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Effectiveness of a supplementary feeding program in child weight gain

ABSTRACT

OBJECTIVE: To evaluate the effectiveness of a governmental supplementary feeding program in child weight gain.

METHODS: A cohort study including secondary data on 25,433 low-income children aged between six and 24 months, participating in a fortified milk distribution program known as Projeto Vivaleite, was performed in the state of São Paulo, Southeastern Brazil, between 2003 and 2008. Weight gain was measured using weight-for-age z-score values, calculated according to the World Health Organization standards (2007). These values were obtained in the program routine, when a child started it and every four months during their stay. Children were divided into three z-score groups when starting the program: weight gain not compromised ($z>-1$); risk of low weight ($-2\leq z<-1$); and low weight ($z<-2$). Multilevel linear regression (mixed model) was used, enabling the comparison, at each age, of adjusted mean z-scores between children starting the program and those who had been participating for at least four months, adjusted for correlation between repeated measurements.

RESULTS: The program had a positive effect on child weight gain, varying according to child nutritional status when starting this program; among those who started it with weight gain not compromised, the mean adjusted gain z-score was 0.183; among those with risk of low weight, 0.566; and among those with low weight, 1.005.

CONCLUSIONS: The program is effective for weight gain in children younger than two years, with a more pronounced effect on children who start the program under less favorable weight conditions.

DESCRIPTORS: Infant Nutrition. Supplementary Feeding, supply & distribution. Nutrition Rehabilitation. Program Evaluation. Nutrition Programs. Multilevel Analysis. Cohort Studies.

INTRODUCTION

Historically, food distribution to vulnerable population groups is a strategy adopted to improve living and health conditions in developing countries, although the literature shows controversial debates on the effectiveness of such action. In this context, there are also supplementary feeding programs to distribute fortified foods, performed worldwide to prevent nutritional deficiencies in more vulnerable groups.[1,15]

Despite the prevalence of child malnourishment in Brazil tending to decrease, this situation is still worrisome in populations with lower socioeconomic

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characteristics,[2,a] because poverty is closely associated with restrictions of access to adequate feeding and health care, resulting in higher nutritional risk.[b]

Brazil is one of the countries that signed the document entitled "A World Fit for Children", where the child health goals to be achieved by 2015 are defined. Among these, it should be emphasized the commitment to the reduction in the prevalence of malnourishment in children younger than five years, especially in those younger than two years.[c] Thus, the assessment of effectiveness of public policies, developed to improve child nutritional conditions, becomes a key instrument to identify the potential of such programs.

In the state of São Paulo, public policies of milk distribution to reduce child malnourishment indices date back to the 1950s and they have changed throughout the years. As an example, the product distributed changed from powdered modified milk to powdered whole milk, from this to fluid whole milk, and at last, in 1999, to fortified fluid milk.[d]

The Projeto Estadual do Leite (Vivaleite[e] – State Milk Project) was established in 1999, under the coordination of the State Department of Agriculture and Supply, aiming to improve the nutritional conditions of low-income children and simultaneously help the flow of milk production from small producers in the state. This project serves approximately 620,000 children annually in the entire state of São Paulo, through the distribution of pasteurized and fortified fluid milk, using an annual fund of 150,000 million *reais* (US$ 85 million), included in the state budget for health. In the countryside of the state of São Paulo, 300,000 children are served, distributed in 606 cities. The criteria to participate in the program are to be aged between six months and six years and to have a family income of up to two minimum wages, while prioritizing those younger than two years.

In 2003, The Department of Agriculture and Supply formed a team of nutritionists to coordinate the anthropometric follow-up of participating children in the countryside, which, although provided for in the program conception, was not performed in the cities, where activities were restricted to milk distribution. Since then, this program has maintained a database with follow-up anthropometric measurements of participating children.

The present study aimed to evaluate the effectiveness of the governmental supplementary feeding program in child weight gain.

METHODS

A cohort study was performed with secondary data on children aged from six to 24 months, from families with a monthly income lower than two minimum wages, living in 311 cities of the countryside of the state of São Paulo, Southeastern Brazil, who began to participate in the Projeto Vivaleite supplementary feeding program, between January 2003 and September 2008.

