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External Evaluation of the Impact of the Human Development Program Oportunidades

Impact of *Oportunidades* on Child Growth and Nutritional Status in Rural Communities

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Note: The opinions expressed by the authors in this document do not reflect the institutional position of the National Institute of Public Health.

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EXECUTIVE SUMMARY

INTRODUCTION

After one and two years of implementation of the *Oportunidades* Human Development Program, there is evidence of a modest impact on the prevalence of anemia and child growth (height-for-age) in children in rural communities across the country. Impact on growth is limited to children among the poorest families (with an income below the mean in the study sample) that started receiving benefits from the Program before the age of six months.

Impact was demonstrated with an experimental design study, in which a group of children that received benefits from the Program immediately after 1998 baseline measurements (early intervention group) was compared against another group integrated in the Program two years later; that is in the late 1999 or early 2000 (late intervention group). Communities where the original groups live (early and late intervention groups) were visited again in 2003 to evaluate the Program's medium term impact on child growth and nutritional status (after a six-year intervention, approximately.) Likewise, a control group was included among children from communities that were not yet included in the Program by 2003 (control group 2003.)

Due to the Program's reported moderate impact on prevalence of anemia in the short term –and on child growth, limited only to a certain group of children–, it is important to corroborate the results and determine if there is a medium term impact. The present study includes four specific objectives aiming to determine if there are differences in hemoglobin concentration, prevalence of anemia, growth (height-for-age,) and the prevalence of stunting in:

1. Children between 24 and 47 months old in 2003, from early intervention communities, compared with children from late intervention communities.

   Hypothesis: since both groups received benefits from the Program during gestation and infancy, there will not be any difference in the nutritional indicators mentioned above.

2. Children between 24 and 47 months old in 2003, from communities included in the Program (both early and late intervention groups,) compared with children from communities where the Program was not offered (control group 2003).

   Hypothesis: the Program will show a modest impact on the mentioned nutritional indicators, since children from beneficiary families received the Program benefits since gestation.

3. Children between 48 and 71 months old in 2003, from early intervention communities, compared with children in late intervention communities.

   Hypothesis: there will be no difference regarding anemia, since all children have received Program benefits for at least four years. Likewise, there will not be difference in stunting, since such differences were found only in a particular sub-group after two years of Program benefits (impact evaluation in 2000;) thus, the group's total average will not reflect an impact in this area.

4. Children between 48 and 71 months old in 2003, from communities included in the Program (both early and late intervention groups,) compared with children from communities where the Program was not offered (control group 2003,) to determine the impact in the medium term.

   Hypothesis: since all children from intervention communities have received the benefits for at least tour years, the Program will have a modest impact on the nutritional indicators.

METHODOLOGY

Sampling Design

The original evaluation sample comprises 506 rural communities, of which 320 were randomly assigned to receive the benefits of the Program since 1998 (early intervention), and the rest in late 1999 (late intervention.) In 2003, 151 additional communities not included in the Program (2003 control) were integrated. Since these communities were not randomly selected, this is a quasi-experimental evaluation. The present analysis uses baseline socio-economic data collected in

1997 from families in early and late intervention communities; the rest of the information, including nutritional indicators, was obtained in 2003. Particularly for the 2003 control group families that were not surveyed in 1997, retrospective socio-economic information was collected during the 2003 data collection. Due to the quasi-experimental design, it was necessary to compare beneficiary and non-beneficiary families with similar observable characteristics; thus, families were matched[a] based on household characteristics. Only families identified as eligible to be integrated in the Program were included in this analysis.

2003 Data Collection, Creation of Response Variables and Data Analysis

Hemoglobin concentration was estimated on a capillary blood sample for anemia diagnosis using a portable photometer. Children's nutritional status was determined using height-for-age and weight-for-height indicators. *Stunting* was defined as height-for-age under two standard deviations below the reference population's median (two standard deviations or more below the median of the international reference population.) *Emaciation* was defined in a similar way, but using the weight-for-height indicator. *Overweight* was defined as weight-for-height two standard deviations or more above the reference population's median.

In order to answer the four objectives of this study, nutritional indicators were compared among children 24 to 47 and 48 to 71 months old in 2003 in the different groups: early intervention *vs.* late intervention, and early and late intervention together *vs.* 2003 control.

SAS 8.02 and STATA 8.2 software were used for the statistical analysis. Difference was considered statistically significant when p-value was less than 0.05.

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[a] Matching was made on STATA® 8.0 software using the nearest neighbor matching method (with five neighbors) and common support data between both probability functions (with and without *Oportunidades*.)

RESULTS

Objectives 1 and 3: Comparison between early and late intervention communities

Just as expected, there were no differences in 2003 on prevalence of anemia, emaciation, and overweight in children 24 to 47 months old between early and late intervention communities, neither on hemoglobin concentration or prevalence of anemia in children 48 to 71 months old between those communities. However, for the sub-group of children 48 to 59 months old, hemoglobin concentration was 0.4/dL higher in early intervention communities ($P<0.01$), and prevalence of anemia was 7.2 percent lower ($p=0.04$.) No differences were found in children 48 to 71 months old on average height-for-age or on prevalence of stunting, emaciation, or overweight.

Objectives 2 and 4: Comparison between intervention communities (both early and late) and 2003 control group

A. Program's impact on anemia and weight-for-height

There was no statistically significant difference on the prevalence of anemia, emaciation, and overweight for children 24 to 47 and 48 to 71 months old between intervention and 2003 control communities. However, for the 61 to 71 months old sub-group, the 2003 control group had 0.42g/dL higher hemoglobin concentration on average than the intervention group.

B. Program's impact on height-for-age

Children 24 to 71 months old in intervention communities grew 0.67cm more on average than children in the 2003 control ($p<0.01$.) The Program's impact was also significant on the prevalence of stunting, which is 12.4% lower in communities integrated to the Program than in control communities (28.7% in intervention communities and 36.9% in control communities $p<0.01$.) Results do not vary depending on the child's sex.

ANALYSIS, CONCLUSIONS AND RECOMMENDATIONS

The Program has had a significant impact on height-for-age and prevalence of stunting among beneficiary children 24 to 71 months old, compared to same- age non-beneficiary children. The magnitude of this impact is slightly less than in the 2000 impact evaluation, but still biologically commendable, based on other research studies.

Analyses reported herein could not identify any impact of *Oportunidades* on prevalence of anemia or weight-for-height indicators in children groups 24 to 47 and 48 to 71 months old. Although some statistically significant differences were observed on hemoglobin concentration and prevalence of overweight in isolated age groups, they are not considered biologically relevant. Differences are small and their statistical significance may be by chance due to the high number of comparisons made. Besides, there is no biological reasoning that could explain a differential impact in the groups observed.

It is possible there was no apparent impact because intervention and control groups were not sufficiently comparable in these aspects, namely because there was not a real control group. Although the propensity score matching method used guaranties similarity among groups, there might be systematic differences between communities that were not considered part of the evaluation. For example, if children in the control group systematically consume food with higher nutritional value (e.g. meat,) the Program's impact could be undetectable. When comparing characteristics of control and intervention groups included in this analysis, there are clearly important differences in variables that have proved to be associated with anemia.

On the other hand, the fact that the impact on young children (12 to 23 months old) after one year of intervention (2000 rural evaluation) was not perceived in older children (24 to 71 months old,) is not entirely contradictory; children's iron requirements decrease after the age of two, as a result of slower growth. Likewise, as a child grows, he or she is more integrated to the family diet; thus, with age, iron consumption increases and the prevalence of anemia decreases. It is not possible to verify the above impact with the present study design, since the age groups analyzed are different.

