# Decreasing stunting, anemia, and vitamin A deficiency in Peru: Results of The Good Start in Life Program

Aarón Lechtig, Guido Cornale, María Elena Ugaz, and Lena Arias

## Abstract

***Background.*** *The rates of stunting, iron-deficiency anemia, and vitamin A deficiency in Peru are among the highest in South America. There is little scaled-up experience on how to solve these problems countrywide.*

***Objective****. To evaluate the Good Start in Life Program during the period from 2000 to 2004.*

***Methods.*** *Data on weight, height, hemoglobin, serum retinol, urinary iodine, and age were obtained from children under 3 years of age during two transverse surveys in 2000 and 2004.*

***Results.*** *In 2004, the program covered 75,000 children, 35,000 mothers, and 1 million inhabitants from 223 poor communities. The rate of stunting decreased from 54.1% to 36.9%, the rate of iron-deficiency anemia decreased from 76.0% to 52.3%, and the rate of vitamin A deficiency decreased from 30.4% to 5.3%* ($p < .01$)*. The annual cost per child was US$116.50.*

***Conclusions.*** *Adaptations of this participative program could contribute to decreased stunting, iron-deficiency anemia, and vitamin A deficiency at the national scale in Peru and many other countries.*

**Key words:** Children, cost, early stimulation, effectiveness, Good Start in Life Program, iron-deficiency anemia, Peru, stunting, vitamin A deficiency

## Introduction

The prevalence rates of chronic malnutrition, iron-deficiency anemia, and vitamin A deficiency in Peru continue to be among the highest in South America [1], and there is little experience on how to conceptualize and implement the necessary interventions to reduce stunting and micronutrient deficiencies countrywide [2]. The objective of this paper is to report on the external evaluation of the Good Start in Life Program, implemented in Peru with the support of UNICEF and funds from the US Agency for International Development (USAID). The aim of the program was to combat chronic malnutrition in children under 3 years of age from poor rural populations of the Andean highlands and the Amazon forest.

## Materials and methods

The design of the external evaluation corresponded to an experimental prospective study in which a baseline survey was performed in 2000 and an endline survey was conducted in 2004 (before-and-after design). The main questions formulated were: What was the problem? What was the intervention? What was the impact? What was the investment? What was the benefit obtained for the investment? What were the side effects? What were the lessons learned? What were the suggestions to improve the program? What was the usefulness of the experience in contributing to decrease the prevalence of stunting, iron-deficiency anemia, and vitamin A deficiency in Peru?

In order to define the nutritional problem, the baseline data were used. Impact evaluation was measured as program effectiveness. The analyses were performed in two samples in each survey: the total sample and the sample of 19 communities that were covered by both surveys. In all cases, analyses were performed of the prevalence of stunting (measured by anthopometric z-scores), anemia (measured by hemoglobin concentrations), and vitamin A deficiency (measured by serum retinol).

The cost assessment was performed on the assumption of a population unit of 100,000 inhabitants and four items: transportation inside the province, personnel, early stimulation, and training. Thus, the estimates

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did not include technical cooperation, publications, transportation outside the province, or health sector supplies and training. All results are given in US dollars at the exchange rate of November 30, 2006 [3].

The program was designed around two main elements: the intervention package, which was of a preventive nature in nutrition, hygiene, health, and early stimulation; and participatory processes of management, capacity development at the individual and institutional levels, and mobilization of human, economic, and organizational resources. These processes cut across all operational activities and were always based on participative approaches. The design and implementation of the program also benefited from an anthropological approach [4].

The main activities in the intervention package were promotion of growth and development, prenatal controls, promotion of adequate feeding of pregnant and lactating women and adequate complementary feeding of their children, early stimulation of the child, exclusive breastfeeding during the first 6 months of life and continued breastfeeding on demand during the first 2 years, control of iron and vitamin A deficiency, promotion of iodated salt intake, and personal and family hygiene.

The program started in 1999 in three regions of the Peruvian Andean highlands (Cusco, Cajamarca, and Apurimac) and one region of the Amazon forest (Loreto) with strengthening of the capacities of the counselor women, the rural health promoters, and the leadership of the communities. The main interface was with the health sector, and frequently one nongovernmental organization was in charge of implementing the intervention. The program team interacted with the community, the personnel of the health facilities, the local nongovernmental organizations, and, less frequently, at the regional and national levels.

