


An Educational Intervention to Mothers Improved the Nutritional Status of Mexican Children Younger Than 5 Years Old With Mild to Moderate Malnutrition

Global Pediatric Health
Volume 6: 1–9
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DOI: 10.1177/2333794X19884827
journals.sagepub.com/home/gph


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Abstract

Malnutrition in children younger than 5 years old has persisted in time (13.5% in 1988 to 12.3% in 2012) in Mexico City. A quasi-experimental study was performed. An educational intervention was given twice a month for 6 months to mothers of mild to moderate malnourished children 1 to 5 years old. Weight, height, and body mass index of the children were obtained at the beginning and 3 and 6 months after the intervention. Thirteen mothers and 15 children were included. The baseline mean weight/age in Z score was -1.49 ± 0.65 , which improved to -1.19 ± 0.60 ($P = 0.001$; per protocol analysis). Linear regression analysis showed a P of 0.006 of the mothers' adherence to improve children's weight. The educational intervention decreased the weight deficit after 6 months with the same economic resources of the family; hence, the adherence of the mothers to the educational intervention is relevant to improve the nutritional status of their children.

Keywords

malnutrition, children, nutrition education

Received February 12, 2019. Received revised August 7, 2019. Accepted for publication September 13, 2019.

Introduction

Mexico is a country of great contrasts in food matters; on the one hand, the obesity epidemic, and on the other, childhood malnutrition.¹

Malnutrition has negative effects on different dimensions of people's lives, such as their educational or professional development, as well as on their economy and productivity, which lead to problems of social insertion and increase of poverty in the population reproducing the vicious circle and being more vulnerable to this disease. Malnutrition is a disease that is caused by the lack of essential nutrients for life that is characterized by the decrease of the mass and body volume of the individual with regard to their age and their height. The most serious effect of malnutrition on children younger than 5 years old is the increase of the risk of death and functions, loss of language ability, motor capacity, and finally failure in cardiac and neurological systems. Children with malnutrition lose

between 12% and 15% of their intellectual potential, they run a risk of contracting infectious diseases 8 to 12 times more than does a healthy child, and are more prone to suffer chronic degenerative diseases since it causes an immunosuppressive effect that predisposes patients to frequent infections^{3,4}.

Malnutrition is classified as acute or severe according to the time of exposure to the disease, and as mild, moderate, and severe according to the degree of intensity.

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Growth retardation is a reflection of the negative effects accumulated through time. According to the National Health Survey in 2012 (ENSANUT [Encuesta Nacional de Salud y Nutrición]), this delay in linear growth had a decrease in rural areas, from 26.9% in 1988 to 13.6% in 2012. However, the prevalence of low height in Mexican children has not changed since 1988 with 13% to 12.3% in 2012.² Having a low height for age is considered as chronic malnutrition that has been classified as mild or moderate according to the World Health Organization Z score (WHO Z score). Due to the few clinical manifestations of mild and moderate malnutrition, it is poorly identified and is often underestimated.³⁻⁵ Therefore, dynamic anthropometry is the only way to detect these patients.⁶ Mild and moderate forms are the most prevalent in Mexico City and should be detected, prevented, and treated in time to prevent them from evolving into severe malnutrition and severely compromising the health of individuals.

The suggested treatment for children with mild and moderate malnutrition involves different areas simultaneously, including pediatric and psychological treatment and food security programs, and recently nutrition education has been proposed as an effective strategy because it is viable, economic, and sustainable, but in our country its effectiveness has not yet been proven.⁷ Currently, it has been proposed that action-oriented nutrition education is more effective than traditional programs.^{7,8} Action-oriented nutrition education is defined as a series of learning practices aimed at facilitating the voluntary adoption of dietary and other behaviors to promote health and well-being.⁹