The criteria of inclusion were as follows: to be aged between six and 24 months, not to have reported health problems, not to have had diarrhea in the last 15 days, not to have been hospitalized in the last three months, not to be a twin, to have completed the information about all the variables of the program registration file, and to have at least two weight measurements taken, including one upon registration.

During the period evaluated, a total of 90,940 children, aged less than 21 months, were registered with the program. Of these, 32% had reported health problems, diarrhea or hospitalization upon registration; 2% were twins; 18% had responsible adults who could not inform the child's weight at birth and exclusive maternal breastfeeding; and 20% were children who had recently registered with the program (length of time lower than four months), thus including only the first weight measurement.

The choice was for the exclusion from the analysis of children who did not have complete data (basically related to the information about weight at birth and exclusive maternal breastfeeding). Comparisons were made between the nutritional characteristics of these children, upon registration, and those of the children included in this study; no significant differences were observed. Thus, the final sample was comprised of 25,433 children living in 311 cities.

In the countryside of the state of São Paulo, the program has determined that children should be weighed and measured upon registration and at every four months, during their stay; data obtained are input to an online computer system, generating a child follow-up database. The availability of data used in the comparisons followed the dynamics outlined in Table 1. The existence of data on weight obtained in a certain age enables the comparison of the indicator, according to participation (those registering and participants), adjusted for measurements repeated in the same individual.

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[a] Ministério da Saúde. Pesquisa Nacional de Demografia e Saúde da Criança e da Mulher - PNDS 2006: relatório final. Brasília; 2008[cited 2008 Oct 1]. Available from: http://www.saude.gov.br/pnds2006

[b] Fundo das Nações Unidas para a Infância. Situação da Infância Brasileira: Desnutrição. Brasília; 2006[cited 2008 Oct 2]. Available from: http://www.unicef.org/brazil

[c] United Nations. Milenium declaration: development goals. New York; 2000.

[d] Stefanini MLR, Lerner BR, Lei DLM, Chaves SP. Fome e política: história, implantação, desenvolvimento, avaliação de um programa federal de suplementação alimentar no Estado de São Paulo. São Paulo: Instituto de Saúde; 1994. (Série Políticas Públicas em Saúde, 1).

[e] Governo do Estado de São Paulo. Decreto n. 45.014 de 28 de junho de 2000. Altera o Decreto n.44.569, de 22 de dezembro de 1999, que instituiu o Projeto Estadual do Leite "Vivaleite". *Diario Oficial Estado Sao Paulo*. 28 jun 2000;Seção I:Página 4.

Data on the characteristics of both children (breast-feeding, weight and height at birth, use of day care center/school, weight and height at every four months) and mothers (age, level of education, marital status, work, income) are recorded in the program registration files and also input to an online system. Such system has data entry filters, with the purpose of minimizing the entry of inconsistent information.

As part of the program routine, all city managers receive periodical training and are instructed to obtain data in the interview with the mother/responsible adult, when child (birth certificate and vaccination card) and adult identification (proof of income and residence and identification card) must be provided. Weight and height measurements must be taken by properly trained professionals in primary health units, using adequate calibrated equipment; it is recommended that children with a diagnosis of weight for age out of the eutrophic range be sent for pediatric care.

The volume of milk distributed is 15 liters/month per participating child, which is equivalent to 500 mL/day. This milk is delivered three times a week in locations established by the municipal government. The milk delivered is fluid, whole, pasteurized, fortified with iron and vitamins A and D, meeting 28% of a child's daily caloric requirements (300 kcal), 38% of proteins (15 g), 63% of iron, 75% of vitamin A and 100% of calcium and vitamin D in children aged from one to three years.

Milk is purchased by the State of São Paulo Department of Agriculture through public tender; hired milk factories deliver this milk to locations designated by municipal governments registered with the program, which are responsible for the registration, distribution and follow-up of participants' nutritional status.

