

Original

A six month randomized school intervention and an 18-month follow-up intervention to prevent childhood obesity in Mexican elementary schools

M. Bacardí-Gascon¹, M.^a E. Pérez-Morales² and A. Jiménez-Cruz³

¹Universidad Autónoma de Baja California. Facultad de Medicina y Psicología. Nutrition Department. ²Facultad de Ciencias Químicas e Ingeniería. ³Facultad de Medicina y Psicología. Nutrition Department. Mesa de Otay. Tijuana BC, México.

Abstract

Background: The objective of this study, focused on parents and children to reduce sedentary behavior, consumption of soft drinks and high-fat and salt containing snacks, and increase the consumption of fruits and vegetables, was to assess the effect of a six month intervention and an 18 month follow-up intervention on the body mass index, food consumption and physical activity of 2nd and 3rd grade elementary school children.

Methods: This was a randomized cluster controlled trial. School children were selected from 2nd and 3rd (n = 532) grade. Measurements: BMI z-score for age and sex was calculated and classified according to the WHO (2006). Abdominal obesity was defined as WC > 90th of NHANES III.

Results: At six months of the study differences were observed in BMI, -0.82 (p = 0.0001). At 24 months, results such as an increase of z-score BMI and waist circumference, a decrease in abdominal obesity, eighth per cent remission and an incidence of 18% of overweight and obesity were observed. Additionally, an increase (p = 0.007) in vegetable intake and physical activity (p = 0.0001) was also reported, along with a decrease in sedentary activities and the consumption of snacks high in fat and salt.

Conclusions: The results of this study indicate that with a comprehensive intervention there is a positive response to lifestyle changes and a reduction of abdominal obesity.

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Key words: Randomized trial. Childhood obesity. Prevention. Mexican schools.

INTERVENCIÓN ALEATORIZADA DE SEIS MESES EN LAS ESCUELAS, CON UN SEGUIMIENTO DE 18 MESES PARA LA PREVENCIÓN DE OBESIDAD INFANTIL EN ESCUELAS PRIMARIAS DE MÉXICO

Resumen

Introducción: El objetivo de este estudio, dirigido a padres y niños para reducir las conductas sedentarias, el consumo de refrescos y de botanas con alto contenido de grasa y sal, y aumentar el consumo de frutas y verduras, fue valorar el efecto de una intervención de seis meses, con un seguimiento de 18 meses, sobre el índice de masa corporal, el consumo de alimentos, y la actividad física de niños de segundo y tercero de primaria.

Métodos: Es un estudio controlado, aleatorizado por conglomerados. Se seleccionaron niños de 2.^o y 3.^{er} (n = 532) grado. Medidas: se calculó el z-score de índice de masa corporal (IMC) para la edad y el sexo y se clasificaron de acuerdo a los criterios de la OMS (2006). La obesidad abdominal se definió como la circunferencia de cintura > percentile 90 del NHANES III.

Resultados: A los seis meses del estudio, se observaron diferencias de IMC, -0,82 (p = 0,0001). A los 24 meses, se observó un aumento del IMC z-score y de circunferencia de cintura, una disminución de la obesidad abdominal, remisión de 8% y una incidencia de 18 % de sobrepeso y obesidad. Además, un aumento (p = 0,007) en el consumo de verduras y en la actividad física (p = 0,0001), así como una disminución en actividades sedentarias y en el consumo de botanas altas en grasa y sal.

Conclusiones: Los resultados de este estudio indican que con una intervención integral hay respuestas positivas en cambios en el estilo de vida y una moderada reducción de obesidad abdominal.

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Palabras clave: Estudio aleatorizado. Obesidad infantil. Prevención. Escuelas mexicanas.

