, and environment, as recommended by Griffiths [7].

Knowledge increase

Increased knowledge is needed to change behavior and consequently improve the nutritional status of people. The postevaluation revealed that the campaign had good results in increasing the knowledge of the beneficiaries. For example, 60% could name specific foods with high micronutrient content. A significant increase in knowledge also occurred in the facilitators, regardless of their age or level of education. Training had an equal impact on knowledge in persons in different age groups and with different levels of formal education.

Reported compliance

This paper presents the reported intake of the supplements by the beneficiaries. Discrepancies between observed and reported compliance can occur. However, the supplementation campaign dealt with such a large population group that compliance could not be directly observed. Therefore, several monitoring events were carried out to reach a clear conclusion on the beneficiaries' compliance. It would not have been possible for the project to observe more than 180 randomly selected persons within their households each month to obtain the information on observed compliance. Beneficiary compliance can be used as an indication of the beneficiaries' willingness and desire to improve their nutritional status. "Beneficiary-reported compliance" was defined as reporting having taken at least 9 supplements out of 12. As shown in **table 6,** an average reported compliance of 90% was maintained over the 3 months for all three groups (women, adolescent girls, and children). This is very much in line with the coverage reported by the facilitators [10], which remained at a consistently high level over the 3 months. Another clear indication of the strong interest and motivation of the primary audience was that they returned each month to collect new supplements and new parts of the nutrition manual and the related economical family recipes.

As the United Nations Sub-Committee of Nutrition [6] and Griffiths [7] stated, demand must be created, which implies well-trained health personnel (the facilitators in this project), supplements packaged in the appropriate forms (tablets and foodlets), and education about proper use. Similarly, social mobilization and social marketing were the basis for the successful promotion of weekly iron–folic acid supplementation in Vietnam, the Philippines, and Cambodia [9, 20, 21].

Acceptability of supplements

External monitoring showed that acceptance of the supplements by the children, adolescent girls, and women was very high and that there were no fatigue effects in the acceptance of the supplement over the 3 months (**table 7**). Perceived physiological changes were reported in all groups. In particular, children and adolescent girls reported feeling significantly hungrier. A nonsignificant increase in activity was reported for all groups.

Mid-term strategy

The beneficiary-reported compliance and the distributor-reported coverage rate were both high [10]. Acceptability of the supplements was very high and without a fatigue effect. In a country like Peru, it cannot be expected that supplements will be distributed free indefinitely. Warnick et al. [19] gave a good example of how supplements could be promoted among resource-poor women. Therefore, introduction of the same supplement in the local market should be considered. Concurrently with free distribution through the official channels, awareness could be created that these supplements can also be purchased on the local market. Increased knowledge of the need for micronutrients in the diet and the perception by the beneficiaries of feeling less tired will create a demand for the supplements when they are no longer distributed without charge. This will also increase supplement intake in those parts of the population that were not beneficiaries of a welfare program. Low-price marketing of the supplements was also successfully introduced in the three country programs of Vietnam, the Philippines, and Cambodia [9, 20, 21].

Conclusions

A well-planned and well-implemented nutrition communication program can secure high compliance of the beneficiaries of micronutrient supplementation programs.

Within a wider supplementation program, a nutrition communication program requires much coordination. In a real-life situation, it is impossible to predict all potential sources of interference, and therefore the implementation of a program may need to differ from the original plan. As a result, sufficient time and resources have to be available to cope with unexpected problems and sudden constraints. Therefore, supplements and communication materials should be ordered early and delivered at least 3 months before distribution to the beneficiaries, as recommended by Gross et al. [10], and an alternative should be at hand if one partner in the program does not comply.

In supplementation programs that cover women and adolescent girls as well as children, the supplements for both groups should be distributed at the same time to reduce distribution costs and encourage joint intake of the supplement within the family.

High compliance as well as increased knowledge of the need for micronutrients in the diet should lead to promotion of the supplement to be purchased in the free market with the same packaging and at reasonable prices.

Supplementation programs can support food-based interventions. Supplementation programs are often criticized as unsustainable nutrition interventions and contrary to efforts for sustainable food-based approaches. The findings of this study demonstrate the opposite. With an adequate communication program, supplementation programs can be used to foster food-based approaches within the target audience.

Behavioral changes are an essential element for achieving adequate nutritional status. Practical recommendations are a sound basis for promoting behavioral changes. Preparing meals according to recipes using economical, nutritious food sources can give the target audience a means of implementing such recommendations.

References

1. Gross R, Lechtig A, López de Romaña D. Baseline evaluation of nutritional status and government feeding programs in Chiclayo, Peru. Food Nutr Bull 2006; 27(suppl):S115-121.
2. Yip R. Iron supplementation: country level experiences and lessons learned. J Nutr 2002;132(4 suppl):859S–61S.
3. Schultink W, van der Ree M, Matulessi P, Gross R. Low compliance with an iron-supplementation program: a study among pregnant women in Jakarta, Indonesia. Am J Clin Nutr 1993;57:135–9.
4. Cavalli-Sforza T, Berger J, Smitasiri S, Viteri F. Weekly iron-folic acid supplementation of women of reproductive age: impact overview, lessons learned, expansion plans, and contributions toward achievement of the millennium development goals. Nutr Rev 2005;63(12 pt 2):S152–8.
5. World Health Organization.Guidelines for the control of iron deficiency in countries of the eastern Mediterranean, Middle East and North Africa. Geneva: WHO, 1996.
6. ACC/SCN, Global nutrition challenges: a life-cycle approach. Ending malnutrition by 2020: An Agenda for Change in the Millennium. 7. Establishing a new agenda for change. Food Nutr Bull 2000; 21(suppl):62–6.
7. Griffiths M. Communication strategies to optimize commitments and investments in iron programming. J Nutr 2002;132(4 suppl):834S–8S.
8. Mason JB, Hunt J, Parker D, Jonsson U. Strengthened nutrition strategies, improving child nutrition in Asia. Food Nutr Bull 2001;22(suppl): 85–96.
9. Khan CN, Thanh HT, Berger J, Hoa PT, Quang ND, Smitasiri S, Cavalli-Sforza T. Community mobilization and social marketing to promote weekly iron-folic acid supplementation: a new approach toward controlling anemia among women of reproductive age in Vietnam. Nutr Rev 2005;63(12 pt 2):S87–94.
10. Gross U, Valle C, Diaz MM. Effectiveness of distribution of multimicronutrient supplements in children and in women and adolescent girls of childbearing age in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S122–9.
11. Cohen S. Developing information, education and communication (IEC) strategies for population programmes. United Nations Population Fund, Technical Paper No. 1, New York: United Nations, 1993.
12. López de Romaña D, Verona S, Aquino Vivanco O, Gross R. Protective effect of multimicronutrient supplementation against anemia among children, women, and adolescent girls in lower-income areas of Chiclayo, Peru. Food Nutr Bull 2006; 27(suppl):S143–50.
13. HealthCom. A tool box for building health communication capacity. Step 3: Draft, pretest and produce. Washington, DC: Academy for Educational Development, Social Development Division, 1995.
14. Erhardt J. Description of the dietetic part of the software. Available at: http://www.nutrisurvey.de/dietetic/dietetic.hmt. Accessed 23 June 2006.
15. Erhardt J. Peruvian food composition table. Available at: http://www.nutrisurvey.de/databases/peru.zip. Accessed 2 August 2006.
16. Gross R, Gross U, Lechtig A, López de Romaña D. We know much about what to do but little about how to do it: Experiences with a weekly multimicronutrient supplementation campaign. Food Nutr Bull 2006; 27(suppl):S111–4.
17. Utomo B. The alleviation of maternal anemia in Indramayu regency, Indonesia. Results from the MotherCare Project (Working Paper 23). Arlington, Va, USA: MotherCare/John Snow, 1993.
18. Ahluwalia N. Intervention strategies for improving iron status of young children and adolescents in India. Nutr Rev 2002;60(5 pt 2):S115–7.
19. Warnick E, Dearden KA, Slater S, Butron B, Lanata CF, Huffman SL. Social marketing improved the use of multivitamin and mineral supplements among resource-poor women in Bolivia. J Nutr Educ Behav 2004;36:290–7.
20. Garcia J, Datol-Barrett E, Dizon M. Industry experience in promoting weekly iron-folic acid supplementation in the Philippines. Nutr Rev 2005;63(12 pt 2):S146–51.
21. Kanal K, Busch-Hallen J, Cavalli-Sforza T, Crape B, Smitasiri S, and the Cambodian Weekly Iron-Folic Acid Program Team. Weekly iron-folic acid supplements to prevent anemia among Cambodian women in three settings: process and outcomes of social marketing and community mobilization. Nutr Rev 2005;63(12 pt 2): S126–33.

Protective effect of multimicronutrient supplementation against anemia among children, women, and adolescent girls in lower-income areas of Chiclayo, Peru

Daniel López de Romaña, Sara Verona, Oscar Aquino Vivanco, and Rainer Gross†

Abstract

Background. *The Integrated Food Security Program (Programa Integrado de Seguridad Alimentaria [PISA]) implemented a campaign to promote weekly multimicronutrient supplementation among women and adolescent girls of childbearing age and children under 5 years of age.*

Objectives. *To assess the impact of the campaign on the growth of children and on anemia among children and among women and adolescent girls of childbearing age.*

Methods. *Weekly multimicronutrient supplementation was provided for 8 weeks. Weights, heights, and hemoglobin concentrations were assessed at the beginning and end of the campaign.*

Results and conclusions. *Although supplementation did not significantly increase the hemoglobin concentrations of children ($p = .80$) or women and adolescent girls ($p = .65$) in the intervention group, the hemoglobin concentrations of the comparison groups were significantly lower after 8 weeks ($p = .001$ for children and $p = .03$ for women and adolescent girls). Furthermore, the percentage of anemic children in the comparison group increased significantly ($p < .001$), and the final value was significantly higher than that for the intervention group ($p = .004$). There were no significant effects of weekly multimicronutrient supplementation on the growth of children, but the study was too short to reliably determine any effects on growth.*

Key words: Anemia, children, hemoglobin, multimicronutrients, supplementation, women

Introduction

Despite efforts in the past decades, micronutrient deficiencies continue to affect millions of people worldwide. Iodine-deficiency disorders still affect over 740 million people, between 100 and 140 million children are vitamin A deficient, and as many as 4 to 5 billion people—66% to 80% of the world's population—may be iron deficient [1]. Iron-deficiency anemia is still the most prevalent micronutrient deficiency worldwide [2]. Furthermore, it is estimated that 20% of the world population is at risk for inadequate intake of absorbable zinc [3]. In Peru, anemia affects approximately 36% of women of childbearing age, 39% of pregnant women, and 50% of children under 5 years of age [4]. It is estimated that 13% of children under five have vitamin A deficiency [5]. In addition, Peru has been classified as a country with a population at high risk for zinc deficiency [3].

The Peruvian population is in a state of rapid urbanization as a result of the migration of the rural population to the more urbanized centers or cities. The percentage of the population living in urban areas increased from 65% in 1981 to 72% in 1997 [6]. People who migrate to the urban areas of the country face new and different problems of nutrition and food security, characterized by insecure availability of food and restricted access to basic services, such as education, health, and sanitation. In rural areas, food security is closely related to local agricultural production and therefore is dependent on weather and climate. Urban areas have better access to basic health and education services, higher food availability, better access to clean water, and new labor opportunities. Nevertheless, the change from rural to urban living involves difficult adaptations to new circumstances and customs. It is in this context that the nutritional problems of people living in rural areas are different from those they

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encounter in urban areas. It is also in this context that the nutritional transition phenomenon occurs, with undernutrition and obesity occurring at the same time in poor sections of urban areas.

