

## Educational interventions for malnutrition in Mexican children Intervenciones educativas para malnutrición en población infantil mexicana

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### Abstract:

**INTRODUCTION:** Malnutrition is the leading cause of infant morbidity and mortality worldwide. In 2019, 21% of children living in rural areas had chronic malnutrition and 24% of children under 12 years of age in the country were overweight or obese. **MATERIAL AND METHOD:** The objective of this article was to know the characteristics of the educational treaties for malnutrition. The search for articles and documents made in Pubmed, Ebsco, Google Scholar and government and international pages. **RESULTS:** 28 nutritional educational interventions were analysed. 21.4% of the studies were carried out in the state of Sonora, 57.1% of the studies were of a quasi-experimental type. The most used strategies in complications include exhibition of theoretical and practical content; use of games (table, crossword puzzles, memory games, etc.); physical activity and use of audiovisual media. 96% of the carried out studies had statistically affected differences with p values from .05 to .000. **CONCLUSIONS:** The educational practices must be carried out in a holistic way determined by the following aspects: Elements of knowledge and food practices; Psycho-emotional elements; Sociocultural and economic elements.

### Keywords:

*Child malnutrition, educational interventions, Mexican population*

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### Resumen:

**INTRODUCCIÓN:** La malnutrición es la principal causa de morbilidad y mortalidad infantil a nivel mundial. Durante el 2019 21% de los infantes que viven en zonas rurales presentan desnutrición crónica y el 24% de los niños menores de 12 años del país presentan sobrepeso u obesidad. **MATERIAL Y METODO:** El objetivo de este artículo fue conocer las características de intervenciones educativas para malnutrición. La búsqueda de artículos y documentos se realizó en Pubmed, Ebsco, Google Schoolar y páginas gubernamentales e internacionales. **RESULTADOS:** Se analizaron 28 intervenciones educativas nutricionales. El 21.4% de los estudios realizados fueron en el estado de Sonora, el 57.1% de los estudios fue de tipo cuasi-experimental. Las estrategias más usadas en las intervenciones consistieron: Exposición de contenido teórico y práctico; uso de juegos (mesa, crucigramas, memoramas, etc.); actividad física y uso de medios audiovisuales. El 96% de los estudios realizados tuvieron diferencias estadísticamente significativas con valores de p desde .05 hasta .000. **CONCLUSIONES:** Las intervenciones educativas deben ser realizadas de manera holística considerando los siguientes aspectos: Elementos de conocimiento y de prácticas alimentarias; Elementos psicoemocionales; Elementos Socioculturales y Elementos económicos.

### Palabras Clave:

*Malnutrición infantil, intervenciones educativas, población mexicana*

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### INTRODUCTION

Malnutrition is the leading cause of infant morbidity and mortality worldwide, responsible for up to 50% of all deaths in children under 5 years of age being one of the main health problems in poor countries; problems due to multiple associated

factors that threaten food security; such as environmental factors, agricultural, political-economic instability and social asymmetry and injustice.<sup>1</sup>

According to the World Health Organization (WHO), malnutrition can be understood as excesses, deficiencies or imbalances in the intake of nutrients and energy consumed by a

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person. It is categorized into 2 types: malnutrition (short stature, low weight, wasting) and the second is overweight and obesity.<sup>2,3</sup>

Some of the effects of chronic malnutrition in infants are the delay in weight gain and growth, total body and adipose tissue deficit, reduced physical-motor activity and complications in mental development. Adding another problem are comorbidities with infectious and epidemic diseases, such as tuberculosis or HIV/AIDS.<sup>1-3</sup>

In the 2018 World Nutrition Report, the situation presented by the world's child population under 5 years of age was that 22.2% suffer from growth retardation, 7.5% suffer from wasting, and 5.6% are overweight. As for the population of babies, each year 20 million register a low birth weight.<sup>4</sup>

At the end of 2018, the statistics provided by The United Nations Children's Fund (UNICEF) regarding Latin America and the Caribbean were: 8.4% of women and 6.9% of men live in severe food insecurity. In ten countries, 20% of the poorest children suffer three times more chronic malnutrition than the richest 20%.<sup>5</sup>

In addition, obesity has become the biggest nutritional threat in Latin America and the Caribbean, approximately one in four adults is obese. Overweight affects 7.3% (3.9 million) of children under the age of 5, a figure that exceeds the world average of 5.6%, measured at that time.<sup>5</sup>

On the other hand, in Mexico, in 2016, according to Consejo Nacional de Evaluación de la Política de Desarrollo Social (CONEVAL), 20% of the population lived with food deprivation, being higher in indigenous, disabled and minor populations.<sup>6</sup>

Regarding statistics during 2019 suggested that 21% of infants living in rural areas are chronically malnourished and 24% of children under 12 years of age in the country are overweight or obese.<sup>6,7</sup>

In addition, the prevalence of anemia in preschool children was 586,806 anemic children in the rural area and 1,497,933 anemic children in the urban area. In addition to this, it is impossible to put aside the reality that Mexico occupies the first place worldwide in childhood obesity, and cases of diabetes and hypertension occur at an early age more frequently.<sup>7</sup>

In the trends of malnutrition in children under 5 years old and school children from 5 to 12 years old according to the surveys: National Survey on Nutrition (ENN) 1988-1999 and National Survey on Health and Nutrition (ENSANUT) 2006-2018, the decrease of the first malnutrition group can be observed, which are: short height, low weight and wasting. In addition to maintenance with gradual increases in recent years in the percentages of malnutrition in the second group, which are: overweight and obesity.<sup>3, 8-12</sup>

Through the passage of time in the history of Mexico, various food aid programs have been developed and implemented, from assistance to those conditioned to investment in human capital development, subsidies for food production and consumption or direct distribution of baskets of food aimed at vulnerable

populations. Even, sometimes, these strategies have been combined into intersectoral programs.<sup>13</sup>

Among the programs and strategies used in our country are:

A) Oportunidades (ExProgresa).

