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Subsidizing children with breakfast can help in reducing malnutrition harms: the experience of the Monte Albán community intervention program of AVSI in Mexico

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TITOLO
Sostenere i bambini con un progetto incentrato sulla colazione può aiutare a ridurre le patologie legate alla malnutrizione: l'esperienza nella comunità di Monte Albán del programma di intervento della Fondazione AVSI in Messico

KEY WORDS
Malnutrition, breakfast, growth status, nutritional status

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Malnutrizione, colazione, crescita e sviluppo, stato nutrizionale

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Summary
In the latest years the fight against malnutrition has led to the development of several community- based programs, meant at sustaining normal growth and development of the weakest strata of the population. AVSI, together with the Mexican partner CRECEMOS, has founded a project aimed at providing daily breakfast to the children of the community of Monte Albán, Oaxaca, Mexico. Considering the short term and long term effects of nutrient's insufficiency, several programs have been targeted for growth promotion showing greater results when children could profit not only from improved nutrition but also from improved learning opportunities in the earliest years of life. The present retrospective study has therefore two main purposes, to compare growth status of Monte Albán children with the national one and second to evaluate the impact of the project on the growth status of children afferent to the association on a regular basis.

Riassunto
Negli ultimi anni la lotta contro la malnutrizione ha portato allo sviluppo di vari programmi su base comunitaria, con lo scopo di sostenere la normale crescita e lo sviluppo delle fasce più deboli della popolazione. AVSI, insieme al partner messicano CRECEMOS, ha fondato un progetto volto a fornire giornalmente la prima colazione ai bambini della comunità di Monte Albán, Oaxaca, Messico. Considerando gli effetti della malnutrizione, sia a breve che a lungo termine, i diversi programmi si sono focalizzati sulla promozione della crescita, dando maggiori risultati quando i bambini erano messi in condizione di beneficiare non solo di una migliore alimentazione, ma anche della possibilità di avere un sostegno all'apprendimento nei primi anni di vita. Il presente studio retrospettivo ha quindi due scopi principali, di confrontare lo stato di crescita dei bambini Monte Albán rispetto agli standard nazionali, e di valutare l'impatto del progetto AVSI sullo stato di crescita dei bambini regolarmente afferenti alla struttura.

Introduction

Nowadays Mexico is facing a double burden when considering nutrition and nutrition related diseases (1). On the one side there is the fast increasing of obesity epidemic, while on the other, poor nutrition is still affecting a large portion of Mexican children; although important progresses have been made in limiting chronic malnutrition in children - decreased from 26.9% in 1988 to 15.5% in 2006- and in reducing acute malnutrition's prevalence to healthy population levels (2). Both issues are still considerably widespread in some areas of the country, especially in rural and low-income districts (3).

Yucatán, Puebla, Oaxaca and Chiapas states have always shown the highest levels of socioeconomic marginalization and malnutrition (4), whose consequences are reflected in nutritional status of children, crucial part of the national agenda in terms of health and equity.

Several programs have been implemented at national and regional levels (2), in order to diminish the diffusion of the problem and to reduce the prevalence of underdevelopment in children. Among those interventions, Desarrollo Integral de la Juventud Oaxaqueña (DIJO), a non-governmental association, part of the AVSI international network, since 1993 has implemented programs directed towards the education of children, youth and families in and around the city of Oaxaca, with the main objective to support the full development of communities living in situations of poverty and marginalization. One of the main nutrition intervention in the Colonia of Monte Albán is the community kitchen called "La Compañía", that provides daily balanced breakfast to children involved in the program.

Previous studies, set in the same area of interest, have used growth status as indicator of health and well-being (5, 6), stressing on how inequalities in nutritional, health and living conditions, and access to resources and services were linked to differences in children's height and weight (7). It was moreover indicated that improvements in living conditions, as through food supplementation, triggered catch-up growth in children, especially the youngest (8).

The relationship between nutritional status and growth has therefore a capital role not only in physical development but also in future cognitive development, schooling and educational achievement (9).

The present retrospective study had two purposes: first, to compare growth status of Monte Albán children with the national one and second to evaluate the impact of "La Compañía" project on the growth status of children afferent the association at a regular basis.

Material and Methods

Setting

Oaxaca is the largest state in central and southern Mexico. The research took place in central valley (Valley of Oaxaca), in Dijo's "Maria de Guadalupe" Community Development Center, located in Monte Albán, a neighborhood of Santa Cruz Xoxocotlán Municipality. The center offers a daily breakfast to more than 150 children, aged 3-12, members of Monte Albán community and involved in the development project called "La Compañía".