The term effectiveness used here refers to the effect achieved by the intervention resulting from operation-alization, in a real, non-controlled situation,[4] a type of approach which is relevant in the area of public health, according to Victora[18] (2002). The response variable used to evaluate program effectiveness during growth was the z-score of the WA (weight-for-age) indicator, calculated according to the new growth curves.[3] Children (n= 748) who had a z-score out of the $-5<z<+5$ interval, in any measurement, were excluded.[19] The utilization of the WA z-score indicator was considered more adequate, because secondary data collected in the routine of primary health units were used and because the effect of the program on the nutritional status of children younger than two years was expected to be evaluated. Weight is a more sensitive body measure than height, once short-term food restrictions readily reduce their values, something that does not occur with height; weight deficits can also be more quickly corrected with adequate dietary changes than those associated with height.[19] Moreover, it is common to find problems in the routine of health services when applying adequate techniques to collect height and weight measurements of children,[17] often restricting the evaluations resulting from these contexts to the use of the WA indicator.

The main independent variable is the status in the program, categorized into 0="registering" or 1="participating". All anthropometric measurements obtained upon registration (first weight measurement) were used as control measures, because children are not receiving supplementary feeding yet, serving as baseline to evaluate participants' growth.

Upon registration, children were divided into three z-score categories to measure the effect of the program, according to their initial nutritional status, with the following being adopted: $z \geq -1$, "weight for age not compromised – WNC"; $-2 \leq z < -1$, "with risk of low weight – RLW"; and $z < -2$, "low weight – LW". These categories were treated as dummy variables (1="yes", 0="no") in the model.

Child age in the weight measurements was included in the model to control its effect on z-score variations. Age was used in its continuous form, "centralized", by subtracting six months from all ages to begin in the zero (0) reference position, corresponding to the actual age minus six months. It was considered convenient, after preliminary inspection, to include the square of the centralized age, enabling a better approximation to the z-score trend, according to the advancement of age of children.

A model using mixed (multilevel) linear regression was developed to adequately explore the hierarchical structure of data, implying the existence of a correlation in the measurements of the same child throughout time and in those of children from the same city.[6,20] A total of three hierarchical levels were considered: 1) ages in the weight measurements (i), nested in each child; 2) children (j), nested in cities; 3) cities (k).

The crude effects of the program were measured in the total sample and separately for each z-score category upon registration and the differences of mean effects between categories of nutritional status upon registration, adopting the WNC group as reference. With the complete model, adjusted z-score values were obtained for all combinations (age, category upon registration and status in the program), enabling the construction of curves and their respective confidence intervals. A significance level of $\alpha = 5\%$ was adopted. Data processing was performed with the Stata software, version 10.1, using the xtmixed command for the multilevel model. For the effect of completion, the equations of the crude and complete models and the Stata command for the complete model are shown as follows:

Crude model
zWA = $\beta_0 + \beta_1$ program
Complete model
zWA = $\beta_0 + \beta_1$ age+ β_2 ^{age2} + β_3 program + β_4 programXage + β_5 RLW + $\beta_6$ageXRLW + β_7 programXRLW + β_8 programXageXRLW + β_9 LW + β_{10} ageXLW + β_{11} programXLW + β_{12}programXageXLW
"X" indicates interaction

xtmixed zWA age age2 program programXage RLW ageXRLW programXRLW programXageXRLW LW ageXLW programXLW programXageXLW ||city:||child: age, cov(unstructured) ml

where:

zWA = adjusted mean z-score of weight for age (WA).

β_0, β_5, β_9 = correspond to the adjusted mean z-score, when the program and age variables are equal to zero (0), of children who registered with their weight not compromised (reference category), with risk of low weight and with low weight, respectively.

β_1, β_6 e β_{10} = β_1 is the z-score variation (including those registering and participants) at each month, when age increases in the reference group (WNC); β_6 is the difference between the z-score variation in the age in the RLW group and the variation measured in the WNC group (β_1); β_{10} is the difference between the z-score variation in the age in the LW group and the variation measured in the WNC group (β_1).

β_2= indicates whether the evolution of z-score in the age occurs as an ascending (+) or descending parabola (-) and the intensity of such evolution.