The Integrated Food Security Program (Programa Integrado de Seguridad Alimentaria [PISA]), managed by the Peruvian National Program of Food Assistance (Programa Nacional de Asistencia Alimentaria [PRONAA]) and the German Agency for Technical Cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit [GTZ]), conducted a baseline survey in the poorest population of the city of Chiclayo, with the objective of understanding the nutrition and food security problems faced by this population. The survey found that 25.5% of children under 3 years of age were stunted, 72% were anemic, 24.3% had vitamin A deficiency, 72% had respiratory infections, and 27% had diarrheal diseases. In addition, approximately 34% of women and adolescent girls of childbearing age had anemia. On the other hand, approximately 20% of men and women were obese [7].

These findings prompted PISA to conduct, among other interventions, multimicronutrient supplementation campaigns in the poorest populations to assess their impact on micronutrient status. The current report presents the biological effectiveness of the fourth and final supplementation campaign of the PISA Project.

Subjects and methods

Subjects

Using the results of the baseline evaluation of the City of Chiclayo, PISA identified 26 communities or "young townships" with stunting rates above the average, which were chosen for the supplementation campaigns. Since this selection included all households in these areas, households from the remaining communities were chosen as a comparison group. Households were selected if they had at least one child under 5 years of age and at least one woman or adolescent girl of childbearing age (12 through 44 years). A total of 866 households (448 in the intervention group and 418 in the comparison group) were randomly selected. On the assumption of a 20% reduction in anemia in the supplemented group, a sample size of 208 individuals per group was estimated to give 80% power and 5% significance to detect a 13% difference in anemia between the two groups. The sample size was doubled to allow for age-related subgroup analysis.

Preparation and distribution of the supplements

Two types of supplements known as Nutrivit were prepared for the study by Hersil, Lima, Peru. For adolescent girls and women of childbearing age (12 through 44 years), capsules containing vitamins and minerals were distributed in blister packs of four capsules. Each capsule provided two recommended daily allowances (RDAs). A second type of supplement, known as foodlets, was especially developed for small children. The foodlet, which could be diluted or masticated by the child, was prepared following specifications used in a previous multicenter study [8] and provided two RDAs per week. Blister packs containing four foodlets were also distributed weekly. The compositions of the capsules and the foodlets are shown in **table 1**. Detailed description of the distribution of the supplements is provided elsewhere in this series of reports [9].

Study design

Three previous pilot supplementation campaigns were conducted in the study area before the fourth campaign. Each campaign had a duration of 3 months, and all were conducted in the year 2000. Because of complications of logistics and study design, only the fourth campaign had initial and final evaluations. The fourth campaign was conducted between June and August of 2002, one and a half years after the last pilot campaign.

TABLE 1. Composition of the Nutrivit supplements distributed to women, adolescent girls, and children

Supplement	Amount
Capsule[a]	
Iron, as ferrous sulfate (mg)	30.0
Zinc, as zinc sulfate (mg)	20.0
Vitamin A, as retinol (mg)	4.0
Vitamin C (mg)	60.0
Folic acid (mg)	0.7
Foodlet[b]	
Vitamin A, as acetate (μg)	750.0
Vitamin D (μg)	10.0
Vitamin E (IU)	12.0
Vitamin C (mg)	70.0
Niacin (mg)	12.0
Thiamine (mg)	1.0
Riboflavin (mg)	1.0
Pyridoxine (mg)	1.0
Vitamin B_{12} (μg)	1.8
Folic acid (μg)	300
Iron, as ferrous fumarate (mg)	20
Zinc, as zinc gluconate (mg)	20
Copper, as cupric gluconate (mg)	1.2
Iodine, as potassium iodide (μg)	100

a. The Nutrivit supplement was distributed to nonpregnant adolescent girls and women of childbearing age (12 through 44 years).
b. The foodlet supplement was distributed to children 6 months through 4 years of age.

Households were chosen by a randomized cluster survey according to standardized methods [10]. Each household answered a questionnaire pertaining to its socioeconomic status. Anthropometric measurements were made of the child, the mother, and an adolescent girl between 12 and 18 years of age, if one was present. Blood samples for measurement of hemoglobin concentrations were collected from the child and mother by finger pricking.

The study design was modified twice because of problems in the provision and distribution of the supplements. First, there was an unforeseen lag in the procurement of the foodlets for the children. Supplementation of the mothers began on schedule, but unfortunately supplementation of the children had to be postponed for 1 month for reasons just mentioned. Therefore, the baseline evaluation had to be performed in two stages. In the first stage, the women and adolescent girls of childbearing age were evaluated, and in the second stage, the project team returned to the same households to evaluate the children.

The second modification was done because the project ran out of supplements. Unfortunately, this happened due to an involuntary error from the manufacturer. Therefore, it was decided to perform the final evaluation in some of the households after 8 weeks of supplementation, instead of the originally programmed 12 weeks of supplementation. As a result, the final evaluation was also completed in two stages. In the first stage, all participating households with a child who had received 8 weeks of supplementation and a woman or adolescent girl of childbearing age who had received 12 weeks of supplementation were assessed. In the second stage, households that had received all 12 weeks of supplementation were evaluated.

Anthropometric and biochemical measurements

The weight of the children was determined with calibrated digital scales (SECA 770, Hamburg, Germany) with a precision of 100 g, by direct weighing, if possible, or by weighing the mother with and without the child. All measurements were performed following standard procedures. The heights of children under 2 years of age were measured with an infantometer built according to the recommendation of Gross et al. [10] with a precision of 0.5 cm. The heights of older children and adults were measured with a length board with a precision of 1 cm. Blood samples were obtained by finger pricking. One drop of freely flowing whole blood was used for the measurement of hemoglobin concentration with a portable photometer (HemoCue, AB Leo Diagnostics, Helsingborg, Sweden).

Statistical analysis

Data analyses were performed with SPSS software (SPSS for Windows, version 11.0, SPSS, Chicago, IL, USA). The *t*-test was used to compare the two groups at baseline. Fisher's exact test was used to compare the percentages of obesity in women and adolescent girls, stunting in children, and anemia in women and adolescent girls and in children at baseline. Analysis of variance (ANOVA) was used to determine differences in weight, height, height-for-age, weight-for-age, and weight-for-height z-scores and in hemoglobin concentrations in children within each study group. Tukey's test was used for post hoc comparisons within the intervention group. The *t*-test was used to compare mean values at 8 weeks between the two study groups. Perarson chi-square tests were used for within-group comparisons of the percentages of stunted and anemic children within the intervention group. Fisher's exact test was used for within-group comparisons of the percentage of stunted and anemic children and the percentage of anemic mothers in the comparison group and for between-group comparisons. All comparisons were performed at the 5% level of significance.

A probit, stepwise, multivariate analysis (Intercooled Stata, version 6.0, Stata Corporation, College Station, TX, USA) was used to estimate which variables explained the presence of anemia (dependent variable) in women and adolescent girls and in children. The model included independent variables related to the capacity of the family to access food (unsatisfied basic needs and overcrowding), to their consumption of iron-containing products (consumption of iron-rich foods and consumption of iron supplements), their capacity to use and correctly choose adequate foods (nutrition knowledge of mother and access to health information), and the characteristics of the individuals themselves (age, sex, etc.). A dummy variable was also introduced to evaluate the impact of supplementation on anemia. A full description of the multivariate analyses is presented elsewhere in this series [11].

Results

Baseline characteristics of the sample

Baseline characteristics of the study groups are shown in **table 2.** There were no significant differences in the number of people in the household (p = .14) or the number of children under five in the household (p = .72). On the other hand, the mean number of years of education of the fathers and mothers in the comparison group was somewhat higher than that in the intervention group (p = .03 and p < .001, respectively). The average age, weight, and height of the women at baseline were 29 years, 59 kg, and 151 cm, respectively; approximately 54% of the women were overweight or obese (body-mass index [BMI] ≥ 25). Women of childbearing age in the comparison group had a higher

TABLE 2. Baseline characteristics of the study groups[a]

Variable	Intervention group (n = 448)	Comparison group (n = 418)	p
No. of people in household	5.8 ± 2.3	6.0 ± 2.3	.14
No. of children under 5 yr of age	1.4 ± 0.8	1.4 ± 0.7	.72
Father's education — yr	3.0 ± 1.4	3.2 ± 1.3	.03
Mother's education — yr	2.5 ± 0.8	2.9 ± 0.7	< .001
Mother's age — yr	28.5 ± 6.8	29.6 ± 6.6	.014
Mothers who were pregnant — %[b]	3.5	3.4	.86
Mother's weight — kg	58.0 ± 9.9	60.4 ± 11.1	.001
Mother's height — cm	150.6 ± 5.7	151.8 ± 5.6	.002
Mother's BMI — m^2/kg	25.6 ± 4.2	26.2 ± 4.3	.03
Mothers with BMI ≥ 25.0 — %[b]	51.0	56.6	.19
Mother's hemoglobin level—g/L	124.7 ± 14.3	126.0 ± 14.3	.19
Anemic mothers (Hb < 120.0 g/L) — %[b]	33.9	29.4	.17
Child's age — yr	2.8 ± 1.3	2.9 ± 1.2	.53
Age distribution of children — mo (%)[c]			.42
6–11	6.3	6.5	
12–17	10.5	7.7	
18–23	14.1	12.0	
24–35	23.0	25.6	
36–47	20.5	24.4	
48–60	25.7	23.9	
Children's sex [b]			.77
M/F	227/221	216/202	
% male	50.7	51.7	
Child's weight — kg	13.2 ± 2.9	13.6 ± 3.2	.07
Child's height — cm	87.9 ± 10.1	89.4 ± 10.2	.04
Child's HAZ	–1.10 ± 1.00	–0.87 ± 1.03	.001
Child's WAZ	–0.45 ± 1.00	–0.31 ± 1.00	.045
Child's WHZ	0.32 ± 0.87	0.31 ± 0.86	.96
Stunted children (HAZ < -2 SD) — %[b]	20.6	12.1	.001
Child's hemoglobin level — g/L	111.9 ± 13.9	113.2 ± 13.9	.17
Anemic children (Hb < 110.0 g/L)— % [b]	39.7	35.4	.20

BMI, body-mass index; Hb, hemoglobin; HAZ, height-for-age z-score; WAZ, weight-for-age z-score; WHZ, weight-for-height z-score

a. Plus–minus values are means ± SD.

b. Fisher's exact test.

c. Pearson chi-square test.

mean age, weight, height, and BMI than those in the intervention group. The mean baseline hemoglobin level was 125.5 ± 14.4 g/L; approximately 30% of the mothers were anemic. There were no significant differences in the mean hemoglobin concentration between the two groups at baseline (p = .19). The average age, weight, and height of the children at baseline were 2.9 years, 13.4 kg, and 88.7 cm, respectively. The average hemoglobin concentration of the children was 112.5 ± 13.9 g/L; nearly 38% of the children were anemic. There were no significant differences in age, age distribution, sex distribution, weight-for-height z-scores, or mean hemoglobin concentrations between the two groups. On the other hand, children in the intervention group had significantly lower mean weight, height, height-for-age z-score, and weight-for-age z-score and a higher incidence of stunting than the comparison group.