Correspondence: Arturo Jiménez-Cruz.
Facultad de Medicina y Psicología. Postgrado en Nutrición.
Universidad Autónoma de Baja California.
14418 Mesa de Otay, Tijuana BC, México.
E-mail: ajimenez@uabc.edu.mx

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Background

The prevalence of overweight and obesity is increasing among children in numerous countries around the world.¹⁻³ Mexican-American children and adolescents and non-Hispanic black female children and adolescents were significantly more likely to be overweight than non-Hispanic white children and adolescents.⁴

In Mexico, the prevalence of overweight and obesity in children 6 to 12 years old was 26% according to the 2006 Health and Nutrition National Survey.⁵ However, in the northwest of Mexico the prevalence of overweight and obesity range from 48% to 50% in urban school children.^{6,8}

The environment is recognized as an agent in the etiology of obesity.⁹⁻¹⁰

Many behaviors are known to be associated with childhood obesity: consumption of sweetened drinks and fast food, the amount of hours spent viewing television, and other sedentary behaviors.¹¹⁻¹² Preventing overweight and obesity requires understanding and addressing the “obesogenic environment” in which children live.¹³

To reduce the epidemic of childhood obesity, environmental factors should be altered.¹⁴ This can be done through teaching and other interventions provided to all children in a variety of settings such as schools and other community locations.¹⁵

Children spend many hours in school. The classroom has long been considered an ideal setting for effective prevention and health promotion.¹⁶ Several school-based interventions have been designed for the purpose of preventing and treating childhood obesity.¹⁷⁻²⁵

It has been pointed out that those interventions should involve all family members.²⁶⁻²⁷ Several authors suggested that targeting school children for education to create a healthy lifestyle, modification of eating habits, and reduction of sedentary behavior appears to be the most effective intervention.²⁸⁻³⁰

However, intervention programs implemented in schools to prevent overweight and obesity in children are yet to yield the expected results.³¹ This may be due to the difficulty of making significant lifestyle changes and the type of environment in which children develop; additional contributors are also the lack of long-term commitment from parents, teachers, and school administrators, the lack of environmental changes in schools and at the community level, as well as cultural and legislative modifications.³²⁻³³

In Mexico, we did not find long-term randomized controlled trials of intervention in schools to prevent childhood obesity. This study aims to answer several questions that can aid in assessing the effect of school intervention for the prevention of overweight and obesity in Mexican children.

The objective of this study, focused on parents and children to reduce sedentary behavior, consumption of soft drinks and high-fat containing snacks, and increase the consumption of fruits and vegetables, was to assess

the effect of a six month intervention and an 18 month follow-up intervention on body mass index (BMI) Z-score, food consumption and physical activity of 2nd and 3rd grade elementary school children.

Methods

Study design

The study was a quasi-experimental randomized cluster controlled trial during a period of 2 years (fig. 1). During the first phase, all components of the intervention were developed and implemented. After the initial six month period, the control group received the intervention due to the benefits observed in the intervention group in the first six months. For the intervention and control group a follow-up program was continued for another 18 months.

Study population

The study was conducted in four elementary schools in Tijuana, Mexico, that agreed to participate in the study. Two public and two private schools of the same socioeconomic status participated. The study was conducted from December 2008 to December 2010. Children of 2nd and 3rd grade were enrolled in the study.

Sample size

We calculated the sample size from a previous pilot study of body mass index in the same elementary school population. There, the BMI standard deviation was 3.5 to detect a difference of 1 kg/m² in BMI between intervention and control groups, with a power of 80% and a significance level of 5%. Considering the cluster design, it was estimated that 250 children were required in each intervention arm. Schools were paired according to size (class groups, and total number of students), BMI classification to ensure that BMI was similar in both groups, and public-private status. Randomization of schools took place within each pair with the toss of a coin.

Intervention

Study protocols were approved by the Ethics Committee of the University of Baja California. Written informed consent was obtained from the parents, and verbal consent was obtained from the children for all measurement procedures and for intervention activities as required by school boards.

Intervention components

The study's intervention consisted of three components: 1) school board and teachers, 2) classroom