This program began by calling Progresa and later in 2001 it changed to Oportunidades having an activity period from 1997 to 2014. It had 10 components that were: a) Food support, b) School supplies support, c) Education support, d) Baby food, and e) Basic health package, f) Young people with opportunities, g) Energy support, h) Support for the elderly, i) Food support live better and j) Child support live better.<sup>14</sup>

B) Liconsa.

It began its intervention in 1944 and its application continues to this day, being a state-owned majority company that aims to improve the nutrition levels of millions of Mexicans. The support is focused on families with poverty, providing excellent quality milk with subsidized price, mainly for girls and boys up to 12 years old.<sup>15</sup>

C) Programs by Desarrollo Integral de la Familia (DIF).

These programs are known as the Comprehensive Strategy for Social Welfare Assistance (EIASA) that from 2001 to the present (2020) is applied and contains 4 elements, all with the purpose of strengthening food security:

- a. School breakfasts. The target population are schoolchildren in risk and vulnerability conditions attending official school sites of the National Education System that are located in rural, indigenous and marginalized urban areas.<sup>16, 17</sup>
- b. Food care for children under five at risk, not in school. The target population under five years of age in a condition of risk and vulnerability, the support is made through the delivery of food support appropriate to their age and providing food guidance to their parents or caregivers.<sup>16, 17</sup>
- c. Food assistance to vulnerable subjects. The target populations are food social assistance people especially infants, adolescents, pregnant and nursing women, people with disabilities, older adults and vulnerable people by income.<sup>16, 17</sup>
- d. Food Assistance to Families in helplessness. People and groups in a condition of vulnerability due to destructive natural phenomena, in this element of DIF programs food support is temporary.<sup>16, 17</sup>

D) Vitamin and Mineral Supplements.

In this support the objective is to increase the total dietary intake, complement it or replace some component, because not all people adequately obtain the necessary nutrients and therefore the supplements are used.<sup>18</sup>

E) Food Program (PAL).

It was combating the persistence of chronic malnutrition, anemia and micronutrient deficiency in a vulnerable population that was not treated by the Oportunidades program. Specifically, it support families with children from 0 to 9 years old to strengthen their development, nutritional supplements for children older than 6 months and under 2 years old, as well as for pregnant or breastfeeding women and fortified milk for infants between 2 and 5 years old.<sup>19-21</sup>

F) Prospera.

The period of operation of this program was from 2014 to 2019, being the successor program of Oportunidades, and similar to this, its attention was for households in a condition of food poverty with the objective of improving living conditions through the coordination of institutional programs that address economic, labor, educational, health and food aspects.<sup>14</sup>

**MATERIAL AND METHOD**

The objective of this article was to analyze the characteristics of educational interventions for malnutrition in the Mexican child population.

The search for articles and documents was carried out in Pubmed, Ebsco, Google Scholar and governmental and international pages.

Inclusion criteria. Original articles were searched. Regarding the Mexican population, it was considered even if they did not reside in Mexico and that the benefits of the interventions were the benefit for the child population; although they will not

Table 1. General data and methodological characteristics of nutritional educational intervention

Year Publication	Place	Objetive	Study and design	Sample	Statistic analysis
2010	Oaxaca	Modify behaviors to prepare lunchboxes through an educational intervention program on nutrition with mothers of preschoolers.	Mixed and pre-experimental.	119 mothers of a preschool in the state of Oaxaca.	Descriptive statistics, calculation of inferential statistics (hypothesis test), correlation coefficients using for each variable; standard deviation of the mean and coefficient of determination r <sup>2</sup> . <sup>22</sup>
2010	Tabasco	Apply a food and nutritional education program to influence the knowledge and food consumption of families.	Pre-experimental.	Mothers, preschoolers and schoolchildren of 62 families.	For the initial and final evaluation: Xi <sup>2</sup> (α = 0.05). In the knowledge about food, a scale value of 0 to 10 points was assigned to issue a grade. <sup>23</sup>
2012	Distrito Federal	Measure the impact of an educational intervention to reduce overweight based on lifestyles in a population of	Quasi-experimental.	40 overweight or obese children and the corresponding 40 mothers.	T de student, Xi <sup>2</sup> (Pre-post) <sup>24</sup>

participate directly in the intervention. As regards temporality, no time limit was used.

Exclusion criteria. Articles that were only proposals for intervention were discarded.

The elements to analyze of each intervention were divided into 2 groups:

- 1) General and methodological data of the nutritional educational interventions (Year of publication, place, objective, Study and design, sample and statistical analysis).
- 2) Characteristics of the strategies, results and findings of nutritional educational interventions (Type of malnutrition, intervention strategies, duration, results and findings).

**RESULTS**

28 original articles of educational interventions aimed at improving the nutritional status of the Mexican child population were analyzed.

The studies that were analyzed and their general and methodological data are shown in Table 1. The places that had the highest performance of interventions were Sonora and Mexico City with 21.4% of studies carried out, by location. The period of performance of the interventions was constant from 2010 to 2019, only in 2011 the publication of studies was not mentioned.