Although the Program had an impact on children's height and the prevalence of stunting, this problem has not yet been eliminated from the population. It is important to consider different ways to increase the Program's possibilities to influence child growth by identifying and improving its weak components. The critical period for child growth is before the age of 2 years. During that age, all *Oportunidades* beneficiary children are entitled to a food supplement. This is a high nutritional value supplement that, if consumed according to the Program's recommendations, should produce an impact on child growth higher than reported herein.

The supplement is well accepted, as informed by mothers. However, it is far below the ideal consumption. Thus, to improve supplement consumption, an in-depth analysis of Program limitations is necessary, regarding both Program management (supply and distribution) and beneficiary families. There is information on this matter from a study conducted in rural communities in Veracruz and Chiapas, as well as in some urban ones (data still in process of analysis.) Findings in rural communities led to redesigning the Program's education sessions, emphasizing food supplement promotion, which caused a positive impact on consumption. This shows the need to improve the Program's education component for all beneficiary families, regarding Program benefits and the correct use of the supplement.

At the moment, the food supplement is not very likely to show an impact on children's iron status because the type of iron used is not properly absorbed. Contrary to stunting, anemia may develop at any stage in life if iron consumption does not meet nutrition demands. The only way to increase hemoglobin concentration and reduce the prevalence of anemia is to increase consumption of bioavailable iron-rich food, such as meat. There is evidence that beneficiary families spend more on animal products, but family food expenses do not always result in younger children's increased consumption. Unfortunately, there are no available data on dietary consumption per person to determine if the Program has had an impact on iron-rich food consumption. The lack of impact on hemoglobin concentration and the high prevalence of anemia among children 24 to 71 months old suggest an inadequate intake of iron-rich foods. The Program's education sessions are an excellent opportunity to provide families with information about iron's importance through life and its most important sources, in order to influence purchase and intrafamily distribution of these foods.

The following recommendations are based on these findings:

1. Change the type of iron used to fortify the food supplement for a more adequate bioavailability (sulphate, fumarate or gluconate.)
2. Strengthen the education sessions component regarding the use of food supplements, both for people responsible for distribution and promotion and for beneficiary mothers. Guarantee a direct delivery of the supplement to children under 2 years old, when impact on growth is potentially higher.
3. Strengthen the education sessions component regarding nourishment of 2 to 5 year old children, including demonstrations and active participation of beneficiary mothers in order to guarantee integration of foods with adequate micronutrient content –such as meat– in their diet.
4. Analyze the possibility of offering some source of iron to children 2 to 5 years old. If this is possible, explore delivery alternatives; specifically carry out a cost-benefit analysis of extensive delivery *vs.* limited delivery based on diagnosed anemia.

At present, a significant proportion of children take the food supplement regularly, improving their diet. The Program's impact on children's height probably reflects a contribution of the food supplement to the quality of their diet. However, there is evidence that intrafamily distribution of the supplement –particularly among children older than 2 years– prevents its adequate consumption among children under that age. Although the supplement's nutrients may offer benefits to children older than 2, they no longer offer the biological potential to improve their growth in height.

The authors of this report hope to achieve higher consumption among the target population –which would cause a higher impact on child growth–, through an improved educational communications Program. An impact evaluation of the educational communications strategy for supplement consumption would help determine if the supply of other highly nutritious foods –besides the supplement– should be increased in some regions of the country to meet families' preferences.

I. INTRODUCTION

Malnutrition, consisting mainly of anemia, deficiency of several micronutrients, and linear growth retardation, is a major public health issue in developing countries.[1] The worldwide prevalence of stunting (height-for-age below a specific cutoff point) is estimated to be 32% and the prevalence of anemia 39% for children under 5 years old.[1] In Mexico, for the same age group, the 1999 National Nutrition Survey (ENN-99) reported a 17.8% prevalence of stunting (height-for-age two standard deviations below the reference population median)[2] and 27.2% of anemia.[3] In rural communities, the prevalence of stunting and anemia were 32.2 and 29.5%, respectively.[3] These high percentages reveal the population's poverty in those communities. The functional consequences of micronutrient deficiencies, anemia, and stunting have been extensively documented, including cognitive development problems and less physical work capacity.[4-9]

In 1997, the Mexican government launched the *Oportunidades* Human Development Program to tackle these problems among low-income populations. One of the Program's main objectives is to improve children's nutritional status. For this purpose, the Program offers cash transfers, food supplements, health services, and health education to beneficiary families.

Oportunidades aims to improve children's nutritional status through a variety of mechanisms. The food supplement is fortified with several micronutrients, all deficient in Mexican children's regular diet.[10] In addition, its distribution is targeted to children in the most vulnerable life stages (gestation and first 2 years,) when nutrient demands are extremely high due to rapid growth. On the other hand, the Program intends to improve the diet's quality and quantity offering cash transfers for higher resource availability. Children may also show lower prevalence and/or gravity of infections due to better nutritional status and increased use of medical services. Health education actions or meetings –compulsory components for all beneficiary mothers or their representatives– could positively influence these three mechanisms.

There is evidence in the short term of a modest impact of *Oportunidades* on child growth (height-for-age) and prevalence of anemia among children in rural communities of Mexico.[11] After one year of implementation, the prevalence of anemia in children 12 to 23 months old was 23.9% lower in intervention communities, compared to non-intervention communities (44.3% *vs.* 54.9%, respectively.) After two years, children from communities included in the Program since 1998 grew one centimeter more than children from communities that were not included since the beginning of the Program. This impact was found only in the group exposed to the Program during the vulnerable stage of 0-2 years (children younger than 6 months at baseline,) from the poorest half of the population studied. A longitudinal sample was used for the analyses, which means that the same children were followed from before the Program's benefits started (1998) until two years later. The impact reported on stature after two years of implementation might be an underestimation, since all families participating in the evaluation were beneficiaries by the end of 1999.[11]

Although these effects on growth and anemia represent important impacts from a public health perspective, the prevalence of these nutritional problems is still high in communities benefiting from the Program. In addition, there is no information whether such impacts have remained constant or have increased, since several communities have been beneficiaries of the Program for nearly six years and could show medium term impacts.

It is important to document whether the Program has had unwanted impacts in the medium term, specifically on weight-for-height (overweight), which typically increases with age.[12] This could happen if the families use their extra resources to purchase low-nutrient and high-energy foods, such as sugar-sweetened beverages, fried snacks, and others.

Data for this analysis come from intervention communities included in the Program since 1998 (**early intervention** group,) from communities included by the end of 1999 (**late intervention** group,) and communities that were not yet included in the Program by 2003 (control communities 2003.) In 2003, the rural communities that participated in the first evaluations of *Oportunidades* were visited again (early and late intervention groups) to determine the Program's impact on child growth and nutritional status after approximately six years of implementation; children from communities that were not included in *Oportunidades* by that year were used as control group. Due to the Program's moderate impact reported after one and two years of implementation –and on child growth, limited only to a certain group of children–, it is important to corroborate those results and determine if the impact persists in the medium term (nearly six years after the Program's implementation.) For that purpose, this study includes four specific objectives aiming to determine if there are differences between the concentration of hemoglobin, the prevalence of anemia, growth (height-for-age) and the prevalence of stunting in:

1. Children between 24 and 47 months old in 2003, from early intervention communities, compared with children from late intervention communities.

   Hypothesis: since both groups benefited from the Program during gestation and infancy, there will not be any difference on the nutritional indicators mentioned above.
2. Children between 24 and 47 months old in 2003, from communities included in the Program (both early and late intervention groups,) compared with children from communities where the Program was not offered (control group 2003).