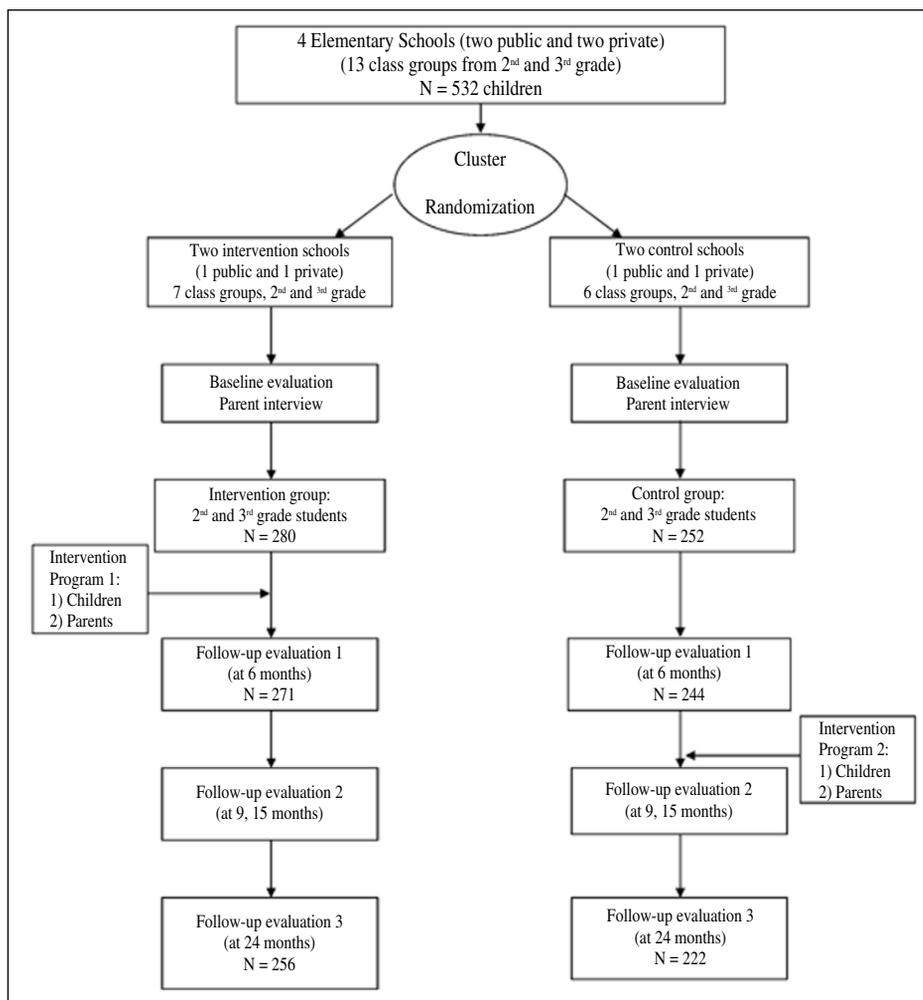


Fig. 1.—Study design.

curriculum, and 3) parent involvement. The intervention approach was based in the Bronfenbrenner's Ecological Model.³⁴ The educational component was designed to be interdisciplinary. Nutrition and physical activity professionals interacted with parents, children, and teachers. Its purpose was to show how food choices and physical activity depend on personal behavior, individual health and school and family environment.

School board and teachers

The study protocol was presented to the school board and teachers to introduce them to the intervention program and to assist them in creating a supportive environment for healthy behaviors. Three 60-minute sessions were delivered by nutrition and PA professionals to discuss healthy lifestyles. Several meetings took place to discuss how to improve school meals and snacks offered in the cafeteria, and also on how to improve PA installations and offer PA activities during and after school.

Classroom curriculum

The classroom curricula for 2nd and 3rd grades were designed to promote healthful eating behaviors and to increase physical activity. One 30-min interactive lesson was delivered by nutrition graduate students each week for 8 weeks during the academic year. The objective of the interactive children sessions was to encourage children to increase fruit and vegetable consumption, to enroll in sports and play activities, to reduce the consumption of soda and snacks with a high fat and sugar content, and to lower the number of hours of TV viewing. This component also included the assessment of dietary intake and physical activity.

Parents' involvement

The aim of the parents' involvement component was to introduce them to the intervention program and to receive nutrition education and extend their knowledge on healthy lifestyle and eating behaviors. The parents' component consisted of a 60-minute session delivered

by nutrition professionals each month for 4 months during the academic year.

Measurements

Participating students in both the intervention and control schools were evaluated during the same week at the beginning of the study and during the follow-up at 6, 9, 15 and 24 months. A report of each child's measurements was sent to the parents at the baseline and end of the intervention.

