# Impact of the Mexican Program for Education, Health, and Nutrition (Progresa) on Rates of Growth and Anemia in Infants and Young Children

## A Randomized Effectiveness Study

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**Context** Malnutrition causes death and impaired health in millions of children. Existing interventions are effective under controlled conditions; however, little information is available on their effectiveness in large-scale programs.

**Objective** To document the short-term nutritional impact of a large-scale, incentive-based development program in Mexico (Progresa), which included a nutritional component.

**Design, Setting, and Participants** A randomized effectiveness study of 347 communities randomly assigned to immediate incorporation to the program in 1998 (intervention group; n=205) or to incorporation in 1999 (crossover intervention group; n=142). A random sample of children in those communities was surveyed at baseline and at 1 and 2 years afterward. Participants were from low-income households in poor rural communities in 6 central Mexican states. Children (N=650) 12 months of age or younger (n=373 intervention group; n=277 crossover intervention group) were included in the analyses.

**Intervention** Children and pregnant and lactating women in participating households received fortified nutrition supplements, and the families received nutrition education, health care, and cash transfers.

**Main Outcome Measures** Two-year height increments and anemia rates as measured by blood hemoglobin levels in participating children.

**Results** Progresa was associated with better growth in height among the poorest and younger infants. Age- and length-adjusted height was greater by 1.1 cm (26.4 cm in the intervention group vs 25.3 cm in the crossover intervention group) among infants younger than 6 months at baseline and who lived in the poorest households. After 1 year, mean hemoglobin values were higher in the intervention group (11.12 g/dL; 95% confidence interval [CI], 10.9-11.3 g/dL) than in the crossover intervention group (10.75 g/dL; 95% CI, 10.5-11.0 g/dL) who had not yet received the benefits of the intervention ($P=.01$). There were no differences in hemoglobin levels between the 2 groups at year 2 after both groups were receiving the intervention. The age-adjusted rate of anemia (hemoglobin level <11 g/dL) in 1999 was higher in the crossover intervention group than in the intervention group (54.9% vs 44.3%; $P=.03$), whereas in 2000 the difference was not significant (23.0% vs 25.8%, respectively; $P=.40$).

**Conclusion** Progresa, a large-scale, incentive-based development program with a nutritional intervention, is associated with better growth and lower rates of anemia in low-income, rural infants and children in Mexico.

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More than half of the yearly 10.8 million deaths of children younger than 5 years are attributed to malnutrition,[1] as assessed by underweight (≥2 SDs below the weight expected for that age, according to the international reference recommended by the World Health Organization [WHO][2]). These deaths are not caused by higher frequency of common childhood diseases but by higher case fatality rates[3,4] and would not occur if the children were not malnourished. Malnourished children who survive have a high risk of impaired health and function throughout life, which contributes to the intergenerational continuation of poverty.[5] In developing countries more than one quarter of all children younger than 5 years, about 150 million total, are estimated to be malnourished.[6] Available nutritional interventions and technologies have proven, under controlled conditions, to be efficacious in preventing and controlling malnutrition[7-10] and improving survival.[11] Because large-scale programs do not provide similar controlled conditions, we would expect these strategies to have less impact when implemented in such

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**Box. Energy and Nutrient Content per *Papilla* Ration (Daily Dose, 44 g)**

Protein, 5.8 g
Energy, 194 kcal
Fats, 6.6 g
Carbohydrates, 27.9 g
Sodium, 24.5 mg
Iron, 10 mg
Zinc, 10 mg
Vitamin A, 400 µg
Vitamin E, 6 mg
Vitamin C, 40 mg
Vitamin $B_{12}$, 0.7 µg
Folic acid, 50 µg

programs.[12,13] Inadequate evaluations to date, however, have meant that little information is available on the effectiveness of these strategies implemented through large-scale programs.[14,15] Reliable evidence of the effectiveness of these strategies applied in large-scale programs is needed for planning sound investments in nutrition and shaping health policies that aim to improve the nutrition and survival of children in countries where the prevalence of malnutrition remains high.

