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Promoting healthful diet and physical activity in the Mexican school system for the prevention of obesity in children*

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Abstract

Objective. This paper describes the rationale, design, and methods of a two-year randomized controlled trial conducted to evaluate the effectiveness of an environmental intervention in 27 elementary schools in Mexico City. **Materials and methods.** There were two units of analysis, school level addressing changes in elementary public part-time schools, and individual-level addressing behavioral changes in students 9 to 11 years of age. Two intensities of an intervention program were implemented (basic and plus), each containing two intervention components: physical activity and nutrition, supported by a communication/education component. Evaluation of the intervention was carried out during the school cycles 2006-2007 and 2007-2008. **Results.** Primary outcomes were overweight and obesity prevalence and fitness; environmental and behavioural measures were also examined. **Conclusions.** This is the first institutional multilevel, multifactorial project, consistent with the best practices available in current literature, carried out in Mexico to prevent childhood obesity in schools.

Key words: obesity /prevention; nutrition; physical activity; evaluation of the effectiveness of interventions; child nutrition; Mexico

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saludable en el sistema educativo mexicano para la
prevención de la obesidad infantil.
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Resumen

Objetivo. El presente trabajo describe el protocolo, objetivo, el diseño y los métodos de un ensayo controlado aleatorio de dos años realizados para evaluar la efectividad de una intervención ambiental en 27 escuelas primarias de la Ciudad de México. **Material y métodos.** El protocolo consta de dos unidades de análisis: el nivel escolar donde se evaluaron los cambios en el entorno escolar de escuelas primarias públicas de medio tiempo y el nivel individual que evaluó los cambios de comportamiento en alumnos de 9 a 11 años de edad. Se implementaron dos tipos de intervenciones: nutrición y actividad física apoyadas de una estrategia de educación/comunicación. Las intervenciones tuvieron dos intensidades: básica y plus. La evaluación de la efectividad se llevó a cabo durante los ciclos escolares 2006-2007 y 2007-2008. **Resultados.** Los resultados iniciales reportan los métodos de evaluación de conducta individual así como la prevalencia de sobrepeso y obesidad. La evaluación ambiental reporta el protocolo de evaluación del entorno escolar. **Conclusiones.** Este es el primer proyecto de la de intervención escolar con un diseño multinivel, multifactorial, basado en literatura científica disponible y en investigación formativa para prevenir la obesidad infantil en las escuelas de la Ciudad de México.

Palabras clave: obesidad/prevenición; actividad física; evaluación de efectividad; nutrición infantil; México

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Background and rationale

The rate of overweight and obesity in Mexican children is growing at an alarming pace. According to findings from the 2006 National Nutrition Survey (NNS), and based on the International Obesity Task Force (IOTF) classification¹ from 1999 to 2006 the rate of overweight and obesity in school-aged children (5-11 years of age) went from 18.4 to 26.2%, representing an increase of 33% in seven years.² The incidence of overweight and obesity in school-aged children is most disquieting in Mexico City, where obesity prevalence, according to the IOTF classification system, was the highest of all regions both in 1999 (24.6%) and in 2006 (33.3%).³

The negative implications associated with the obesity epidemic facing countries around the world are extensive, particularly when the condition is observed at an early age.^{4,5} At an individual level, childhood overweight carries a myriad of short and long-term health risks by increasing the likelihood of type 2 diabetes, renal diseases, metabolic syndrome, hypertension and hyperlipidemia^{6,7} as well as depression.⁸ Collectively, overweight and obesity carry sizeable economic implications for health systems and societies.⁹

The school is an important system in the human social structure and serves as a connection of children to the social infrastructure.^{10,11} Schools represent a contained setting where children spend one third of their day; they are an ideal community structure within which to intervene on child well-being.¹² School-based health promotion interventions are recommended for children due to the feasibility of combining environmental and behavioral strategies within a common setting.¹² Prevention of childhood obesity founded on an ecological approach that addresses environmental conditions prevailing at schools in addition to behavioral targets, has become a common practice around the world. A recent review provides convincing evidence that school-based interventions are effective for preventing obesity by enhancing healthy eating and physical activity at school.¹³ Extensive research shows successful interventions with positive behavioral outcomes such as improved dietary practices,¹⁴⁻¹⁷ and PA practices during recess and PE classes^{18,19} in schools of developed countries. However, the effectiveness of ecological multifactor, multilevel, school-based interventions that address both dietary and PA behaviors in developing countries is limited and inconsistent.²⁰⁻²²