Effect of supplementation on anthropometric and biochemical variables of children

The effect of supplementation on the anthropometric and biochemical indices of the children is shown in **table 3**. The mean weight of the children in the intervention group was not significantly different from baseline after 8 weeks of supplementation (13.2 ± 2.9 vs. 13.6 ±3.1 kg), but it was significantly lower at 12 weeks than at 8 weeks (13.0 ± 2.9 vs. 13.6 ± 3.1 kg, p = .02). After 8 weeks of supplementation, the mean weight of the intervention group was not significantly different from that of the comparison group (13.6 ± 3.1 vs. 13.5 ± 3.2 kg; p = .50). There were no significant differences

TABLE 3. Initial and final anthropometric and biochemical variables for children according to treatment group

Variable	Intervention group				Comparison group			
	Baseline (n = 441)	8 wk (n = 409)	12 wk (n = 251)	p^*	Baseline (n = 409)	8 wk (n = 407)	p^*	p-treatment**
Weight (kg)	13.2 ± 2.9[a,b]	13.6 ± 3.1[a]	13.0 ± 2.9[b]	.02	13.6 ± 3.2	13.5 ± 3.2	.66	.50
Height (cm)	87.9 ± 10.1	88.6 ± 10.3	87.0 ± 10.0	.15	89.4 ± 10.2	88.1 ± 11.0	.10	.54
HAZ	–1.1 ± 1.0	–1.1 ± 0.9 †	–1.2 ± 0.9	.07	–0.87 ± 1.03	–0.87 ± 1.00 †	.98	.007
Stunted (HAZ < –2 SD) (%)***	20.6	15.9	20.8	.16	12.1	12.2%	.99	.16
WAZ	–0.45 ± 0.97[a]	–0.26 ± 0.96[b]	–0.40 ± 1.01[a,b]	.02	–0.31 ± 0.98	–0.17 ± 1.03	.052	.22
WHZ	0.32 ± 0.87[a]	0.53 ± 0.82[b]	0.35 ± 0.89[a]	.001	0.31 ± 0.84	0.46 ± 0.87	.02	.27
Hb (g/L)	111.9 ± 13.9	111.7 ± 13.7†	112.4 ± 15.1	.80	113.2 ± 13.9	108.5 ± 13.5 †	< .001	.001
Anemic (%)***	39.7	40.2 †	37.6	.79	35.4	50.4% †	< .001	.004

Hb, hemoglobin; HAZ, height-for-age z-score; WAZ, weight-for-age z-score; WHZ, weight-for-height z-score. Anemia defined as Hb < 110 g/L.

* Comparisons made within each study group (ANOVA). Means within the same group with different superscripts are significantly different from each other (p > .05, Tukey's test for post hoc comparisons within intervention group).

** Comparisons made between final values (8 weeks) between the two groups (t-test). Means with the same superscript (†) are significantly different from each other.

*** Pearson chi-square test for within-group comparisons in intervention group and Fisher's exact test for within-group comparisons in comparison group and between-group comparisons. Means with different superscripts are significantly different from each other.

in height within the intervention group after either 8 or 12 weeks of supplementation (p = .15). The height after 8 weeks of supplementation was not significantly different between the two groups (p = .54).

The mean height-for-age z-score remained constant in supplemented children (p = .07). In addition, there were no significant changes in the percentage of stunted children over time (p = .16). Furthermore, the difference in height-for-age z-score between the two groups observed at baseline did not change over time. The mean weight-for-age z-score of the supplemented children was significantly higher after 8 weeks of supplementation (–0.26 ± 0.96 vs. –0.45 ± 0.97, p = .02), but the value at 12 weeks was not significantly different from the baseline value (–0.40 ± 1.01 vs. –0.45 ± 0.97). Furthermore, the mean final value was not significantly different from that of the comparison group (p = .22). Children in the intervention group had significantly higher weight-for-height z-scores after 8 weeks of supplementation (0.53 ± 0.82 vs. 0.32 ± 0.87, p = .001), but these values were not significantly different from those for the comparison group (0.53 ± 0.82 vs. 0.46 ± 0.87, p = .27).

The mean hemoglobin concentrations of the intervention group after 8 and 12 weeks of supplementation were not significantly different from those at baseline (p = .80). However, after 8 weeks the mean hemoglobin concentration of the comparison group decreased significantly from 113.2 ± 13.9 to 108.5 ± 3.5 g/L (p < .001), and the final value was significantly lower than that for the intervention group (108.5 ± 13.5 vs. 111.7 ± 13.7; p = .001). The percentage of anemic children in the intervention group did not change significantly after either 8 or 12 weeks of supplementation (p = .79), but the percentage of anemic children in the comparison group was significantly higher after 8 weeks (35.4% vs. 50.4%; p < .001), and the final value was also significantly higher than that for the intervention group (50.4% vs. 40.2%; p = .004).

Effect of supplementation on biochemical and anthropometric variables of women and adolescent girls

The effect of supplementation on the anthropometric and biochemical indices of the women and adolescent girls is shown in **table 4.** The mean hemoglobin concentration of the women and adolescent girls in the intervention group did not change after 8 weeks of supplementation (p = .65). Nevertheless, the hemoglobin concentration in the comparison group was significantly lower after 8 weeks (126.4 ± 14.2 vs. 123.9 ± 13.9 g/L, p = .04), and these values were significantly lower than those in the intervention group (123.9 ± 13.9 g/L vs. 125.6 ± 12.7 g/L, respectively; p = .03). The percentage of anemic women and adolescent girls increased in the comparison group, although the change was barely significant (29.4% vs. 35.9%, p = .054). Furthermore, at the end of the trial the prevalence of anemia among women and adolescent girls in the comparison group tended to be higher than that in the intervention group, but this difference was also nonsignificant (35.9% vs. 29.7%; p = .06). There was no effect of supplementation on the mean BMI of the women and adolescent girls in the intervention group (p = .54), and the two groups did not differ significantly in BMI at the end of the study (p = .14).

Multivariate analysis to explain anemia

Table 5 shows the results of the multivariate analysis. Unsatisfied basic needs and pregnancy were signifi-

TABLE 4. Initial and final biochemical and anthropometric variables for women and adolescent girls of childbearing age according to treatment group

Variable	Intervention group		p^*	Comparison group		p^*	p-treatment**
	Baseline (n = 443)	8 wk (n = 405)		Baseline (n = 418)	8 wk (n = 409)		
Hb (g/L)	125.3 ± 14.1	125.6 ± 12.7†	.65	126.4 ± 14.2^a	123.9 ± 13.9^{b}†	.04	.03
Pregnant (%)	3.6	6.2		3.4	6.4		
Anemia (%)***	33.9	29.7	.19	29.4	35.9	.054	.06
BMI	25.6 ± 4.2	25.7 ± 4.2	.54	26.2 ± 4.3	26.0 ± 4.2	.50	.41
Obese (BMI > 25) (%)	51.0	50.6	.95	55.6	54.7	.83	.14

Hb, hemoglobin; BMI, body-mass index. Anemia defined as Hb < 110 g/L.
* Comparisons made within each study group (ANOVA). Means with different superscripts are significantly different from each other.
** Comparisons made of final values between the two groups (t-test). Means with different symbol superscripts (†) are significantly different from each other.
*** Fisher's exact test.

TABLE 5. Multivariate analysis to explain anemia (probit model)

Variable	Effect	SE	z-score	$p > \|z\|$
Women and adolescent girls (n = 817)				
Unsatisfied basic needs	0.048	0.016	2.91	.004
Overcrowding	0.004	0.009	0.48	.533
Nutrition knowledge (1 = yes, 0 = no)	0.002	0.035	0.08	.937
Pregnancy (1 = yes, 0 = no)	0.185	0.072	–2.82	.005
Supplementation (1 = yes, 0 = no)	–0.097	0.034	2.61	.009
Children (n = 815)				
Unsatisfied basic needs	0.04	0.018	1.91	.056
Age of child	–0.01	0.001	–12.26	.000
Sex of child (1 = M, 0 = F)	0.08	0.037	2.11	.035
Supplementation (1 = yes, 0 = no)	–0.11	0.034	2.61	.009

cantly associated (p = .004 and p = .005, respectively) with anemia in women and adolescent girls at baseline. Supplementation reduced the rate of anemia in women and adolescent girls (p = .009). In children both age and sex were significantly associated with anemia. Younger children were more likely to have anemia than older children (p < .001), and boys were more likely to be have anemia than girls (p = .035). As with women and adolescent girls, supplementation of children significantly decreased anemia (p = .009).

Discussion

The overall objective of the Integrated Food Security Program was to evaluate the food security and nutritional situation of a periurban Peruvian population to design an intervention strategy targeted to those at risk. As a result of the evaluation, weekly multimicronutrient supplementation was identified as an important strategy to control micronutrient deficiencies of the poor. The results showed that multimicronutrient supplementation with two recommended daily allowances (RDAs) per week had a significant benefit for both women and adolescent girls of childbearing age and children under 5 years of age.

The nutritional characteristics of the population that participated in the fourth supplementation campaign were somewhat similar to those observed during the baseline survey of the overall community. In general, the prevalence of stunting in children living in these communities was approximately 15%, which is lower than the 25% observed at the national level [4]. Similarly, the prevalence of anemia found initially in the present subgroup of children is lower than that observed during the baseline survey (37.6% vs. 65.7%,) and than that observed at the national level (37.6% vs. 49.6%). It is not clear why the prevalence of anemia in children declined between the baseline survey and the fourth supplementation campaign, but it is possible that the previous campaigns contributed to this improvement. The nutritional characteristics of the women and adolescent girls illustrate the nutrition transition occurring in Peru. Approximately 54% of the women and adolescent girls in the fourth supplementation campaign were overweight or obese, and 34% of them were anemic. The results are consistent with what is observed at the national level, with 47% of women being overweight or obese and 32% being anemic [4].

As expected, the baseline characteristics of the intervention group were not exactly the same as those of the comparison group. The parents in the comparison group had more education than those in the intervention group. Furthermore, women and adolescent girls of childbearing age in the comparison group on average were older and had higher weights, heights, and BMI than those in the intervention group. These differences were expected, because the poorer communities were deliberately selected for the intervention. Despite these differences, the mean hemoglobin concentration and the prevalence of anemia were similar in the two groups at baseline. The children in the intervention group were shorter and were more likely to be stunted at baseline than those in the comparison group, a result consistent with the indicators of greater wealth in the comparison group.

Supplementation with multimicronutrients for 8 weeks had no detectable effect on either the weight or height of the children. However, 8 weeks of supplementation was probably not long enough to produce changes in anthropometric indices [12]. Several studies have examined the effect of multiple micronutrient supplementation on children's growth. Although there are differences among these studies in study design and duration of supplementation, most of the results do not show a positive effect of either daily or weekly multimicronutrient supplementation on growth in comparison with a placebo [13–17]. When positive growth responses did occur, they were limited to certain subgroups of children, such as those initially stunted [13].

Eight weeks of supplementation with multimicronutrients was not enough time to produce an increase in hemoglobin concentrations in children. Nevertheless, when compared with the trend of the comparison group, the results from the supplemented group show that supplementation had a preventive or protective effect against anemia. Both groups had similar rates of anemia before the supplementation campaign, but while the prevalence of anemia in the intervention group remained constant, the prevalence in the comparison group increased significantly during the 8-week period. This increase was notable (10.2%) provided that there was only an 8-week lapse between the two evaluations. Nevertheless, measurement error can be safely ruled out given that the same procedures were used for the collection and analysis of the blood samples at both time points. Although the present study did not evaluate intakes, it is possible that the increase in the prevalence of anemia was a reflection of the community as a whole having less access to and/or consumption of iron-rich foods. The present results differ somewhat from those of interventions providing weekly multimicronutrient supplements to young children for 12 to 24 weeks, in which hemoglobin concentrations responded positively to supplementation [13, 15–18]. Given that the dose of iron was the same for all studies (20 mg once per week), it is possible that the differences observed in the present study were due to the shorter duration of supplementation. Therefore, if weekly multimicronutrient supplementation was included in a large-scale national program for children, it would probably have to be implemented for at least 12 weeks to produce a positive effect on hemoglobin levels, as observed in other randomized trials.