Despite Mexico's 40-year tradition of high expenditure in food distribution programs,[16] according to a national probabilistic survey conducted in 1998, there were still high prevalences of stunting (17.7%) and anemia (27.2%) in children younger than 5 years.[17] In this survey, rural children at the lower socioeconomic tertile (the group equivalent to the beneficiaries of the program discussed herein) had a much higher prevalence of stunting (38.8%) and a slightly higher prevalence of anemia (29.9%) than the national averages or the prevalences for all rural areas (31.6% for stunting and 29.5% for anemia) (J.A.R., unpublished data).

Moreover, the decline observed in stunting between 1988 and 1998 in Mexico is unsatisfactory relative to advances made in other Latin American countries of comparable economic conditions.[17] Little can be postulated about the reason for this discrepancy between investments made and the nutritional outcomes in Mexico because, before 1998, nutrition interventions were not evaluated. In 1997, a large-scale human capital development program called "Progresa" (Program for Education, Health, and Nutrition), which included a nutritional component, was introduced. Evaluation of overall impact was incorporated into the design of the program after its inception in 1997 and includes several expected outcomes in health, education, and nutrition. This article documents the short-term impact of Progresa on nutritional outcomes.

## METHODS

### The Program

Progresa (currently called Oportunidades) is a large-scale incentive-based welfare program that has been applied by the Mexican federal government since 1997. Its principal aim is to develop human capital in low-income households. In other words, the program's underlying premise is that investments in nutrition, health, and education in young children who live in low-income environments will improve their chances of accessing higher education, better jobs, and in turn a better quality of life in adulthood.[18] Investment in these 3 basic needs is considered central to breaking the intergenerational continuation of poverty.

The incorporation of families across the country into the program had to be phased in according to the federal resources made available, which in turn allowed for the ethical quantitative comparison of control and intervention groups. During its first 3 years, the program succeeded in covering almost all eligible families living in rural areas. Coverage expanded from about 300 000 families in 1997 to approximately 2.6 million families in 2000, about 40% of rural families and 10% of all families in Mexico. Currently, the program covers 4.5 million low-income families (about 20% of all families in Mexico) in urban and rural areas.

The description of eligibility and program administration that follows refers to the program in rural areas during the same period when the evaluation reported in this article was conducted (1998-2000).

Household eligibility for Progresa was determined in 2 stages, first by identifying underprivileged communities and then by choosing low-income households within those communities.[19] Underprivileged communities were identified according to the proportion of households living in poverty by using data from the 1995 National Census. Low-income households were selected according to an index of objective, easy-to-collect characteristics such as housing materials, water and sanitation facilities, education, and family structure; these were shown to be good proxies for poverty assessment.[20] To improve transparency, the list of beneficiaries was approved by a community assembly. On average, 78% of the households in selected communities were classified as eligible for program benefits, and 97% of these eligible households enrolled in the program.

Progresa provided micronutrient-fortified foods for women and children and health services and cash transfers for the family. The food supplements were targeted to the groups of individuals that are more likely to benefit from the product[21]: children aged 4 to 23 months, underweight children aged 2 to 4 years, and pregnant and lactating women in the low-income beneficiary households. The supplements were designed by a group of experts in nutrition according to evidence about the nutritional status of the population for whom the supplements were intended.[22,23] The main ingredients were dry whole milk, sugar, maltodextrin, and the micronutrients most deficient in their diet (Box).[24] Supplements came in the form of a dry mix offered in 3 flavors that required hydration before consumption. They were distributed at health centers in 240-g packages containing about 5 daily rations (the daily ration recommended was 44 g). Mothers were instructed to add 4 spoons of boiled water to 1 ration, which produces a puree consistency, referred to in Spanish as *papilla*.

Families enrolled in the program (Progresa families) received 2 types of cash transfers every 2 months: a universal cash amount for all families and a specific cash transfer associated with school attendance of their school-aged children enrolled in third-grade primary school to third-grade secondary school. The transfer associated with school attendance varied according to the number of children attending school and their grade level; in secondary schoolchildren, it was more for girls than for boys. Families received the universal cash transfer as long as they complied with specific health care appointments in health centers for all family members, including immunizations, well baby care and growth monitoring of children, prenatal and postnatal care and education for women, check-up visits for other family members, and a mandatory session on nutrition and health education. Only about 1% of households were denied the cash transfers for noncompliance during the evaluation period. Monthly transfers averaged about $25 per family. Typically, the cash transfers added about 20% to 30% to the household income.