Regarding the methodology of application of these studies, 57.1% was of a quasi-experimental type, being the most used type of study. Mothers, fathers, teachers and health professionals participated in the processes during the intervention.

		schoolchildren aged 6 to 11 years.			
2012	Sonora	Execution and analysis of an educational intervention in order to increase knowledge and healthy habits in schoolchildren.	Quasi-experimental.	222 children from 6 to 12 years old, 51% women and 49% men.	Differences between levels were applied using the Mann-Whitney U test and the Wilcoxon test. <sup>25</sup>
2012	Tijuana	Reduce sedentary behaviors, the consumption of soft drinks and snacks high in fat and salt, and increasing the consumption of fruits and vegetables, was to assess the effect of a six-month intervention on parents and children.	Quasi-experimental.	32 children of 2nd and 3rd. grades of primary education.	Body mass index Z scores. Spearman's R, Mann-Whitney Xi2, Wilcoxon. <sup>26</sup>
2012	Mexico State	To evaluate the effectiveness of a nutrition and physical activity strategy, called "Nutrition in motion" to maintain Body Mass Index (BMI) values of schoolchildren in the State of Mexico.	Community trial.	1,000 primary school children, 510 experimental group and 490 control group.	Descriptive statistics, 1 to 10 in degree of knowledge, logistic regression., OR. <sup>27</sup>
2013	Mexico City	Evaluate the effectiveness of an environmental intervention in 27 primary schools in Mexico City.	Experimental.	886 4th grade students to 6th. primary grade, between 9 and 11 years old.	Descriptive and inferential statistics. <sup>28</sup>
2013	Sonora	To evaluate the effect of an intervention program in school children from six to eight years old in Hermosillo, Sonora.	Randomized experimental and controlled	126 children from 6 to 8 years old.	Descriptive analysis, comparison between groups T tests for independent samples or Mann-Whitne samples (Dependent on the normality of the variables). For categorical variables, Fischer and logistic regression tests were used. <sup>29</sup>
2014	Sonora	Analyze the effect of an educational intervention on the consumption of fruits, vegetables, fat and physical activity in schoolchildren in Sonora Mexico.	Quasi-experimental .	129 schoolchildren between 6 and 12 years old.	Descriptive analyzes, t test and Mann-Whitney test for independent samples, prueba2 test and linear regression analysis. Sports and sedentary activities were measured in hours per week. <sup>30</sup>
2014	Mexico State	To explore the effect of the intervention "Nutrition on the Move" on overweight and obesity in schoolchildren.	Quasi-experimental.	1020 children, 510 control group and 510 experimental group.	Descriptive statistics, inferential statistics: student's t, Xi2, Ward's method. <sup>31</sup>
2014	México City	To assess the feasibility and impact of a pilot intervention to prevent obesity in children aged 2 to <5 years in primary care clinics in Mexico City.	Quasi-experimental.	306 pairs of parents and children were recruited: 168 experimental group and 138 control group.	Multivariate regression models, linear regression, BMI Z scores. <sup>32</sup>

2014	Monterrey	Implement an individualized dietary intervention, face to face, supported by parents and school association to promote healthy eating habits and decrease in body mass index.	Community trial.	125 children, 5 to 12 years old studying primary school.	Descriptive and inferential statistics: Student's T. <sup>33</sup>
2015	Mexico State	Provide a step-by-step description of the design and implementation of an educational intervention to promote healthy eating and physical activity called "Healthy Break."	Pre-experimental.	2,762, children between 10 and 12 years of primary school.	Xi2, t of student. <sup>34</sup>
2015	Mexico City	Design and evaluate the effect of a multifaceted care-based intervention in kindergartens to reduce obesity risk behaviors in preschool children.	Community trial, cluster randomized.	16 nurseries of the IMSS, 674 children, 336 of the intervention group and 338 of the non-intervened group, and parental involvement.	Descriptive analysis, and the change per stage in each group and between both groups at each stage was compared with the Xi2 test. <sup>35</sup>
2015	Sonora	To assess the effect of an educational intervention in preschool children with cardiovascular risk factors in a family medicine unit in the state of Sonora.	Quasi-experimental.	43 children aged 3-5 years, 62.8% men and 37.2% women.	Descriptive and inferential statistics were used: t Student and Xi2. <sup>36</sup>
2015	Colima	Evaluate the impact of an educational intervention program (PIE) on the willingness of the target subject to change in attitude towards school obesity, and knowledge about healthy eating, better eating behaviors; increased physical activity; the practice of exercise and sport; and the ability to sustain the changes incorporated at the conclusion of the PIE.	Intervention trial.	10 obese schoolchildren, 80% men and 20% women between 7-11 years and 9 parents 1 mother; in a primary school in the city of Comala.	Change in the program impact indicator was measured by the McNemar test for paired observations. <sup>37</sup>
2016	Nayarit	To assess the effectiveness of an educational intervention in nutritional status and the level of knowledge about food and physical activity in schoolchildren.	Quasi-experimental.	368 schoolchildren between 9 and 11 years old.	Descriptive and inferential statistics: Student's t for dependent samples with a significance level of 0.05. <sup>38</sup>
2017	Sonora	To assess the effect of an educational strategy on the nutritional status and reading of food labels in overweight and obese nine to twelve-year-old schoolchildren.	Quasi-experimental.	62 school children between 9 and 12 years old.	The significant difference between the initial and final scores of the questionnaire was determined using the Wilcoxon test. McNemar test, Xi2 and Student's t test were used. <sup>39</sup>
2017	Puebla	Evaluate the impact of a four-month nutritional	Quasi-experimental.	62 children from 2 to 5 years old.	For the comparison before and after the Student,