   Hypothesis: the Program will show a modest impact on the mentioned nutritional indicators, since children from beneficiary households received the Program benefits since gestation.
3. Children between 48 and 71 months old in 2003, from early intervention communities, compared with children in late intervention communities.

   Hypothesis: there will be no difference regarding anemia, since all children have received the Program benefits for at least four years. Likewise, there will not be difference in stunting, since such difference was found only in a particular sub-group after two years of Program benefits (impact evaluation in 2000); thus, the group's total average will not reflect such impact.

4. Children between 48 and 71 months old in 2003, from communities included in the Program (both early and late intervention groups,) compared with children from communities where the Program was not offered (control group 2003,) to determine the impact in the medium term.

    Hypothesis: since all children from intervention communities will have received the benefits for at least tour years, the Program will have a modest impact on the nutritional indicators.

The rest of the document is divided into three sections: the methodology section includes methodological aspects, including sample selection, the 2003 survey evaluation and data processing; results, specifically qualitative data, and statistical tests –not considering their implications– are presented in the results section; and finally, aspects related to findings' implications, strengths and limitations of the study, conclusions, and recommendations, are included in the analysis, conclusions, and recommendations section.

II. METHODOLOGY

SAMPLING DESIGN

The original evaluation sample (from the 1998-2000 impact evaluation) comprises 506 rural communities,[b] of which 320 were randomly assigned to the early intervention group and 186 to the late intervention group. The evaluation sample communities were first visited during the Household Socioeconomic Characteristics Survey in the summer of 1997 (Encaseh 1997), which constitutes the study's baseline; that is characteristics before Program implementation. Follow-up surveys (rural household evaluation surveys, Encel) were conducted half-yearly in 1998, 1999, and 2000. In 2003, those communities were visited again for the next Encel survey (figure 1.) Anthropometric and hemoglobin concentration data from the Encel cross-section survey were used for this report's analyses.

To be able to compare communities included in the Program for five or six years with communities that had never received the Program's benefits, 151 more communities –from the same states as the original sample, but not integrated in the Program yet– were included in the 2003 evaluation (2003 control.) These communities were selected using a matching method at community level, so they would be similar (regarding observable characteristics aggregated at a community level) to the original evaluation communities (early and late intervention.) Matching was made using a propensity score[13,14] that represents the estimated probability of a community to receive the Program's benefits, according to its characteristics. Matching details are described in "Technical note on using matching estimators to evaluate the *Oportunidades* Program for six year follow-up evaluation of *Oportunidades* in rural communities."[15]

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[b] Located in the seven states where *Oportunidades* started operations in 1997: Guerrero, Hidalgo, Michoacán, Puebla, Querétaro, San Luis Potosí y Veracruz.

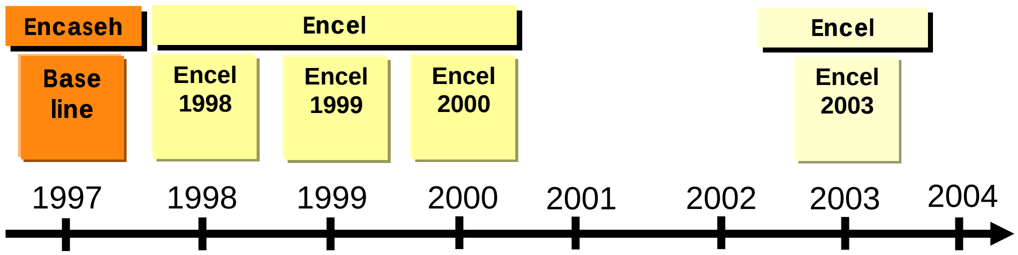

Figure 1. *Oportunidades* in rural communities, impact evaluation design

2003 FIELD DATA COLLECTION AND CREATION OF RESPONSE VARIABLES

Before each field trip, evaluators were trained and standardized on anthropometric measurements, questionnaire fill-out and application, and capillary blood sampling. Prior to fieldwork, supervisors introduced themselves to the corresponding local and sanitary authorities and informed them of their visit to the community and the activities to be conducted. After identifying the selected sample household, evaluators presented themselves to the family and verified their identification information. Families were explained the objectives and procedures of the study; an informed consent letter was read to them and if they agreed to participate, they were asked to sign or fingerprint it. When an evaluator did not find someone to provide the information, or family members were not available, the visit was rescheduled.

The present analysis uses 1997 socioeconomic data from families in early and late intervention communities. The rest of the information, including nutritional indicators, was collected in the 2003 Evaluation Survey (Encel 2003.) The field data collection described as follows is limited to this survey. For the 2003 control group families that were not surveyed in 1997, retrospective socio-economic information was collected during the 2003 data collection.

Hemoglobin concentration and prevalence of anemia

Hemoglobin concentration was estimated with a capillary blood sample using a portable photometer (Hemocue, Inc., Mission Viejo, California, US.) Only hemoglobin values between 4 and 18.5g/dL were included in the analysis; values out of this range were eliminated. Anemia was defined based on hemoglobin concentration values one point below a cutoff point, depending on the subject's age and altitude above sea level in the place of residence. The cutoff point used was based on recommendations from the World Health Organization (WHO): 11 g/dL for children 24 to 59 months old, and 11.5 g/dL for children 60 to 71 months old.[16] For communities located over 1000 m above sea level, the following equation was used to adjust the hemoglobin concentration:[17]

$$\% \text{ Hb} = 93.3197 * 10^{\,0.0000251 * \text{altitude}}$$

Thus,

$$\text{Hb}_{\text{adjusted}} = 100 * \text{Hb}_{\text{obs}} / \{(93.3197) * (10^{\,0.0000251 * \text{altitude}})\}$$

Altitude data for the communities were obtained from the National Institute of Statistics, Geography, and Informatics (INEGI.)

Anthropometric Measurements

Standardized methods were used to measure weight and height[18] and every measure was taken twice for quality control. When both measurements varied less than 0.5 kg and 3.0 mm respectively, they were averaged out; otherwise, they were considered missing data. To evaluate child growth, height-for-age and weight-for-height indicators were used. The Z score for each indicator was estimated using ANTHRO[19] software, based on WHO[2] reference tables, specific for age and sex, with the following formula:

$$Z \ score = \frac{indicator \quad individual \quad value - reference \quad median}{reference \quad standard \quad deviation}$$

The resulting Z value represents the location of the subject in relation to the reference median, considering the indicator's variability for a healthy reference population. A weight-for-height Z score of -2 means the evaluated child's weight is two standard deviations below the median in the reference population distribution for that child's particular age.

Stunting was defined as height-for-age under two standard deviations below the reference population median.[3] Emaciation and overweight were defined in a similar way, but using the weight-for-height indicator and the cutoff point of two standard deviations below or above the reference population median respectively.

Child's age was estimated based on date of birth and date of interview, if data were available; if a date was missing, reported age was used instead. Date of birth was asked in two different instruments during the Encel 2003: the biological questionnaire (where anthropometric data and hemoglobin concentration were collected) and the socioeconomic questionnaire (where household related information was collected.) 470 children were left out because it was not possible to determine their age accurately; their date of birth was different in the biological questionnaire and in the socioeconomic questionnaire (appendix 2) and it also differed from the age reported in both questionnaires.

For children whose reported age and estimated age (based on birth date) varied more than six months, their weight and height were compared with normal value tables (median ± 2 standard deviations,) for their age and sex, according to the WHO reference population, in order to determine which age to use (reported or estimated.) When height and weight values were within the normal values for both ages (e.g. when the difference between the two ages was less than 12 months,) weight-for-height was also considered.