The protective effect of supplementation is also seen in women and adolescent girls of childbearing age. Hemoglobin levels remained similar to those at baseline in the intervention group, while those in the comparison group decreased significantly. As occurred with the children, the rate of anemia in women and adolescent girls increased significantly in the comparison group and remained constant in the intervention group. One study in Indonesia showed that the hemoglobin status of adolescent girls was significantly improved after only 8 weeks of weekly supplementation with multimicronutrients, which included 60 mg of iron [19]. It is likely that the difference in dosage explains the differences between the two studies. Therefore, it is recommended that for women and adolescent girls a higher dose of iron (i.e., 60 mg) than what was used in this study for weekly administration should be used or the duration of the campaign be increased by a few weeks if the dose is kept at the same level.

Given the hemoglobin status and rates of anemia of the overall population, it is likely that these persons have marginal levels of iron and possibly other micronutrients, and thus any change that results in a decrease of dietary intake or an increase in infections could lead to an increase in the rates of anemia, as was observed in the comparison group. The dose of micronutrients administered in the study may have been sufficient only to enable the intervention group to maintain their current levels but not high enough to cause an improvement. Nevertheless, further proof of the positive effects of supplementation on this population is given by the multivariate analysis, which showed that both in women and adolescent girls and in children, supplementation had a positive and significant effect on anemia.

In conclusion, weekly supplementation with multimicronutrients had a protective effect on the hemoglobin levels of both women and adolescent girls of childbearing age and children under 5 years of age. A weekly multimicronutrient supplementation intervention program for women, adolescent girls, and children is feasible, acceptable, and cost-effective, although modifications, such as better integration between different sectors working in public health, adjustment of the micronutrient doses provided both to women and adolescent girls and to children, and optimization of the duration of intervention, are needed to maximize its biological effect.

References

1. WHO nutrition web page. Available at: http://www.who.int/nut. Accessed 23 June 2006.
2. WHO. The World Health Report 2002: Reducing risks, promoting healthy life. Geneva: World Health Organization, 2002. Available at: http://www.who.int/whr/previous/en/index.html. Accessed 23 June 2006.
3. International Zinc Nutrition Consultative Group (IZiNCG). Technical Document no. 1. Assessment of the risk of zinc deficiency in populations and options for its control. Food Nutr Bull 2004;25(suppl):S94–204.
4. Instituto Nacional de Estadística e Informatica. Encuesta demográfica y de salud familiar (ENDES IV). Lima, Peru, 2001.
5. Ministerio de Salud del Perú. Instituto Nacional de Salud. Situación nutricional del Peru. Available at: http://www.ins.gob.pe. Accessed 23 June 2006.
6. Webb R, Fernández-Baca G. Perú en números: 1997. Anuario Estadístico, Cuánto S.A., Lima, Peru, 1997.
7. Gross R, Lechtig A, López de Romaña D. Baseline evaluation of nutritional status and government feeding programs in Chiclayo, Peru. Food Nutr Bull 2006; 27(suppl):S115–21.
8. Gross R, Benade S, López de Romaña G. The International Research on Infant Supplementation initiative. J Nutr 2005;135:628S–30S.
9. Gross U, Valle C, Diaz MM. Effectiveness of distribution of multimicronutrient supplements in children and in women and adolescent girls of childbearing age in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S122–9.
10. Gross R, Kielmann A, Korte R, Schoeneberger H, Schultink W. Guidelines for nutrition baseline surveys in communities. Jakarta, Indonesia: South East Asian Ministry of Education Organization–Tropical Medicine (SEAMEO-TROPMED) and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), version 1.2, 1997. Available at: http://www.nutrisurvey.de. Accessed 23 June 2006.
11. Lechtig A, Gross R, Paulini J, López de Romaña D. Costs of the multimicronutrient supplementation program in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl): S151–9.
12. Rivera JA, Hotz C, Gonzalez-Cossio T, Neufeld L, Garcia-Guerra A. The effect of micronutrient deficiencies on child growth: a review of results from community-based supplementation trials. J Nutr 2003;133(11 suppl 2): 4010S–20S.
13. Thu BD, Schultink W, Dillon D, Gross R, Leswara ND, Khoi HH. Effect of daily and weekly micronutrient supplementation on micronutrient deficiencies and growth in young Vietnamese children. Am J Clin Nutr 1999;69:80–6.
14. Penny ME, Marin RM, Duran A, Peerson JM, Lanata CF, Lonnerdal B, Black RE, Brown KH. Randomized controlled trial of the effect of daily supplementation with zinc or multiple micronutrients on the morbidity, growth, and micronutrient status of young Peruvian children. Am J Clin Nutr 2004;79:457–65.
15. López de Romaña G, Cusirramos S, López de Romaña D, Gross R. Efficacy of multiple micronutrient supplementation for improving anemia, micronutrient status, growth, and morbidity of Peruvian infants. J Nutr 2005;135:646S–52S.
16. Smuts CM, Dhansay MA, Faber M, van Stuijvenberg ME, Swanevelder S, Gross R, Benade AJ. Efficacy of multiple micronutrient supplementation for improving anemia, micronutrient status, and growth in South African infants. J Nutr 2005; 135:653S–9S.
17. Untoro J, Karyadi E, Wibowo L, Erhardt MW, Gross R. Multiple micronutrient supplements improve micronutrient status and anemia but not growth and morbidity of Indonesian infants: a randomized, double-blind, placebo-controlled trial. J Nutr 2005;135:639S–45S.
18. Hop LT, Berger J. Multiple micronutrient supplementation improves anemia, micronutrient nutrient status, and growth of Vietnamese infants: double-blind, randomized, placebo-controlled trial. J Nutr 2005;135: 660S–5S.
19. Angeles-Agdeppa I, Schultink W, Sastroamidjojo S, Gross R, Karyadi D. Weekly micronutrient supplementation to build iron stores in female Indonesian adolescents. Am J Clin Nutr 1997;66:177–83.

Costs of the multimicronutrient supplementation program in Chiclayo, Peru

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Abstract

Background. *There is little information on the cost parameters of weekly multimicronutrient supplementation programs.*

Objective. *To assess the cost parameters and cost-effectiveness of a weekly multimicronutrient supplementation program in an urban population of Peru.*

Methods. *Data from the Integrated Food Security Program (Programa Integrado de Seguridad Alimentaria [PISA]), which distributed capsules and foodlets to women and adolescent girls and to children under five, were extrapolated to a population of 100,000 inhabitants.*

Results. *The annual cost per community member was US$1.51. The cost-effectiveness ratio was US$0.12 per 1% of prevented anemia per community member.*

Conclusions*. These costs are in the upper margin of iron supplementation alone. They will decrease notably when weekly multimicronutrient supplementation programs are integrated into health packages and participation by women increases. Focusing on micronutrient deficiencies would prevent these problems, and food-distribution programs would be effectively targeted to food-deficient populations.*

Key words: Anemia, children, costs, cost-effectiveness, micronutrient supplementation, urban, women

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Introduction

Micronutrient supplementation has been identified as one of the most efficient public health interventions. According to the Copenhagen Consensus, the provision of micronutrients to control iron-deficiency anemia has been ranked next to treatment of HIV/AIDS as the second most cost-effective investment to meet the world development challenges [1].

Weekly multimicronutrient supplementation is expected to be less expensive than daily supplementation [2]. Evidence is essential for decision-making regarding the scaling-up of programs. However, there is little information available on the cost-effectiveness of these programs in larger populations. Thus, the objective of the present paper is to assess the cost, effectiveness, and cost-effectiveness ratio of a weekly multimicronutrient supplementation program. In particular, the analysis was aimed to include not only the purchasing cost of the supplements (foodlets and capsules), but also the costs of human resources, materials for education and social communication, and transportation.

Materials and methods

Population studied

In 2001, the Integrated Food Security Program (Programa Integrado de Seguridad Alimentaria [PISA]), in coordination with the Regional Health Directorate of Lambayeque (Dirección Regional de Salud Lambayeque [DIRESA]), began to implement a weekly multimicronutrient supplementation program for women and adolescent girls aged 12 through 44 years and children under 5 years of age living in the coastal city of Chiclayo, Peru. PISA conducted a baseline study to determine the rate of stunting in children from low-income areas in Chiclayo [3]. A census was then conducted to determine the number of women and adolescent girls of childbearing age and under-five children living in those 26 communities previously identified as poor and where the prevalence of stunting was higher than 15% [3]. From a total of 66,299 inhabitants, 20,082 women and adolescent girls of childbearing age and 8,081 children under 5 years of age were identified as potential beneficiaries of the multimicronutrient supplementation program. Two types of supplements, known as Nutrivit, were prepared for the study. For women and adolescent girls of childbearing age, capsules containing vitamins and minerals were distributed in blister packs of four capsules; each capsule provided two recommended daily allowances (RDAs) per week. A second type of supplement, called the foodlet, was especially developed for small children. The foodlet could be masticated by the child and provided two RDAs per week. Blister packs containing four foodlets were also distributed weekly. The supplements were produced by Hersil Laboratories, Lima, Peru, which obtained the micronutrient premix from Roche Laboratories. The micronutrient contents of the two supplements are described by López de Romaña et al. [4]. During the fourth campaign of the supplementation program, 47% of the women and adolescent girls of childbearing age and 88% of the children were covered [5].

Data collection

The analysis was based on data collected in the fourth campaign of the micronutrient supplementation, which was implemented from May through August, 2001. The distribution of the micronutrients and the nutrition communication campaign have been described by Gross et al. [5, 6].

The sources of information were the documents generated by PISA, such as accounts, budgets, and monitoring and evaluation reports, as well as the databases from the surveys performed. In addition, primary data were collected by interviews with key persons and specific surveys involving community representatives. All costs presented were transformed from Peruvian currency (soles) into US dollars with the use of conversion rates officially registered for the year 2001. The rate was 3.521 soles per US$1 in 2001 and 3.329 soles per US$1 in March 2006. In other words, the program expenses would have been 5% lower if it had been implemented in 2006 [7].

Statistical analysis

The analysis was conducted in three steps: estimation of the cost of the weekly multimicronutrient supplementation program, estimation of the effectiveness of the intervention in women and adolescent girls and in children, and estimation of the cost-effectiveness of the program.

Costs

The estimation of the routine cost of the weekly multimicronutrient supplementation program per year was extrapolated to a population unit of 100,000 community members in order to allow for the calculation of costs in other populations and draw conclusions on the affordability of the present intervention. Costs included the production and distribution of the supplements (capsules and foodlets), the communication campaign, the monitoring component, and program management. In order to calculate the cost estimate of the present analysis, three adjustments had to be made with regard to the actual costs of PISA: 1) the quota of general administrative costs, the cost of evaluations in depth, and the cost of the time that the community spent in the program were excluded; 2) the expenditures were calculated on a 1-year basis by extrapolating the cost of implementation of a half-year campaign to two campaigns per year; and 3) the duration of the supplementation campaign was extrapolated to 16 weeks per semester instead of the 12 weeks of the original project.