Different systematic reviews and studies conducted in Africa and Asia report the effect of various educational interventions. A systematic review of published randomized and quasi-randomized trials on PubMed, Cochrane Library, and WHO regional databases was conducted in Pakistan in 2011.¹⁵ The primary outcomes were change in weight and height during the study period among malnourished children 6 to 24 months of age. They hypothesized that provision of complementary food and education of mother about it would significantly improve the nutritional status of the children in the intervention group compared with that of the control group. They concluded that provision of appropriate complementary food (with or without nutritional education) and maternal nutritional counseling alone lead to significant increase in weight and height in malnourished children. In Malawi, in 2014, another systematic review was conducted to analyze the effectiveness of community-based nutrition education on the nutrition status of under-5 children in developing countries.¹¹

A search of the literature was conducted using different databases, such as CINAHL (Cumulative Index to Nursing and Allied Health Literature), EMBASE, Medline, and Web of Knowledge, and 9 studies were identified for the critical appraisal process. They concluded that the evidence from the identified studies suggests that community-based nutrition education improves the nutrition status of under-5 children in developing countries.^{10,12,14,16} They suggested that malnourished children cannot receive the same nutrition intervention as healthy children can;¹¹ that the educational intervention should be appropriate to the initial nutritional status of the child,¹² according to the geographical region and local resources,¹² as well as the improvement is dependent on the duration and type of intervention.^{10,11,12,14,15,16}

In Mexico, it has not been possible to measure the effectiveness of this strategy on its own, since it is usually part of large integral programs such as Prospera. There are 2 ways to transmit knowledge about nutrition: (1) through nutrition counseling of messages in one single moment and (2) through a formal education system. Nowadays, the Food and Agriculture Organization supports that nutrition education follows a systematic program with a defined methodology and has the objective to achieve learning in students and develop their competitiveness over time.⁷ This is in accordance to the Norm-043-SSA (NOM-043) published in the Official Mexican Journal of the Ministry of Health in which the following concepts are defined:

- Health education is a permanent process of teaching and learning that exchanges and analyzes information to develop skills and changes attitudes in students with the purpose of inducing behaviors of health care individually and collectively.
- Nutrition counseling is a set of actions that provides scientifically validated and systematic information with the purpose of developing skills, attitudes, and practices related to food and nutrition based on the correct diet individually or family considering economical, geographical, cultural, and social conditions.

As a result of advances in cognitive psychology, a system about learning called *constructivism* has been developed. It emphasizes that students need to be guided as active knowledge builders capable of solving problems and is viable for any group.

In the aforementioned literature, it is observed that the main differences between interventions that utilize nutrition education and counseling are that in the

educational process there is a systematic methodology with special techniques in which assertive communication and interventions are allowed and need to be evaluated, while nutrition counseling formulates guidelines or specific tools of each country to be used as a support in a presentation and does not need to be evaluated.¹²⁻¹⁶ In the case of Mexico, the feeding guidelines proposed in NOM-043 of the Ministry of Health are used.⁹

Since malnutrition is the underlying cause of half of child mortality in the world, many programs attempt to attend to this issue but there is a lack of evidence on effective ways to decrease child malnutrition.¹⁷ Chronic malnutrition affects the health and development of children seriously, and this has not changed in Mexico City since 1988. It is important to think of a system that focuses on mild and moderate malnutrition in Mexico City and observe if it behaves similarly to the populations of underdeveloped countries in rural areas, that is, risk factors such as inadequate patterns of nutrition, low schooling of parents, lack of hygiene, and food insecurity.¹⁸

In Mexico, there are programs that have been applied to rural populations to treat severe malnutrition. They include food guidance as one of its components; however, the impact of education or food orientation programs on the receiving population could not be evaluated, which prevented to make an objective judgment on the utility of the various efforts, otherwise isolated. Every program, however small, must be evaluated in order to optimize resources.²⁰

After an epidemiological study of respiratory viruses conducted at a Pediatric Hospital in Mexico City, 40% of the patients younger than 5 years old presented mild to moderate malnutrition. We developed a nutritional intervention (called Nutrition Club [NC]) based on education with a constructivist approach to the mothers of these children.