The baseline survey was performed from April to November 2000 by the Instituto de Investigacion Nutricional (IIN) from Lima. The endline survey (termed endline 1) was performed by the Facultad de Medicina of the University Cayetano Heredia from Lima (Departamento de Salud Pública) from October to December 2004. The agency responsible for this external evaluation was the nongovernmental organization Agencia Internacional de Seguridad Alimentaria y Nutricional (AISA). In addition, necessary information and feedback were provided by committee members from UNICEF, Lima. The interval between the end of the baseline and the start of endline survey 1 was 46 months.

It is not known what proportion of the individual children surveyed in 2004 participated in the program or for how long. Given the high intensity of program activities in each community, it is inferred that most of the children surveyed in 2004 had at least one contact with the program activities (e.g., community meetings and home visits) for promotion of growth and development. Coverage of program immunizations was regularly above 80%, but no coverage data were available for several other important activities.

A cumulative population list was made of all the communities and their population sizes. Then the number of groups required for each department was calculated by dividing the sample size by the number of children present in the smallest community. In order to select the groups to be surveyed, a random number was assigned to identify each community [4, 5]. In the selected communities, households were chosen at random. In those communities for which maps were available, the blocks required to complete the sample size were chosen at random. In areas for which there were no maps, systematic sampling was performed, taking as a starting point a well-known site in each community.

Before beginning information collection, the surveyors and the supervisor obtained the family's consent by explaining the objectives of the survey, the voluntary nature of their participation, and their rights not to answer some questions and to reject some procedures. Potential advantages and disadvantages for the families and the communities were also outlined. Consent forms were then read and signed in occasions using interpreters. No data were collected when there was no family consent. No data was available on the frequency of no family consent.

During the process of information collection, the supervisor selected at random 15% of all forms completed during the day to review the most important variables (children's age, date, survey location, and anthropometric values). To ensure data quality control, the supervisor verified and standardized the anthropometric equipment and measured four children selected at random on a daily basis to compare the results with those obtained by the surveyors.

To measure the weight of children under 3 years of age, Salter scales were used with a precision of 100 g, with the children wearing minimal clothing. In some cases, it was necessary to weigh the clothing and subtract their weight from the total weight. The scales were calibrated with standard weights the night before they were used and recalibrated in the field when there was suspicion of error. Height was measured by portable tallimeters with a precision of 0.3 mm [6].

Hemoglobin was measured in capillary blood from children with the use of a Softclix Plus lanzometer with disposable sterile lancets. One drop was placed directly in the hemocuvette and read on the HemoCue with a precision of 0.1 g/dL. The HemoCue was calibrated with a standard the night before and also in the field when necessary [7, 8].

A larger blood sample (five drops) was taken from every fourth child for the determination of serum retinol, and a sample of urine was obtained to measure iodine. The blood sample was collected in a heparinized tube (Heparine-Lithium) marked and sent to a nearby

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laboratory for centrifugation and plasma freezing. Later in the day they were sent to a central laboratory in Lima for retinol analysis by high-pressure liquid chromatography (HPLC) [9]. The urine samples were marked and sent to the central laboratory for quantitative determination of iodine [10].

All information was sent to Lima and entered with the use of the program FOX-PRO. When errors were detected, the forms were returned to the field for direct verification by the supervisor. A second stage of quality control was performed with the use of frequency tables and histograms. Spreadsheets with the different variables were created for analysis; the programs used were SPSS 7.0 for Windows, Epi Info, and the National Center for Health Statistics (NCHS) standards [11].

## Results

The data under the baseline columns of **tables 1–4** describe the nutritional problems in these communities in children under 3 years of age during 2000 at the beginning of the program. The communities were characterized by high prevalence rates of stunting (54.1% in **table 1**) and iron-deficiency anemia (76.0% in **table 3**). There were moderate prevalence rates of vitamin A deficiency (30.5% in **table 4**) and global malnutrition (23.7% in **table 1**). Acute malnutrition was 1.8% (**table 1**). Iodine-deficiency disorders affected 16.8% of children with urinary iodine below 100 μg/L**.** It was probable that there was a high prevalence of retardation in mental and psychomotor development because of the lack of early stimulation and the high prevalence of iron-deficiency anemia and stunting.