In order to get closer to the differences in implementation possibilities among developing countries, cost calculations were made for two scenarios. In one scenario, the weekly multimicronutrient supplementation program is implemented alone; in the other scenario, it is implemented as part of a broader public nutrition package in which several other interventions (e.g., growth-monitoring, oral rehydration, immunization, deworming, and malaria prevention and treatment) would also be in place. The yearly costs were calculated for each community member, targeted member, and member actually covered by the program.

Effectiveness

The effectiveness of the program was calculated by bivariate and multivariate analysis. For the bivariate analysis, the indicator selected to estimate program effectiveness was the magnitude of the protective effect of the supplementation, as measured by the avoidance of anemia in children and women and adolescent girls of childbearing age receiving supplementation as compared with a control group.

Effectiveness was estimated by the equation

$$E = (d - c) - (b - a)$$

where

d = prevalence of anemia value after the intervention in the control group,

c = prevalence of anemia value before the intervention in the control group,

b = prevalence of anemia value after the intervention in the supplementation group, and

a = prevalence of anemia value before the intervention in the supplementation group.

Therefore, the expression ($d - c$) represents the change in the prevalence of anemia observed in the control group, and the expression ($b - a$) represents the change in the prevalence of anemia observed in the supplemented group. In other words, effectiveness was estimated by subtracting the increment observed in the supplemented group from the increment observed in the control group. This analysis was made for both children under 5 years of age and for women and adolescent girls of childbearing age.

A probit, stepwise, multivariate analysis was used to estimate which variables explained the presence of anemia in women and adolescent girls and in children (dependent variable). The independent variables included in the model were related to the family's capacity to access food (unsatisfied basic needs and overcrowding), the availability of resources (consumption of iron-rich foods and consumption of iron supplements), their capacity to correctly choose and use adequate foods (mother's nutrition knowledge and access to health information), and the characteristics of the individuals themselves (age, sex, and pregnancy). A dummy variable was also introduced to evaluate the impact of supplementation on anemia after statistically controlling for the other variables included in the model.

The theoretical model was

$$Y = F(U, A, D, P, O)$$

where Y represents the prevalence of anemia for the individual and is estimated operationally as the probability of having anemia, U represents the variables related to utilization, A represents the variables related to access, D represents the variables related to availability, P represents the variables related to personal characteristics, and O represents other factors, not included above, which could be associated with the prevalence of anemia, such as intake of vitamin supplements, intake of medicines, and whether the child received colostrum.

There are two alternative ways to solve the equation according to F: a logit binomial model, in which F represents a logistic cumulative function, and a probit model, in which F is a normal cumulative function. Both alternatives delivered similar values for the estimates. However, the probit model was selected because the errors tended to be lower than with the logit model. Therefore, if the probability of having anemia, Y, is the dependent variable to be estimated, the equation can be expressed as

$$Y_i = F(BX_i) + u_i$$

where Y is the individual's probability of having anemia, X includes all variables that could have an effect on the probability, B represents the relationships to be estimated, and U is the estimate error. The subindex i defines the cluster of variables for the ith individual, in this case a woman or adolescent girl or a child. Since Y_i is a nonobserved variable, it was necessary to use a fictitious dichotomous variable Y_i^*, where the variable is assigned a value of 1 if the individual has anemia and a value of 0 if the individual has no anemia. In the end, what was estimated was the probability that one individual has anemia, expressed as follows:

$$Pr\ (Y_i^* = 1) = Pr\ (u_i > BX_i) = 1 - F\ (BX_i)$$

and then

$$\text{Pr}\ (Y_i^* = 0) = F\ (BX_i)$$

where F is a function of the cumulative probability of u_i. The probit model uses the normal distribution function where it is assumed that $u_i \sim \text{N}(0, \text{Var}(u_i))$.

In summary, the magnitude of the impact or effectiveness of the multimicronutrient intervention was estimated in terms of the variation in the probability that an individual has anemia either as a consequence of the intervention or as a consequence of a change in one or more of the variables included in the model, also called explanatory variables.

Tables 1 and **2** present the list of explanatory variables (vector X above) included in the regression models and the directions of their expected effects for children and for women and adolescent girls, respectively. All variables were selected post facto by using information from the fourth supplementation campaign. The stepwise regression method was used to identify those variables that were most highly correlated with anemia. Regressions were computed for children and for women and adolescent girls of childbearing age both at the beginning and at the end of the campaign, for a total of four regressions.

Cost-effectiveness

Cost-effectiveness (CE) was expressed in terms of the ratio

$$\text{CE} = a/b$$

where

- a = unitary cost of the program (US dollars per capita), under different assumptions mentioned above, and
- b = program effectiveness expressed in percentage points of protective effect by each method used for estimation (bivariate or multivariate).

Cost-effectiveness estimates are presented for both methods. The cost analyses were performed with the SPSS software package (SPSS for Windows, version 11.0, SPSS, Chicago, IL, USA). The effectiveness and cost-effectiveness analyses were performed with Intercooled Stata 7.0 for Windows 98/95/NT (Stata Corporation, College Station, TX, USA).

TABLE 1. Variables used in the regression model and their expected effects in children under 5 years of age

Variable	Value	Direction of the expected effect
Dependent variable		—
Presence of anemia	Anemia present: 1 Anemia absent: 0	
Access to food		
Unsatisfied basic needs	Continuous variable	Positive
Overcrowding	Continuous variable	Positive
Food availability		
Intake of iron-rich foods	No: 0, yes: 1	Negative
Intake of other iron supplements	No: 0, yes: 1	Negative
Food utilization		
Mother's knowledge of nutrition	No: 0, yes: 1	Negative
Mother's knowledge of breastfeeding	No: 0, yes: 1	Negative
Access to MOH IEC material	No: 0, yes: 1	Negative
Personal characteristics		
Age of the child	Continuous variable	Negative
Sex of the child	Female: 0, Male: 1	Positive
Age of the mother	Continuous variable	Negative
Who is the caregiver	Mother: 1, others: 0	Negative
Other variables		
Intake of other vitamin supplements	No: 0, yes: 1	Negative
Intake of other medications	No: 0, yes: 1	Negative
Child received colostrum	No: 0, yes: 1	Negative
Intervention variable		
Supplementation	No: 0, yes: 1	Negative

MOH, Ministry of Health; IEC, information, education, and communication

Results

Costs

The total cost of the multimicronutrient supplementation program when implemented alone would be US$150,767 per year for a population unit of 100,000 (**table 3**). The purchasing cost of the supplements was only a quarter of the total cost if the supplementation campaign was implemented alone and half of the total cost if it formed part of a broader approach; the remaining costs were attributable to human resources and materials. If the supplementation program was implemented as part of a comprehensive public health package, the costs of the supplementation program could be reduced to half (US$72,971 per year), mainly because of the savings on management. The annual costs per person per year of the weekly multimicronutrient program are shown in **table 4**. It can be observed that if the supplementation intervention is implemented alone, the cost per community member per year is approximately US$1.51, the cost per targeted beneficiary per year is US$3.55, and the cost per covered participant per year is US$6.04. On the other

TABLE 4. Estimated cost per individual of a weekly multimicronutrient program when implemented alone and when implemented as part of a public health package, extrapolated to a population of 100,000, based on the experience of PISA

Type of individual	Cost (US$/yr)	
	Program alone	Public health package
Community members (n = 100,000)	1.51	0.73
Targeted beneficiaries (n = 42,500)[a]	3.55	1.72
Actually covered beneficiaries (n = 24,977)[b]	6.04	2.92

a. In the PISA population, 30.3% were women and adolescent girls of childbearing age and 12.2% were children under 5 years of age. Extrapolation to a population unit of 100,000 would yield 30,300 women and adolescent girls of childbearing age and 12,200 children under 5 years of age, for a total of 42,500 targeted beneficiaries.

b. Forty-seven percent of women and adolescent girls of childbearing age and 88% of children under 5 years of age were covered [5]. The number of targeted individuals who actually received the supplements would be (0.47 × 30,300) 14,241 women and adolescent girls + (0.88 × 12,200) 10,736 children = 24,977.

TABLE 2. Variables used in the regression model and their expected effects in women and adolescent girls of childbearing age

Variable	Value	Direction of the expected effect
Dependent variable		—
Presence of anemia	Anemia present: 1 Anemia absent: 0	
Access to food		
Unsatisfied basic needs	Continuous variable	Positive
Overcrowding	Continuous variable	Positive
Food availability		
Intake of iron-rich foods	No: 0, yes: 1	Negative
Intake of other iron supplements	No: 0, yes: 1	Negative
Food utilization		
Knowledge of nutrition	No: 0, yes: 1	Negative
Access to MOH IEC material	No: 0, yes: 1	Negative
Personal characteristics		
Age of the woman or girl	Continuous variable	Negative
Presence of pregnancy	No: 0, yes: 1	Positive
Other variables		
Intake of other vitamin supplements	No: 0, yes: 1	Negative
Intake of other medications	No: 0, yes: 1	Negative
Intervention variable		
Supplementation	No: 0, yes: 1	Negative

MOH, Ministry of Health; IEC, information, education, and communication

TABLE 3. Estimated costs of a weekly multimicronutrient program for a population of 100,000 when implemented alone and when implemented as part of a public health package, based on the experience of PISA

Items			Number	Cost (US$/yr)	
				Program alone	Public health package
Human resources	Project management	Head Coordinators Field staff (half time)	1 2 20	72,600	18,150
	Community	Facilitators/transport Refreshment/T-shirts	800 800		
Materials[a]	Communication	Printing Leaflets Posters Calendars Beneficiaries' manuals Facilitators' manuals Flags Transport	 33,000 1,000 33,000 33,000 800 800	12,000 30,015	3,000 15,669
	Supplements	Capsules (US$/0.008 unit) Foodlets (US$/0.603 unit) Transport	33,000 12,000	36,152	36,152
Total				150,767	72,971

a. The costs of all materials have been calculated with a 10% overhead.

hand, if the intervention is implemented as part of a broader approach, the costs are cut to approximately half of the above.