β_3, β_7, β_{11} = β_3 is the effect of the program (difference of z-score between participants and those registering) on the reference category (WNC); β_7 is the difference between the effect of the program on the RLW group and the effect on the WNC group (β_3); β_{11} is the difference between the effect of the program on the RLW group and the effect on the WNC group (β_3).

β_4, β_8, β_{12} = β_4 is the effect of the program (difference in z-score between participants and those registering) on the age in the reference category (WNC); β_8 is the difference between the effect of the program on the RLW group and the effect on the WNC group (β_4); β_{12} is the difference between the effect of the program on the age in the RLW group and the effect on the WNC group (β_4).

The present study was approved by the Research Ethics Committee of the Faculdade de Saúde Pública da Universidade de São Paulo (Process 1905 of February 18th, 2009).

RESULTS

The analysis of characteristics of children when registering with the program revealed that they were equally distributed according to sex, the majority of whom did not use a day care center or school; had not been exclusively breastfed until the age of six months; were not being breastfed; were eutrophic; and were cared for

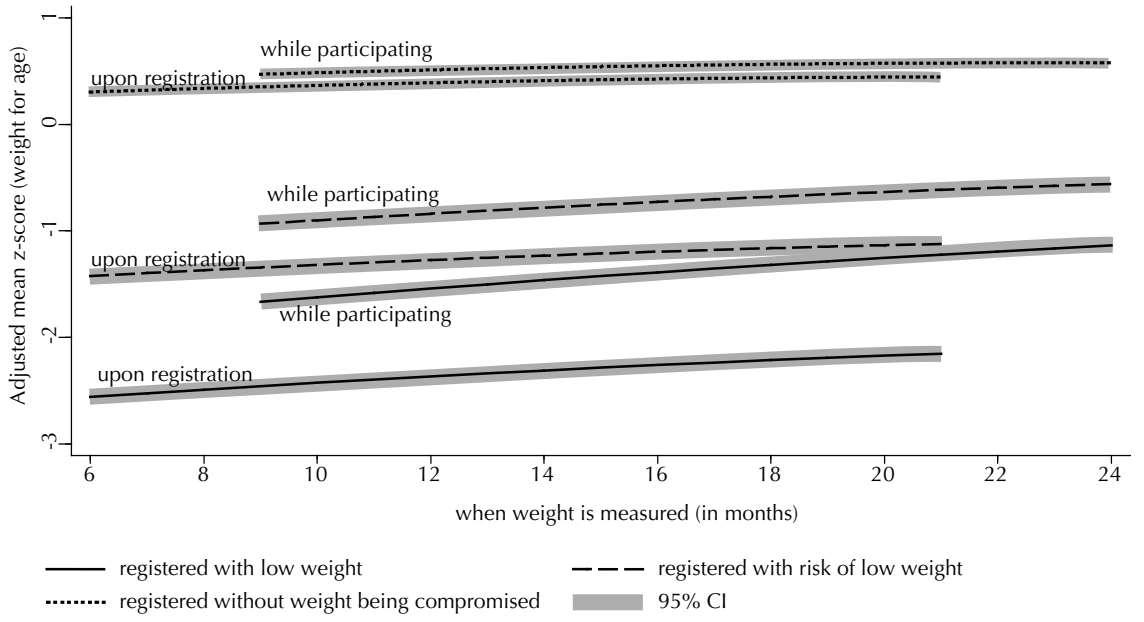

Figure 1. Comparison of z-score upon registration and while participating in the program for four months or more, according to age when weight is measured. State of São Paulo, Southeastern Brazil, 2003-2008.