		education strategy for preschoolers in rural communities.			Wilcoxon, Xi2 and McNemar t tests were used. <sup>40</sup>
2017	North of Mexico	To know the effect of an educational intervention on the pattern and knowledge of physical activity (AF) in school-age children from 6 to 8 years old in northern Mexico.	Randomized and controlled clinical tests.	159 school children aged 6 to 8, 49% women and 51% men.	Differences between T test groups for independent samples and $\chi^2$ . The effect of the program was evaluated by the test for paired proportions. Statistical significance was considered at $p \leq 0.05$ . <sup>41</sup>
2018	Tamaulipas	Evaluate the application of a board game to teach concepts of nutrition and physical activity to primary and secondary school children.	Quasi-experimental.	377 students, 48.1% women and 51.9% men.	Student's t-test for comparisons, significance level of 0.05 ( $p \leq 0.05$ ). <sup>42</sup>
2018	Mexico City	Evaluate the application of a board game to teach nutrition and physical activity concepts to primary and secondary school children.	Quasi-experimental.	377 students, 48.1% women and 51.9% men.	Student's t-test for comparisons, significance level of 0.05 ( $p \leq 0.05$ ). <sup>43</sup>
2019	Mexico City	Evaluate an educational intervention for mothers to improve the nutritional status of Mexican children under 5 with mild to moderate malnutrition.	Quasi-experimental.	13 mothers and 15 children were included.	Z Scores, ANOVA, Xi2, Fisher. <sup>44</sup>
2019	Morelos	To compare the physical condition of children in eight primary schools in the state of Morelos, post-implementation of an intervention to prevent childhood obesity.	Community trial	214 children (111 intervention locality and 103 control locality). 51.4% women and 48.6% men.	Xi2, Descriptive Statistics, Mann-Whitney U, Hodges-Lehmann. Statistically significant differences were considered with a value of $p < 0.05$ , and a significant interaction with a value of $p < 0.2$ . <sup>45</sup>
2019	Chiapas	Evaluate the impact of a community program aimed at improving malnutrition of children in a rural community in the State of Chiapas, Mexico.	Descriptive, analytical and longitudinal evaluation study a program from a database.	113 children under the age of five from a rural area, 46% male and 54% female.	The following were estimated: Weight for age (P / E); Size for age (T / E); Weight for size (P / T); Body mass index for age (BMI / E), according to WHO guidelines. Position and dispersion measurements, Student's T test, Kruskal-Wallis, MacNemar test for paired data and simple linear regression were calculated. <sup>46</sup>
2019	California	Estimate the effects of a multifaceted community intervention on the body mass index (BMI) among children of Mexican origin.	Multifaceted, quasi-experimental intervention study.	782 children between 3 and 8 years old at the start of the study. 430 in the control group and 352 in the comparison group.	Descriptive analyzes detected differences between the intervention and comparison communities when comparing means and percentages with chi-square or t-student tests. <sup>47</sup>

2019	Queretaro	Provide a step-by-step description of the design, implementation, and evaluation of an intervention plan for Mexican mothers of school-age children to promote healthy eating and prevent childhood obesity.	Quasi-experimental.	50 mothers of 57 school-age children 6-11 years old.	Descriptive and inferential statistics: student's t, Z scores for BMI and KAP scores. <sup>48</sup>
2019	Community of the central zone of Mexico	Describe the design, implementation and evaluation of an educational initiative carried out in a Mexican town. With the aim of promoting the consumption of fruits, vegetables and plain water among preschoolers through the influence of their mothers and teachers.	Quasi-experimental.	27 mothers and fathers of preschool children.	Descriptive and inferential statistics: Kruskal-Wallis. <sup>49</sup>

Source: Own elaboration

In the aspect of the characteristics of the intervention design referring to strategies and sessions used, the results and findings are observed in Table 2. Concisely, the most used strategies in the interventions consisted of: Presentation of theoretical and

practical content; use of games (table, crossword puzzles, memory games, etc.); physical activity and use of audiovisual media.

Table 2.  
Characteristics of the strategies, results and findings of nutritional educational interventions

Type of malnutrition	Intervention strategies	Duration	Results	Findings
Unspecified, because it was measured and intervened at the level of knowledge for behavioral modification.	Exhibition of thematic plan: General aspects of nutrition, child nutrition at different stages of life, food groups, vitamins and minerals (the dish of good eating), hand washing and food hygiene.	6 sessions, 1 per week, 120 min. each.	In the pre evaluation: 8 healthy and 111 unhealthy. In the post: 117 healthy and 2 unhealthy. If there were statistically significant differences.	Nutritional educational interventions modify mothers' eating behaviors. <sup>22</sup>
Unspecified, because it was measured and intervened at the level of knowledge for behavioral modification.	The Food Educational Program (PEAN) contemplated 3 documents: a) General food and nutrition educational program. b) Action Plan c) Thematic session manual.  The techniques were: Guiñol Theater, exhibitions, games (lotteries, memory games),	20 sessions.	The modification of the knowledge on food and nutrition of the groups was significant (p = 0.000) from one evaluation to another, in 2006 69.5% of preschoolers had poor knowledge with grades below 5, and by 2007 it was reduced to 13.5%, increasing the appropriate knowledge with grades from 7 to 10, in schoolchildren and mothers the behavior of the results from one year to another was similar.	The application of the program managed to show favorable changes in relation to knowledge about food, the increase in the consumption of healthy foods and the elimination of the ingestion of other harmful food that allow the proposal to be accepted as valid and feasible. <sup>23</sup>