STATISTICAL ANALYSIS

Hemoglobin Concentration, Weight-for-Height and Prevalence of Anemia, Emaciation, and Overweight

In order to document any systematic difference in baseline (1997) between intervention group (early and late) and 2003 control group, housing characteristics, availability of goods, family demographic composition, and family head and partner characteristics were compared. Regression models of generalized estimating equations (GEE),[20] were used, integrating the community as a conglomerate, to take into consideration that children living in the same community are not independent. GEE models are a powerful and flexible alternative for modeling data with conglomerates. Although they do not answer to any of the study's specific objectives, they document the need of a matching analysis, since the design to obtain the control group was quasi-experimental.

Two analysis strategies were used to evaluate the Program's impact on hemoglobin concentration, weight-for-height and their respective prevalences. The first one takes advantage of the experimental design of the original evaluation sample, and it only compares the early intervention group with the late intervention group in 2003, to identify differences between children, depending on the time benefited from the Program (objectives 1 and 3.) Comparisons were made using GEE regression models.

The second strategy uses the quasi-experimental design of the current rural sample, which includes the 2003 control group, to verify the Program's short term impact (shown in the 2000 impact evaluation) in children 24 to 47 months old (specific objective 2,) and to evaluate the medium term impact on children 48 to 71 months old in 2003 (specific objective 4.) All children in intervention communities (both early and late) between 24 and 47 months old in 2003 were exposed to the Program since birth, while children 48 to 59 months old in the late intervention group were exposed to the Program after one year of age, approximately; however, no significant differences are expected in the overall impacts. Nevertheless, all analyses were made by age sub-group. For children 60 to 71 months old, only early intervention group were exposed during the first year of age, while late intervention group were included after the age of 12 months. These analyses are based only on children from families matched for each of the response variables, according to the propensity score matching procedure described as follows.

Since 2003 control group was obtained using a quasi-experimental design, comparisons between beneficiary and non-beneficiary communities are necessary to include only individuals from families with similar observable characteristics. This helps avoid possible biases when the design is not totally random. For example, 2003 control group might have a different socioeconomic level, compared to early and late intervention groups. Matching allows comparisons between children with similar characteristics to compensate potential systematic differences. Matching[c] between intervention groups (early and late together) and 2003 control group was made using the propensity score estimated at family level and extrapolated to the individual level. Rosenbaum and Rubin[13] proved that matching between intervention and non-intervention subjects based on their characteristics is equivalent to matching them using an aggregated index of characteristics to balance treatment and control samples. The coarsest balancing index is the propensity score, which estimates the conditional probability of being treated, given the prior-treatment values of the vector characteristics. This is a very important result in practice, since it reduces potential matching problems. Particularly for this study, the propensity score is the probability of a family to be included in *Oportunidades*, given certain observable characteristics prior-intervention (1997 baseline), and was estimated using a regression model considering only families that had at least one child between 24 and 71 months old. Appendix 1 shows the variables used to estimate the propensity score. Missing data was imputed for some families (<10% per variable.). For continuous variables, the treatment group mean was imputed, and for categorical variables, a new category of missing datum was added. Likewise, dichotomic variables were added to indicate if the datum was imputed or not.

For both intervention groups (early and late,) only families studied from the beginning of the evaluation were used; that is those with baseline information available and eligible to receive the Program's benefits according to the classification based on their 1997 socioeconomic information (Household Socioeconomic Characteristics Survey, Encaseh 1997.) For the 2003 control group, eligible families were selected according to the classification obtained based on their 2003 socioeconomic information (Encel 2003.) Moreover, for both intervention groups (early and late,) families integrated in the Program after 1999[d]

[c] STATA® 8.0 software was used for this purpose, using the nearest neighbor matching method (five neighbors) and common support data between both probability functions (intervention and control.)

[d] *Oportunidades* Administrative data (anio_inc) from Encel 2003 database were used.

were excluded. Table in Appendix 2 shows sample sizes for this analysis and number of cases excluded for several reasons.

The Program's average impact on the response variables between intervention group (early and late) and 2003 control group was estimated using STATA's[21] psmatch2 routine, with the following formula:

$$\text{Average impact} = \frac{\sum_{j=1}^{n}\left(y_{1j} - \hat{y}_{oj}\right)}{n}$$

Where :

y_{1j} is the response variable for the j - th child in the treatment group.

$\hat{y}_{oj}$ is the average response variable for the 5 children in the control group matched with the j - th child in the treatment group.

n is the total number of children in the treatment group that were matched.

The average impact standard error was estimated using the nonparametric resampling method implemented with the STATA command *bootstrap.*[22]

Height-for-Age and Prevalence of Stunting

In order to find a more powerful matching method, another strategy was used to analyze all the outcome variables of interest. Since results in both strategies were similar for all variables, except height-for-age and prevalence of stunting, this section describes the second strategy of the analysis.

The control sample was sought to be as similar as possible to the treatment group in terms of individual, family, and community characteristics; specifically, it was considered appropriate to restrict the treatment sample to families with similar controls, and controls with similar treatment families, based on a variety of characteristics. First, wealthiest families in the new control communities (2003 control group) were excluded, based on goods and characteristics reported in 2003. Likewise, all families from communities with high concentrations of wealthy families were excluded (more than 40 %.) The purpose of these "hard" filters was to exclude from the control sample those families with a higher income level than the typical *Oportunidades* beneficiary family in rural Mexico. The filters were housing quality, car and truck ownership, possession of durable goods, and possession of large and costly animals; 979 families were excluded from the new control communities using these filters.

Afterward, propensity score methods were used to select new control families as similar as possible to intervention families in the original evaluation sample. The common support sample was defined as the observations with propensity score higher than the first percentile of the propensity score distribution in the treatment group, and lower than the 99th percentile of the new control group distribution.

Program's impact on height was estimated based on data from children 24 to 71 months old, once non-poor families were eliminated using hard filters. Families from intervention communities that had been in the Program for less than three years –in 2003– were also eliminated. Program's impact on height was estimated using multiple regression methods, with particular control on individual, family, and community characteristics, as well as the total monetary transfers from the Program to the family, first with the entire sample, and then limiting the analysis to the common support sample. Results were similar when total transfers were adjusted to the family composition (transfers per capita); thus, only total transfers' results are presented herein. Standard errors were adjusted by correlations among conglomerates at community level.

Statistical analysis was made on SAS 8.02[23] and STATA 8.2[21] software. Difference was considered statistically significant when $p<0.05$.

III. RESULTS

Table 1 shows 1997 housing characteristics, availability of goods, family demographic composition, and family head and partner characteristics for intervention groups (early and late) and for the 2003 control group. Many differences were found between the groups, showing mainly that control group families tend to have more resources available. For example, 75.9% of families in the intervention group have dirt floors, compared to 62.3% in the 2003 control group (p<0.01.) The percentage of families with refrigerator or car in the intervention group was less than in the 2003 control group. However, intervention group families had a higher percentage on land and work animals ownership (p<0.01.)