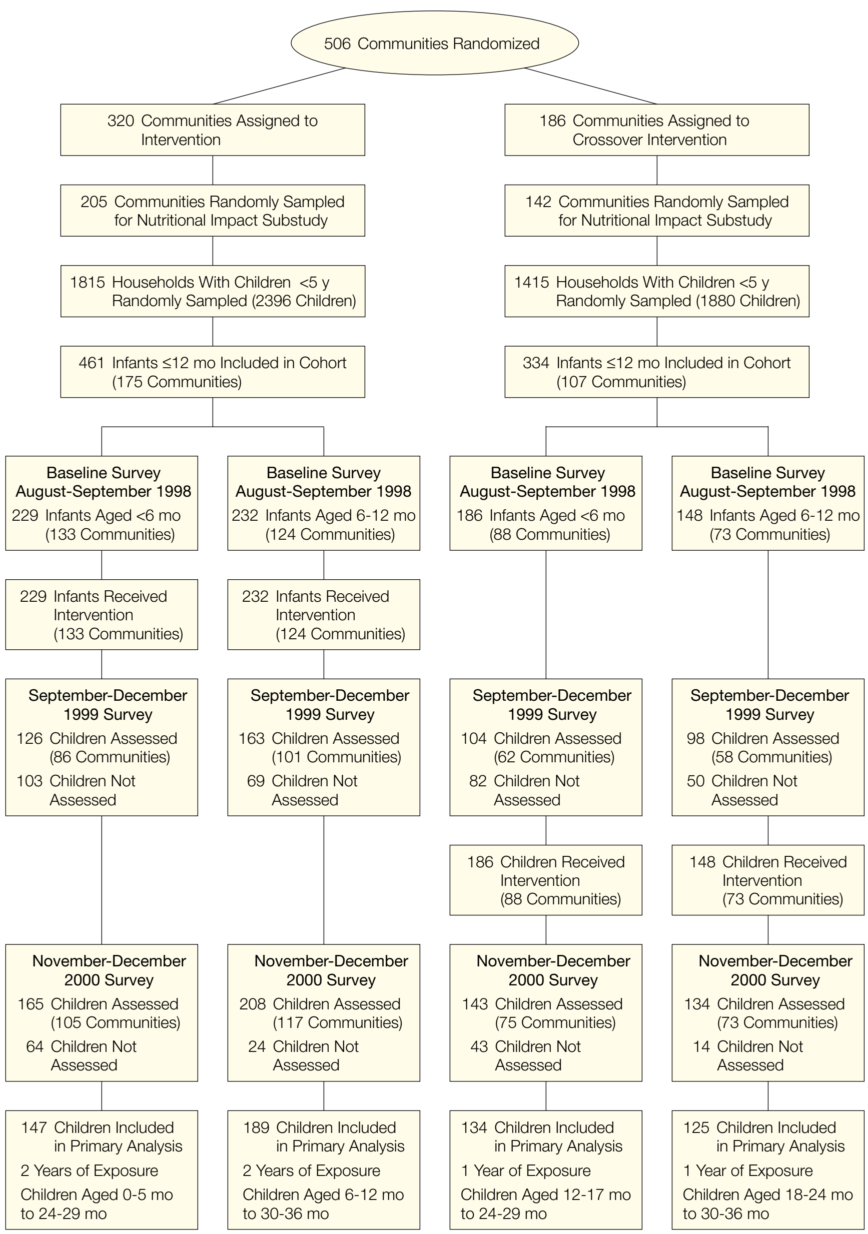
## Evaluation Design and Sample

The evaluation of the nutritional impact of the program was commissioned by the Ministry of Health to the National Institute of Public Health. Planned as a randomized intervention,[25,26] the study was conducted in 6 contiguous states in the central region of the country (Guerrero, Hidalgo, Puebla, Querétaro, San Luis Potosí, and Veracruz), representing the largest area in which the program operated.