Anthropometric measurements

Height was measured (without shoes) to the nearest 0.1 cm using a portable stadiometer (Model 214 Road Rod, Seca Corp, Hanover, MD, USA). Weight was measured (in light clothing) to the nearest 0.1 kg using previously calibrated electronic scales (Model 2001; Tanita Corp. Tokyo, Japan). BMI (kg/m^2) and z-scores were calculated using the WHO (2007) LMS parameters for sex and age. Cut-off points for overweight were $\geq 1\text{SD}$, and obesity $\geq 2\text{SD}$.³⁵ Waist circumference (WC) was measured using a flexible and retractable measuring tape (SECA) at the midpoint between the lower rib and the top of the iliac crest at the end of a gentle expiration. WC measurements were compared to the 90th percentile³⁶ for abdominal obesity for children.

Dietary assessment

Children completed a dietary registry on a randomly selected weekday. The registry was analyzed based on portions of food groups targeted in the intervention: number of servings of cereals and grains, meat, milk, fruits, vegetables, sweetened beverages, candies and snacks.

Food inventory

Children also completed a questionnaire on food inventory, which included number of portions of: fruits, vegetables, cookies, candies, snack and sweetened beverages they had available in their homes or that they bought on the day of the inventory.

Physical activity monitoring

We used a previously published questionnaire in the literature by Godard et al., 2008, that used similar school-based intervention studies. Physical activity self-report questionnaires developed and validated in Chile (INTA PA questionnaire) were used to assess physical activity levels in children.³⁷

We measured the reproducibility and validity, in a group of 45 children in this study, with an accelerometer ActiGraph (Medina, 2010).³⁸ Children completed the PA questionnaire with their teacher's assistance.

Outcome variables

Primary outcomes: BMI z-score changes between control and intervention groups and pre- and post-intervention.

Secondary outcomes: Changes in waist circumference; overweight and obesity prevalence; remission (percentage of children who were overweight or obese at baseline but were not overweight or obese at follow-up); incidence (percentage of children with normal weight at baseline who became overweight or obese at follow-up); fruit and vegetables consumption and availability; physical activity and sedentary behavior.

Statistical analysis

We performed an assessment of test-retest for all variables and determined the correlation of responses by evaluating the Spearman Rho. Independent t- tests, Mann-Whitney test, or chi-square tests were used to assess baseline differences between intervention and control groups, and paired t-test, or Wilcoxon test, were also used to compare data on those students who completed the study (Baseline vs. Intervention). Differences in BMI and WC between the control and intervention group at six months were calculated using mixed regression models taking into account the intention-to-treat analysis with imputation for missing data substitution values before the intervention (baseline) with BMI data and WC baseline covariates, and the intervention as random factor and group (classes) as fixed factor. Statistical significance was determined by a two-tailed method with $\alpha = 0.05$. The study was designed to have 80% power to detect an effect of 0.20 or higher. Data were analyzed with SPSS 16.0 (SPSS Inc., Chicago, USA; 2007).

Results

Figure 1 describes the flow of participants through the trial. The intervention and follow-up period was from December 2008 to December 2010. Outcome measures were recorded at baseline and at 6, 9, 15 and 24 months after the start of the intervention program.

The population consisted of 532 school children in second and third grade; the average age at baseline was 8.5 ± 0.73 years. The intervention group consisted of 280 students (48% girls) in seven class groups and two schools. The control group consisted of 252 school children (50% girls) in six class groups and two schools. The rate of consent of parents and children

Table I
Participants' characteristics at baseline

Variables	Participants		p
	Mean (SD)		
	Control	Intervention	
Total, n	252	280	
Age (years)	8.4 ± 0.7	8.5 ± 0.7	0.65
Weight (kg)	32.5 ± 9.2	32.8 ± 9.3	0.81
Height (m)	1.33 ± 0.08	1.31 ± 0.08	0.09
BMI (kg/m ²)	18.3 ± 3.5	18.7 ± 3.8	0.16
BMI z-score	0.85 ± 1.4	1.05 ± 1.4	0.11
WC (cm)	63.5 ± 10.4	64.7 ± 10.5	0.21

BMI = Body mass index; WC = Waist circumference.

was 97% and adherence at the end of the study was higher than 90%.

The participants' characteristics at baseline are reported in table I. There were no statistically significant differences between the intervention and control group in any of the anthropometric variables at baseline.