The multicausal overlapping framework was used for problem analysis [12]. The immediate causes of stunting were inadequate birthweight, faulty complementary feeding, and high incidence rates of diarrhea and acute respiratory infections. In addition, underlying factors such as inadequate child care practices—including lack of hygiene, lack of early stimulation, and absence of exclusive breastfeeding during

TABLE 1. Impact of the program on height-for-age, weight-for-age, and weight-for-height z-scores[a]

| Department | Height-for-age (stunting) | | | | Weight-for-age (global malnutrition) | | | | Weight-for-height (acute malnutrition) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Baseline | | Endline 1 | | Baseline | | Endline 1 | | Baseline | | End line 1 | |
| | < −2 HAZ — % (*n*) | Mean HAZ | < −2 HAZ — % (*n*) | Mean HAZ | < −2 WAZ — % (no.) | Mean WAZ | < −2 WAZ — % (*n*) | Mean WAZ | < −2 WHZ — % (*n*) | Mean WHZ | < −2 WHZ — % (*n*) | Mean WHZ |
| Total sample | | | | | | | | | | | | |
| Apurímac | 55.2 (571) | −2.13 | 38.5** (221) | −1.76** | 25.9 (571) | −1.36 | 26.2 (221) | −1.44 | 3.0 (571 ) | 0.03 | 1.8 (221) | −0.41** |
| Cajamarca | 49.2 (185) | −1.96 | 37.5* (216) | −1.66* | 18.9 (185) | −1.16 | 16.7 (216) | −1.00 | 1.1 (185) | 0.11 | 0.5 (216) | 0.14 |
| Cusco | 66.1 (310) | −2.13 | 49.5** (204) | −1.98 | 25.5 (310) | −1.27 | 29.4 (204) | −1.48* | 0.3 (310) | 0.08 | 2.0 (204) | 0.32** |
| Loreto | 30.0 (140) | −1.57 | 24.2 (236) | −1.35* | 17.1 (140) | −1.27 | 10.2* (236) | −1.48* | 1.4 (140) | 0.08 | 1.7 (236) | 0.32** |
| Total | 54.1 (1,206) | −2.04 | 36.9** (877) | −1.68** | 23.7 (1,206) | −1.28 | 20.3 (877) | −1.21 | 1.8 (1,206) | 0.04 | 1.5 (877) | −0.14** |
| Subsample | | | | | | | | | | | | |
| Apurímac | 56.4 (149) | −2.13 | 42.9* (84) | −1.90* | 21.5 (149) | −1.34 | 26.2 (84) | −1.55* | 2.0 (149) | 0.11 | 0.0* (84) | −0.42** |
| Cajamarca | 61.8 (68) | −2.13 | 39.6* (48) | −1.83 | 17.6 (68) | −1.24 | 31.3 (48) | −1.33 | 1.5 (68) | 0.14 | 0.0 (48) | −0.17 |
| Cusco | 68.9 (151) | −2.23 | 42.3* (71) | −1.96* | 33.1 (151) | −1.43 | 29.6 (71) | −1.47* | 0.7 (151) | −0.06 | 4.2* (71) | −0.34 |
| Loreto | 30.0 (140) | −1.57 | 29.8 (124) | −1.42* | 17.1 (140) | −1.12 | 10.5 (124) | −1.01 | 1.4 (140) | −0.14 | 2.4 (124) | 0.11 |
| Total | 53.5 (508) | −2.01 | 37.3** (327) | −1.71** | 23.2 (508) | −1.29 | 21.7 (327) | −1.30 | 1.4 (508) | 0.00 | 1.8 (327) | −0.16 |

HAZ, height-for-age z-score; WAZ, weight-for-age z-score; WHZ, weight-for-height z-score

*$p < .05$, ** $p < .01$ (2-tailed test).

*a.* For each indicator, the percentage and number of cases falling below − 2 z-scores from the standard are given, as well as the mean z-score. Indicators were measured at baseline and at the endline 1 (2-year) survey.

*b.* The two surveys covered two overlapping sets of communities. This subsample was made up with children from the same 19 communities which were covered by the baseline and the endline 1 surveys.

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the first 6 months of life—were causes of stunting.

Inadequate complementary feeding resulted from the overlap of several underlying and basic causes: inadequate access to foods by families (food insecurity at the household level); inadequate access to quality health services, including referrals to the second level of health services, resulting in common infectious diseases that decrease children's appetite; lack of potable water, sanitation, and garbage disposal services, leading to diarrhea and reinforcing the decrease in appetite; faulty child-care practices, including lack of hygiene, absence of exclusive breastfeeding during the first 6 months of life; and lack of access to education and resources at the family level. The program was carried out in a context of chronic malnutrition, poverty, social exclusion, and ineffective food assistance programs [13, 14].