FIGURE 1 shows the sampling frame and sample sizes. Five hundred six communities were randomly selected from the pool of communities that were eligible to receive the program benefits; 320 of these communities were randomly assigned to receive Progresa in 1998, whereas the rest of the communities (n = 186) were assigned to act as controls for 2 years, that is, their enrollment was scheduled to begin in 2001 to allow for 2 years without the intervention. However, the enrollments of these 186 communities in the program occurred 1 year earlier than originally planned, in late 1999, because of political pressure to accelerate the program.

The nutritional impact substudy was conducted in a random selection of 205 of the 320 communities scheduled to enroll in the program at the end of 1998 and 142 communities randomly selected from the 186 communities that enrolled a year later, in late 1999. The 205 communities are referred to as intervention communities for their earlier and longer exposure time, and the 142 communities that were enrolled

**Figure 1.** Study Design



after 1 year of observation are referred to as crossover intervention communities.

A subsample was chosen because a smaller number of children was adequate to assess the expected 2-year impact on growth (0.8 cm) and anemia (10-percentage-point reduction). The sample size was calculated according to the original 2-year intervention design for 1-tailed tests, assuming a .05 significance level and a power of 90%. It was first estimated as a simple random sample, which was further multiplied by a design effect of 1.4 to take into account the complex sample design.[27,28]

Data on a cohort of all infants 12 months or younger (n=795; 461 in intervention and 334 in crossover intervention communities) were collected at baseline, between August and September 1998, from a random sample of eligible households with children younger than 5 years. They were surveyed again in September to December 1999 and in November to December 2000.

To assess differences in height, children were followed up for approximately 2 years, as was planned when the evaluation was designed, from 1998 to 2000. During this period, the intervention children received 2 years of Progresa, whereas the crossover intervention children received it during the second year only. Because all the children were the same age, the intervention children received Progresa for the first and second year of life, whereas the crossover intervention children received it in the second year of life only. Thus, we expected better height growth in the intervention children than in the crossover intervention children because of a difference in span of exposure to Progresa and because the crossover intervention children received Progresa only at an age when the impact of supplementary feeding in height is smaller.[21] Because we expected that the largest effects would occur in younger infants and in the poorest households, analyses of the effects on growth were conducted by age group at baseline (<6 months and 6-12 months) and by socioeconomic status (SES) category.

The longitudinal cohort was studied in 1999 to estimate the association between anemia rates and exposure to Progresa during the previous year. At the 1999 survey, the intervention communities had been receiving Progresa for 1 year, whereas the crossover intervention communities had not. In 2000, the cohort was also studied to estimate the differential effects of 1-year exposure (crossover intervention communities) and 2-year exposure (intervention communities) on anemia rates.

Written consent for participation was obtained from the mother or self-identified decision maker in each household. The project was approved by the Human Subjects and Ethics Committee of the National Institute of Public Health, Mexico.

## Data Collection and Processing

Weight and recumbent length (in children <2 years) and standing height (in children 2-4 years) were obtained by using standard anthropometric methods.[29] Weight was measured to the nearest 10 g with an electronic scale (model 1583; Tanita, Tokyo, Japan); length (to the nearest millimeter), with a locally made measuring board of 1.3 m; and standing height, with a stadiometer with the capacity to measure up to 2 m and a precision of 1 mm (model E-1; Dyna-Top, Mexico City, Mexico). The measurements were obtained by anthropometrists who were trained to take all measurements by using standard techniques.[30] The child's birth date was reported by the mother and corroborated in a large proportion of children by using birth certificates or vaccination cards, which are considered reliable documents in Mexico. Length and weight data were transformed to *z* scores.[2] Anthropometrists were instructed to refer children with clinically severe malnutrition to the health centers for treatment and to advise supervisors to follow up at the health centers. However, no cases were reported.