	projections, culinary preparations, sociodramas.			
Overweight and obesity	Advice from a pedagogue, a psychologist and a nutritionist.  Topics: Causes and risks of obesity; Healthy eating habits; Risky habits of inadequate nutrition; Psychological, social and physiological consequences of diabetes; Food groups and cooking workshop where they focused on food preparation.	30 sessions, 2 weekly, 30 min each session, for 3 months.	The pre-test showed that the level of knowledge of mothers and children about nutrition was insufficient; healthy lifestyles were at an optimum level for mothers and sufficient for children, with no statistically significant differences detected between the experimental group and the control group. After the intervention, there were significant differences between the experimental group of mothers, increasing knowledge and improving attitudes, while in children there were no significant differences.	It is necessary to complement physical activity with adequate eating habits, recognizing the need for multidisciplinary work and the active participation of society. <sup>24</sup>
Not specified, but focused on: food and hygiene	Participatory and playful methodology that showed healthy practices and under the pedagogical support of constructivism.	1 weekly session of 1 hour.	Before the intervention, only 32.4% of the participants had a high knowledge of good nutrition; in the post-evaluation this percentage increased to 57%, differences that were statistically significant (p = 0.000).	The results indicate changes in the knowledge of the participants; but in his practice the expected results were not observed, only the information is not sufficient for behavioral changes. <sup>25</sup>
Overweight and obesity	The intervention was based on the Bronfenbrenner Ecological Model. Interdisciplinary and had 3 components:  1) School meeting with teachers 2) Application in the classroom 3) Parental involvement	6 months of intervention, with a follow-up of 18 months.	After the intervention, differences in BMI were observed, -0.82 (p = 0.0001). At 18 months, the consumption of vegetables and physical activity increased (p = 0.007) (p = 0.0001), as did the decrease in sedentary activities and the consumption of snacks high in fat and salt.	The results of this study indicate that with a comprehensive intervention there are positive responses to changes in lifestyle (diet and physical activity) in addition to a moderate reduction in abdominal obesity. <sup>26</sup>
Overweight and obesity	The intervention carried out:  1) Physical activity workshops. 2) Puppet theater, based on the theory of peer learning. 3) Two-day workshops at each school to raise awareness about healthy eating and physical activity. 4) Sale of fruits, vegetables and pure water in the school cooperative 5) Promotion of water consumption. 6) Physical activity before class	6 months in daily sessions for 3 weeks.	The estimated probability of obesity between onset and end stage decreased 1%. The intervention is highly significant (p = 0.01) (OR = 0.68; 95% CI 0.52, 0.91). Furthermore, girls had a protective effect on obesity (OR = 0.56, 95% CI 0.39 to 0.80).	The intervention strategy is effective in maintaining the BMI of the students. <sup>27</sup>



- 7) Broadcasting of recorded audio announcements at school.
- 8) Games organized during the break
- 9) Placing banners at school
- 10) Delivery of healthy recipe calendars.

Overweight and obesity	<p>Socio-ecological model: Nutrition and physical activity.</p> <p>Year 1:</p> <ol style="list-style-type: none"> <li>1) Promotion of availability of healthy foods</li> <li>2) Promotion of adequate culinary technique.</li> <li>3) Limit the exposure to inadequate diet</li> <li>4) Ensure drinking water</li> </ol> <p>Year 2: Same strategies but with greater rigor of application</p>	2 years; during the first year it lasted 7 months and 8 in the second.	Improved nutrition and physical activity practices.	The school environment plays an important role in maintaining the energy imbalance that leads to overweight and obesity in schoolchildren. <sup>28</sup>
Not specified, but focused on: Availability of healthy foods in school stores; Increase in the consumption of healthy foods during recess and Reduction in the consumption of kilocalories, total fats and carbohydrates.	<p>Components:</p> <ol style="list-style-type: none"> <li>1) Educational talks for parents and schoolchildren,</li> <li>2) Advertising signs inside the classroom,</li> <li>3) Availability of healthy foods (in the school store) with incentives,</li> <li>4) Weekly awards for consumption of healthy foods during recess,</li> <li>5) Transmission of a children's couplet with messages related to promoting the consumption of healthy foods,</li> <li>6) Workshops for school store dealers and</li> <li>7) Preparation of information leaflets for parents.</li> </ol>	6 months, 1 monthly session, in addition to various activities of various times, such as songs, posters, etc.	The availability of healthy foods in school stores increased after applying the intervention program ( $p \leq 0.05$ ) and the consumption of fruits and vegetables during recess increased. Non-operated schoolchildren are at higher risk of consuming unhealthy foods during recess (RM, 95% CI, 3.7, 1.7-7.8, $p = 0.001$ ). Macronutrient consumption was lower ( $p \leq 0.05$ ) in the intervention group. The PI had a positive effect on the consumption of food by schoolchildren.	The applied program had a positive effect on the variation and frequency of consumption of healthy foods compared to a group of schoolchildren without the intervention. The program also had a positive impact in terms of reducing energy and macronutrient consumption, mainly carbohydrates and fat. <sup>29</sup>
Not specified, but focused on issues in nutritional information and physical activity with supervised participation.	<ol style="list-style-type: none"> <li>a) Educational workshop on nutrition for schoolchildren,</li> <li>b) Educational workshop on recreational physical activity for schoolchildren,</li> <li>c) Educational talks on nutrition and physical activity for parents.</li> </ol> <p>Videos, manual activities, crossword puzzles, food tasting according to the topic, physical activity.</p>	9 months, only in the first component it is mentioned that there were 9 sessions, but frequency and time are not mentioned, nor in the other components.	After the intervention program, the consumption of fruits and vegetables of the intervened schoolchildren was significantly higher ( $p = 0.032$ ) and the total fat consumption decreased ( $p = 0.02$ ). The intervened students increased the number of hours of physical activity and decreased sedentary activities ( $p = 0.04$ and $p = 0.006$ respectively). In addition, they showed greater knowledge in nutrition than those not intervened ( $p = 0.05$ ).	The program was effective in improving the consumption of fruits, vegetables and fats in the diet of schoolchildren, also showed a positive effect on physical activity and knowledge in nutrition. <sup>30</sup>