At six months BMI differences between control and intervention group were -0.82, 95% CI (-0.97,-0.67) (p = 0.0001) in students who were measured (3% of the students were not measured). When intention-to treat analysis was performed using mixed regression models with BMI data as baseline covariate, the intervention as random factor and group (classes) as fixed factor yielded differences in BMI of -0.74, 95%CI (-1.12, -0.36) (p = 0.001). After six months of intervention the control group received the intervention and the data was analyzed as pre- and post-intervention. At 24 months an increase of z-score BMI and waist circumference, and a decrease in abdominal obesity, eight per cent remission and an incidence of 18% of overweight and obesity was observed (table II). Table III shows the results of consumption of targeted food groups, time spent in different PA activities and in sedentary behaviors. At the end of the study there was an increase (p = 0.007) in vegetable intake and physical activity (p = 0.0001). A decrease in sedentary activities and fried food consumption was also observed.

Several changes took place in the school setting, which were higher in the private schools. These schools changed the food products offered in school stores; more fruits and vegetables were made available along with snacks low in fat and salt. School menus were also changed by including more fruit and vegetables and reducing fat. One private school was able to provide sports venues by constructing a soccer field and basketball courts.

There were also changes in the home environment, as parents decreased the availability of snacks high in fat and salt (p = 0.01), sweetened beverages (0.0001), and cookies, chocolates and candy (p = 0.05). The avail-

Table II
BMI, BMI z-score, WC, prevalence of overweight and obesity and abdominal obesity

Variables	Participants		p
	Mean (SD)		
	Pre-intervention N (532)	Post-intervention N (478)	
BMI (kg/m ²)	18.5 ± 3.7	19.8 ± 4.1	0.001
BMI z-score	0.93 ± 1.4	1.02 ± 1.3	0.001
WC (cm)	64.2 ± 10.4	68.5 ± 11.6	0.0001
Overweight and obesity (%)	45.3	51.3	0.001
Remission ^a (%)	-	8.5	-
Incidence ^b (%)	-	18.0	-
Abdominal obesity (%)	20.6	15.2	0.0001

^aFrom overweight and obesity to normal weight.

^bFrom normal weight to overweight and obesity.

Table III
Foods consumption, PA and sedentary behaviors pre- and post- intervention

Variables	Intervention		p
	Pre-intervention Mean (SD)	Post-intervention Mean (SD)	
<i>Food portions</i>			
Fruits	1.21 ± 1.25	1.13 ± 1.08	0.26
Vegetables	0.43 ± 0.59	0.52 ± 0.60	0.007
Sugar sweetened beverages	1.07 ± 1.02	1.69 ± 0.82	0.0001
Soda	0.29 ± 0.65	0.30 ± 0.64	0.56
Chocolates and candy	0.41 ± 1.04	0.35 ± 0.81	0.24
Snacks containing fat and salt	0.33 ± 0.84	0.25 ± 0.70	0.03
<i>Activities</i>			
TV (h/day)	1.84 ± 1.17	1.68 ± 0.90	0.02
Computer and video games (h/d)	1.01 ± 1.09	1.08 ± 0.95	0.31
Sitting (h/d)	9.94 ± 2.39	9.45 ± 1.91	0.001
Outdoors playing (h/d)	1.42 ± 0.91	1.39 ± 0.85	0.63
Physical Education (h/week)	0.90 ± 0.39	0.97 ± 0.15	0.003
Supervised sports or dance (h/week)	1.35 ± 2.01	2.12 ± 2.49	0.0001

ability of fruits remained the same and less vegetables were available (p = 0.0001).

Discussion

A long-term environmental intervention addressed to parents and elementary school children targeting BMI and lifestyle changes of 2nd and 3rd grade pupils

showed positive results in lifestyle changes and abdominal obesity. At six months there was a greater decrease in BMI in the intervention group than in the control group, although it was not sustained after 18 and 24 months. At 24 months of intervention in the first group and 18 months in the second group a remission of overweight and obesity of 8.5% was observed, and the prevalence of abdominal obesity decreased five percentage points. Additionally, the study found an increase in vegetable consumption, a reduction in the intake of snacks high in fat and salt, an increase of physical activity and a decrease in sedentary activity. It is known that BMI may indicate leanness rather than fatness, particularly among children engaging in physical activity;¹⁷ on the other hand, abdominal obesity in children could predict obesity and diabetes later in life,^{30,39} thus indicating the positive anthropometrical outcome of this long-term intervention.