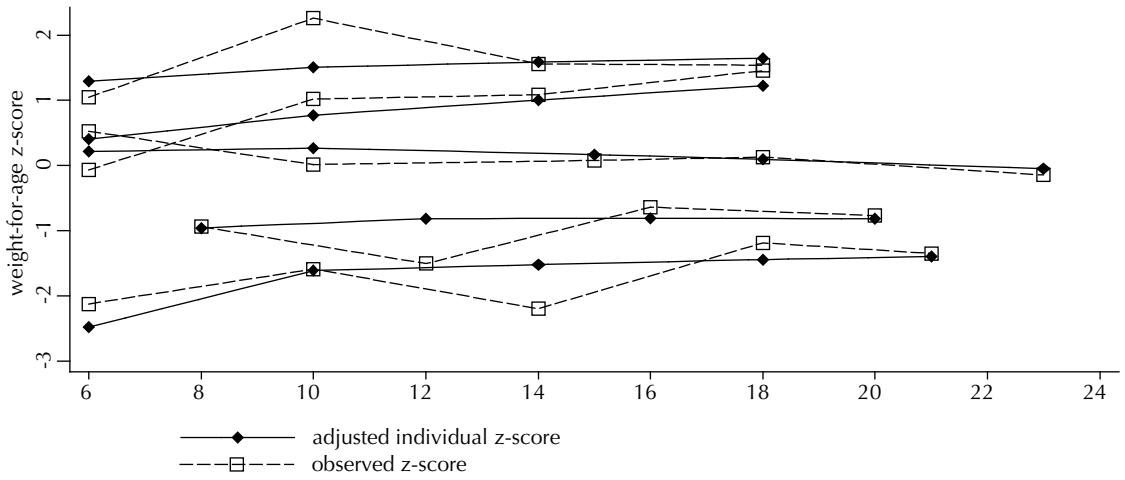

Figure 2. Illustration of adjustments made by the multilevel model. State of São Paulo, Southeastern Brazil, 2003-2008.

their own mothers, most of whom did not have a paid job (Table 2). Mean weight at birth was 3,200 g, with a prevalence of 7.2% of low weight at birth. It could be observed that the majority of children belonged to families with five individuals or more and with a per capita income of less than ¼ of a minimum wage. Among the maternal characteristics, approximately ¼ of the mothers were adolescents, had less than five years of education and did not have a partner. With regard to the nutritional status when registering with the program, about 18% of children had their weight compromised.

Table 3 shows the mean differences in z-score used to verify the effectiveness of the program, in the total sample and also separately, according to categories of

Table 1. Distribution of children, according to age when weight was measured and time of this measurement. State of São Paulo, Southeastern Brazil, 2003-2008.

Age when weight was measured (months)	Measurement				
	First	Second	Third	Fourth	Fifth
6	8,731	0	0	0	0
7	4,230	0	0	0	0
8	2,698	0	0	0	0
9	1,961	1,470	0	0	0
10	1,416	5,447	0	0	0
11	1,201	3,954	0	0	0
12	942	2,372	0	0	0
13	788	1,718	1,228	0	0
14	643	1,262	4,440	0	0
15	694	1,012	3,169	0	0
16	526	833	1,840	0	0
17	488	740	1,276	1,003	0
18	413	599	985	3,957	0
19	360	579	726	2,675	0
20	293	501	623	1,670	0
21	49	458	527	1,148	874
22	0	430	483	832	3,477
23	0	363	437	657	2,297
24	0	361	360	553	1,365
22	0	430	483	832	3,477
Total	25,433	22,099	16,094	12,495	8,013

nutritional status upon registration. In the total sample, children who participated in the program, regardless of their nutritional status upon registration, showed a weight-for-age z-score significantly higher than that of non-participating children, with a mean difference of 0.263 z-score units.

In the three categories of nutritional status upon registration, participation in the program led to weight gain, with a z-score of 1.005 in participants who registered with low weight, 0.566 in those with risk of low weight and 0.183 in those whose weight was not compromised. Comparison among effects, expressed by the coefficients of interactions between program and category of nutritional status in the complete model, indicated significant differences, enabling one to affirm that the greater the amount of weight being compromised upon registration, the higher the effect of the program.

The complete model shows the adjusted effect of the program in the WNC category, a z-score of 0.115. The sum of this effect with the coefficient of the programXRLWR variable (0.271) results in the effect of the program on the RLW category, a z-score of 0.386. Following the same reasoning, the effect of the LW category is obtained, a z-score of 0.755.