The aim of this study was to evaluate the effect of an educational intervention aimed at mothers of 1- to 5-year-old children with mild to moderate malnutrition on their nutritional status measured with the classification of the WHO Z score for weight/age, height/age, and body mass index (BMI)/age, at a Pediatric Hospital in Mexico City.

Materials and Methods

Study Setting and Population

The study was conducted at a Pediatric Hospital attending children from very low-income families from the South of Mexico City (incomes of 2500 MXN to 4300 MXN according to the National Council for the

Evaluation of Social Development policies [CONEVAL; Consejo Nacional de la Evaluación de la Política de Desarrollo Social, in Spanish). The study population included children from the external consultation of the hospital from 1 to 5 years old with mild to moderate malnutrition according to the WHO Z scores classification of weight for age, height for age, and BMI for age. The mothers who could read and write or could not read and write were invited to participate and signed a written informed consent. Mothers and children with severe malnutrition and with intellectual disabilities or physical congenital abnormalities impairing feeding or physical growth, with chronic degenerative illnesses or heart conditions and serious illnesses that required hospitalization, or were suffering from diseases that predispose to malnutrition were excluded.

Procedures

A quasi-experimental study was performed. A quasi-experimental study is carried out when no comparative group is available, when the baseline is the characteristic to be compared with the result (before and after study), or it is not possible to make a random assignment of the maneuver or a blinded assessment of it.²⁰ This educational intervention was designed by our group; we chose this design to prove the possible effect of the intervention as an exploratory study.

In this study, mothers in the waiting room of the external consultation were invited to have their children with malnutrition to participate in the study. A standardized pediatrician performed the assessment of the children and treatment in case of parasitic or urinary tract infections.

The children were measured without clothes standing on a scale with a capacity of 140 kg for weight and 198 cm for height. The anthropometric indexes were transformed to Z scores using the child WHO AnthroPlus v.1.0.4 app. Children were classified with moderate malnutrition with a Z score from -2 to -3 for weight/age and height/age, mild malnutrition with a Z score from -2 to -1, and children with Z scores <-1 were classified as normal. The anthropometric measures were repeated at 3 and 6 months after the intervention. A blood draw was taken for blood chemistry and blood count; urine test and culture as well as stool examination were performed in each child at the recruitment and at 6 months.

The intervention started with 16 mothers and 18 children according to the sample size estimation. A monthly pantry with beans, rice, oil, lentils, and cornmeal was given to make up for the money they invested for transport to the hospital.

Table 1. Description of the educational intervention.

Concept	Activity	Description
Nutrition Club	Delivered at the hospital to mothers	Sessions of 1 hour every 15 days for 6 months based on the good practices in Information, Communication, and Education Programs in Food and Nutrition (ICEAN). Based on the 4 pillars of the Delors Report. Use of specific food guides of Mexico regulated by NOM-043-SSA.
Nutrition Education Program	The educational method used was the constructivism that focuses on learning and modifies concepts; it is personal, social, effective, and works on the transformation and transmission of knowledge Educational techniques	The design of the Nutrition Education Program was elaborated according to the specifications of an integrated course that promotes meaningful learning according to Dr Lee Fink. Oral presentations, reflective dialogue, case presentation, inverted classroom, and the realization of a portfolio with personal recipes.
Nutrition strategy	Specific menus were designed and adjusted to the family budget and balanced for the correct diet of infants and pre-school children	Caloric and proteins needs were calculated to malnourished children between 1 and 5 years old.