Effectiveness

The results of the bivariate analyses are shown in **table 5**. It can be seen that for women and adolescent girls of childbearing age, the prevalence of anemia increased in the control group from 29.4% to 35.9%, while in the supplementation group there was no increase (33.9% vs. 29.7%). This resulted in an estimate of effectiveness of 10.7%. Similarly, the prevalence of anemia among children increased in the control group from 35.4% to 50.4%, while there was no increase in the supplemented group (39.7% vs. 40.2%). Therefore, the estimated effectiveness of the supplementation campaign for children was 14.5%. **Table 6** shows those

TABLE 5. Estimated effectiveness of weekly multimicronutrient supplementation in women and adolescent girls of childbearing age and in children according to bivariate analysis

Variable	Intervention		Control	
	Before (n = 448) (a)	After (n = 408) (b)	Before (n = 418) (c)	After (n = 409) (d)
Women and girls				
Prevalence of anemia	33.9%	29.7%	29.4%	35.9%
Change in prevalence		$(b - a) = - 4.2\%$		$(d - c) = 6.5\%$
Effectiveness		$(d - c) - (b - a) =$ $(6.5\%) - (- 4.2\%) = 10.7\%$		
Children				
Prevalence of anemia	39.7%	40.2%	35.4%	50.4%
Change in prevalence		$(b - a) = 0.5\%$		$(d - c) = 15.0\%$
Effectiveness		$(d - c) - (b - a) =$ $(15.0\%) - (0.5\%) = 14.5\%$		

TABLE 6. Variables significantly correlated with the prevalence of anemia

Variable	Children at baseline	Children at the end	Women and adolescent girls at baseline	Women and adolescent girls at the end
Access to food				
Unsatisfied basic needs	X	X	X	X
Overcrowding	—	—	X	X
Food availability				
Intake of iron-rich foods	—	—	—	—
Intake of other iron supplements	—	—	—	—
Food utilization				
Mother’s knowledge of nutrition	—	—	X	X
Mother’s knowledge of breastfeeding	—	—	—	—
Access to MOH IEC material	—	—	—	—
Personal characteristics				
Age of the child	—	—	—	—
Sex of the child	X	X	—	—
Age of the mother	X	X	—	—
Who is the caregiver				
Pregnancy			X	X
Other variables				
Intake of other vitamin supplements	—	—	—	—
Intake of medicines	—	—	—	—
Child received colostrums	—	—	—	—
Intervention variable: supplementation	—	X	—	X

MOH, Ministry of Health; IEC, information, education, and communication

TABLE 7. Multivariate analysis to explain anemia (probit model)

Variable	Effect	SE	z-Score	$P > \|z\|$
Women and adolescent girls (*n* = 817)				
Unsatisfied basic needs	0.048	0.016	2.91	.004
Overcrowding	0.004	0.009	0.48	.533
Nutrition knowledge (1 = yes, 0 = no)	0.002	0.035	0.08	.937
Pregnancy (1 = yes, 0 = no)	0.185	0.072	–2.82	.005
Supplementation (1 = yes, 0 = no)	–0.097	0.034	2.61	.009
Children (*n* = 815)				
Unsatisfied basic needs	0.04	0.018	1.91	.056
Age of child	–0.01	0.001	–12.26	.000
Sex of child (1 = M, 0 = F)	0.08	0.037	2.11	.035
Supplementation (1 = yes, 0 = no)	–0.11	0.034	2.61	.009

variables in the multivariate analysis that were significantly correlated with the prevalence of anemia.

The results of the multivariate analyses are shown in **table 7.** The dummy variable representing supplementation appeared in the hypothesis expected direction, with a statistically significant effectiveness that ranged between 9.70% for women and adolescent girls and 11.65% for children. Among women and adolescent girls of childbearing age, the variable with the highest effect on anemia was pregnancy (effect, 18.5%; *p* = .005), followed by supplementation and unsatisfied basic needs. In children the variables that had a significant effect on anemia were supplementation, age, and sex. Unsatisfied basic needs appeared on the borderline.

TABLE 8. Cost-effectiveness per individual of a weekly multimicronutrient supplementation program when implemented alone and when implemented as part of a public health package, based on the experience of PISA[a]

Type of individual	Cost	Cost-effectiveness (bivariate analysis)[b]	Cost-effectiveness (multivariate analysis)[c]
Program alone			
Community member	1.51	0.12	0.14
Targeted beneficiary	3.55	0.28	0.33
Participating beneficiary	6.04	0.50	0.57
Public health package			
Community member	0.73	0.06	0.07
Targeted beneficiary	1.72	0.14	0.16
Participating beneficiary	2.92	0.23	0.28

a. Cost-effectiveness is estimated as the number of US dollars per 1% of protective effect or US dollars necessary for the prevention of a 1% increase in the prevalence of anemia in a population unit of 100,000 inhabitants. Cost data are copied from table 4.

b. The effectiveness estimate used for the bivariate analysis was 12.6%, which is the average of the effect in children (14.5%) and the effect in women and adolescent girls (10.7%).

c. The effectiveness estimate used for the multivariate analysis was 10.6%, which is the average of the effect in children (11.7%) and the effect in women and adolescent girls (9.8%).

Cost-effectiveness

The figures presented in **table 8** are the cost-effectiveness estimates in US dollars per 1% of protective effect. To calculate the cost-effectiveness by analysis performed, a nonweighted average was taken of the effect of supplementation in children and in women and adolescent girls obtained by each analysis. Thus, the effectiveness estimate used for the bivariate analysis was 12.6%, which is the average of the effect observed in children (14.5%) and the effect observed in women and adolescent girls (10.7%). The effectiveness estimate used for the multivariate analysis was 10.6%, which is the average of the effect observed in children (11.7%) and the effect observed in women and adolescent girls (9.8%). The data in this table indicate that the cost-effectiveness ratios were US$0.12 per point prevalence of protective effect per community member, US$0.28 per community member targeted, and US$0.50 per covered member. Again, when the micronutrient supplementation was considered as part of a public healthcare package, these values decreased by half.

Discussion

According to the findings, the cost of the weekly multimicronutrient supplementation program was US$1.51 per community member. Therefore, to cover the total population of Peru, which currently is approximately 28 million, the cost of weekly multimicronutrient supplementation of all children and all women and adolescent girls of childbearing age would be around US$42 million per year. In 2001, Peru spent more than US$200 million on food-distribution programs. During 2003, US$115 million was spent to distribute approximately 3.5 million rations on the Peruvian coast. It was not possible to estimate the exact coverage provided by the programs, given that in many cases the same individuals participated in more than one program. Nevertheless, the average cost of the ration per year was roughly US$32.9, with large variations among programs.

As shown by the results of the baseline study [3], even though 68% of the households are poor, there is hardly any energy deficiency observed that would justify food aid in this population. On the other hand, in this type of setting (i.e., poor coastal urban population) there is evidence of a high prevalence of iron-deficiency anemia and an increase in the prevalence of overweight and obesity. All of the above suggests that means other than food distribution should be identified to assist low-income households, and that nutrition programs in the coastal urban region should focus on controlling micronutrient deficiencies. If these two conditions were met, micronutrient deficiencies could be prevented and food-distribution programs would not increase the risk of overweight. As a result, food aid could be transformed into food-supplementation programs that would be better targeted to assist those who really need it, and in the process economic resources could be diverted to assist in the reduction of poverty by other mechanisms.

The results of vitamin A supplementation programs show that the cost of providing supplements ranges from US$1.01 to US$5.42 per recipient per year [8–10]. This program cost is in the upper range of costs of iron-supplementation programs, which was US$3.17 to US$5.30 per recipient per year [11]. The high cost in this study (US$6.04 per recipient) was due to the facts that the program was implemented alone, the participation of women and adolescent girls was low, the cost of the nutrition education campaign that was needed to achieve high compliance rates was high [6], and the cost of providing multimicronutrients, in particular the foodlet administered to small children, was higher than the cost of providing a single micronutrient.

The cost of the nutrition education component in this program was estimated as US$72,315, or 48% of the total cost, and the cost per covered participant was US$2.90. According to Ho, the cost of a nutrition education program is US$2.50 per participant per year, an amount that should be considered in all public health and nutrition programs to obtain high compliance [12]. Finally, it should be noted that in the present analysis, all costs have been calculated based on the implementation of the supplementation program in a district. If the program is implemented nationwide, additional costs for social communication, advocacy, management, and administration at the national level would have to be included. However, some of these additional costs would be partially compensated by the increase in scale of the material produced (lower costs per unit of larger produced amount) and national communication campaigns, which could reduce the activities required at the local level.

A point to be made regarding the estimates of effectiveness is that the variables included in the multivariate analysis had heterogeneous measurement errors. For example, identifying a woman as belonging to the supplementation group had very low error, but variation was introduced by coverage and compliance, which are components of the supplementation variable. Variables such as child age and sex are known to have very low measurement error. However, the remaining variables included in the multivariate analysis, such as pregnancy, unsatisfied basic needs, mother's nutrition knowledge, overcrowding, intake of iron-rich foods, intake of other iron supplements, mother's knowledge and practices of adequate breastfeeding, access to educational material from the Ministry of Health, intake of other vitamin supplements, intake of medicines, and whether the child received colostrum at birth, were expected to have high measurement errors within and across populations.

Furthermore, the fact that the control group was not designed as a paired control may have introduced additional noise in the system. Finally, it has been reported that the HemoCue method of assessing hemoglobin concentration can have significant measurement errors if capillary blood is used [13, 14]. Given that these variables were used as gross proxies of the phenomena they were supposed to measure, the protective effect of supplementation was probably underestimated.

With acknowledgment of the above reservations and the advantages and limitations of the two analytic methods used, the following conclusions can be drawn: both methods delivered estimates of effectiveness in the direction of the expected effect; both methods delivered higher estimates for children than for women and adolescent girls; the estimates resulting from the multivariate analysis were consistently lower than those from the bivariate analysis because of the statistical control for the effect of covariation that was applied in order to obtain the net differentiated effect of the supplementation; and the difference between the methods in the protective effect against an increase in the prevalence of anemia is on the order of 2%. Thus, the true value of the effectiveness of supplementation probably lies within this range.

There is little information available about the cost-effectiveness of similar programs to permit useful comparisons with the present analysis. No important differences in cost-effectiveness were anticipated between children versus women and adolescent girls, since the slighter higher effectiveness observed in children is compensated almost totally by the higher cost of the foodlets for children compared with the cost of the capsules for women and adolescent girls. Analysis using the total cost of the more expensive pilot project (PISA) delivered very similar cost-effectiveness ratios for children and for women and adolescent girls (US$0.71 and US$0.70, respectively). A program with the same design using higher doses or implemented for longer periods of time could be expected not only to have a protective effect but also to notably reduce the prevalence of anemia and other micronutrient deficiencies, with few cost increases. This is because the cost estimates already include the costs of an extension of the supplementation period from 12 to 16 weeks, two campaigns per year instead of one, transportation of the supplements, program management, and nutrition education.

For example, doubling the iron content of the supplement for adults would add only US$264 to the cost of ingredients. This would imply an increase of 0.18% (US$264/US$150,767) in the total cost per year if the program is implemented alone and 0.36% (264 US$/72,971 US$) if it is implemented as part of a comprehensive public nutrition package. Increases of similar orders of magnitude would be observed in the yearly costs per community member, per targeted beneficiary, and per actually covered beneficiary. The reason for this is that the major component of the total cost of the supplements (US$36,152) is the cost of transport (US$28,652, or 79.3%) and not the cost of the ingredients (US$7,500, or 20.7%). The transport cost would not vary significantly if the amount of the ingredients was doubled. In fact, the cost of purchasing the supplements was 5.0% of the total cost of the program when it was implemented alone and 10.3% of the total cost of the program when it was implemented integrated into a broader range of activities (US$7,500/US$150,767 and (US$7,500/US$72,971, respectively).

Thus, multimicronutrient supplementation is notably more cost-effective than the current food-distribution programs, which do not address micronutrient deficiencies occurring in these populations and may increase the risk of overweight and obesity. Food-distribution programs are also very expensive, with annual costs of more than US$20 per capita, and usually involve undesirable vertical approaches, with the risk of insufficient transparency and accountability.