## Impact

The program was associated with a decrease in the prevalence of chronic malnutrition from 54.1% to 36.9% (**table 2**), a decrease in the prevalence of iron-deficiency anemia from 76.0% to 52.3 % (**table 3**), and a decrease in the prevalence of vitamin A deficiency from 30.4% to 5.3% (**table 4**). All of these decreases in prevalence were statistically significant ($p < .01$, $t$-test), and similar results were obtained when the same variables were analyzed in terms of anthropometric z-scores and concentrations of hemoglobin and serum retinol.

In 2004, the program covered approximately 75,000 children under 3 years of age and 35,000 pregnant and lactating women living in 223 rural communities. The main participating partners were the Health Directorates of Cusco, Apurímac, Loreto, Cajamarca, and Ayacucho, the personnel of 434 health facilities, several local nongovernmental organizations, 23 local radio stations, and the leadership of the 223 communities.

Of course, it was desirable that all children surveyed in 2004 had participated in the Good Start in Life Program. However, coverage by the program was not one of the criteria for survey sample selection. Although coverage was generally above 80%, it varied with the type of intervention activity.

**Tables 2 and 5** present the results of bivariate analysis and multivariate analysis predicting stunting, in order to statistically control for possible confounding factors. Multivariate analyses failed to detect which specific program activities were responsible for this reduction. This result is interpreted as meaning that the program as a whole, and not an isolated part of it, was responsible for the observed impact. It would be appropriate to further assess the sustainability of these reductions in 2009, when the program is expected to show a decrease in the prevalence of low birthweight and improvements in psychomotor and mental development.

TABLE 2. Impact of the program on chronic malnutrition in children according to sex, age group, and number of inhabitants per community[a]

| Group | % (no.) malnourished | |
|---|---|---|
| | Baseline | Endline 1 |
| Total sample | | |
| Sex | | |
| Male | 54.3 (589) | 41.0** (458) |
| Female | 54.0 (617) | 32.5** (419) |
| Age group | | |
| 0–5 mo | 16.6 (163) | 8.2** (85) |
| 6–11 mo | 37.6 (234) | 22.9** (179) |
| 12–23 mo | 67.3 (453) | 47.6** (313) |
| 24–35 mo | 65.4 (355) | 42.1* (299) |
| Total | 54.1 (1205) | 36.9** (876) |
| Subsample of the same 19 communities[b] | | |
| No. of inhabitants per community | | |
| > 60 | 1.0 (205) | 30.9* (152) |
| ≤ 60 | 62.0 (303) | 42.9** (175) |

*$p < .05$, ** $p < .01$ (2-tailed test).

*a.* Analysis of variance was performed to explain prevalence of chronic malnutrition. Predictor variables ($p < .01$) were child's age, department of residence, child's sex, number of inhabitants per population unit, and type of survey (baseline or endline 1).

*b.* The two surveys covered two overlapping sets of communities. This subsample was comprised of children from the same 19 communities which were covered by the baseline and the endline 1 surveys.

TABLE 3. Impact of the program on the prevalence of iron-deficiency anemia in children under 3 years of age according to department (total sample)

| Department | % (no.) with anemia | |
|---|---|---|
| | Baseline | Endline 1 |
| Cusco | 85.6 (353) | 72.4** (112) |
| Cajamarca | 88.3 (332) | 50.7** (24) |
| Apurímac | 75.1 (401) | 62.0** (178) |
| Loreto | 55.1 (316) | 24.1** (163) |
| Total | 76.0 (1,402) | 52.3** (520) |

** $p < .01$ (2-tailed test).

TABLE 4. Impact of the program on the prevalence of hypovitaminosis A (serum retinol < 20 µg/L) in children under 3 years of age according to department (total sample)

| Department | % ($n$) with hypovitaminosis A | |
|---|---|---|
| | Baseline | Endline 1 |
| Cusco | 33.0 (109) | 6.2** (128) |
| Cajamarca | 29.9 (87) | 4.5** (24) |
| Apurímac | 29.6 (95) | 2.4** (170) |
| Loreto | 28.6 (90) | 8.0** (157) |
| Total | 30.4 (381) | 5.3** (479) |