Sample

A cohort of 259 children afferent "La Compañía" community kitchen were enrolled in 2007 and followed until 2010. Name of the child, age and sex were recorded at admission in the centre.

Meal

On the basis of the nutritional status (see *Growth status evaluation* subsection), children were divided in three groups, *i)* green group, for those with a normal BMI, *ii)* yellow group for the children slightly

underweight, *iii)* red group, for those markedly underweight.
Nutritional requirements were defined for each group according to the values recommended from the Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán (INNSZ), considering an age-specific average (between males' and females' reference values) daily energy intake. Starting from a basic daily breakfast of an average of 500The daily breakfast was a 400 KCalories meal, composed by 60% carbohydrates, 15% proteins and 25% lipids, with a fair distribution of mono- and polyunsaturates fats, vitamins, minerals and dietary fiber. According to the guidelines of INNSZ; modification were made on the basis of children nutritional status.
Breakfast was prepared directly in DIJO center. Portions were prepared as divided in 3 main groups by age and nutritional status. Each child received a meal with an energetic intake equal to the 35% of the daily ratio as recommended from INNSZ:,, small portions/450 Kcal (for children (from 1 to 5), medium portions/630Kcal (for children (from 6 to 11) and big portions/900 Kcal((for children (from 12 till 18 years).
In general, the proportion of proteins for the red group was increased as well as the proportion of carbohydrates and proteins for the yellow group.

Anthropometrics

Height and weight, assessed respectively in cm and kg, were registered for each child using a measuring board, accurate 1 cm, and a balance scale, accurate to within 0.1 kg. Four measurements were taken every year, in the months of March, June, September and December.

Growth status evaluation

Age, sex and anthropometric measurements were used to calculate z-scores for weight/age, height/age and weight/height, according to WHO 2006 child growth standards guidelines (10, 11). WHO 2006 child growth standards (12) were used to confront actual growth status and adequate growth status. Each child's growth status trend was evaluated.

Statistical analysis

Data have been summarized using percentiles whenever possible. Robust location measures were preferred, adopting medians as standard.
BMI z-scores and prevalence rates were computed using a WHO set of S-plus functions ported to the R-system (13).
Difference in distribution in BMI z-scores at 1, 2 and 3 years since intervention were evaluated using the relative distribution methods (14). Graphical inspection was presented using smoothed probability density function estimates and relative cumulative distribution functions. Quantitative comparisons were presented using the entropy measure, which is a measure of the dispersion of the distribution, and the median polarization index, which provides a mean of capturing distributional polarization. Entropy measure has been decomposed in median and shape effect and the median polarization index in upper and lower polarization indexes, representing the contributions made by components above and below median of the relative distribution of each year since intervention started vs. baseline. Expectile regression (15) has been used to first depict and subsequently evaluate observed and expected BMI growth over time since intervention started.
All computations have been performed with the R system (16), using the reldist (17) and the expectreg (18) libraries.

Results

Sample characteristics have been synthesized in Table 1. Crude data reported an increase in the median weight and height, from 20.8 kg to 28.4 kg and from 114 cm to 129 cm, respectively. Median z-

score for height and weight are presented, being negative in all cases considered.

Although not significant, according to the median polarization index shown in Table 2 there is a shift from to the tails to the center of the BMI distribution increasing with time (3.1% in the 2nd year and 8.6% in the 3rd year).

Adjusted BMI scores are presented in Table 3, considering their prevalence rates at baseline, 1st and 2nd year of intervention. Prevalence of children with BMI scores higher than 1 SD increased from baseline till the 2nd year of intervention. The 3rd year was not considered, due to small sample size.

Figure 1 presents the graphical inspection of distributional changes in children's BMIz, showing a smoothing of the tails representing undernourished children and an increased peak at normality levels. In Figure 2 the estimated effect of intervention is represented, showing improvement in children status within the three years period , in particular in the tails of the distribution. Same results can be seen in Figure 3, where the curves identify a constant improvement in children health status, with the progressive deviation from the baseline condition during the three years.