Table 1. Housing characteristics, availability of goods, family demographic composition, family head and partner characteristics in 1997[†], by type of intervention

Variable	Intervention[‡] (n=2,081)	Control 2003[§] (n=1,547)	p Value[¥]
Dirt floor in the house (%)	75.9	62.3	<0.01
Cardboard, palm, or reed roof (%)	43.3	37.6	0.78
Brick, adobe, wood, concrete walls (%)	78.5	75.1	0.07
Number of rooms (mean)[††]	1.5	1.5	0.77
Piped water (land or house) (%)	27.4	36.8	0.58
Has toilet (%)	48.4	45.1	0.12
Electricity available (%)	66.6	61.1	<0.01
Blender available (%)	16.5	18.4	0.29
Refrigerator available (%)	3.3	6.5	<0.01
Stove available (%)	15.2	21.4	0.97
Water heater available (%)	1.9	2.4	0.31
Radio available (%)	53.5	40.7	<0.01
Record/CD player, music equipment available (%)	2.9	2.8	0.58
Television available (%)	30.9	27.9	<0.01
VCR available (%)	1.3	1.8	0.40
Washing machine available (%)	1.0	1.6	0.50

Fan available (%)	3.6	5.7	0.45
Car available (%)	0.3	1.5	<0.01
Truck available (%)	1.5	2.4	0.24
Own land (%)	57.0	33.2	<0.01
Own work animals (%)	32.8	18.9	<0.01
Number of people in the family (mean)	6.2	6.2	0.91
Number of people between 0 and 5 (mean)	1.7	2.3	<0.01
Number of people between 6 and 14 (mean)	1.7	1.1	<0.01
Number of people between 15 and 21 (mean)	0.6	0.7	0.02
Number of people older than 40 (mean)	0.6	1.1	<0.01
Family head's age (mean)	36.8	34.9	<0.01
Family head is male (%)	95.5	91.3	<0.01
Family head speaks an indigenous tongue (%)	50.0	26.9	0.20
Family head has some degree of instruction (%)	74.4	29.5	<0.01
Family head works (%)	93.8	81.7	<0.01
Family head's partner's age (mean)[‡‡]	30.5	31.6	0.02
Partner speaks an indigenous tongue (%)[‡‡]	48.5	26.1	0.17
Partner has some degree of instruction (%)[‡‡]	67.8	32.0	<0.01
Partner works (%)[‡‡]	12.4	14.4	0.01

† From Encaseh 97 for early and late intervention communities, and from the retrospective information questionnaire applied during Encel 2003 for control communities.
‡ Early intervention communities plus late intervention communities.
§ Communities where the Program was not yet implemented in 2003.
¥ GEE model, to compare means or proportions by type of community.
†† Not including kitchen, hall and bathroom.
‡‡ Estimation based on the number of families that report to have a partner (intervention =1958, control=1454.)

IMPACT ON HEMOGLOBIN CONCENTRATION, WEIGHT-FOR-HEIGHT AND THEIR RESPECTIVE PREVALENCES

Objective 1: Comparison Between Early and Late Intervention Communities (children 24 to 47 months old)

There were no differences in 2003 on hemoglobin concentration or prevalence of anemia in children 24 to 47 months old among early and late intervention communities (table 2.) Prevalence of anemia was 42.5% in children 24 to 35 months old, and 30% in children 36 to 47 months old. Likewise, there were not differences on average weight-for-height or prevalence of emaciation or overweight between early and late intervention communities.

Table 2. Hemoglobin, weight, and respective prevalences in children between 24 and 47 months old from early and late intervention communities. 2003 Encel Cross-Section Survey

Age Group Variable	Type of community: Late Intervention			Early Intervention			p Value[†]
	N[‡]	Mean	SD[§]	N[‡]	Mean	SD[§]	
24 to 35 months old							
Age (months)	211	30.3	3.4	316	30.0	3.4	0.23
Hemoglobin (g/dL)[¥]	200	11.2	1.4	303	11.1	1.5	0.86
Anemia (%)[††]	200	42.5	-	303	42.6	-	0.98
Weight-for-height,[‡‡] Z score	193	-0.1	0.9	293	-0.1	0.8	0.98
Emaciation (%)[§§]	193	2.1	-	293	0.7	-	0.20
Overweight (%)[¥¥]	193	1.6	-	293	1.0	-	0.63
36 to 47 months old							
Age (months)	285	42.1	3.6	374	42.2	3.6	0.73
Hemoglobin (g/dL)[¥]	278	11.5	1.3	366	11.5	1.3	0.93
Anemia (%)[††]	278	30.9	-	366	29.2	-	0.57
Weight-for-height,[‡‡] Z score	275	0.1	0.8	363	0.0	0.8	0.18
Emaciation (%)[§§]	275	0.4	6.0	363	1.4	11.7	0.16
Overweight (%)[¥¥]	275	2.2	-	363	1.4	-	0.63
24 to 47 months old							
Age (months)	496	37.1	6.8	690	36.6	7.0	0.32
Hemoglobin (g/dL)[¥]	478	11.4	1.4	669	11.3	1.4	0.59
Anemia (%)[††]	478	35.8	-	669	35.3	-	0.96
Weight-for-height,[‡‡] Z score	468	0.0	0.9	656	0.0	0.8	0.27
Emaciation (%)[§§]	468	1.1	-	656	1.1	-	0.98
Overweight (%)[¥¥]	468	1.9	-	656	1.2	-	0.41

[†] To compare the mean or prevalence by type of community, a GEE model was used, integrating the community as a conglomerate to take into consideration that many children live in the same community.

‡ Children from eligible families, according to the 1997 classification criteria.
§ Standard deviation.
¥ Altitude-adjusted values.[17]
†† Based on hemoglobin concentration adjusted below 11 g/dL for children 24 to 59 months old, and 11.5 g/dL for children 60 to 71 months old.[16]
‡‡ Estimated as (subject's weight – reference population median weight-for-height)/ reference standard deviation.[2]
§§ Defined as weight-for-height two standard deviations below the reference population median[2]
¥¥ Defined as weight-for-height two standard deviations above the reference population median.[2]

Objective 2: Comparison Between Intervention Communities and Control Group (children 24 to 47 months old)

Prevalence of anemia in 2003 control communities was not different from intervention communities (early and late), both for children 24 to 35 and 36 to 47 months old (table 3.) Likewise, there were no statistically significant differences in weight-for-height and its respective prevalence.

Table 3. Hemoglobin, weight, and respective prevalences in children 24 to 47 months old from intervention and control communities. 2003 Encel cross-section survey.

Variable	Type of Community						
	2003 Control†		Intervention‡		Effect	SE§	P Value
	N¥	Mean	N¥	Mean			
24 to 35 months old							
Age (months)	181	29.23	445	30.13	0.90	0.70	0.20
Hemoglobin (g/dL)¥	172	11.24	424	11.13	-0.11	0.27	0.67
Anemia (%)††	172	36.93	424	42.92	5.99	8.94	0.50
Weight-for-height,‡‡ Z score	167	-0.06	411	-0.06	<0.01	0.10	0.91
Emaciation (%)§§	167	0.00	411	1.45	1.45	0.59	0.01
Overweight (%)¥¥	167	0.24	411	1.21	0.97	0.62	0.11
36 to 47 months old							
Age (months)	209	41.85	542	42.12	0.27	0.56	0.63
Hemoglobin (g/dL)¥	200	11.52	529	11.50	-0.02	0.24	0.95
Anemia (%)††	200	31.11	529	30.05	-1.06	6.40	0.86
Weight-for-height,‡‡ Z score	194	0.04	527	0.07	0.03	0.17	0.86
Emaciation (%)§§	194	1.63	527	0.76	-0.87	1.88	0.64
Overweight (%)¥¥	194	7.17	527	1.89	-5.28	3.73	0.15
24 to 47 months old							
Age (months)	386	35.08	1006	36.83	1.75	0.95	0.07
Hemoglobin (g/dL)¥	369	11.37	972	11.33	-0.04	0.22	0.87
Anemia (%)††	369	33.06	972	35.69	2.63	5.31	0.62
Weight-for-height,‡‡ Z score	361	-0.03	955	0.02	0.05	0.09	0.61
Emaciation (%)§§	361	1.27	955	1.05	-0.22	1.26	0.85
Overweight (%)¥¥	361	1.84	955	1.57	-0.27	1.20	0.82

† Communities where the Program was not yet implemented in 2003
‡ Early and late intervention communities
§ SE = Estimated difference standard error. Resampling simulation result (*bootstrap*) with 200 repetitions.[22,24,25]
¥ Number of matched children
£ Altitude adjusted values[17]
†† Based on hemoglobin concentration adjusted below 11 g/dL.[16]
‡‡ Weight-for-height estimated as (subject's weight – reference population median weight-for-height)/ reference standard deviation using the WHO reference recomendation[2]
§§ Defined as weight-for-height two standard deviations below the WHO reference population median[2]

¥¥ Defined as weight-for-height two standard deviations above the WHO reference population median[2]
££ The sample size of the 24 to 47 months group does not equal the sum of the 24 to 35 and 36 to 47 months sub-groups, probably because some children were not matched in each age sub-group, but they were when both sub-groups were merged.