Nutritional Education Intervention

We designed an action-oriented education nutrition program based on a constructivist system directed to a meaningful learning called “Nutrition Club.”^{21,22} It consists of 1-hour sessions every 15 days for 6 months based on the good practices about ICEAN (Information, Communication and Education Programs in Food and Nutrition) for Latin America,²³ in the 4 pillars of the Delors report (report to UNESCO for the education of the XXI century by Jacques Delors),²⁴ and in the nutrition orientation Mexican guides regulated by NOM-043-SSA (Table 1).⁹

Sample Size Calculation and Statistical Analysis

The sample size was estimated using the mean difference formula,¹⁹ considering $Z\alpha = 1.96$, $Z\beta = 0.84$. The main outcome variable was the increase in 0.5 of the WHO Z score for weight/age before and after the intervention. A total of 16 children plus 20% of loss were included. We used paired Student’s *t* test and analysis of variance (ANOVA) to show possible differences in Z score for weight/age, Z score for height/age, and Z score for BMI/age of the children from the beginning to 3 and 6 months after the intervention. Chi-square or Fisher exact test was used to determine the effect of adherence to treatment from the mothers and the comorbidity of the children on their nutritional status. The multivariate model was performed using a multiple linear regression adjusted by children’s age and initial weight, as well as mother’s scholarship, age, number of children, and their

adherence to the intervention. The dependent variable was Z score weight/age at 6 months. The analyses were carried out per protocol (PP) and intention to treat (ITT).

Ethical Approval and Informed Consent

This study was approved by the Ethics and Research Committees of the Hospital Pediatrico de Coyoacan (# 3020010514) and Facultad de Medicina, Universidad Nacional Autónoma de México (# 059/2014). It was conducted in accordance with the standards of research ethics in human subjects of the Helsinki Declaration 1975 and revised in 1983 in addition to the General Law of Health of Mexico in the field of health research. The signed written informed consent to have their children participate in the study and the mothers to attend to the workshops of the Nutrition Club intervention of all parents or guardians of the children participating in the study was obtained.

Results

Thirty-seven mothers of 37 children were interested to participate in the study; 18 children and 16 mothers who met the inclusion criteria were included but only 13 mothers and 15 children completed the intervention. The children had a median age of 30.5 months (interquartile range = 25-49) and 56% were male. The mean \pm standard deviation Z score of weight/age at baseline was -1.42 ± 0.60 , Z score for height/age was -1.69 ± 1.24 , classified as mild malnutrition without any other comorbidity (Table 2). There were no statistically significant differences by sex in terms of age, Z score for

Table 2. Baseline Characteristics of the Children.

Category	Total Children	Boys	Girls	P
Sex, n (%)		10 (56.3)	8 (43.8)	
		Median (IQR)	Median (IQR)	
Age (months)	30.5 (25-49)	28 (20-56.5)	35 (23-45)	1.00*
Weight (kg)		11.3 (9.8-14.9)	11.4 (8.6-12.8)	.837*
Height (cm)		85 (78.2-102.2)	87.5 (78.3-91.5)	.681*
	Mean (SD)	Mean (SD)	Mean (SD)	
Z score weight/age	-1.42 (0.60)	-1.30 (0.41)	-1.53 (0.78)	.466**
Z score height/age	-1.69 (1.24)	-1.34 (0.99)	-2.01 (1.46)	.322**
Z score BMI/age	-0.48 (1.11)	-0.66 (0.98)	-0.36 (1.28)	.603**
		Median (IQR)	Median (IQR)	
Hemoglobin (g/dL)		13.80 (12.8-14.2)	13.85 (10.7-14.3)	.681*
Hematocrit (%)		39.7 (37.2-41.1)	39.9 (31.1-41.5)	.837*
Glucose (mg/dL)		79 (73-80.5)	78.5 (78-85)	.681*
Cholesterol (mg/dL)		145 (106-167)	150.5 (143-164)	.536*
Triglycerides (mg/dL)		74 (51-97)	75 (61-105)	.681*
Total proteins (g/dL)		6.6 (6.5-6.9)	6.8 (6.8-7.0)	.606*
Albumin (g/dL)		4.3 (4.2-4.4)	4.2 (4.15-4.27)	.299*
Globulins (g/dL)		2.5 (2.1-2.7)	2.6 (2.57-2.80)	.252*
AG relation (g/dL)		1.7 (1.6-2.1)	1.6 (1.5-1.6)	.091*
Sodium (mmol/L)		138 (136-140)	138 (137.5-138)	.681*
Potassium (mEq/L)		4.4 (4.3-4.5)	4.3 (4.2-4.57)	.758*
Chlorine (mmol/L)		107 (104-110)	109 (108.2-109.5)	.408*
Calcium (mg/dL)		9.4 (9.4-9.8)	9.8 (9.62-9.85)	.351*
Phosphorus (mg/dL)		5.8 (5.6-6.4)	5.5 (5.15-5.75)	.142*
Magnesium (mg/dL)		2.1 (2.1-2.2)	2.1 (2.0-2.2)	.606*

Abbreviations: IQR, interquartile range; SD, standard deviation; BMI, body mass index.