** $p < .01$ (2-tailed test).

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TABLE 5. Variables predicting height-for-age z-scores among children under 3 years of age at endline 1 survey (total sample)

| Associated with height-for-age: *$p < .05$, **$p < .01$ (2-tailed test) | Spearman rho (*n*) | Characteristics not associated with height for age: $p > .05$ (2-tailed test) |
|---|---|---|
| Child receives support from health promoter | −0.084* (544) | Shows carnet. Child complies with the growth monitoring and development program (GMDP). GMDP is performed by professionals or by health personnel, or with father present; community supports child care; child care is supported by radio or by health personnel. |
| Child receives support from nongovernmental organization personnel | 0.136** (544) | |
| Child is currently breastfed | −0.102** (670) | Was or is breastfed, was breastfed during the first hour or the first day of life. |
| Child participates in complementary feeding programs | 0.138** (671) | Participates in other programs: Milkglass (Vaso de Leche), Wawa Huasi, People's dinners (Comedores Populares), ADRA-OFASA[a] |
| Child participates in PACFO (National Program of complementary food for population groups at high nutritional risk) | 0.236** (671) | |
| Child participates in other government feeding programs | −0.086* (671) | |
| Child is immunized against polio | 0.179* (149) | Coverage of immunizations for age; immunization against tuberculosis, measles, yellow fever, in addition presence of diarrhea or coughing. |
| Child's appetite decreased during last disease | 0.138** (668) | Number of days eating PHBV (protein of high biological value); number of times eating PHBV; decreased liquids during or after last disease; decreased solids during or after last disease. |
| Child is adequately fed for age (PAADE) (Niños con Alimentación Adecuada para la Edad) | 0.179** (692) | Protein, fat, or energy intake; did not eat PHBV during last week; number of days given PHBV; did not receive PHBV yesterday; number of times given PHBV yesterday. |
| Mother's age | 0.106** (665) | |
| Mother's number of years of schooling | −0.115** (614) | |
| Type of household floor | 0.198* (149) | Light (availability at home of electric light) − 0.064 ($p$ = .099; at least one basic need not satisfied; with another child who does not go to school; inadequate household; no hygienic services available; type of wall and ceiling; parents receive financial support from other persons. |
| Has potable water | −0.142** (673) | |
| Has sanitation (toilet) | −0.075* (673) | |

Multivariate analysis predicting height-for-age z-scores for endline 1 survey, total sample ($r = 0.272$):

| Standard error = 1.00; mean squares = 12.209; residual = 1.006; constant = −9.077** | Beta |
|---|---|
| Mother's number of years of schooling | 0.179** |
| Has sanitation | 0.082* |
| Is adequately fed for age (PAADE) | −0.133** |
| Participates in complementary feeding programs | −0.090* |

*a.* Adventist Agency for development and assistance resources—philanthropic work of Adventist Social Assistance
* $p < .05$, ** $p < .01$ (2-tailed test)

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**Table 5** also shows the available data from the endline 1 survey on complementary feeding, breastfeeding, morbidity, water and sanitation, and socioeconomic information. A series of these variables was statistically associated with stunting, and theoretically they had the potential to create a confounding between the program and its impact on stunting. However, most of these *r* values were below 0.2, and therefore the probability of confounding was also very low.

A further examination of the multivariate analysis indicated that only four variables retained a statistically significant ($p < .05$) association with stunting. Thus, 54.2% of children of mothers with no education were stunted, as compared with 29.7% of children of mothers with 7 or more years of education. Similarly, 32.0% of children who had any type of sanitation (toilet) inside the household were stunted, as compared with 37.9% of children with sanitation outside the household.

The other two selected variables in the multivariate analysis were: appropriate feeding for the child's age (**table 5**) and the number of government complementary-feeding programs providing support to the child, which shows positive association. Only 21.8% of children not covered by government feeding programs were stunted, as compared with 43.3% of those covered by one or more programs. We interpret this result as indicating that stunted children are more likely to be referred to and enrolled in feeding programs, rather than that the feeding programs caused stunting.

The net additional annual cost per inhabitant was US$7.07 during the first year of implementation and US$3.69 during the subsequent years. The annual cost was US$93.20 for each programmed child (i.e., child included and scheduled for intervention plan) and US$116.50 for each child programmed and actually covered (i.e., administration of an intervention, such as a vaccine). If the program covered the entire poor population in Peru, estimated at 15.12 million, the total cost would be $106.9 million during the first year of implementation and $55.8 million during each subsequent year. For comparison, in 2001 the country spent more than US$200 million in food-assistance programs, with no detectable nutritional impact.

The ratio of investment to benefit was US$1.64 per inhabitant for each decrease of one percentage point in the prevalence of chronic malnutrition in children under three during the first year of implementation and US$0.86 during each of the subsequent years. A 15-year period will be required to reduce the current national level of stunting from 24.5% to less than 10%. It was estimated that there will be an annual increase of US$1.15 in the gross national product for each dollar invested during this 15-year period. This is equivalent to a return of 115% per year in the gross national product, beginning in the first year following the 15-year period (year 16).