Objective 3: Comparison Between Early and Late Intervention Communities (children 48 to 71 months old)

No differences were found on hemoglobin concentration and prevalence of anemia among children 48 to 71 months old from early and late intervention communities. However, for the 48 to 59 months old sub-group, hemoglobin concentration was significantly higher, and prevalence of anemia was 7.2 percent less, in early intervention communities. There were no differences among children 48 to 71 months old on average weight-for-height or prevalence of emaciation or overweight.

Table 4. Hemoglobin, weight, and respective prevalences in children 48 to 71 months old from early and late intervention communities. 2003 Encel cross-section survey.

Variable	Type of Community						P Value†
	Late intervention			Early intervention			
	N‡	Mean	SD§	N‡	Mean	SD§	
48 to 59 months							
Age (months)	261	53.8	3.6	382	53.8	3.6	0.97
Hemoglobin (g/dL)¥	258	11.6	1.4	376	12.0	1.3	<0.01
Anemia (%)††	258	27.9	-	376	20.7	-	0.04
Weight-for-height,‡‡ Z score	254	0.1	0.8	370	0.2	0.8	0.94
Emaciation (%)§§	254	0.0	-	370	0.8	-	-
Overweight (%)¥¥	254	2.0	-	370	1.4	-	0.56
60 to 71 months							
Age (months)	297	65.6	3.7	408	65.7	3.5	0.54
Hemoglobin (g/dL)¥	292	12.0	1.4	402	11.9	1.4	0.52
Anemia (%)††	292	30.1	-	402	33.8	-	0.32
Weight-for-height,‡‡ Z score	288	0.1	0.9	397	0.1	0.8	0.99
Emaciation (%)§§	288	1.0	-	397	0.0	-	-
Overweight (%)¥¥	288	1.7	-	397	1.3	-	0.72
48 to 71 months							
Age (months)	558	60.1	6.9	790	60.0	6.9	0.80
Hemoglobin (g/dL)¥	550	11.8	1.4	778	11.9	1.3	0.30
Anemia (%)††	550	29.1	-	778	27.5	-	0.61
Weight-for-height,‡‡ Z score	542	0.1	0.8	767	0.1	0.8	0.95
Emaciation (%)§§	542	0.6	-	767	0.4	-	0.68
Overweight (%)¥¥	542	1.8	-	767	1.3	-	0.45

† To compare the mean or prevalence by type of community, a GEE model was used, integrating the community as a conglomerate to take into consideration that many children live in the same community.
‡ Children from eligible families, according to the 1997 classification criteria.
§ Standard deviation.
¥ Altitude-adjusted values.[17]
†† Based on hemoglobin concentration adjusted below 11 g/dL for children 24 to 59 months old, and 11.5 g/dL for children 60 to 71 months old.[16]
‡‡ Estimated as (subject's weight – reference population median weight-for-height)/ reference standard deviation.[2]

§§Defined as weight-for-height two standard deviations below the reference population median [2]
¥¥ Defined as weight-for-height two standard deviations above the reference population median.[2]

Objective 4: Comparison Between Intervention Communities and Control Group (children 48 to 71 months old)

In 2003, there were no statistically significant differences found between intervention (both early and late) and control communities for the response variables studied, except for hemoglobin concentration in children 60 to 71 months old, which was 0.42 g/dL on average higher in control than in intervention group. Prevalence of overweight in children 48 to 59 months old was higher in intervention than in 2003 control group (table 5.)

Table 5. Hemoglobin, weight, and respective prevalences in children 48 to 71 months old from intervention and control communities. Encel Cross-section survey 2003.

Variable	Type of Community: 2003 Control† N¥	2003 Control† Mean	Intervention‡ N¥	Intervention‡ Mean	Effect	SE§	P Value
48 to 59 months							
Age (months)	195	53.49	568	53.78	0.29	0.67	0.66
Hemoglobin (g/dL)¥	195	11.43	559	11.83	0.40	0.30	0.19
Anemia (%)††	195	35.20	559	23.43	-11.77	8.63	0.17
Weight-for-height,‡‡ Z score	191	0.42	551	0.16	-0.26	0.13	0.06
Emaciation (%)§§	191	0.00	551	0.36	0.36	0.24	0.14
Overweight (%)¥¥	191	0.11	551	1.81	1.70	0.58	0.01
60 to 71 months							
Age (months)	242	64.86	592	65.70	0.84	0.56	0.13
Hemoglobin (g/dL)¥	238	12.36	581	11.94	-0.42	0.18	0.02
Anemia (%)††	238	25.26	581	32.01	6.74	5.84	0.24
Weight-for-height,‡‡ Z score	236	0.28	574	0.14	-0.14	0.16	0.35
Emaciation (%)§§	236	0.14	574	0.52	0.38	0.34	0.27
Overweight (%)¥¥	236	3.27	574	1.56	-1.71	1.54	0.27
48 to 71 months							
Age (months)	441	59.19	1201	60.07	0.88	0.89	0.32
Hemoglobin (g/dL)¥	436	11.92	1181	11.88	-0.04	0.21	0.85
Anemia (%)††	436	30.24	1181	28.19	-2.05	6.26	0.74
Weight-for-height,‡‡ Z score	433	0.25	1166	0.15	-0.10	0.10	0.30
Emaciation (%)§§	433	0.00	1166	0.42	0.42	0.18	0.02
Overweight (%)¥¥	433	1.51	1166	1.71	0.20	0.74	0.78

† Communities where the Program was not yet implemented in 2003
‡ Early and late intervention communities
§ SE = Estimated difference standard error. Resampling simulation result (*bootstrap*) with 200 repetitions.[22]
¥ Number of matched children
£ Altitude adjusted values[17]
†† Based on hemoglobin concentration adjusted below 11 g/dL.[16]
‡‡ Estimated as (subject's weight – reference population median weight-for-height)/ reference standard deviation using the WHO reference recomendation[2]
§§ Defined as weight-for-height two standard deviations below the reference population median[2]
¥¥ Defined as weight-for-height two standard deviations above the reference population median[2]

££ The sample size of the 48 to 71 months group does not equal the sum of the 48 to 59 and 60 to 71 months sub-groups, probably because some children were not matched in each age sub-group, but they were when both sub-groups were merged.

Lastly, it is important to mention that when analyzing hemoglobin concentration, weight-for-height, and their respective prevalences, with the strategy used to examine height-for-age (next section,) results are consistent with those reported herein.

IMPACT ON HEIGHT-FOR-AGE AND PREVALENCE OF STUNTING

Children 24 to 71 months old in intervention communities grew 0.67 cm on average more than children in 2003 control communities (p<0.01.) Program's impact was also significant on the prevalence of stunting, which is 17.4% less in communities integrated to the Program than in control communities (28.7% in intervention communities and 36.9% in control communities p<0.01.) Results do not vary depending on child's sex.