To our knowledge, this is the first 24-months randomized, school-based intervention conducted in a Latin-American country. Our results are consistent with those observed in other studies conducted in developed countries with an evaluation ranging from 1 to 4 years.^{17-19,22-23,30}

Furthermore, this study observed a remission of obesity of 8.5%, which is in the range observed in another four-year intervention study, showing an increase of 5.2% to 11.1% in the prevalence of overweight and 3.9% to 5.1% in obesity.²² Nevertheless, an incidence of overweight and obesity of 18% was observed in this study is much higher than the one observed in the USA (28) or Germany.²² However in both studies, a low adherence was reported.^{18,22}

On the other hand, our results are not consistent with a 3-year intervention conducted in China.²⁰ where a significant reduction of BMI in the IG was obtained. The difference in the results might be due to distinct school environmental rules, among which can be included the lower number of hours (5-6 hours) Mexican children spend at elementary schools.

The significant increase in the servings of vegetables per day is also consistent with those observed in Norway, where a strong increase of vegetables and fruits consumption was observed. However, they offered a no cost fruit and vegetables program as part of the intervention.²⁵

Another positive result of the program was the reduction in consumption of snacks high in fat and salt, which coincided with the decrease of their availability at home. The food consumption changes observed in this study might be the results of both family and school environments modifications.

Nevertheless, there was no observed effect on the consumption of carbonated drinks, and in fact a significant increase in the consumption of sweetened drinks (other than sodas) was found, this might be due to the beliefs held by most Mexican mothers that juices and other non carbonated drinks are healthy.⁴⁰

Activities that are performed sitting, such as in class activities, doing homework, reading, drawing, car or

bus riding, watching TV, and playing computer or video games, decreased significantly ($p = 0.001$). Likewise, the total number of hours devoted to physical activity (physical education, sports and dance activities), had a significant increase from 2.25 to 3.10 hours per week. These positive results on physical activity contrast with the results observed in Australia.²⁴

Conclusions

The results of this intervention showed positive changes in food and physical activity behavior, in the availability of foods at home and at schools, and in the sports activity settings in one school. The most effective change was to modify the time devoted to activities that are performed while sitting and watching television, followed by an increase in physical activity (physical education school and sports activities outside of school) and positive nutrition-related behaviors such as increasing vegetable consumption and decreasing fat intakes. Therefore, we could imply that changes in attitudes among parents did encourage children's participation in scheduled activities such as sports and physical education academies during and after school hours and in reducing the availability of high risk foods.

One limitation of this study was the lack of control over other social, cultural and community contingencies.

The strengths of this study are that it was a long-term, randomized intervention based in primary schools, which included several levels or components, with the participation of principals, teachers, parents and school children. The intervention was conducted in two public and two private schools of the same socioeconomic level, which might facilitate the opportunity to generalize our findings with other schools in Mexico sharing the same socio-demographic characteristics. In addition, the program was addressed to all children, including those overweight and not overweight. The program was standardized through structured training and a written plan of the activities in each session. The rate of consent to participate among parents and children was high, as well as the adherence to the program.

The sustainability and generalizability of the program is potentially high. This was a simple and inexpensive intervention and obligatory school and out of school environmental changes might help increase the positive effects on lifestyles and obesity.

However, future research should examine the effects in other contexts, such as in lower socioeconomic status populations, rural areas, ethnic groups, etc.

In conclusion, our school-based program reduced abdominal obesity, increased physical activity and consumption of vegetables, and reduced the consumption of snacks with high fat content and the percentage of children with abdominal obesity.

Authors' contributions

BMG: conceived of the study, participated in the design of the study, anthropometric assessments, parents sessions, acquisition of data and performed the statistical analysis.

EPM: participated in the design of the study, anthropometric assessments, acquisition of data and analysis, parents sessions, supervision of the field intervention.

AJC: conceived of the study, and participated in its design and coordination, parents sessions and helped to draft the manuscript.

All authors read and approved the final manuscript.

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