Finally, no side effects were detected.

## Discussion

What follows is a review of the activities implemented as part of the intervention and the available literature on nutritional impact, particularly on stunting. All educational activities were performed by the health promoters and the community counselors during the daily home visits and during the daily community meetings organized for growth monitoring and early stimulation. Most of the educational messages were later repeated by other means, such as communal radio and conversations among village people.

*Adequate promotion and monitoring of child growth and development using the Ministry of Health material and equipment at the community level with the participation of the mother and the father.* This has been reported as the axis of most successful community-based programs [15–17]. The current coverage of this activity, as measured by the percentage of parents showing the updated carnet, was 75.6%, the percentage of parents and caretakers who received information on the growth and development of their children was 79.3%, and the proportion of community members supporting child care was 81.4%.

*Education of the mother on handwashing by the mother and the child before and after serving meals and changing diapers; consumption of boiled water in a cup by the child, adequate disposition of the child's excreta, and location of domestic animals outside the household area.* The data in **table 5** show that only adequate disposition of the child's excreta (sanitation, Beta value: 0.082*) kept a significant association with stunting. The literature has shown that this set of hygiene practices has been associated with a moderate decrease in the prevalence of diarrhea and stunting [18–20].

*Adequate number of prenatal monitoring visits, including monthly monitoring of weight gain during pregnancy.* A replicable association has been demonstrated in the literature between the number of prenatal monitoring visits and improved birthweight and lower maternal mortality [20, 21].

*Education of the mother to reach a daily intake of five meals during pregnancy, with at least one portion of cheese, meat, or eggs.* This is associated with better weight gain during pregnancy, improved birthweight [21, 22] with a lower prevalence of stunting and better growth and development [21–27].

*Promotion of constant support, love, and consideration from the father and the family to the pregnant and lactating mother, and vice versa.* Although this has not been completely documented, it makes sense that an appropriate affective environment would improve the emotional status of the mother and probably help her to be a good caretaker of her baby [12, 27].

*Preparation of the pregnant mother for exclusive breastfeeding, starting during the first hour after delivery and continued on demand without restrictions during*

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*the first 6 months of life, without ingestion of water, other liquids, or foods; continuation of breastfeeding after 6 months of age without restrictions.* Exclusive breastfeeding has demonstrated beneficial effects on physical growth, development, morbidity, and child and infant mortality [27–40].

*Early stimulation of the child during the first 3 years of life by caressing, kissing, embracing, massaging, conversation, story telling, singing, and playing according to the specific protocol with adequate daily frequency.* The percentage of children who received early stimulation from five to seven times per week was 52.5% ($n = 927$). The estimated coverage of early stimulation at baseline was approximately zero, since there were almost no formal systematic activities reported in this area before the program started in these populations. The effect of these activities on mental development has yet to be assessed. A strong association has been detected since the 1980s between early stimulation and better development, and between child weight, height and cognitive test performance. Apparently, this relationship goes in both directions: from early stimulation to better development and improved physical growth and vice versa [41–43].

*Education of the mother about adequate complementary feeding from 6 to 24 months of age, including the best ages for introduction of semisolid preparations, with adequate frequencies for the age; daily intake of at least one portion of meat, egg, or cheese; and provision of the child with a dish, cup, and teaspoon and consumption by the child from the family pot after 12 months of age.* The literature suggests a clear association between adequate complementary feeding and improved physical growth [27], improved development [44–46], and decreased infant morbidity and mortality [46].

*Education of the mother about the need for increased frequency of meals and liquids when the child has an infection.* When this behavior has been induced, it has been associated with decreased dehydration, better weight recovery, and improved linear growth after the infection [47].

*Education of the mother about consumption of iodated salt by the whole family.* In the Peruvian Andean region, this has been shown to be the best intervention to prevent mental and physical growth retardation due to iodine deficiency [48–52].

*Supplementation of infants and children below 3 years of age with vitamin A capsules integrated as part of the immunization campaigns, twice a year.* In addition, educational messages were delivered during the home visits and during the community growth-monitoring meetings for better dietary intake of carotenoids and vitamin A, including increased intake of vitamin A–fortified foods by children and mothers. Regular supplementation with vitamin A in children under 3 years of age and pregnant women has been associated with a reduction of both maternal and young childhood morbidity and mortality [53–57].