Overweight and obesity	<ol style="list-style-type: none"> <li>1) Nutrition and physical activity workshops.</li> <li>2) Puppet theater.</li> <li>3) Physical activity.</li> <li>4) Physical activation.</li> <li>5) Organized games.</li> <li>6) Promotional banners.</li> <li>7) Recipe calendars.</li> <li>8) Activities for teachers and school cooperatives.</li> <li>9) Diffusion of audio announcements in the public of the schools.</li> <li>10) Sale of fruits, vegetables and pure water at school. food cooperative.</li> </ol>	6 months, distributing the different activities between school times.	The prevalence of overweight and obesity was higher in GP 1 (medium food availability and high socioeconomic index), lower in GP 2 (high food availability and low ISE) and 3 (low food availability and median income) ( $p < 0.001$ ). The interaction between GP and intervention shows differences for GP 3 ( $p = 0.066$ ), the GP interaction with stage showed differences between GP 1 against 3 ( $p = 0.014$ ) and 2 against 3 ( $p = 0.055$ ).	It is necessary to identify the factors that contribute to obesogenic patterns, as well as to implement new strategies for the prevention of obesity in school-age children. <sup>31</sup>
Overweight and obesity	<p>Chronic care model:</p> <ol style="list-style-type: none"> <li>1) Intervention in spaces and clinical areas</li> <li>2) Educational sessions with the use of motivational activities, interviews, surveys, informative topics and nutritional practices.</li> <li>3) Active participation of parents and children (games and nutritional practices)</li> <li>4) Family collective strategies</li> </ol>	6 educational sessions, of 2 hours each.	Intervention participants with high adherence to the program (5-6 sessions) decreased snacks and screen time and increased vegetable consumption. 90% of parents who completed the post-intervention survey were satisfied with the program.	Although satisfaction was high among participants, barriers to participation and retention included cost of transportation and time. In the intention-to-treat analysis, intervention effects on vegetable intake were found. <sup>32</sup>
Overweight and obesity	<p>Dietary intervention:</p> <ol style="list-style-type: none"> <li>1) Anthropometric evaluation.</li> <li>2) Dietary evaluation using a 24-hour diet</li> <li>3) Diet planning</li> <li>4) Instructions for structured diets.</li> <li>5) Information for adequate practices in food preparation, focused on parents.</li> </ol>	13 sessions every 3 weeks, 45 minutes each session.	A significant decrease in the percentile of the body mass index and energy intake was found. Among other energy-dense foods, they had a significant decrease in servings per day and servings per week. There was a significant increase in daily and weekly servings of water and nutrient dense foods such as fruits.	This intervention created healthy eating habits and decreased body mass index in a high-risk population. <sup>33</sup>
Nutrition in general, overweight and obesity	<ol style="list-style-type: none"> <li>1) Nutrition workshops with children (use of puppets).</li> <li>2) Awareness workshops for teachers on healthy eating habits.</li> <li>3) Environmental modification activities.</li> <li>4) Routines of physical activity with the school community.</li> <li>5) Activities for parents focused on food preparation .</li> </ol>	3 months, with sessions of 60 min.	The children's knowledge results revealed a statistically significant difference for physical activity and nutritional knowledge. Teachers' knowledge of nutrition and physical activity, an improvement in knowledge about food groups was observed.	The communication process is an effective tool for program planners to design interventions aimed at managing prevalent health problems such as overweight and obesity in school-age children. <sup>34</sup>
Not specified, but focused on topics in	<ol style="list-style-type: none"> <li>1) Interactive sessions, Training for nursery staff,</li> <li>2) Educational sessions</li> </ol>	1 year, 12 interactive weekly educational	There was a reduction in the availability of some non-recommended foods at home	The improvement in physical activity can have an effect in the long term; Innovative strategies

nutritional information and physical activity	with children and 3) Workshops with parents.  Knowledge of food, physical activity, childcare.	3) sessions for children and six family workshops.	and greater physical activity in the intervention group.	that modify dietary risk behaviors for obesity in families are required. <sup>35</sup>
Overweight and obesity with cardiovascular risk	Session topics: 1) "What are cardiovascular risk factors?"; 2) "How to prevent cardiovascular risk factors?"; 3) Nutritional orientation focused on the feeding of children between three and five years of age; 4) Importance of physical activity to control obesity.  Expository sessions with slides, mind maps and brochures, use of procedural guides for physical activity.	4 months, a monthly session, of 60 minutes each session.	Initial obesity decreased significantly, with differences between initial and final weight, in addition to glucose, cholesterol and triglyceride values ( $p = 0.00$ ).	A comprehensive family educational strategy, focused on the modification of risk factors through adequate eating habits and physical activity, produces a positive and significant effect on the reduction of obesity and cardiovascular risk factors, both physically and chemically. <sup>36</sup>
Overweight and obesity	The PIE combined video presentations, motivational interviews, role-plays, interactive workshops and relaxation and stress coping techniques. The impact of the PIE on the domains indicated was assessed using instruments created ad hoc.	4 weeks, 2 hours educational sessions	In the responsible father or mother, there was a change in attitude towards obesity and improved knowledge about healthy eating and the promotion of physical activity. No significant impact was observed in the attitude of the target subjects towards the adoption of healthy eating behaviors and the incorporation of physical activity, nor safety of continuation of healthy behaviors.	Educational interventions can mobilize the parents of the obese schoolchild towards a change in attitude towards this health problem. Other interventions must be designed to accompany the target subjects in adopting new lifestyles, diet and physical activity. <sup>37</sup>
Underweight, overweight and obesity	Two health education programs with topics on nutrition and physical activity were developed for the intervention group and for the addiction prevention control group, lasting three months.	3 months	The prevalence of overweight and obesity occurred in both sexes in 43.3% before and 44% after the intervention, with a higher prevalence in children. There was a significant difference in BMI in the control group and in the girls in the study group. After the intervention, the level of knowledge about nutrition increased in 83.5% in the study group and 263.4% in the control group. The educational intervention managed to reduce low weight rates, but increased overweight and obesity.	Educational intervention can be effective in increasing knowledge in nutrition and inducing children to significant changes in health habits. Greater parental involvement is suggested to achieve better results. <sup>38</sup>
Overweight and obesity	A strategy for education in food label reading was applied.	1 year between the pre-test-intervention strategy and the post-test.	There was a significant difference between the questionnaire score before and after the strategy ( $p < 0.05$ ). Favorable changes in nutritional status, adiposity and laboratory studies were obtained ( $p < 0.05$ ).	Children between nine and twelve are able to learn to interpret nutritional information with educational programs, this can influence their nutritional status and eating habits. <sup>39</sup>