According to research carried out by our team, the public school environment in Mexico can be considered to be "obesogenic" (obesity promoting), not only because of restricted opportunities for physical activity²³ but also because of increased opportunities

to consume energy-dense foods and snacks including sugar-sweetened beverages (SSB).²⁴⁻²⁶ The dramatic rise in the prevalence of overweight and obesity in Mexican children and the obesogenic environment that prevails in Mexican schools provide a solid rationale to develop effective strategies to address this serious public health problem. The National Institute of Public Health in Mexico (Instituto Nacional de Salud Pública, INSP) designed and implemented an innovative environmental intervention to promote healthy lifestyles to address obesity in school-aged children from 27 elementary schools in Mexico City. This paper describes the design and methods of a two-year randomized controlled trial that was conducted to evaluate the effectiveness of the INSP environmental/behavioural intervention to prevent childhood obesity. An overarching research goal was to provide evidence to foster policy change in Mexican elementary public schools.

Study intervention goals and aims

Goal. To obtain evidence to be used for fostering policy change aimed at achieving an environment that promotes healthy dietary practices and physical activity of children in Mexican elementary public schools.

General aim. The overarching goals of the intervention were to establish a healthy school environment that would contribute to the attainment of energy balance (healthy eating and PA) and to reduce the risk of unhealthy excessive weight gain in school-aged children.

Specific intermediate aim 1) focused on school environmental change, and include increasing availability of healthy food and beverages (including drinking potable water), reduction of the opportunities to eat, increasing opportunities to engage in PA and the use of available areas and/or sports equipment at intervention schools in Mexico City.

Specific intermediate aim 2) focused on behaviour change, and included increasing physical activity, reducing caloric intake and achieving healthier eating, during school time in children attending public elementary schools in Mexico City through the modification of the school environment and a communication strategy.

Long-term specific aims. To contribute to the reduction of the prevalence of obesity in children from grades 4th, 5th and 6th from the participating schools, and to increase their fitness scores.

Study design

A randomized control trial (RCT) was conducted in 27 schools in Mexico City, interventions were randomly allocated to the basic intervention (n=8), the plus in-

tervention (n=8) and to control (n=11). The evaluation of the intervention used an experimental design and was carried out during the school cycles 2006-2007 and 2007-2008. The RCT consisted of one baseline and three follow-up evaluations. The follow up evaluations were carried out at the end of the school cycle in 2007, at the beginning of the school cycle in 2008 and at the end of the 2008 school year. A monitoring information system was used throughout the intervention period to assure minimal compliance of the schools with the strategies. The monitoring information system focused on the collection of food availability and physical activity process indicators.

School inclusion criteria: Due to logistic constraints and funding availability, we limited the project to elementary schools in the south of Mexico City. The selection of schools was thus constrained to those located in four "delegaciones" (administrative zones that comprise Mexico City): Xochimilco, Magdalena Contreras, Coyoacán and Tlalpan, and meeting the following inclusion criteria: a) being a public school of Mexico City; b) having a part-time schedule (children attending from 8:00 am to 12:30 pm); c) belonging to the socioeconomic status (SES) classified by the Ministry of Education (*Secretaría de Educación Pública*, SEP) as low SES (C category in Mexico City); d) having at least 300 students enrolled at the elementary level (three or more groups per grade); e) having an availability of school sports materials (provided by SEP); f) having similar size areas to perform PA; and g) participating in the Federal School Breakfast Program; h) being a part-time school (i.e., 4.5 hrs/day).