References

1. Bhagwati JN, Fogel RW, Frey BS, Lin JY, North DC, Schelling TC, Smith VL, Stockey NL. Expert panel ranking. In: Lomborg B, ed. Global crisis, global solutions. Cambridge, UK: Cambridge University Press, 2004.
2. Gross R. Micronutrient supplementation in the life cycle. UNICEF, New York, 2002.
3. Gross R, Lechtig A, López de Romaña D. Baseline evaluation of nutritional status and government feeding programs in Chiclayo, Peru. Food Nutr Bull 2006; 27(suppl):S115–21.
4. López de Romaña D, Verona S, Aquino O, Gross R. Protective effect of multimicronutrient supplementation against anemia among children, women, and adolescent girls in lower-income areas of Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S143–50.
5. Gross U, Valle C, Diaz MM. Effectiveness of distribution of multimicronutrient supplements in children and in women and adolescent girls of childbearing age in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S122–9.
6. Gross U, Valle C, Diaz MM. Effectiveness of the communication program on compliance in a weekly multimicronutrient supplementation program in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S130–42.
7. Gobierno del Perú. Ministerio de Economía y Finanzas. Estadísticas económicas. Tipo de Cambio. March 2006. Available at: http://www.mef.gob.pe. Accessed 11 July 2006.
8. Fiedler JL, Dado DR, Maglalang H, Juban N, Capistrano M, Magpantay MV. Cost analysis as a vitamin A program design and evaluation tool: a case study of the Philippines. Soc Sci Med 2000;51:223–42.
9. Fiedler JL. The Nepal National Vitamin A Program: prototype to emulate or donor enclave? Health Policy Plan 2000;15:145–56.
10. Edejer TT, Aikins M, Black R, Wolfson L, Hutubessy R, Evans DB. Cost effectiveness analysis of strategies for child health in developing countries. BMJ 2005; 331:1177.
11. Caulfield LE, Richard SA, Rivera JA, Musgrove P, Black RE. Stunting, wasting, and micronutrient deficiency disorders. Available at: http://files.dcp2.org/pdf/DCP/DCP28.pdf. Accessed 11 July 2006.
12. Ho TJ. Economic issues in assessing nutrition projects: costs, affordability and cost effectiveness. PHN Technical Note 85-14. Washington, DC: World, 1985.
13. Neufeld L, Garcia-Guerra A, Sanchez-Francia D, Newton-Sanchez O, Ramirez-Villalobos MD, Rivera-Dommarco J. Hemoglobin measured by Hemocue and a reference method in venous and capillary blood: a validation study. Salud Publica Mex 2002;44:219–27.
14. Morris SS, Ruel MT, Cohen RJ, Dewey KG, de la Briere B, Hassan MN. Precision, accuracy, and reliability of hemoglobin assessment with use of capillary blood. Am J Clin Nutr 1999;69:1243–8.

Lessons learned from the scaling-up of a weekly multimicronutrient supplementation program in the Integrated Food Security Program (PISA)

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Abstract

Background. *Weekly multimicronutrient supplementation was initiated as an appropriate intervention to protect poor urban populations from anemia.*

Objective. *To identify the lessons learned from the Integrated Food Security Program (Programa Integrado de Seguridad Alimentaria [PISA]) weekly multimicronutrient supplementation program implemented in poor urban populations of Chiclayo, Peru.*

Methods. *Data were collected from a 12-week program in which multimicronutrient supplements were provided weekly to women and adolescent girls 12 through 44 years of age and children under 5 years of age. A baseline survey was first conducted. Within the weekly multimicronutrient supplementation program, information was collected on supplement distribution, compliance, biological effectiveness, and cost.*

Results. *Supplementation, fortification, and dietary strategies can be integrated synergistically within a micronutrient intervention program.*

Conclusions. *To ensure high cost-effectiveness of a weekly multimicronutrient supplementation program, the following conditions need to be met: the program should be implemented twice a year for 4 months; the program should be simultaneously implemented at the household (micro), community (meso), and national (macro) levels; there should be governmental participation from health and other sectors; and there should be community and private sector participation. Weekly multimicronutrient supplementation programs are cost effective options in urban areas with populations at low risk of energy deficiency and high risk of micronutrient deficiencies.*

Key words: Anemia, children, multimicronutrient supplementation, urban, women

Introduction

Worldwide, population growth is concentrated in urban areas of developing countries [1], and urban dwellers increasingly experience food insecurity and malnutrition (undernutrition, including micronutrient deficiencies, and overnutrition). However, there is little understanding of the manifestations, magnitude, severity, and causes of this problem, and such understanding is needed to implement appropriate nutrition programs for urban populations. Nutritional anemia is by far the most prevalent micronutrient deficiency [2], and weekly multimicronutrient supplementation has been suggested as an adequate intervention to control this problem [3]. However, little information is available on how to successfully implement weekly multimicronutrient supplementation programs on a large scale.

The objective of this paper is to present the lessons learned from the weekly multimicronutrient supplementation intervention implemented as a component of the Integrated Food Security Program (Programa Integrado de Seguridad Alimentaria [PISA]) in low-income urban populations of Chiclayo, Peru. The paper will also provide suggestions for weekly multimicronutrient supplementation programs to improve food and nutrition security in poor urban populations.

Subjects and methods

Using the results of the baseline evaluation of the city of Chiclayo, PISA identified 26 low-income communities

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with high rates of stunting within the city as potential populations for the supplementation campaigns [4].

To measure the biological effectiveness of the intervention, households were randomly selected to participate in the supplementation campaign if they had one child under 5 years of age and one woman or adolescent girl of childbearing age (12 through 44 years) [5]. The remaining communities of the city served as a control group. In total, 866 households (448 in the intervention group and 418 in the control group) were chosen to participate in the study. Anthropometric and biochemical measurements were performed on both the children and their mothers. Biological effectiveness was measured in terms of the protective effect (prevention of increase in the prevalence of anemia) of weekly multimicronutrient supplementation in comparison with the control group. Coverage was estimated from reports on the whole study population provided by community facilitators [6]. In addition, beneficiary-reported compliance was assessed in a sample during the entire campaign [7]. On the basis of PISA's accounting documents, costs were calculated, in US dollars per year, for a population unit of 100,000 inhabitants [8]. The cost-effectiveness ratio was estimated in terms of the cost in US dollars of each percentage point of protective effect.

Results and conclusions

Nutrition security is more than food security

The findings of the baseline survey triggered several meetings with community representatives, nongovernmental organizations, government authorities, donor agencies, and program operators to develop a causal framework for appropriate intervention strategies based on UNICEF's framework on malnutrition [9]. Four thematic areas were identified as key for intervention: nutrition, hygiene, health care, and purchasing power. In addition, three cross-cutting strategies were selected to support the interventions: communication, organization (community empowerment and capacity-strengthening), and extension services.

Within the theme of feeding, multimicronutrient supplementation at the household (micro) level was identified as an important strategy to control micronutrient deficiencies of the poor. In addition, the increase of income opportunities provided by opening a savings and credit program to improve purchasing power was identified as another strategy that could be used to improve the nutritional status of the present population, in particular for those households considered extremely poor. However, it was also emphasized by all participating institutions and organizations that an improvement of community services, such as water and sanitation infrastructure, was also needed to improve the nutritional situation of the population.

Despite this conceptual agreement, in practice the intervention elements were not implemented in the same geographic area or over the same time interval, since each sector identified its scope of action according to its needs and convenience. Therefore, it was not possible to observe synergistic effects. Multisectoral public health interventions require clear overarching leadership and accountability to avoid sector-driven agendas that miss opportunities for synergism. If the quality of the total system is to be greater than the sum of its subsystems, so that the effect of nutrition security is greater than that of food security, an adequate managerial response will be required, which is often lacking.

In summary, once the key problems of the target population have been identified, the program management must assure from the first planning stage that all sectors work in the same geographic area at the same time and with the same population. To achieve joint planning and programming, only joint budgeting and monitoring must be allowed, and all sectors must work to improve and maintain household food security with common collective influence on the indicators.

Supplementation plus fortification plus dietary approach: comprehensive micronutrient programs supporting nutrition strategy

In program implementation, concerns are often stated that supplementation is not sustainable and that it adversely affects sustainable fortification and dietary approaches. The experience of PISA has shown that supplementation campaigns can be easily used as an entry point for dietary information and improved food intake practices. It is well known that supplementation programs are more expensive than fortification programs [10]. However, as shown by the example of PISA, supplementation allows better targeting than feeding, especially for coverage of the poorest, most difficult-to-reach households.

Supplementary feeding programs designed as a dietary approach to cover difficult-to-reach individuals are far more expensive but may be necessary for those households living in extreme poverty with wasted members. Therefore, the perennial question—whether to use a supplementation, fortification, or dietary approach—is the wrong one. All three micronutrient approaches have their justification. The questions that should be asked are which micronutrient intervention(s) should be used for which target groups and under which conditions, and how can the three approaches be implemented to support each other synergistically, since in most circumstances, one approach alone is insufficient to effectively reach all population groups in need?

Linear dose–response relationship of micronutrients: More input–more outcome

The effectiveness of a supplementation program depends on the efficacy of the supplement, the effectiveness of distribution, and the rate of sustained consumption of the supplement. High efficacy can be achieved if the bioavailabilty and the dose per kilogram of the micronutrient administered to the individual are high. The weekly multimicronutrient supplementation program has had a cost-effective preventive impact on anemia. In view of the linear dose–response relationship of many micronutrients, including iron, which has been demonstrated in the IRIS efficacy study [11]; the absence of oxidative stress in weekly iron supplementation [12]; and the low additional costs of iron in the supplement, an increased cost-effectiveness may be achieved with a higher iron content in the supplement (120 mg for women and adolescent girls and 60 mg for children under five). Although a few studies [13–15] suggest that even in episodes of malaria infection, which contributes to metabolic stress, iron supplementation is safe as long its administration is intermittent, more research is needed on the effects of further increases in the iron content of the supplement, particularly for communities with a high prevalence of infections. In the meantime, to achieve high coverage of 12 doses [16], it is recommended that the intervention time be increased from 3 to 4 months.

The three-M approach: Simultaneous implementation of interventions at the household (micro), community (meso), and national (macro) levels

As with all nutrition interventions, micronutrient supplementation is relevant to all levels of society, from the individual and household (micro) levels, to the community, subdistrict, district, and province (meso) levels, up to the national and global (macro) levels [17]. For the three levels of social organization, different kinds of actions are necessary to secure effectiveness and sustainability (**table 1**). At the micro level, appropriate nutritional behaviors, practices, and choices need to be fostered. At the meso level, adequate basic services and supplies need to be provided and facilitated. At the macro level, appropriate supportive policies, legislation, and budgets need to be available.

PISA made an effort not only to secure adequate supplies and services at the meso level, but also to influence nutritional practices and choices at the micro level by a well-implemented social communication strategy. Therefore, compliance within the group of participants was high, even over time, although little success was achieved at the macro level. Although the National Program of Food Assistance (Programa Nacional de Asistencia Alimentaria [PRONAA]) supported the program with the assistance of the German Agency for Technical Cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit [GTZ]), governmental commitment was not sufficient to ensure continuity of the program after German assistance concluded. More scaling-up experiences need to be implemented by other governmental sectors to create additional evidence that wider populations can be reached. For example, supplementation programs could be implemented within the Ministry of Education in order to reach primary and secondary schoolchildren. In addition, clear regulations, defined by the Ministry of Health, are needed to provide a legal basis for agencies and the private sector. Once more evidence is available regarding scaling-up experiences with different target groups and a legal basis has been created, budget lines need to be established by the government.

The diversity and complexity of causality of nutritional problems often leads to excessively broad and ambitious planning of interventions. In particular, if resources are limited, it is better to plan and implement a few focused interventions but carry them out consistently at all levels (micro, meso, and macro) than to try to solve all the problems at the same time without adequate coverage at all socio-organizational levels.