*Supplementation with iron pills.* In one department, supplementation every other day was done systematically with the slow-release ferrous sulfate pill for pregnant women and children under 3 years of age. In the other three departments, supplementation was performed with ferrous sulfate syrup for children under 3 years of age and with ferrous sulfate pills for pregnant and lactating women who had iron-deficiency anemia (i.e., whenever there was a medical indication). In addition, education was provided to mothers on how to improve iron dietary intake and how to increase the daily intake of iron-fortified foods. This was complemented with better control of common childhood infections at the health services in order to better control iron-deficiency anemia. These activities have been associated with decreased prevalence of iron-deficiency anemia, improved performance on cognitive tests, improved adult labor productivity, better physical growth, and decreased maternal mortality [58–78]. Control of iron deficiency, together with deficiencies of zinc, vitamin A, and other nutrients, has been associated with decreased stunting [75]. Furthermore, control of iron and vitamin A deficiency is considered to be the second most important intervention to prevent stunting [75].

*Education of the mother on the need to complete the set of immunizations for the child and the mother, plus daily coordination with the nearest health service to facilitate actual immunization of children and women.* In a sample of 147 children, the endline 1 survey found a coverage of 84.4% for poliomyelitis vaccine, 82.3% for measles vaccine, and 92.5% for tuberculosis vaccine. These coverage values were above the national goals of the Ministry of Health for the year 2004. In the study sample, the coverage of polio vaccine was significantly associated with lower stunting prevalence (**table 5**). The literature also offers ample information on the negative effects of several preventable, common infectious diseases on physical growth. These diseases include measles, tuberculosis, and poliomyelitis; the growth parameters studied were physical growth velocity in terms of weight-for-age and the prevalence of stunting [76].

The strategy used to deal with confounding and to assess its potential to explain the associations found was focused entirely in analysis, since the design did not include appropriate control groups. The following criteria were used to judge the degree of causality between the program and its potential effects: strength and consistency of the statistical association, time and dose response, whether the results are expected from published research and analogous with similar program situations, whether the results are not expected in populations not covered by similar programs (specificity), and coherence of the total available evidence. These criteria were selected from the literature [79, 80], and

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on the basis of the results detected, the overall conclusion provided a view of the degree of the cause–effect relationships.

### Was the impact on stunting of a causal nature?

The data in **tables 1** and **2** show that there is, in fact, a strong statistical association between program implementation and a decrease in stunting; the observed association is consistent, and there is a clear time response. None of the tests yielded unexpected results. Although data on dose–response relationships were not available, such a result is available in the literature [81]. Finally, these results were not observed in similar regions that did not undergo an intervention during the same period. Thus, no significant changes were detected in the national prevalence of stunting in children under 5 years of age, which was 25.4% in 2000 and 26.7% in 2004 [82].

The impact on stunting was not confounded by the child's age and sex, department of location, type of survey (baseline and endline 1) or degree of rurality as measured by size of population of the community. Finally, the additional large set of statistical analyses presented in **table 5** failed to detect any confounding factor among those variables associated with stunting that could explain the observed impact. There was coherence in the total data, and similar results were obtained when the variables were analyzed in terms of anthropometric z-scores. On the basis of these results, it was concluded that the probability of a cause–effect relationship between program implementation and the observed decrease in stunting was very high.

### Was the impact on iron-deficiency anemia of a causal nature?

The data in **table 3** show that there was, in fact, a significant statistical association between program implementation and a decrease in iron-deficiency anemia in each of the four departments analyzed; the observed association was consistent, and there was a clear time response. Loreto was the only department in which there was a systematic high coverage (more than 80%) by the intervention with ferrous sulfate slow-release pills given every other day. This was also the department with the highest impact, a 50% reduction of the prevalence of iron-deficiency anemia from baseline. In the other three departments, the intervention was based on dietary improvement with animal foods and, when indicated on medical basis, antiparasitic treatment and daily ferrous sulfate syrup. The coverage of these activities, in terms of actual increase in iron intake, was low (less than 50%).

Although study data on dose–response relationships were not available, such a result was in fact available from the literature. Finally, these results were similar to those observed in several countries with similar strategies [83]. No significant changes were detected in the national prevalence of anemia in children under 5 years of age which was 49.6% in 2000 and 50.4% in 2004. Most anemia in Peru is iron-deficiency anemia [82]. There was coherence in the whole set of the analyses performed, and similar results were obtained when the same variables were analyzed in terms of hemoglobin concentrations. On the basis of this information, it was concluded that the probability of a cause–effect relationship between program implementation and decrease in iron-deficiency anemia was high.