*Mann-Whitney U test.

**Student's t test.

weight/age, Z score for height/age, Z for BMI/age, or biochemical values. The median age of the mothers was 29 years old, 57% had 1 or 2 children, 43% were married, 57% were housewives, and 71.4% finished middle school (Table 3); no changes were found during the whole intervention.

At the end of the NC, an increase of 0.19 ($P = 0.03$) for Z score weight/age was found in the ITT analysis from -1.42 ± 0.60 , which improved to -1.32 ± 0.56 at 3 months and to -1.23 ± 0.54 at 6 months. A Z score difference for weight/age of 0.30 ($P = 0.001$) was found in the PP analysis from -1.49 ± 0.65 , which improved to -1.31 ± 0.64 at 3 months and to -1.19 ± 0.60 after 6 months.

Using the ANOVA of repeated measurements, a difference in weight for age Z score was found from the baseline to 3 months ($P = 0.036$) and from 3 to 6 months ($P = 0.018$; Figure 1). The only variables that were significant in the multivariate model were initial

Z score for weight/age ($P = 0.0001$) and adherence ($P = 0.006$; Figure 2).

Discussion

One of the risk factors that have been reported for child malnutrition is poverty.¹³ In 2013, CONEVAL reported that 2 565 000 people lived in poverty accounting for 30% of Mexico City's population. Of these, 219 000 were in extreme poverty and the remaining 2 346 000 in moderate poverty, which increases year after year.

According to INEGI (National Institute of Statistics and Geography) Mexico, these sectors of the population that live in poverty invest more than 40% of their income to purchase food. The inflationary process has a greater impact on the families of lower economic resources and has a direct impact on food consumption. The food substitution strategy is given according to a cost/benefit ratio in which higher-calorie food is purchased at lower

Table 3. Baseline Characteristics of the Mothers.

Category	n (%)	Median (IQR)
Mothers	16 (100)	
Age		29.7 (26.5-38.2)
Spending of food/month (Mexican pesos)		2600 (1950-3700)
Scholarship		
Primary	4 (21.4)	
Middle school	11 (71.4)	
High school	1 (7.1)	
Number of children		
1 or 2	9 (57.1)	
3 or 4	7 (43.0)	
Live in the house		
1 to 2 persons	1 (7.1)	
3 to 5 persons	8 (50.0)	
6 to 8 persons	6 (35.7)	
9 to 11 persons	1 (7.1)	
Marital status		
Single	5 (28.6)	
Married	7 (43)	
Free union	4 (28.6)	
Previous information		
No	16 (100)	
Labor status		
No	9 (57.1)	

Abbreviation: IQR, interquartile range.

cost but this does not imply that the family's diet is appropriate and thus can affect the nutritional status of the whole family.²⁵

Hence, it is important to plan a good strategy that can attend to the health needs of these families. Nutrition education has been positioned as an excellent alternative for treating child malnutrition in African and Asian countries; different studies conclude that the nutritional status of the children improves depending on the geographical region, the initial nutritional status of the child, and by the type of intervention.¹²

A low WHO Z score height/age in children younger than 5 years old represents a population that lives with chronic malnutrition, gradually and consistently affecting its health especially on their physiological development, and at the intellectual level as, at this age, the brain is one of the most affected, producing irreversible metabolic and structural alterations. The capacity of intellectual concentration affects their learning process and therefore their inability to live in fullness in the adult stage.¹⁸