A blood sample was obtained in the 1999 and 2000 surveys, when all children were aged 12 months or older, by means of digital capillary puncture. Blood samples were not obtained in 1998, when children were younger than 12 months, because parents were reluctant to permit drawing blood (even the small amounts of capillary blood required) from infants. The concentration of hemoglobin in the blood sample was measured with a portable photoreflectometer (Hemocue, Angelholm, Sweden). The photometer was calibrated by using the international hemoglobin standard,[31] according to the recommendations of the International Committee of Standardization in Hematology. In 1999, 28 children with hemoglobin values lower than 9 g/dL, indicative of severe anemia, were provided ferrous sulfate treatment and were excluded from the analysis. For children living in altitudes above 1000 m, the hemoglobin values were adjusted with an equation developed for Mexican populations[32] to obtain predicted hemoglobin at sea level. Anemia was defined as serum hemoglobin concentrations lower than 11 g/dL at sea level.

Information about the frequency of *papilla* consumption was obtained in the 1999 survey by interviewing the mother or the person who fed the child. The person interviewed was asked about the usual frequency of *papilla* consumption during a typical week. Children were classified as having high supplement consumption when the mother or informant reported consumption for 4 or more days per week.

In 1999 and 2000, socioeconomic information was collected in each household. Information included household characteristics (construction materials used for floors, walls, and ceilings), possession of household goods (radio, television, VCR, telephone, refrigerator, laundry machine, and hot water heater), and household services (water and sanitation facilities and type of fuel used for cooking). Information was collected by combining interview with the mother or the children's caregiver and direct observation. In 1999 and 2000, SES scores were generated by using the first component obtained by principal components analysis.[33] Only variables with factor loadings greater than 0.5 were retained in the model. The first component explained 49% of the total variability in 1999 and 45% in 2000. The resulting SES is a normalized variable. Higher values of the SES correspond to better household conditions.

### Statistical Analyses

Baseline characteristics of the study children, their mothers, and SES were compared by age group between intervention groups by using a 2-tailed test. For continuous variables, random-intercept linear models were used to take into account the clustering effects within communities. For categorical dependent variables, generalized estimating equations (GEE) were used to account for clustering.

All outcomes were analyzed with the following independent variables: SES group (below vs at or above the 50th percentile), intervention or crossover intervention group, and infants younger than 6 months in 1998 vs infants aged 6 to 12 months, plus the 2-way and 3-way interactions. To increase statistical power, these analyses were covaried on age as a continuous variable because age was always statistically significant, even when age group was included. These equations were simplified to exclude interactions if $P>.10$ and main effects if $P>.05$. Sex did not increase power and was not included. Potential community confounders at randomization and those that might occur thereafter were taken into account by the randomization of the interventions to the communities.[34]

The increment in height from baseline in 1998 to 2000 was modeled as a random-intercept linear model[35] to take into account that the interventions were randomized to the community and not to the individual children. This model also takes into account clustering, meaning children in the same community will be more similar to each other than children across communities. Length in 1998 (centimeters) was included as a covariate to take into account regression to the mean of the increment. Data from 1999 were not used because of the large proportion of missing data and because 1 year of intervention was considered insufficient to find effects on linear growth.

**Table.** Characteristics at Baseline (1998) for Infants Measured in 2000, by Age and Intervention Group

| | Mean (SD)* | | | |
|---|---|---|---|---|
| | Infants <6 mo | | Infants 6-12 mo | |
| Variable | Intervention (n = 165) | Crossover Intervention (n = 143) | Intervention (n = 208) | Crossover Intervention (n = 134) |
| Females, No. (%) | 79 (48) | 80 (56) | 94 (45) | 66 (49) |
| Age, mo | 2.77 (1.6) | 2.89 (1.4) | 8.81 (2.0) | 8.99 (2.0) |
| 2000 SES score | −0.13 (0.9) | −0.15 (1.0) | −0.05 (0.9) | 0.07 (0.9) |
| No. with data | 152 | 138 | 199 | 128 |
| Length, cm | 58.00 (4.9) | 58.85 (4.3) | 68.32 (3.7) | 68.43 (3.6) |
| No. with data | 164 | 141 | 207 | 132 |
| z Score | | | | |
| Length for age | −0.45 (1.0) | −0.25 (1.0) | −1.04 (1.1) | −1.03 (1.0) |
| No. with data | 162 | 141 | 205 | 131 |
| Weight for age | 0.10 (1.0) | 0.19 (0.9) | −0.77 (1.2) | −0.72 (1.1) |
| No. with data | 163 | 142 | 207 | 133 |
| Weight for length | 0.46 (1.0) | 0.45 (1.0) | −0.01 (1.2) | 0.07 (1.0) |
| No. with data | 156 | 138 | 205 | 130 |

Abbreviation: SES, socioeconomic status.
*Unless otherwise indicated.