Governmental participation: Leadership without exclusivity by the health sector

Governmental commitment to nutrition in general and to the control of micronutrient deficiencies in particular requires broad involvement of different sectors of the government. The experience of PISA showed that most health facilities complied with the implementation of intramural activities, whereas extramural actions had to be performed by others. Given that reports from different parts of the world have illustrated the effectiveness of weekly supplementation

TABLE 1. Causes of malnutrition in relation to socio-organizational levels and intervention categories

Cause	Socio-organizational level		Intervention category
Direct or immediate	Micro	Individuals, families	Changes in behavior, practices, and choices
Underlying	Meso	Communities, districts	Availability of and access to adequate basic supplies and services, and facilitative and safe environments
Basic	Macro	Nations, regions, global	Appropriate policies and sustainable programs, enabling legislation, and budgets

in schoolchildren [15, 18–24], PISA explored the possibility of implementing supplementation campaigns in coordination with other sectors of the government, such as education, in order to reach an age group that was not being covered by the program. Unfortunately, these efforts were not successful. PISA also explored the possibility of integrating supplementation strategies into the governmental feeding program, but without much success.

Thus, on the basis of the present experience, it can be said that micronutrient programs require broad governmental commitment under the leadership of one sector, which is accountable for creating an environment that stimulates participation from other sectors.

Community participation and private sector involvement: Partnerships beyond government and agencies

Much has been published on the importance of community participation to achieve effective and sustainable public health interventions [25]. The positive impact of community participation on the supplementation program of PISA confirms earlier experiences. In this context, empowerment of women to make the best decisions for their children and themselves is an essential component. Furthermore, the universal effort to implement the rights of children and women will help to mobilize the necessary capacities to make this approach successful.

Equally important is a constructive involvement of the private sector in the production and supply of commodities. At the end of the program in Chiclayo, many mothers went to PISA asking about the possibility of purchasing the micronutrients on their own. Unfortunately, the program did not make any efforts to seek for a market-driven response to improve the micronutrient supply. Sustainability, at least for a part of the population, might have been achieved if PISA had searched from the beginning for additional supply channels beyond the public sector. Successful micronutrient distribution by the private sector has been reported from the neighboring country of Bolivia [26].

Sustainable partnership can only be expected if the following conditions are met at the planning stage of a program:

» The expectations of all partners are frankly expressed, respected, and made achievable in the program strategy (e.g., political goals for the government, economic goals for the private sector, and socioeconomic goals for the community) to create a "win-win" situation for all constituencies;
» The planning, implementation, and monitoring of the program are transparent and impartial, requiring an equal empowerment of all partners and low transaction costs for each partner.

Appropriate communication strategy: Marketing beyond social goals

Governmental and private sectors have to join forces to provide similar messages about a product in order to avoid confusion and mistrust among the public. The private sector has often created mistrust in the consumer community by providing "asymmetric" information, in which messages about the product hold out promises far from reality. At the same time, messages about a product disseminated from public programs too often are not well received by the target audience because the product information is too obviously aimed only at the poor and does not meet the aspirations of the target audience. Poor people have dreams and desires that do not differ from those of the rest of society. These aspirations are very well used by the private sector for marketing purposes. In summary, the private sector is far better than the public sector in assuring that their products are appealing and available to the public.

An excellent example of a joint, synergistic public–private marketing strategy of an attractive product is the case of salt fortification in Ghana [27]. The Ministry of Health, supported by UNICEF, implemented an attractive nationwide communication campaign about the importance of the consumption of iodized salt. Afterwards, the private sector used the same health messages to market iodized salt. Similar strategies could be used for multimicronutrient supplementation programs. PISA copied private-sector marketing strategies. However, it missed the opportunity to communicate and market synergistically within a public–private partnership.

We have learned the lesson from experience with fortification programs that the private sector is a necessary element for sustainable success. This experience must be also be applied to supplementation. Only if the right conditions are created by the government will the private sector invest in appropriate marketing strategies to reach low-income consumers.

Recommendations

The recommendations arising from this study take into consideration the following:

» Although there is no global assessment available [28], in the estimation of the World Health Organization iron deficiency is the most prevalent micronutrient deficiency [4];
» In many countries, the population suffers additionally from other micronutrient deficiencies [29], which may also contribute to anemia [30];
» Fortification works only in countries with efficient food systems, which require legislation, law

enforcement, quality assurance systems, sustained production, and adequate marketing and distribution systems. Even in those countries where food fortification works, such as Peru [4] and many other countries [28], fortification alone does not satisfy the physiological needs of small children, pregnant women, and the most vulnerable groups;

» Iron supplementation may present health risks if its levels are excessive, especially in populations with high rates of malaria infection;
» Weekly iron supplementation, as currently recommended, shows no signs of free-radical production or other adverse effects.;
» With an adequate social marketing and business marketing strategy, a high consumption rate of supplements can be achieved and maintained [29, 30].

Therefore, in countries in which the prevalence of anemia is above 20%, weekly multimicronutrient supplementation is recommended twice a year for at least 4 months for children under 5 years of age and for adolescent girls and women of reproductive age (12 through 44 years).

References

1. FAO. Food insecurity in an urban future. 2004. Available at: http://www.fao.org/newsroom/en/focus/2004/51786/article_51797en.html. Accessed 23 June 2006.
2. WHO. Version 3, March 2004. Geneva: World Health Organization. Available at: http://www.who.int/nut/htm. Accessed 23 June 2006.
3. Gross R, Benade S, López de Romaña G. The International Research on Infant Supplementation initiative. J Nutr 2005;135:628S–30S.
4. Gross R, Lechtig A, López de Romaña D. Baseline evaluation of nutritional status and government feeding programs in Chiclayo, Peru. Food Nutr Bull 2006; 27(suppl):S115–21.
5. López de Romaña D, Verona S, Aquino O, Gross R. Protective effect of multimicronutrient supplementation against anemia among children, women, and adolescent girls in lower-income areas of Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S143–50.
6. Gross U, Valle C, Diaz MM. Effectiveness of distribution of multimicronutrient supplements in children and in women and adolescent girls of childbearing age in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S122–9.
7. Gross U, Diaz MM, Valle C. Effectiveness of the communication program on compliance in a weekly multimicronutrient supplementation program in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl):S130–42.
8. Lechtig A, Gross R, Paulini J, López de Romaña D. Costs of the multimicronutrient supplementation program in Chiclayo, Peru. Food Nutr Bull 2006;27(suppl): S151–9.
9. UNICEF. Nutrition strategy. New York: UNICEF, 1990.
10. Caulfield LE, Richard SA, Rivera JA, Musgrove P, Black RE. Stunting, wasting, and micronutrient deficiency disorders (Chapter 28). In: Disease Control Priorities in Developing Countries, 2nd ed. Washington DC: IBRD/Oxford University Press and the World Bank, 2006. Available at: http://www.dcp2.org/pubs/DCP. Accessed 11 August 2006.
11. Smuts CM, Lombard CJ, Benade AJ, Dhansay MA, Berger J, Hop le T, López de Romaña G, Untoro J, Karyadi E, Erhardt J, Gross R; International Research on Infant Supplementation (IRIS) Study Group. Efficacy of a foodlet-based multiple micronutrient supplement for preventing growth faltering, anemia, and micronutrient deficiency of infants: the four country IRIS trial pooled data analysis. J Nutr 2005;135:631S–8S.
12. Casanueva E, Viteri FE. Iron and oxidative stress in pregnancy. J Nutr 2003;133(5 suppl 2):1700S–8S.
13. Schellenberg D, Menendez C, Kahigwa E, Aponte J, Vidal J, Tanner M, Mshinda H, Alonso P. Intermittent treatment for malaria and anaemia control at time of routine vaccinations in Tanzanian infants: a randomised, placebo-controlled trial. Lancet 2001; 12(357):1471–7.
14. Verhoef H, West CE, Nzyuko SM, de Vogel S, van der Valk R, Wanga MA, Kuijsten A, Veenemans J, Kok FJ. Intermittent administration of iron and sulfadoxine-pyrimethamine to control anaemia in Kenyan children: a randomised controlled trial. Lancet 2002;360(9337): 908–14.
15. Ekvall H, Premji Z, Bjorkman A. Micronutrient and iron supplementation and effective antimalarial treatment synergistically improve childhood anaemia. Trop Med Int Health 2000;5:696–705.
16. Berger J, Thanh HT, Cavalli-Sforza T, Smitasiri S, Khan NC, Milani S, Hoa PT, Quang ND, Viteri F. Community mobilization and social marketing to promote weekly iron-folic acid supplementation in women of reproductive age in Vietnam: impact on anemia and iron status. Nutr Rev 2005;63(12 pt 2):S95–108.
17. Gross R, Schoeneberger H, Pfeifer H, Preuss H-J. The four dimensions of food and nutrition security: definitions and concepts. SCN News 2000;20:20–5.
18. Berger J, Aguayo VM, Tellez W, Lujan C, Traissac P, San Miguel JL. Weekly iron supplementation is as effective as 5 day per week iron supplementation in Bolivian school children living at high altitude. Eur J Clin Nutr 1997; 51:381–6.
19. Soemantri AG, Hapsari DE, Susanto JC, Rohadi W, Tamam M, Irawan PW, Sugianto A. Daily and weekly iron supplementation and physical growth of school age Indonesian children. Southeast Asian J Trop Med Public Health 1997;28(suppl 2):69–74.
20. Muro GS, Gross U, Gross R, Wahyuniar L. Increase of compliance with weekly iron supplementation of adolescent girls by an accompanying communication programme in secondary schools in Dar-es-Salaam, Tanzania. Food Nutr Bull 1999;20:435–44.
21. Aguayo VM. School-administered weekly iron supplementation—effect on the growth and hemoglobin status of non-anemic Bolivian school-age children. A randomized placebo-controlled trial. Eur J Nutr 2000; 39:263–9.

22. Beasley NM, Tomkins AM, Hall A, Lorri W, Kihamia CM, Bundy DA. The impact of weekly iron supplementation on the iron status and growth of adolescent girls in Tanzania. Trop Med Int Health 2000;5:794–9.
23. Hall A, Roschnik N, Ouattara F, Toure I, Maiga F, Sacko M, Moestue H, Bendech MA. A randomised trial in Mali of the effectiveness of weekly iron supplements given by teachers on the haemoglobin concentrations of schoolchildren. Public Health Nutr 2002;5:413–8.
24. Roschnik N, Parawan A, Baylon MA, Chua T, Hall A. Weekly iron supplements given by teachers sustain the haemoglobin concentration of schoolchildren in the Philippines. Trop Med Int Health 2004;9:904–9.
25. UNICEF. The state of the world's children. New York: UNICEF, 1998.
26. Warnick E, Dearden KA, Slater S, Butron B, Lanata CF, Huffman SL. Social marketing improved the use of multivitamin and mineral supplements among resource-poor women in Bolivia. J Nutr Educ Behav 2004;36:290–7.
27. Government of Ghana/Unilever. It started as a small lump on my throat and gradually swelled to the size of a melon. London: Unilever Corporate Relations, 2005.
28. Viteri F, Berger J. Importance of pre-pregnancy and pregnancy iron status: can long-term weekly preventive iron and folic acid supplementation achieve desirable and safe status? Nutr Rev 2005;63.
29. Paulino LS, Angeles-Agdeppa I, Etorma UM, Ramos AC, Cavalli-Sforza T. Weekly iron-folic acid supplementation to improve iron status and prevent pregnancy anemia in Filipino women of reproductive age: the Philippine experience through government and private partnership. Nutr Rev 2005;63(12 pt 2):S109–15.
30. Garcia J, Datol-Barrett E, Dizon M. Industry experience in promoting weekly iron-folic acid supplementation in the Philippines. Nutr Rev 2005;63(12 pt 2):S146–51.

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In Memoriam

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