The purpose of the study was to attend to the needs of these families adapting the intervention to their lifestyle. We worked with the mothers because in Mexico, as in other developing countries, they are responsible for

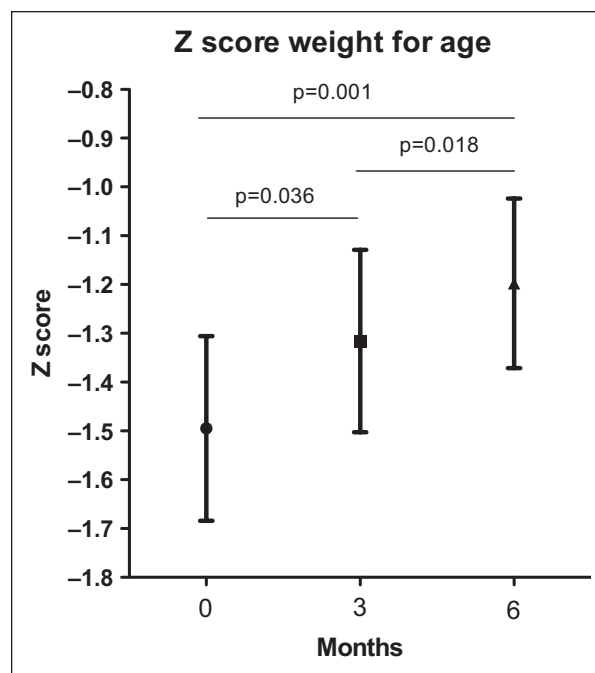


Figure 1. Analysis of variance for repeated measurements. Per protocol analysis. Changes in Z score of weight for age in malnourished children at 0, 3, and 6 months after the educational intervention.

feeding the children.^{14,15} Our aim was to improve the nutritional status of the children trying to provide them a better perspective of life through nutritional education to mothers.

We developed and tested a new nutrition education strategy specific for mothers of children younger than 5 years old diagnosed with mild and moderate malnutrition who live in Mexico City. It has been shown that nutrition education can also positively affect food security, improve dietary behavior, and has long-term effects on parents or primary caregivers' behavior. Nutritional education focuses especially on everything that influences the proper consumption of food and the right dietary practices, including food habits, food selection and preparation based on individual characteristics, and the environmental conditions.⁷

The NC program is based on a constructivist system following a design directed to a meaningful learning. We considered constructivism as a system in which a person participates as an active constructor of his/her own knowledge and, in consequence, he/she becomes capable of modifying or adopting new concepts.²¹

This system is an individual process that has to be contextualized in a social and in an effective manner to make sure knowledge is transformed and transmitted. Hence, we designed a program that promotes significant

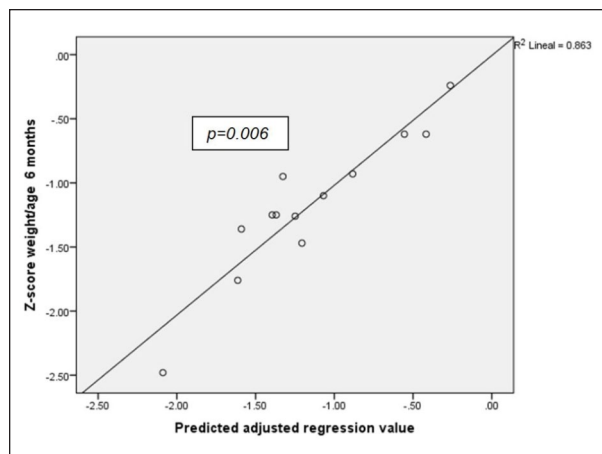


Figure 2. Multiple linear regression. Intention to treat analysis. Model adjusted by initial children's WHO Z score weight/age, initial children's age, mother's adherence to treatment, mother's age, mother's scholarship, and number of children in the family.

learning based on the model of Dr Fink.²² This model complies with a series of guidelines that interact with one another to ensure a good design of the program so that mothers could repeat and transmit what they learn. In a preliminary analysis, we applied an informal survey and observed that our population of mothers did not have any knowledge about malnutrition before the intervention and they could modify it at the end of the NC when their children showed an improvement of the WHO Z score weight/age.