Table 1 - Crude characteristics of the sample. Data are percentages (absolute numbers) for categorical variables and I quartile/median/III quartile for continuous variables

	Baseline	1 year	2 years	3 years
	(N=259)	(N=221)	(N=151)	(N=67)
Sex:	55% (143)	55% (143)	55% (143)	55% (143)
Age (months)	41.52772/ 77.96304/111.96715	41.52772/ 77.96304/111.96715	41.52772/ 77.96304/111.96715	41.52772/ 77.96304/111.96715
Weight (kg)	14.800/20.800/28.600	16.125/22.800/30.900	19.500/24.900/33.900	22.000/28.400/40.000
Height (cm)	98.000/114.000/128.250	103.000/119.000/132.000	111.000/125.000/136.000	118.000/129.000/145.000
BMIcrude	15.45684/16.30724/17.55870	15.35786/16.37755/17.65505	15.44593/16.39236/18.12790	15.83769/17.13967/18.73960
BMIzeta	-0.4050/ 0.2200/ 0.8650	-0.3100/ 0.2000/ 0.9200	-0.4200/ 0.0250/ 0.6750	-0.3375/ 0.0700/ 0.8250
Wzeta	-1.1900/-0.6600/ 0.1600	-1.0375/-0.4300/ 0.1850	-1.3000/-0.5100/ 0.1800	-1.2700/-0.6700/-0.1200
Hzeta	-1.8200/-1.2800/-0.6350	-1.8300/-1.2600/-0.5700	-1.8650/-1.2150/-0.5850	-2.0275/-1.4150/-0.8950

Table 2 - Summary statistics for the location/shape decomposition of the relative distribution of BMI z-scores after one, two and three years after the beginning of the intervention, compared with baseline

Entropy measures	1 year				2 years				3 years			
overall change in BMI z score	2.252				4.688				4.688			
median effect	1.142				2.385				2.385			
shape effect	1.111				2.303				2.303			
% due to median	50.686				50.884				50.884			
% due to shape	49.314				49.116				49.116			
Polarization Index	Estimate	95% C.I.		P-value	Estimate	95% C.I.		P-value	Estimate	95% C.I.		P-value
Median Index	-0.005	-0.141	0.131	0.473	-0.031	-0.174	0.113	0.339	-0.086	-0.250	0.078	0.152
Lower Index	-0.088	-0.355	0.180	0.261	-0.069	-0.354	0.216	0.317	-0.201	-0.517	0.116	0.107
Upper Index	0.079	-0.192	0.351	0.283	0.008	-0.282	0.298	0.478	0.029	-0.299	0.356	0.432

Table 3 - Prevalence rates of adjusted BMI scores at baseline, at 1 year and 2 years after the intervention. Data are not presented after 3 years since intervention because of too small sample size