High ingestion of *papilla* in 1999 (≥4 days/week) was also investigated because it is an intermediate outcome necessary to achieve impacts on hemoglobin concentration and growth. It was modeled with the same main and interactive effects as was growth in height by using a GEE model.

Anemia rates for 1999 and 2000 were not related to SES or age groups. We expected that the children who received Progresa in the first year would have lower rates of anemia in 1999 than those children who had not received Progresa and that the anemia rates in the latter group would decrease from 1999-2000. Therefore, we tested for the difference in anemia rates between intervention groups in 1999. We also tested for the greater improvement in anemia rates in the crossover intervention group as they caught up in response to Progresa in the second year by testing the interaction between intervention groups and year with GEE, which takes into account clustering within community but not the positive correlation of anemia between 1999 and 2000.

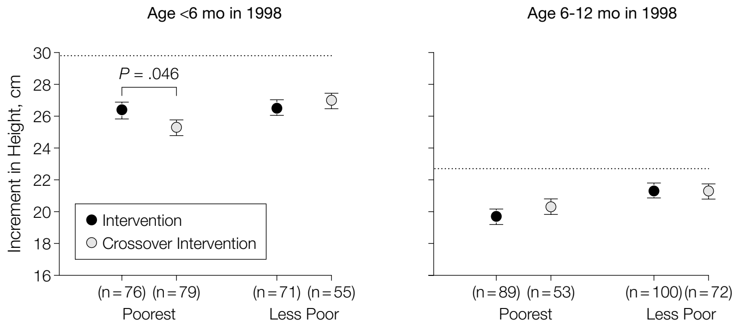
Statistical significance was declared for 2-tailed tests at $P<.05$. Statistical analyses were done using PC-STATA (release Intercooled Stata 8.2, Stata Corp, College Station, Tex) and PC-SAS (release 8.02, SAS Institute Inc, Cary, NC).

## RESULTS

At baseline, 795 children aged 12 months or younger (461 in the intervention group and 334 in the crossover intervention group) were studied. At the end of the study, in 2000, 650 of these children were assessed. Attrition rates were 26% among infants aged 5 months or younger and 10% among those aged 6 to 12 months, with little difference between the intervention and crossover intervention groups (Figure 1). In 1999, the proportion of children who were not assessed was much greater. There was a 45% loss of measurement among those aged 5 months or younger and a 32% loss among those aged 6 to 12 months, which was due to an unusually long and severe rainy season that resulted in a high rate of temporal emigration from a large number of communities because of damage caused by severe flooding.

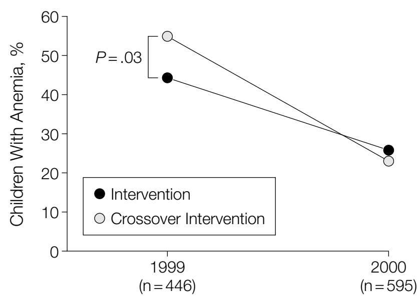
The TABLE shows descriptive statistics of the main outcomes studied in the

**Figure 2.** Incremental Growth in Height From Baseline in 1998 to 2000




Adjusted height increments by age and length in 1998 by using a random-intercept linear model. The expected growth from the World Health Organization reference standards is plotted for comparison (dotted lines).[2] Data are presented as mean (SE).

**Figure 3.** Prevalence of Anemia by Year of Survey and Intervention Group, 1999-2000




Data were adjusted by age using a generalized estimating equation model.

panel of infants who were followed up longitudinally for 2 years. Data are presented by age categories at baseline. Blood samples were not obtained for infants, and socioeconomic information is unavailable for 1998; therefore, hemoglobin and SES data were unavailable at baseline. No significant differences were found in the comparison of the main outcomes between intervention and crossover intervention infants.