The verification of z-score variation in the age, in both participants and those registering, showed that an increase in age resulted in an increase in z-score (age, ageXRLW, ageXLW) in all categories of nutritional status.

The statistical significance of the square of age indicated curves with a parabolic behavior, probably reflecting the normal growth pattern.

The differences between z-score variations in the age of those registering and participants, in the RLW and LW groups (programXageXRLW and programXageXLW), were found to be significant, indicating that the effect of the program in these categories increased with age; in contrast, in the WNC group, the effect of the program was similar in all ages.

The effect of the program in each category of nutritional status and its variations with age can be observed in Figure 1.

The comparison between the effects of the program on age, measured in each category of nutritional status, is expressed by the program, age and nutritional status interactions, indicating that the effect of the program did not vary according to age in both children registering without their weight compromised and those registering with low weight. This effect increased with the increase in age in the group of children with nutritional risk upon registration. Figure 1 shows this behavior, showing that the curves upon registration and

Table 2. Distribution of children, according to socio-demographic characteristics and health conditions. State of São Paulo, Southeastern Brazil, 2003-2008. (N= 25,433)

Variable	%
Sex	
Male	50.1
Female	49.9
Weight at birth	
< 2,500g	7.2
≥ 2,500g	92.8
Exclusive breastfeeding at six months	
Yes	26.3
No	73.7
Breastfeeding when registering with the program	
Yes	45.3
No	54.7
Use of a day care center or school	
Yes	6
No	93.8
Nutritional status (weight-for-age z-score) when registering	
Low weight	3.3
Risk of low weight	14.3
Weight not compromised	82.4
Number of weight measurements taken	
2	33.7
3	23.2
4	21.8
5	21.3
Residents in the household	
2|- 4	33.3
5|- 6	46.5
6|- or more	20.2
Age of mother/responsible adult (in years)	
<20 (adolescents)	22.6
≥ 20 (non-adolescents)	77.4
Level of education of mother/responsible adult (in years of education)	
0|- 5	19.8
5|- 9	37.1
9|- or more	43.4
Per capita income (in minimum wages)	
< 0.25	49
0.25 |- 0.5	43.7
≥ 0.5	7.4
Work of mother/responsible adult	
Yes	18.6
No	81.4
Marital status	
With a partner	75.7
Without a partner	24.3

Table 3. Mean weight-for-age z-score differences in participants and children registering, in the total sample and in categories of nutritional status upon registration, obtained from (crude and adjusted) multilevel models. State of São Paulo, Southeastern Brazil, 2003-2008. (N= 25,433).

Variable		Coef.	IC 95%
Total sample (n=25.433)			
Constant		0.038	0.013;-0.062
Status in the Vivaleite (program)	Upon registration (ref.)	0	
	While participating	0.263	0.255;0.271
Weight not compromised upon registration (n=20,967)			
Constant		0.356	0.336;0.376
Status in the Vivaleite (program)	Upon registration (ref.)	0	
	While participating	0.183	0.175;0.191
Risk of low weight upon registration (n=3,631)			
Constant		-1.408	-1.427;-1.340
Status in the Vivaleite (program)	Upon registration (ref.)	0	
	While participating	0.566	0.546;0.586
Low weight upon registration (n=835)			
Constant		-2.533	-2.583;-2.484
Status in the Vivaleite (program)	Upon registration (ref.)	0	
	While participating	1.005	0.954;1.056
Complete model (n=25,433)			
Constant		0.306	0.286;0.325
Age (in months) when weight was measured		0.018	0.144;0.210
Square of the age (in months) when weight was measured		-0.001	-0.001;-0.000
Status in the Vivaleite (program)	Upon registration (ref.)	0	
	While participating	0.115	0.093;0.137
Risk of low weight upon registration (RLWR)	No (ref)	0	
	Yes	-1.729	-1.763;-1.696
Low weight upon registration (LW)	No (ref)	0	
	Yes	-2.864	-2.930;-2.798
Program X RLW (a)		0.271	0.239;0.304
Program X LW (b)		0.640	0.576;0.704
Lincom a- b		0.369	0.299;0.438
Program X age*		0.001	-0.002;0.004
Age X RLW (c)		0.011	0.005;0.017
Age X LW (d)		0.018	0.006;0.029
Lincom c-d*		-0.007	-0.020;0.006
Program X age X RLW (e)		0.007	0.001;0.013
Program X age X LW* (f)		0.017	-0.001;0.022
Licom e-f*		0.004	-0.009;0.016
Parameters of random effects			
City level			
sd (_cons)		0.09	0.07;0.11
Child level : without structure			
sd (age when weight was measured)		0.04	0.04;0.05
sd (_cons)		0.71	0.69;0.72
corr (criidadpes0,const)		-0.13	-0.16;-0.11
sd (residue)		0.42	0.42;0.43