Malnutrition in general	Illustrative teaching material and educational workshops with emphasis on proper nutrition and eating habits.	4 months, 6 sessions, 3 in one month and another 3 in another month with a 2 months separation between these groups of sessions.	19 patients (30.6%) with malnutrition (with malnutrition or overweight / obesity) were found at the first consultation. There was no significant difference in the percentage of subjects with malnutrition ( $p = 0.289$ ), weight above normal ( $p = 0.508$ ) or without malnutrition ( $p = 0.143$ ) after the intervention.	This intervention failed to improve the nutritional status of preschoolers in rural communities. <sup>40</sup>
Overweight and obesity	The program consisted of educational sessions (theoretical and practical) on the benefits of physical activity and sports (running, walking, jumping, among others), as well as the harms of a sedentary lifestyle. These activities were carried out both in the classroom and outdoors.  Use of videos, physical activity.	6 months, sessions of 2 hours each.	Children assigned to the intervention not only improved their knowledge about recreational AF ( $p = 0.03$ ), but also increased the practice of walking (+ 23%), dancing (+ 19%) and playing soccer (+ 19%) ( $p \leq 0.05$ ).	The educational program had a positive effect on the participation and knowledge of children's recreational activities. <sup>41</sup>
Not specified, but focused on topics in nutritional informational issues and physical activity	Board game: In the game, each participant goes through the food board by squares and each one describes the type and quantity of nutrients in the food (proteins, fats, water, minerals, etc.). The nutrient content described is recorded on an individual board, dotted board, that each player has. This board contains the main components of the body (skin, organs, blood, bones, among others) with the list of the elements that make them up (proteins, fats, water or minerals).	1 month, one session per week, one hour each.	From a general knowledge questionnaire before and after the application of the game, the following score was obtained in primary students: before the game $9.36 \pm 4.33$ and at the end of $10.9 \pm 4.96$ ( $p < 0.01$ ) and in the same way in High school students $13.53 \pm 3.79$ and $14.85 \pm 4.32$ ( $p < 0.01$ ) of 15 questions about nutrition and physical activity.	The Armando A. Nutritional game is considered a useful tool to acquire knowledge about healthy habits. <sup>42</sup>
Overweight and obesity	The intervention had two components: 1) Parents and schoolchildren attended in-person educational sessions to promote healthy eating habits and physical activity, 2) Use of the internet and mobiles to obtain information for remote activities.	10 months, 1 3-hour session each month for parents and 4 bi-monthly 1.5-hour workshops.	The intervention improved metabolic parameters; the intervention group showed a negative effect on the concentrations of glucose, low-density lipoprotein-cholesterol, insulin. The intervention improved body mass indexes in the experimental group compared to the control group.	The intervention through multiple components that promoted healthy eating and physical activity habits improved the metabolic parameters of the children in the study after one year, regardless of their nutritional status. <sup>43</sup>

Mild to moderate malnutrition	<p>We designed an action-oriented nutrition education program based on a constructivist system aimed at meaningful learning called "Nutrition Club".</p> <p>Based on good practices on ICEAN (Information, Communication and Education Programs in Food and Nutrition) for Latin America, on the 4 pillars of the Delors Report (report to UNESCO for education in the 21st century by Jacques Delors), and on the nutrition oriented in the Mexican guidelines regulated by NOM-043-SSA.</p>	6 months, 2 sessions per month, 1 hour session every 15 days.	The mean reference weight / age on the Z score was $-1.49 \pm 0.65$ , which improved to $-1.19 \pm 0.60$ ( $P = 0.001$ ; by protocol analysis). Linear regression analysis showed a P of 0.006 of 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; therefore, the adherence of mothers to educational intervention is relevant to improve the nutritional status of their children. <sup>44</sup>
Overweight and obesity	<p>Strategies directed at children, their parents, teachers, educational authorities, community leaders, and local government authorities.</p> <p>The implemented intervention included three components: 1) Food; 2) Physical Activity, and 3) Social participation.</p>	3 years.	The results show that the physical condition is better in the children of the locality where the intervention was implemented compared to that of the children of the control locality. This difference is maintained regardless of the sex or nutritional status of children.	An important limitation of this study is not having the baseline measurement of physical condition before the intervention, but a beneficial effect may be suggested due to the intervention because the conditions of the localities are similar within each locality among the children who were evaluated. <sup>45</sup>
Chronic malnutrition	The planning and execution methodology of the program activities was based on the levels of approach of the Ecological Model that had the child as its main axis considering the interrelation of individual, family, social and community elements.	4 months.	56.1% of children with an initial diagnosis of short stature or risk of short stature began to have an appropriate height for their age (Z Height / age) and according to the Weight / Height Z Score, 33% had some type Malnutrition or at risk improved your initial diagnosis. However, in all analyzes these differences were not statistically significant.	It is concluded that the community program during the 4 months of implementation contributed to improve some anthropometric indicators; although no apparent effects were found in indicators related to chronic malnutrition. <sup>46</sup>
BMI increase	Parent workshops on nutrition and physical activity, school nutrition lessons, and an improved physical education program for children; and a monthly coupon for fruits and vegetables.	3 years	The term of intervention was only significant for children who were obese at the start of the study. The intervention was significantly and inversely associated with BMI in obese children in all age groups and children of normal weight in the older age group (over 6 years). The intervention resulted in a significantly lower BMI in obese girls in all three age groups relative to their counterparts in the comparison group.	A multifaceted community intervention was effective in slowing the growth rate of BMI among obese children of Mexican origin and children of normal weight over 6 years. Furthermore, girls and boys respond differently, implying that gender-specific strategies must be considered. The findings also suggest that to improve the effectiveness of interventions, clinicians should work with a variety of community stakeholders, including parents,