### *Papilla* Intake

*Papilla* intake information was available for 341 children, 72% of the total number of children for which information is available in 1999. Fifty-seven percent (n = 122) of the children in the intervention communities consumed *papilla* regularly (≥4 days/week) in 1999 at the end of the first year of intervention. As a result of program leakages, there was some regular ingestion of *papilla* in the crossover intervention communities during 1999 (13 children; 9.7%). Among the intervention group infants in 1999, 58.0% of older infants (6-12 months of age) and 55.8% of infants younger than 6 months consumed *papilla* at least 4 days a week ($P = .09$). Adjusting for age, a higher percentage of the poorest infants ingested *papilla* at least 4 days a week compared with the less-poor infants (61.0% vs 52.9%; $P = .22$) in the intervention group in 1999. During the second year, the amount of *papilla* ingested was not significantly different between the intervention group and the crossover intervention group ($P = .18$).

### Growth

FIGURE 2 shows the adjusted increments in height by age, length, SES, and intervention groups. The expected growth from the WHO reference standards is plotted in the figure for comparison.[2] The triple interaction between age, SES, and intervention groups was significant ($P = .04$), showing that the effect of exposure to Progresa was different among the 4 subgroups (age at baseline and SES subgroups). This triple interaction was due to the greater effect ($P = .046$) on infants younger than 6 months at baseline and who lived in the poorest households. Among these infants, adjusted height was greater by 1.1 cm (26.4 cm in the intervention group vs 25.3 cm in the crossover intervention group).

### Hemoglobin and Anemia

Mean hemoglobin values were higher in the intervention group (11.12 g/dL; 95% confidence interval [CI], 10.9-11.3 g/dL) after 1 year in the Progresa program relative to the crossover intervention group (10.75 g/dL; 95% CI, 10.5-11.0 g/dL) who had not received Progresa benefits that year ($P = .01$). In 2000, the difference between intervention groups was no longer significant ($P = .26$) after both groups had been in the program during the previous year.

FIGURE 3 shows that the prevalence of age-adjusted anemia in 1999 was higher in the crossover intervention group (54.9%) than in the intervention group (44.3%) ($P = .03$), whereas in 2000 the difference was not significant (23.0% vs 25.8%, respectively) ($P = .40$). However, the change in the difference between the intervention or crossover intervention group that occurred from 1999 to 2000 was significant ($P = .002$) for the interaction term, even though the method to estimate the interaction underestimates its significance.

## COMMENT

This randomized effectiveness study showed that Progresa, a large-scale government program that includes a nutrition intervention, is associated with better growth in height and lower rates of anemia in low-income rural Mexican infants.

Benefits in height were found in infants with the highest response potential: the poorest (below the 50th percentile of SES distribution) and younger infants (<6 months at baseline). Among this group, infants in the intervention group had a 2-year increment in height of 1.1 cm relative to the crossover intervention group (Figure 2). This statistically significant difference is also biologically important; it is one fourth of the deficit in growth of the youngest poorest crossover intervention infants relative to their genetic potential, as estimated from the WHO reference standards[2] for children of the same age. Growth benefits occurred as expected in the subgroup with the highest response potential, reinforcing the biological plausibility of the results.[36]

This study has several limitations. One concern was a possible selection bias caused by loss to follow-up, particularly in 1999 when rates of loss to follow-up were high. However, no differences in any of the baseline variables were found between children lost to follow-up and those who were not for either intervention group or year (1999 and 2000).

The results may underestimate the real effects of Progresa interventions because the group that was originally allocated to be the control was included in the Progresa program 1 year earlier than planned. However, the crossover intervention group's exposure time was shorter than that of the intervention group and introduced during an age period that has lower potential for growth response. Had the crossover intervention group remained a control group during the first 2 years of the study, the height increments of this group might have been smaller, and therefore the difference between intervention groups might have been greater. In addition, about 10% of infants in the crossover intervention group were receiving *papilla* throughout the first year of the evaluation because of program leakage. These children benefited from the program during the same period of high growth-response potential as the intervention group, thus diminishing the difference between the groups.