Our initial evaluation confirms the prevalence of malnutrition in Mexico that is often unnoticed because symptoms are subtle. Therefore, the children do not receive specific treatment leaving them at risk of affecting their physical and intellectual development for an adequate growth and fullness in their adult life.

In the ITT analysis, we found that the NC program had a statistically significant improvement in the weight/age of 0.19 in the Z score, and PP analysis improved in 0.3 Z score. Even though in height/age and BMI/age we did not see a statistically significant difference, we observed a positive trend to improve after 6 months of the intervention. The multiple linear regression shows that initial weight and adherence to treatment had a statistical significant effect on the final weight of children after 6 months of the intervention. In contrast, in a cluster-randomized trial performed in Peru, an improvement was found in weight/age of 0.29 of the Z score in the intervention group compared with the comparison group when they proved a nutritional counseling intervention in children of 18 months of age in a peri-urban area.¹⁷ Overall, evidence suggests that improvement in weight

and height are type-intervention, initial children weight, and geographically dependent.¹¹

Adherence to treatment means they attended at least to the 75% of sessions and in that period they had knowledge acquisition. This leads us to assume that mothers with a better meaningful learning and adherence to the NC are capable of improving the nutritional status of their children.

Although we did not measure qualitative concepts, mothers' testimonies showed that an environment of motivation, social interaction, and a support network between them was built both in person and in the social networks through WhatsApp technology.

In Mexico, most of the studies about child malnutrition focus on how to improve complementary feeding in children younger than 2 years old with moderate or severe malnutrition in rural areas.²⁶ However, our analysis confirms the presence of malnutrition in children younger than 5 years in the urban area. This formal education program can be considered as a way to empower mothers to improve their children's health in an economical and viable way. If we add food aid programs, we could reinforce the ethical principles of justice and beneficence²⁷ to these families and children's health would probably benefit more in the short term and establish secure nutrition, offering great benefits to as many children as possible.

One limitation of the study is that this is a quasi-experimental study, and although the educational program improved the nutritional status of the children, we could not analyze the isolated effect of the maneuver with other possible confounding variables. Another limitation is the sample size of the population, although with a small sample size, statistical differences were observed at 3 and at 6 months after the intervention. If statistical differences were found with a small sample size, a bigger sample size would give even more differences. Although it is important to test the intervention with a control group in a higher number of subjects to test the effectiveness, this first approach to test the intervention was successful.

Further studies are needed to explore the external validity of the educational intervention.

The educational intervention NC aimed at mothers of children with mild to moderate malnutrition decreased their children's weight deficit after 6 months with the same economic resources of the family. The adherence of the mothers to the educational intervention is relevant to improve the nutritional status of their children, suggesting meaningful learning.

Acknowledgments

The authors would like to thank Dr Rodolfo Rivas-Ruiz for his valuable help in the statistical analysis, Yuridia

Sánchez-Azcona and the Instituto Técnico y Cultural for supporting the Nutrition Club with monthly pantries, and Mrs Josefina Bolado, Head of the Scientific Paper Translation Department, from División de Investigación at Facultad de Medicina, UNAM, for editing the English-language version of this manuscript.

Author Contributions

SSE and RMWC conception and design, SSE and MMTT patient recruitment, educational intervention and data acquisition, SSE and RMWC analysis and writing of the manuscript, all critical review of the manuscript.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Sonia Sanchez-Encalada and Myrna M. Talavera-Torres declare that they do not have a commercial or other association that might pose a conflict of interest. Rosa M. Wong-Chew has received personal fees from Sanofi as speaker and GSK and Abbvie as consultant outside the submitted work.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Sonia Sánchez-Encalada was a recipient of a scholarship for her master studies from Consejo Nacional de Ciencia y Tecnología (CONACYT).

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