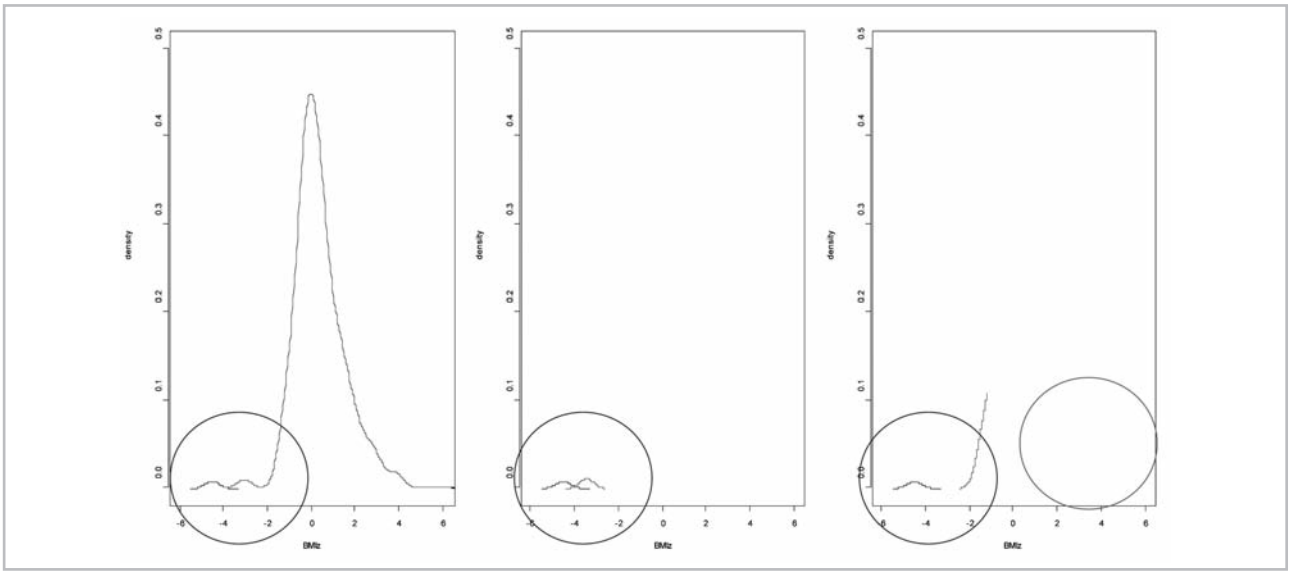
Age	% < -3 SD	95%	C.I.	% < -2 SD	95%	C.I.	% > +1 SD	95%	C.I.	% > +2 SD	95%	C.I.	% > +3 SD	95%	C.I.	Mean	SD
Baseline																	
5	0	0	2.3	0	0	2.3	27.3	6.4	48.2	13.6	0	30.2	9.1	0	23.4	0.7	1.28
6	0	0	3.6	0	0	3.6	7.1	0	24.2	0	0	3.6	0	0	3.6	0.2	0.74
7	4	0	13.7	4	0	13.7	24	5.3	42.7	8	0	20.6	0	0	2	0.23	1.46
8	0	0	3.1	0	0	3.1	6.3	0	21.2	6.3	0	21.2	0	0	3.1	0.07	0.92
9	0	0	2.5	0	0	2.5	15	0	33.1	10	0	25.6	0	0	2.5	0.14	1.07
10	0	0	3.3	0	0	3.3	33.3	6.1	60.5	20	0	43.6	0	0	3.3	0.69	1.12
11	0	0	5	0	0	5	10	0	33.6	0	0	5	0	0	5	0.19	0.67
12	0	0	3.3	0	0	3.3	20	0	43.6	6.7	0	22.6	0	0	3.3	0.45	0.96
1 year																	
5	0	0	3.3	0	0	3.3	20	0	43.6	6.7	0	22.6	6.7	0	22.6	0.26	1.29
6	0	0	2.5	0	0	2.5	35	11.6	58.4	10	0	25.6	5	0	17.1	0.93	1.07
7	0	0	3.3	0	0	3.3	20	0	43.6	6.7	0	22.6	6.7	0	22.6	0.47	1
8	0	0	2.6	0	0	2.6	15.8	0	34.8	0	0	2.6	0	0	2.6	0.26	0.75
9	0	0	3.3	0	0	3.3	20	0	43.6	13.3	0	33.9	0	0	3.3	0.26	1.01
10	0	0	4.2	0	0	4.2	16.7	0	41.9	8.3	0	28.1	0	0	4.2	0.17	1.09
11	0	0	3.8	0	0	3.8	38.5	8.2	68.8	15.4	0	38.8	0	0	3.8	0.62	1.14
12	0	0	7.1	0	0	7.1	0	0	7.1	0	0	7.1	0	0	7.1	-0.28	0.65
2 years																	
5	0	0	4.2	0	0	4.2	33.3	2.5	64.2	8.3	0	28.1	0	0	4.2	0.58	1.06
6	0	0	4.2	0	0	4.2	33.3	2.5	64.2	0	0	4.2	0	0	4.2	-0.01	1.13
7	0	0	3.8	0	0	3.8	23.1	0	49.8	15.4	0	38.8	7.7	0	26	0.5	1.18
8	0	0	3.8	0	0	3.8	23.1	0	49.8	7.7	0	26	7.7	0	26	0.25	1.07
9	0	0	3.6	0	0	3.6	21.4	0	46.5	0	0	3.6	0	0	3.6	0.18	0.83
10	0	0	4.5	0	0	4.5	9.1	0	30.6	9.1	0	30.6	0	0	4.5	0.04	0.91
11	0	0	5.6	0	0	5.6	0	0	5.6	0	0	5.6	0	0	5.6	-0.52	0.83
12	0	0	5.6	0	0	5.6	22.2	0	54.9	11.1	0	37.2	0	0	5.6	0.24	1.13

Discussion

In September 2000, 191 United Nations member states signed a resolution on reaching by 2015 eight international millennium development goals (MDGs) (19). Among those, the fight against malnutrition is one of the essential points to achieve nearly all of the MDGs. Mexico has shown evident progress preventing children's undernourishment in the last two decades (1, 20), appearing on track to reach the goals (21), although it still accounts for the second highest number of indigents in Latin America (22), mostly allocated in the southern regions of the country (4, 6).