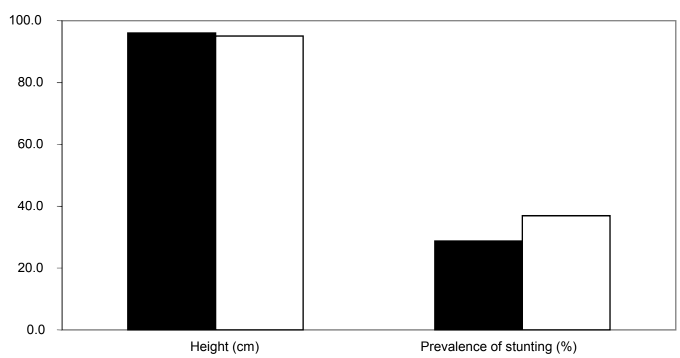

Figure 1. *Oportunidades'* impact on height and prevalence of stunting in children 24 to 71 months old. Black bars = Intervention; white bars = Non-intervention. Both comparisons are statistically significant (P<0.01).

IV. ANALYSIS, CONCLUSIONS AND RECOMMENDATIONS

The Program has had an important impact on height-for-age and prevalence of stunting in beneficiary children. The magnitude of this impact is slightly less than in the 2000 impact evaluation,[11] but still biologically commendable, based on other research studies[26-28] and on this study's design.

This report's analyses could not identify any impact of *Oportunidades* on prevalence of anemia or weight-for-height indicators in children groups 24 to 47 and 48 to 71 months old. Differences observed on hemoglobin concentration and prevalence of overweight in isolated age groups (table 5) are not considered biologically relevant. Differences are small and their statistical significance may be by chance due to the high number of comparisons made. Besides, there is no biological reasoning that could explain a differential impact on the groups observed.

To contextualize the results on anemia, it is important to consider both the methodology used and the ability of the Program to influence on the hemoglobin concentration in children older than 2 years. The only design that allows conclusive affirmations about causality is the randomized trial with a contemporary control group.[29] Evaluation in early and late intervention groups allowed this kind of comparison, since the Program was allocated randomly before it was implemented in 1997. For the 2003 evaluation, control communities were selected based on characteristics apparently similar to the intervention groups, with no random allocation. Possibly, there was no apparent impact on anemia because intervention and control groups were not sufficiently comparable to constitute a real control group. Theory shows that the propensity score matching method used in this design (quasi-experimental) guaranties similarity among groups, at least in the variables observed and used for estimation.[13] The propensity score method does not allow control on characteristics that were not observed as part of the evaluation, and which could indicate systematic differences between communities. For example, if children in the control group systematically consume food with higher nutritional value (e.g. meat,) the Program's impact could be unnoticeable.

It is also important to take into consideration that the 2003 control communities were not part of the initial evaluation (original sample.) Thus, data used for matching is retrospective, which could introduce a memory bias in recalling socioeconomic conditions six years behind. There are yet other limitations to the analysis method used. Matching was made at family and not child level. It would be more appropriate to find control children that, besides having the same propensity score, had the same age and sex, and other characteristics. This is difficult for nutritional status comparisons, since response variables are the only available information for each child. When comparing characteristics in control and intervention groups included in this analysis, there are clearly important differences in variables that have proved to be associated with anemia.

The fact that on the 1999[11] evaluation there was an impact on prevalence of anemia in children younger than 2 years of age, but it was not perceptible in children 2 to 6 years old, is not entirely contradictory; children's iron requirement decreases after the age of two, as a result of slower growth.[30] Likewise, as a child grows, he or she is more integrated in the family diet; thus, with age, iron consumption increases, and prevalence of anemia decreases.[30] It is not possible with the present study design to verify the impact found in previous evaluations of children under 2 years old, since analyzed age groups are different.

Although the Program has had an impact on children's height and prevalence of stunting, this problem has not yet been eliminated from the population. It is important to consider different ways to increase Program's possibilities to influence on child growth by identifying and improving its weak components. The critical period for child growth is before the age of 2 years.[31] During that age, all *Oportunidades* beneficiary children are entitled to receive a food supplement. This is a high nutritional value supplement that, if consumed according to the Program's recommendations, should produce an impact on child growth higher than herein reported.[26-28]

The supplement is well accepted –as informed by mothers. However, it is far below the ideal consumption.[11,32,33] Thus, to improve supplement consumption, an in-depth analysis of Program restraints is necessary, regarding both Program's management (supply and distribution) and beneficiary families, is necessary. There is information on this matter from a study conducted in rural communities in Veracruz and Chiapas,[33] as well as in some urban communities (data still in process of analysis.) Information from rural communities has lead to redesign the Program's education sessions, emphasizing food supplement promotion. The material used for this purpose has had an important impact on knowledge and consumption of the supplement in the distribution areas.[33] It is urgent to improve this Program's health-education component for all beneficiary families, regarding Program's benefits and correct use of the supplement.

At the moment, the food supplement it is not very likely to show an impact on children's iron status because the type of iron used is not properly absorbed.[e] Contrary to stunting, anemia may develop at any stage in life if iron consumption does not meet nutrition demands. The only way to increase hemoglobin concentration and reduce the prevalence of anemia in children older than 2 years that have stopped using the supplement is to increase consumption of easily-absorbed iron-rich food, such as red meat. There is evidence that beneficiary families spend more in meat,[36] but increase in family consumption of a certain product, does not always result in a greater consumption in younger children. Unfortunately, there are no available data on dietary consumption per person to determine if the Program has had an impact on iron-rich food consumption. The lack of impact on hemoglobin concentration and the high prevalence of anemia among children 24 to 71 months old suggest an inadequate intake of iron-rich foods. The Program's health education sessions are an excellent opportunity to provide families with information about iron's importance through life and its most important sources, in order to influence purchase and intrafamily distribution of these foods.

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[e] At present, the supplement contains reduced iron, with a very low bioavailability.[34] Researchers from the National Institute of Public Health (INSP) have suggested Liconsa and the Ministry of Health (SSA) to change the iron format to sulfate, fumarate, or other type of iron with higher bioavailability. This change is fundamental, because the current supplement does not have direct impact on children's iron status.[35]

Despite the positive impact of the Program on children's height, nutrition-related issues persist in the communities. 20 to 30% of children have anemia and stunting, which remain important public health issues among the studied population. Obviously, this means it is necessary to reconsider which Program aspects should be strengthened in order to reduce the magnitude and prevalence of these issues.

The following recommendations are based on findings reported herein:

1. Change the type of iron used to fortify the food supplement for one with adequate bioavailability (sulphate, fumarate or gluconate.)
2. Strengthen the education sessions component regarding the use of food supplements, both for people responsible of distribution and promotion and for beneficiary mothers. Guarantee a direct delivery of the supplement to children under 2 years old –when impact on growth is potentially higher.
3. Strengthen the education sessions component regarding nourishment of children 2 to 5 years old, including demonstrations and active participation of beneficiary mothers in order to guarantee the integration of foods with adequate micronutrient content, such as meat, in their diet.
4. Analyze the possibility of offering some source of iron to children 2 to 5 years old. If this is possible, explore delivery alternatives; specifically analyze cost-benefits of extensive delivery *vs.* limited delivery based on diagnosed anemia.