Study sampling

Sampling Frame: There were two units of analysis in this study: elementary public part-time* schools (primary sampling unit) and students 9 to 11 years of age within schools (secondary sampling unit). Some of the environmental effects were evaluated at the school level, while the behavioural effects and the long-term outcome variables were evaluated at the individual (child) level. Individual level effects were evaluated in 4th and 5th grade public school students, who were followed over two years through to their completion of the 5th and 6th grades respectively. Children ages 9 to 11 years of age

were chosen as the secondary sampling unit because during this stage of child development and maturation, intermittent physical activity (highly common in younger ages) decreases, and more structured patterns of physical activity are seen.²⁷ This is more convenient for measurement and better captures whether or not children have the habit of practicing physical activity.²⁷ Moreover, children in the 9 to 11 year age range are able to understand and reliably answer closed-ended questionnaires because they are generally becoming more competent in thinking abstractly and in grasping more complex concepts.^{28,29}

Sample size calculation: Since there was no epidemiological, behavioural and contextual information regarding public elementary school children in Mexico City when we designed the study we used the information available from the previous phase of this study (formative research) to calculate the sample size. This calculation was done in accordance with the obesity prevalence observed in the formative evaluation phase carried out in 2005-2006 in 12 schools of Mexico City by the INSP research team.* Assuming a 40% prevalence of overweight and obesity in the project schools, observed during a formative evaluation phase, a 10% difference in BMI prevalence between children from intervention and those from control schools would be considered to be a clinically meaningful difference.³¹ The sample size required to detect a 10% difference between groups was calculated to attain a power of 0.8 and a type I error (alpha) <0.05 (two-tailed), using an intra-class correlation coefficient (ICC) of 0.08.³⁰ This calculation yielded a minimum sample size of eight schools, in each of the two intervention groups (described below) and eight schools in the control group, with 240 children per group for anthropometric measurements. The number of children selected to assess opportunities to engage in moderate to vigorous physical activity (MVPA) in physical education (PE) classes and recess, and the number of children selected for the evaluation of food intake were based on the largest possible number given logistic and financial restrictions of observation methodologies.

School selection: A preliminary list of 1 283 schools in Mexico City was provided by the Federal Administration of Educational Services in the Federal District of Mexico (*Administración Federal de Servicios Educativos del Distrito Federal*, AFSEDF). We identified 274 schools located in the four "delegaciones" of interest (Xochimilco, Tlalpan, Magdalena Contreras,

* Schools with a part-time schedule of 8 a.m. to 1 p.m. are more common in Mexico City. At the time of the study, a small proportion of elementary schools in Mexico City provided lunch and afternoon activities and could be considered full-time. These schools were not included in this study.

* Bonvecchio A, et al. Formative research for the design of an obesity prevention school based intervention. *Salud Publica Mex* 2012. Submitted for publication.

and Coyoacán). Of these, only 84 met the inclusion criteria, and 40 agreed to participate in the study. Finally, from those 40, we randomly selected 27 schools, oversampling the control group by three schools in anticipation of attrition.

Student recruitment: All the children from grades 4th to 5th in the 27 schools were invited to participate in the evaluation. Approximately 2 430 consent forms and information letters were sent to parents. Overall 1 712 students obtained parental consent. Student assent was also sought on data collection day. No data were collected without both parental and student consent. Out of 1 712 eligible students, we randomly selected 886 children at baseline and followed them during the second year. In order to compensate for attrition of 56 students from year 1 to year 2, an additional 93 students were recruited in the second year. Thus the 93 students recruited into the study in year 2 (2007), had the same exposure/dose as the other 886 students who were part of the study from 2006. Student selection was stratified by school grade and performed with a computer-generated

random numbers list assuming an equal proportion of girls and boys and an equal proportion of children from every 4th and 5th grade classroom per school. Figure 1 shows the project consort diagram

Study outcomes

To evaluate the effectiveness of the INSP environmental/behavioural intervention in 27 elementary schools in Mexico City we identified the following outcomes:

Intermediate outcomes: a) the availability of healthy foods and beverages (including water) during recess time; b) opportunities to eat at schools; c) opportunities to engage in PA at school; d) intake of food and beverages at school; e) opportunities to be active during PE class and recess time; and, f) quantification of physical activity during PE and recess time.