A direct effect of poverty is the lack of resources for children nutrition (23), ending in the development of acute and chronic forms of undernutrition, with long-term physical and intellectual consequence, mostly when malnu-

Figure 1 - Distributional changes after (from left to right) one, two and three years since intervention started. Blue lines are representing the distribution of BMI z-scores after the intervention and the black line the baseline, plotted for convenience of comparison. The nutritional intervention has the effect of smoothing the tails of the distribution, in particular the long left tail, presenting underfed children



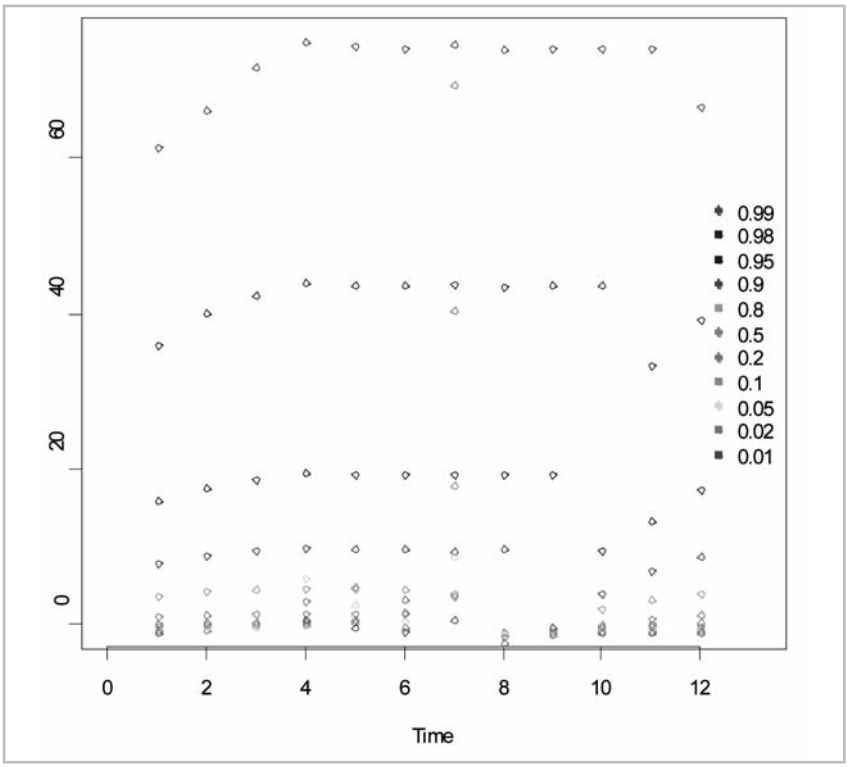
trition occurs in the early years of a child's life (24). During the first five years of life, children set the basis of their lifelong development (25), therefore proper progresses have to be assessed, to ensure efficient intervention at early stages, considering brain's greater plasticity and physiologic development (26). As indicated from Grantham-McGregor when reviewing several works on the effect of severe childhood malnutrition on mental development (27), deficit in intelligence and school performance continued to adolescence compared with control children. Moreover the presence of cognitive and educational deficits in stunted children was an established result (27).

WHO 2006 Growth Charts (11) were chosen in order to assess children's nutritional status, because they appeared to be more appropriate when considering malnutrition, thus allowing a more focused intervention effort and use of resources for targeting programs at infants most at risk of undernutrition (28). BMI z-score were utilized in order to evaluate children's nutritional status compared to the referent population of the same age and gender, as suggested from previous studies on Oaxaca's population (6). Our sample showed an 8% of children presenting with a BMI z-score lower than -2.

Compared to the WHO 2006 growth standards (10), DIJO's children confirmed previous researches held in the same territory (5, 29), showing lower BMI scores, especially when considering younger children.

The main effect seen after the intervention of DIJO's group was a switch of the undernourished portion of children towards normal levels. Focusing on Figure 1, the three years nutritional intervention, not only increased the portion of children setting around normal BMI scores, but smoothened the tails of BMI dis-

Figure 2 - Estimated effect of intervention since start (time unit: trimester via expectile regression functions



tribution, especially on those that were presenting the most problematic nutritional status.

Considering the short term and long term effects of nutrient's insufficiency, several programs have targeted growth promotion (30), showing greater results when children could profit not only from improved nutrition but also from improved learning opportunities in the earliest years of life (31, 32). In addition, growth potential is similar across countries, and stunting in early childhood is caused by poor nutrition and infection rather than by genetic differences (27).