The intervention group had better growth in height than the crossover intervention group, but it was not sufficient to achieve adequate growth. At the end of the evaluation, the poorest young infant group benefited the most from Progresa. They were aged 24 to 29 months and 1.1 cm taller, but they still had a height deficit of 3.4 cm relative to the height-for-age distribution recommended by WHO[2] for this age period. This deficit is equivalent to about 1 SD.

In a literature review of effectiveness studies aimed at improving the nutritional status and growth of infants,[14] only 3 studies were identified as having height or height-for-age *z* score as an outcome. At baseline, infants in the studies were aged 6 to 12 months. The effect documented in our study (*z* score, 0.3) is similar to that of 2 of the studies reviewed (*z* score, 0.3-0.4) but smaller than that reported in the third study (*z* score, 0.87). However, baseline mean height-for-age *z* score was high in Progresa children (−1.06) relative to the 3 studies reviewed (−1.8 to −1.6). Therefore, smaller effects would have been expected in Progresa children.

In 1999, after 1 year of program implementation, the rate of anemia in the intervention group was significantly lower than that in the crossover intervention group that had not yet received the benefits of Progresa (Figure 3). In the last follow-up survey, at the end of 2000, the difference in anemia rates observed in 1999 had disappeared. Our interpretation of this finding is that Progresa improved the hemoglobin concentration in the crossover intervention group, which received the benefits of the program in the second year ending in 2000. Anemia in both groups in 2000 was below the national average prevalence of 34.0% for poor rural children of the same age groups,[17] indicating that both groups benefited. The difference in 1999 in anemia rates is important but is nevertheless insufficient, considering that the anemia rates remained high, at more than 44%, in the intervention group that benefited from Progresa during the first year. In addition, although the prevalence of anemia declined to similar rates in both groups after year 2, approximately one quarter of children who received Progresa had anemia.

It is unlikely that the high anemia rates are due to nonnutritional causes of anemia such as parasitic infections because malaria and hookworm, 2 of the parasites that contribute most to anemia, are uncommon in Mexico. For example, only 786 new cases of malaria were reported in Mexico in 2002,[37] and a literature review of studies conducted between 1981 and 1992 in high-risk populations in Mexico reported a pooled general prevalence of hookworm infections of 1.8%.[38]

A possible reason for the inadequate effects of the nutritional supplement may be the fact that reduced iron, which is not absorbed well, was used for the fortification of *papilla* (J.A.R. et al, unpublished data).[39] As a result of this evaluation, a number of studies are now being undertaken to identify a more bioavailable iron compound for use in the fortification of *papilla*.

In addition to the intake of *papilla*, other Progresa interventions that may have contributed to the nutritional impact should be considered, including other dietary improvements associated with cash transfers and maternal nutrition education,[40] lowered diarrhea rates because of better sanitation and quality of housing through cash transfers, and an increased use of primary health care.[20,41] The program has expanded to urban areas, and we are evaluating its impact on dietary intake and health care use.

## CONCLUSIONS

This is the first evaluation of the nutritional impact of a large-scale program in Mexico and one of few in developing countries,[14] and results are being used for program improvement. This experimental study showed improvements in height increments and anemia rates associated with exposure to Progresa, a program with a nutrition component, which covered about 2.6 million families by the end of the evaluation period and that today reaches 4.5 million families. The randomized design of the study allowed us to attribute the biologically important differences between intervention groups to the effect of the program. This evaluation is important because it is one of the few well-controlled effectiveness evaluations of large-scale programs that showed positive effects on nutrition and that also promises to support informed program improvements.

**Author Contributions:** Dr Rivera had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

*Study concept and design:* Rivera, Shamah, Villalpando.
*Acquisition of data:* Rivera, Shamah, Villalpando.
*Analysis and interpretation of data:* Rivera, Sotres-Alvarez, Habicht, Shamah.
*Drafting of the manuscript:* Rivera, Sotres-Alvarez, Habicht.
*Critical revision of the manuscript for important intellectual content:* Rivera, Habicht, Villalpando.
*Statistical expertise:* Rivera, Sotres-Alvarez, Habicht.
*Obtained funding:* Rivera, Shamah.
*Administrative, technical, or material support:* Shamah.
*Supervision:* Shamah, Villalpando.
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