At present, an important proportion of children take the food supplement regularly, improving their diet.[33] The Program's impact on children's height probably reflects a contribution of the food supplement to the quality of their diet. However, there is evidence that intrafamily distribution of the supplement –particularly among children older than 2 years– prevents its adequate consumption among children under that age.[32,33] Although the supplement's nutrients may offer benefits to children older than 2 years, they no longer offer the biological potential to improve their growth in height.[31]

To improve iron status in children too old to receive the food supplement, it is necessary to increase iron consumption through diet or some other kind of supplement. Through an improved educational communications Program, the authors of this report hope to attain higher supplement consumption levels and a better use of resources to enrich the population's diet –which would cause a higher impact on child growth and iron status.

An impact evaluation of the educational communications strategy for supplement consumption would help determine if the supply of other highly nutritious foods –besides the supplement– should be increased in some regions of the country to meet families' preferences.

The recommendations presented herein aim to increase the iron quality of the food supplement offered; increase the food supplement habitual consumption; improve the levels of micronutrients in regular diets among children older than 2 years; and explore new mechanisms to increase the amount of iron in those children's diets.

Appendix 1. Logistic Regression Model[†] to Estimate the Probability[‡] of Participation in *Oportunidades*

Variable	Coeff.	EE[§]	P Value	variable	Coeff.	EE[§]	P Value
Cement floor	-0.31	0.15	0.04	Imputed data indicator Work animals	-1.44	0.88	0.10
Mosaic or wood floor	-0.12	0.48	0.81	Number of people	0.22	0.09	0.01
Tin or asbestos roof	-0.08	0.19	0.69	0-5 year old children	-0.97	0.12	0.00
Tile, stone, brick or block roof	-0.56	0.30	0.06	6-14 year old children	0.04	0.09	0.66
wood, concrete, adobe or brick walls	0.05	0.31	0.87	15 to 21 year old people	-0.08	0.09	0.38
Number of rooms	0.08	0.05	0.10	People older than 40	-1.41	0.12	0.00
Piped water in the land	-0.81	0.26	0.00	Family head's sex	0.48	0.33	0.14
Piped water in the house	-0.30	0.38	0.42	Family head's age	0.08	0.01	0.00
Imputed data indicator Water	-1.08	0.78	0.17	Family head speaks an indigenous tongue	1.39	0.29	0.00
Waterless toilet	-0.06	0.20	0.75	Imputed data indicator Family head speaks an indigenous tongue	0.21	1.06	0.84
Water flush toilet	-1.24	0.32	0.00	Family head has elementary or higher education	1.94	0.16	0.00
Imputed data indicator Toilet	-0.38	0.59	0.52	Imputed data indicator Family head has elementary or higher education	-0.49	0.54	0.36
Electricity	-0.24	0.27	0.37	Family head works	-0.87	0.25	0.00
Blender	0.02	0.18	0.90	Partner's education	1.13	0.19	0.00
Refrigerator	-0.95	0.36	0.01	Imputed data indicator Partner's education	-1.86	0.92	0.04
Stove	-0.43	0.20	0.03	Partner's age	0.01	0.01	0.40
Water heater	0.51	0.42	0.23	Partner works	-0.82	0.22	0.00
Radio	0.54	0.16	0.00	Imputed data indicator Partner works	-1.24	1.18	0.29
CD / record player	0.41	0.34	0.23	Partner speaks an indigenous tongue	-0.13	0.31	0.67
Television	0.14	0.17	0.39	Imputed data indicator Partner speaks an indigenous	-0.46	0.89	0.61

				tongue			
VCR	-0.04	0.43	0.92	Hidalgo	-0.94	0.80	0.24
Washing machine	0.36	0.47	0.45	Michoacán	-1.55	0.72	0.03
Fan	-0.59	0.40	0.14	Puebla	-1.77	0.71	0.01
Car	-0.86	0.71	0.22	Querétaro	-2.29	1.03	0.03
Truck	0.35	0.43	0.41	San Luis Potosí	-2.06	0.78	0.01
Imputed data indicator							
Truck	-0.40	0.86	0.64	Veracruz	-2.77	0.68	0.00
Own land	0.70	0.19	0.00	Constant	-0.64	0.81	0.43
Own work animals	0.59	0.19	0.00				
Amount of observations	3,415			Pseudo R^2	0.48		

† GEE logistic regression model, integrating the community as a conglomerate to take into consideration that many children live in the same community.
‡ The dependent variable takes the value 1 if the family belongs to the intervention sample (early or late) and the value 0 if it belongs to the 2003 control sample.
§ SE=estimated regression coefficient standard error.

Appendix 2. Flow Table of Sample Sizes

Number of 2 to 6 Year Old Children by Type of Community				
	Type of Community (TIPO_LOC)			
	1	2	3	Total
	Early	Late	Control 2003	
ORIGINAL RURAL 2003 †	3,583	2,827	2,434	8,844
ORIGINAL RURAL 2003 including only children from families in the original evaluation sample‡	2,499	1,815	2,434	6,736
Intersect 1997 databases§	2,436	1,756	2,415	6,607
Girls (SEX=2)	1,183	880	1,196	3,259
Boys (SEX=1)	1,253	876	1,219	3,348
Percentage of children in the original evaluation sample that intersect the 1997 DB by folio and family	97.5%	96.7%	99.7%	98.0%
Intersect 1997 databases§ and are POOR¥ families	1,559	1,112	2,043	4,714
Inconsistencies: children with an integration year other than 1998 and 1999 for early and late intervention respectively. There are no inconsistencies in the 2003 control group.	22	19	0	41
Only includes children in the original evaluation sample‡ that intersect 1997 databases§ and are from poor¥ families, without inconsistencies in the year of integration.	**1,537**	**1,093**	**2,043**	**4,673**

AGE CLEANING				
ORIGINAL RURAL 2003 †	3,583	2,827	2,434	8,844
ORIGINAL RURAL 2003 † eliminating entries where birth date in the biological questionnaire and in the socioeconomic questionnaire are different.	3,478	2,741	2,155	8,374
Eliminating entries where it was not possible to determine the correct age (reported age or estimated age)††	3,471	2,734	2,150	8,355
Only includes children in the original evaluation sample‡	2,443	1,763	2,434	6,344
Intersect 1997 databases§	2,384	1,707	2,132	6,223
Percentage of children in the original evaluation sample that intersect the 1997 DB by folio and family	97.6%	96.8%	99.7%	98.0%
Intersect 1997 databases§ and are POOR¥ families	**1,523**	**1,089**	**1,789**	4,401
Inconsistencies: children with an integration year other than 1998 and 1999 for early and late intervention respectively. There are no inconsistencies in the 2003 control group.	**22**	**18**	**0**	40

Only includes children in the original evaluation sample[‡] that intersect 1997 databases[§] and are poor[¥] families, without inconsistencies in the year of integration.	**1,501**	**1,071**	**1,789**	**4,361**
Only includes children in the original evaluation sample[‡] that intersect 1997 databases[§] and are from poor[¥] families, without inconsistencies in the year of integration & ESTIMATED AGE FROM 24 TO 71 M	**1,480**	**1,054**	**1,772**	**4,306**
24-35 M	**316**	**211**	**416**	**943**
36-47 M	**374**	**285**	**466**	**1,125**
48-59 M	**382**	**261**	**434**	**1,077**
60-71 M	**408**	**297**	**456**	**1,161**

[†] They are identified in the database when h_regisi is different from missing datum.
[‡] They are identified in the database when HOG_NUE=1 (families in the original sample.)
[§] Collected in Encaseh 97 for early and late intervention communities and in the retrospective information questionnaire of Encel 2003 for control communities.
[¥] Intervention groups (early and late) according to the1997 criterion (POBRE_1), and 2003 control group according to the 2003 (MPPOB)) criterion.
[††] Correct age (reported or estimated) was determined when they varied for more than 12 months.

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