* p>0.05

participation of children who start the program with a nutritional risk become more distant from one another with the increase in age.

The comparison of the effects of the program with the increase in age, in each category of nutritional status, is shown in the curves of Figure 1, obtained from the complete model. It can be clearly observed that participating children who registered with risk of low weight and low weight increased their weight-for-age indices significantly on average. The behavior of these curves illustrates the magnitude of the effect of the program, especially among those who start the program with a worse nutritional status. Figure 2 shows, as an example, the z-scores observed in five children and the respective values adjusted due to the multilevel model.

DISCUSSION

The Vivaleite Project is effective for weight gain in children younger than two years, once children exposed to the program (participants) show higher mean z-scores of weight-for-age than those not exposed (those registering), an effect which is directly proportional to the level of nutritional deficiency upon registration.

The results of the present investigation are in agreement with other studies that evaluate supplementary feeding programs[2,5,7,8,10,16,f] and verify the positive impact of such programs on the growth of participating children. Although these other programs have characteristics that are different from those of the Vivaleite Project and the evaluations involved other methods of analysis, including the use of distinct anthropometric indicators and reference growth standards, the results converge to the conclusion that participation in supplementary feeding programs leads to an improvement in anthropometric indicators of participating children. A similar aspect of such programs is the combination of supplementary feeding and primary health actions, such as immunizations and routine anthropometric follow-up. Literature reviews[1,14] point to better results from supplementary feeding programs combined with health actions, others[11] indicate that results are at times irrelevant, when supplementary feeding is seen as mere food distribution.

The greatest effects found in children whose nutritional status is more compromised, upon registration, were also observed in other studies[1,2,7,13,14] and are consistent with the reasoning of biological plausibility: children with a poorer nutritional status improve more.

The literature[9] establishes some important questions so that studies that compare intervention group and control group are valid. Validity will be guaranteed when there are similar groups and control of confounding factors.

The present study measured the effect of the program on the growth of participating children, using children registering with this program as comparison group (children not exposed to any project actions and not consuming supplementary feeding yet). Thus, this study sought to control the effect of the following factors, which were external to the program and could be associated with child growth: 1) biological characteristics at birth did not differ between participants and those registering, once anthropometric data from the same child, obtained at different moments, were used; 2) socioeconomic conditions were not significantly changed during the observation period. Thus, the possibility of a child, whose family has an income higher than two minimum wages, staying in the program is minimal, due to the criterion of permanence established by decree, which is monitored by the municipal government and indirectly controlled by the families on the waiting list; 3) the effect of age was controlled by the use of the weight-for-age z-score and by the comparison between mean z-scores of participants and those of children registering with the program, in children of the same age; and 4) the possibility of seasonal influence was excluded, once registration with the program occurred throughout the entire observation period.

The statistical analysis technique used also helped to control such factors, because it considers the possible correlations existing among individuals living in one location and among repeated measurements of one individual.

In addition to factors that were sought to be controlled, it is understood that studies on intervention actions in populations are subject to other problems, such as supplement intrafamilial dilution and lack of awareness of participants' actions, among other things. A study on effectiveness like the present one implies this situation, although revealing results from the actual dynamics of the target population, in a well-defined context of public health. Thus, the results of this evaluation translate into the effectiveness of the Vivaleite Project, under actual and usual functioning conditions.

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