school officials, and policy makers.<sup>47</sup>

Overweight and obesity	The session had 4 different types of activities:  1) An instructor-led group talk, active learning activities, a cooking class, and a home. 2) He designed the necessary teaching material for the program and developed a brochure (supplementary material) with the topics. 3) Review of the matter in charge of the health professionals 3) Preparation of recipes were prepared based on traditional Mexican culture.	20 months, 6 monthly sessions of 90 min each.	The acceptability and utility scores were 100 and 90%, respectively. Mothers read an average of 71% of home and prepared readings. 62% of the recipes they learned. The average acceptability score for homemade recipes was 91%. After the intervention, the knowledge related to the mother's nutrition significantly increased	Intervention mapping and social cognitive theory are useful models for designing and delivering an intervention that provides a holistic approach to promoting healthy eating. <sup>48</sup>
Overweight and obesity	Intervention mapping approach and social cognition.  1) Sessions with mothers 2) Work with teachers	2 90-minute sessions with mothers, 2 120-minute workshops with teachers.	The results revealed positive changes between the two groups: participants became more interested in healthy nutrition, increased their purchase, preparation and intake of healthy foods and promoted their consumption.	This confirms that it is possible to achieve favorable changes in eating habits among those who participate in educational initiatives in Mexico. <sup>49</sup>

Source: Self made

The type of malnutrition to which the interventions focused the most was overweight and obesity with 57.1%. Regarding the intervention techniques, it was found that 100% included the aspect of nutrition knowledge focused through thematic exposition or the use of didactic workshops and 57.1% of the interventions mention having had the participation of family and teachers.

In addition, regarding the main results and findings, 96% of the studies carried out had statistically significant differences for p values from .05 to .000. 100% of the studies generated some type of behavioral change in both parents and children.

## DISCUSSION

Various works have documented how the trend in malnutrition has been decreasing as food aid programs have been implemented. However, statistics with a greater emphasis on overweight and obesity still persist.<sup>50-54</sup>

These statistics generate that Mexico has a "double burden", and this refers to malnutrition and overweight / obesity, since the former affects physical and intellectual development, while overweight and obesity increase the risk of this same disease in stages later in life, which presupposes the appearance of chronic non-communicable diseases, which in turn has consequences

such as disability and premature death, in addition to a high economic burden.<sup>55,56</sup>

As for obesity, Mexico is the first world place in this disease in children and the second in adults; This is produced by the scarcity of resources for the acquisition of healthy foods, generating the consumption of diets with an inadequate nutritional content.<sup>58,59</sup>

That is why it is important that, in addition to international and national programs, strategies continue to be generated to promote the elimination of malnutrition; among which are educational interventions in nutrition. The documentary search allowed 28 interventions to be analyzed, of which all had changes between the start and end of the application, in 27 of them there were changes with statistically significant differences.<sup>22-49</sup>

These investigations suggest the need to continue generating actions that can eliminate socioeconomic gaps in care for malnutrition through community interventions, this being in the nature of scientific evidence.<sup>40</sup>

The use of didactic techniques to improve the physical condition of schoolchildren through physical activity has been important in all the participants, even including those of sedentary lifestyle and not only those who had the facility or habit of participating in sports activities.<sup>25,27,28,31</sup>

One of the objectives of the interventions should always be to increase knowledge, improving psycho-emotional levels and eating practices; and to reduce the variables that may generate biases, also considering the participation of all available social networks: family, teachers, tutors, etc; in addition to addressing sociocultural factors.<sup>22-24, 29, 30, 35-38</sup>

Among the limitations presented by the interventions are: the short periods of application of the programs, as this reduces the possibility of obtaining concrete and global changes and improvements in the levels of malnutrition; and another limitation that is methodological in nature is the absence of a control group.<sup>22, 23, 34</sup>

These limitations are reflected in the fact that although there were differences in the improvement in malnutrition levels, they were not consistently shown in each of them (low weight, short height, overweight and obesity).<sup>22, 34</sup>

An educational nutritional intervention can be considered effective when malnourished patients will be reclassified into malnourished patients after the strategy has been applied; for example: if malnourished patients significantly increased their weight or if overweight patients reduced it considerably.<sup>33, 40, 43, 46</sup>

It is also important to consider that when there is a dissociation between the evidence obtained the experimental studies in the field of health and the application in the real world, this type of flexible designs could be considered acceptable and realistic.<sup>34, 45, 46</sup>

## CONCLUSIONS

National food aid programs are a fundamental pillar in addressing malnutrition in the school and non-school child population in Mexico.

However, there are still gaps between these programs and vulnerable populations, so it is necessary to generate strategies to reduce them. Among these strategies are educational interventions, but for these to work properly, the following considerations must be considered and worked on in a timely manner:

- a) Elements of knowledge and food practices.
- b) Psycho-emotional elements
- c) Sociocultural Elements
- d) Economic elements.

Considering in an important way the discrepancy that may exist when intervening due to all those strange or unknown variables that would affect the intervention.

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