When analyzing the specific case of Southern Mexico, energy, protein, saturated fat and fiber intakes were the lowest observed in a recent study on energy and nutrient in school-aged children, showing even lower number in the rural context (33).

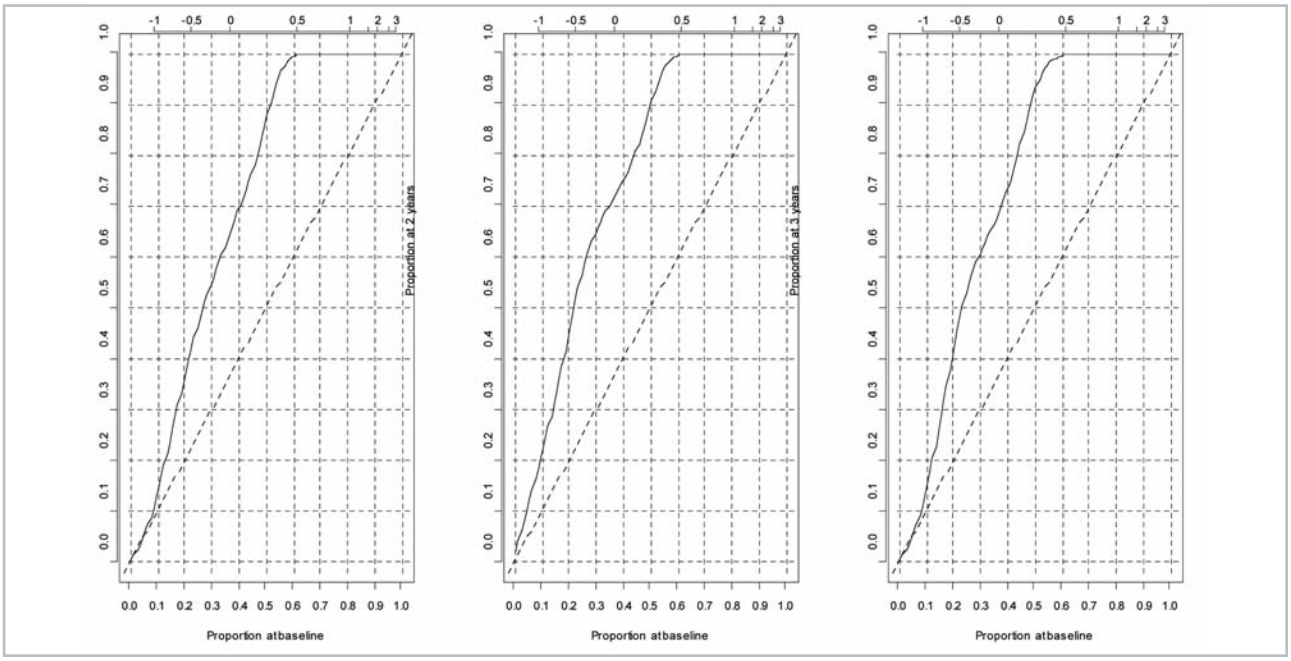
The main focus of Monte Albán community kitchen colony was therefore to provide children afferent to the center with a balanced meal, in order to tackle micronutrients deficit. As shown from results, the effects of the intervention can be shown mainly in two aspects: *i)* the improvement of health status in children starting with the lowest BMI; *ii)* the contribution to regularize children BMI towards normal level during the three year intervention.

Most intervention studies have not addressed local food-based strategies for the prevention of micronutrient deficiencies, although there have been successful educational interventions focused on increased diversity that have shown promising results (34). Actions based on social and cultural fabric of the targeted population are considered as ensuring of optimal safe use of local affordable foods (35), with a higher cost-effective impact (36). Improving children's frequency to the centre showed an increase in the proportion of children setting around normal nutrition level, with a movement towards healthier status within the years.

Although the study assessed only the physical development in children, who were attending the community kitchen, data showed how growth status is consistently regularized and wealth pursued during the intervention, granting physical stability to the children.

In conclusion, the lack of basic nutrients for child's development lead to a low mental ability and to a social distress. For this reason, since the first years of life, a varied

Figure 3 - Relative distribution (Cumulative distribution Function) of BMI z-scores at baseline and (from left to right) respectively 1, 2 and 3 years since intervention started



diet that guarantees a suitable intake of all the essentials constituent for children growth, is necessary. Further studies in this community should match the growth status to the cognitive developmental assessment, to give further insights on the potential efficacy of community based program in reaching the MDGs.

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