### Was the impact on vitamin A deficiency of a causal nature?

The data in **table 4** show that, similarly to the cases of stunting and iron-deficiency anemia, in the case of vitamin A deficiency the statistical association was strong; the observed association was consistently significant in each of the four departments analyzed, and there was a clear time response. In the total sample, the prevalence of vitamin A deficiency decreased from 30.4% to 5.3%, (i.e., to about one-sixth of the baseline prevalence). Data on a dose–response relationship were not available given the design of the program, but such results have been presented in the available literature. Finally, these results were similar to those from the programs of vitamin A supplementation integrated with immunizations [83].

Although no data were available for comparison of the trends in vitamin A deficiency in areas not covered by the program, the total set of the observed results was coherent, and similar results were obtained when the same variables were analyzed in terms of serum retinol levels. On the basis of this information, it was concluded that the probability of a cause–effect relationship between program implementation and a decreased prevalence of vitamin A deficiency was high.

The above review of those actions implemented as part of the program intervention shows that it was reasonable to expect a decreased prevalence of stunting, as well as a decreased prevalence of vitamin A deficiency and iron-deficiency anemia, from this joint set of actions. Contrary to most of the research quoted here, the objective of this program was not to demonstrate a cause–effect relationship for a single intervention activity. Instead, the program design called for implementation of a series of activities that together could decrease stunting, iron-deficiency anemia, and vitamin A deficiency. Instead of dissecting the isolated impact of one intervention activity, the objective was to assess the impact of a whole series of intervention activities [12, 78].

As indicated in **table 5**, none of the multiple correlations that were calculated shed light on which one

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of the intervention activities statistically explained the observed impact. However, there are many examples in the literature on free-living human populations in which the calculation of multiple correlations did not isolate the effect of a single action, even if there was such an action in reality. Thus, the current results indicate that the program, considered as the whole set of interventions, had an impact on the prevalence rates of stunting, iron-deficiency anemia, and vitamin A deficiency.

### Lessons learned

Contrary to programs in other regions of the world, this program did not have a priority focus on curative approaches, mostly because the few cases of severe malnutrition detected were referred to health care services and treated as indicated by standard practice. The lesson is that in this scenario, the decreased prevalence of stunting was the result of a mostly preventive approach that prioritized children under 3 years of age and pregnant women.

In order to detect clear effects in each community, it was necessary to train optimum numbers of community health personnel. The necessary training must begin at the inception of implementation, with a focus on strengthening the capacities of individuals and their teams (health promoters, family counselors, parents, community leaders, and personnel of primary level health services). The lesson is that in these communities, an average of one community health promoter for every 20 families and one family counselor for every 10 families was adequate.

The authors would expect no impact if the program was implemented without intensive participation of the community members, as has been the case in many other government programs in which participation was not part of the program focus. The lesson here is that program success was largely dependent on the quality of the participation process.

It is well known and accepted by the research community that community promotion of growth and development is a valid program instrument. In addition, in this program, daily early stimulation of children either at home or in community organizations made a powerful contribution to a happy and proactive environment for parents, children, and community workers. The lesson is that community promotion of growth and development associated with early stimulation of the child was, once again, an effective and feasible instrument that probably contributed to the decreased prevalence of stunting and improved psychomotor and mental development as well.

In many countries, the participation of nongovernmental organizations may help programs such as the one described here to expand and be successful. However, the performance of these organizations may be quite variable. In this study, several of the organizations participating at the beginning of the program had to be replaced because of performance problems; finding the most appropriate ones became a serious problem on the national scale. However, when local organizations performed satisfactorily, they contributed significantly to program success. The most suitable characteristics of these local organizations are: trainable nature, and susceptible to introduction into the corresponding organization's culture. The lesson is that expansion of the program to the national scale may require sustained training and reorganization of participating nongovernmental organizations to ensure program participation and success. In addition, it will require wide social communication approaches to attract support from the private sector and from community, municipal, regional, and national governments [80, 84, 85].

## Conclusions

The Good Start in Life Program had several successful characteristics: it had a common conceptual framework; participation was key; it strengthened capacities at the community level; the focus was on children under 3 years of age and pregnant and lactating women; it included daily intensive early stimulation of the child; it was adaptable to different situations; it had a significant impact on stunting, iron-deficiency anemia, and vitamin A deficiency; the cost and the benefit for the investment were known and feasible; and it strengthened the rights of women and children.

Local governments can decrease the prevalence of stunting, iron-deficiency anemia, and vitamin A deficiency by applying multicausal programs focused on food, health, and care.

This scaled-up program was effective and efficient and could be successfully adapted to other countries. It would not be advisable to implement the package of activities without community participation.

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