Long-term outcomes: a) prevalence of overweight and obesity; b) body composition; c) average fitness scores of students based on cardio-respiratory fit-

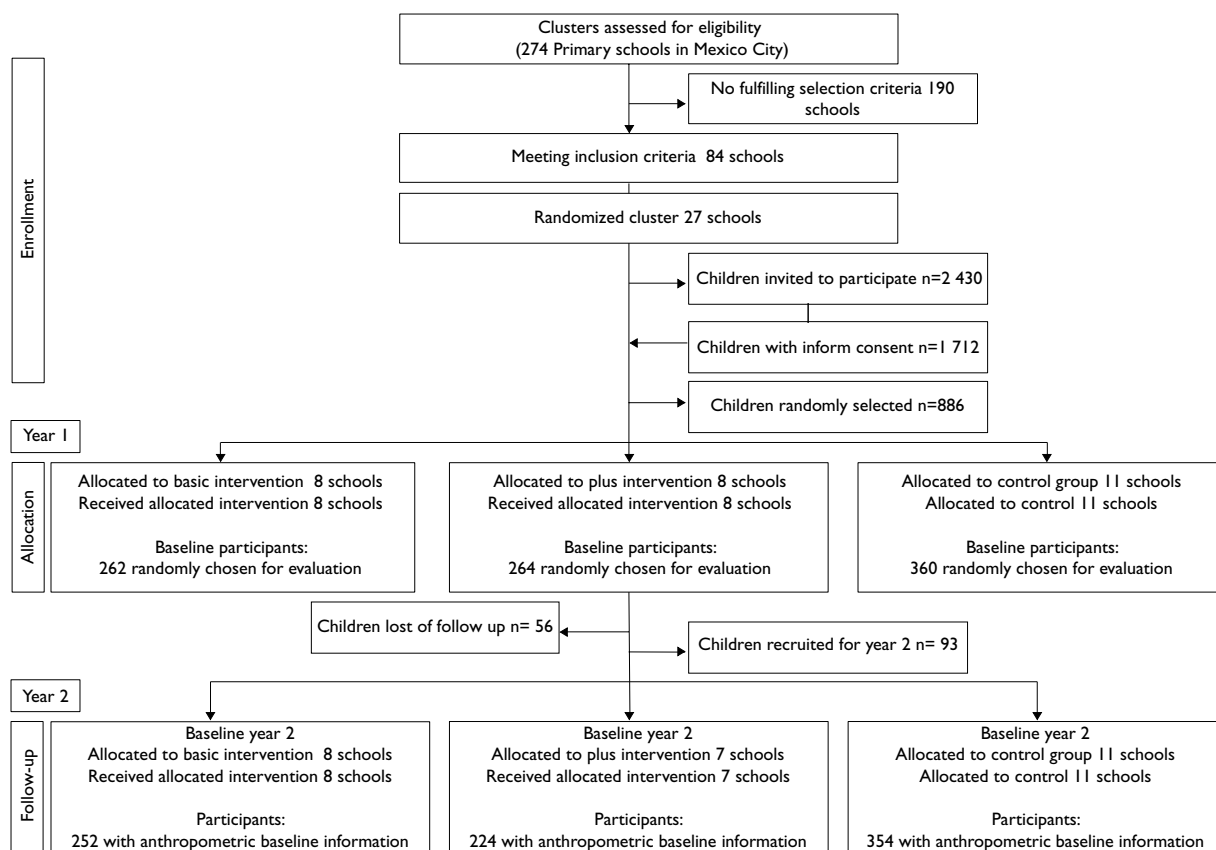
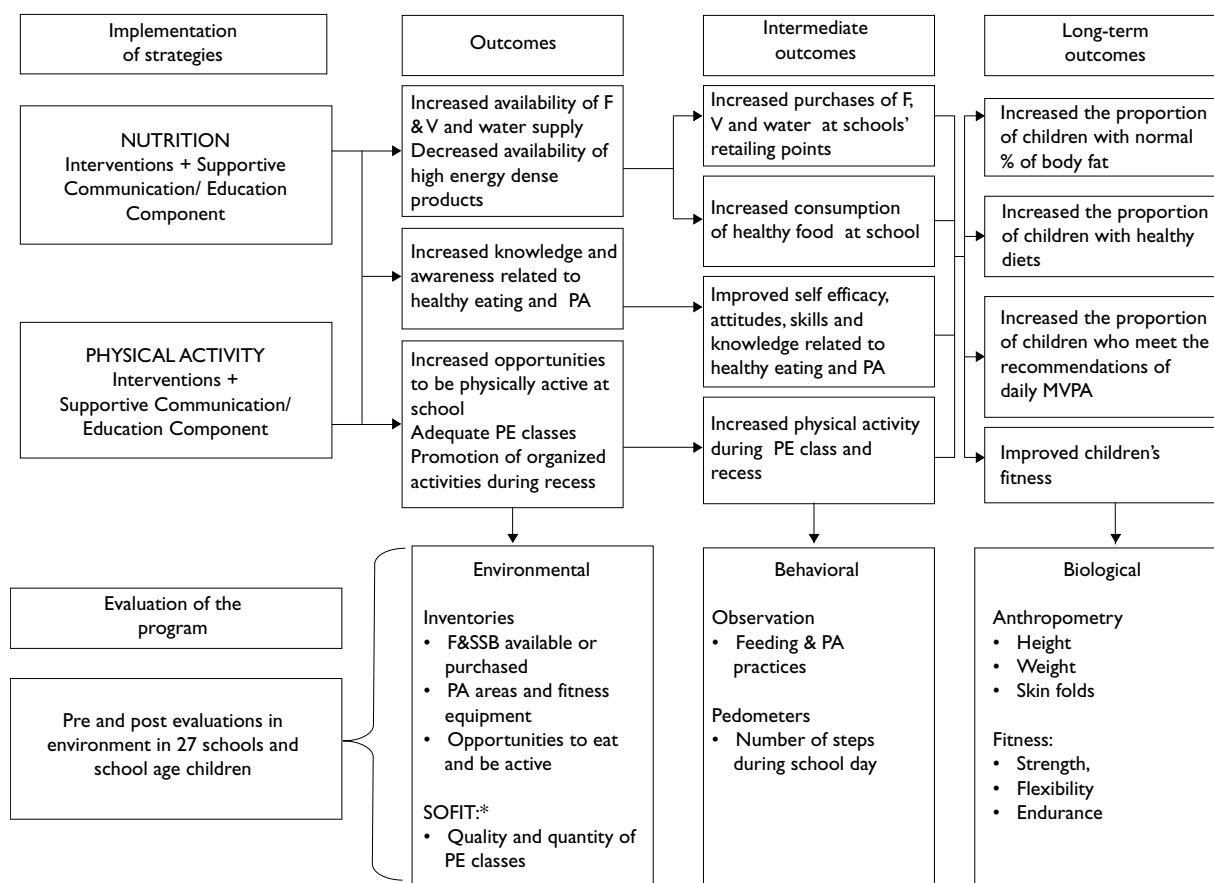


FIGURE 1. CONSORT DIAGRAM OF PROMOTING HEALTHFUL DIET AND PHYSICAL ACTIVITY IN THE MEXICAN SCHOOL SYSTEM FOR THE PREVENTION OF OBESITY IN CHILDREN



* SOFIT: System for observing fitness instruction time

F&V: Fruit & vegetables

PA: Physical activity

PE: Physical education

MVPA: Moderate to vigorous physical activity

F&SSB: Food and sugar-sweetened beverage

FIGURE 2. LOGIC FRAMEWORK OF PROMOTING A HEALTHFUL DIET AND PHYSICAL ACTIVITY IN THE MEXICAN SCHOOL SYSTEM FOR THE PREVENTION OF OBESITY IN CHILDREN

ness, muscular endurance, and flexibility. A detailed description of measures is provided in a subsequent section. Figure 2 presents the intervention outcomes/evaluation logic model as per Goodstadt health promotion logic models.³¹

Ethics approval and informed consent letters: The Research, Ethics and Biosecurity Committee of the INSP reviewed and approved the study protocol. All parents of selected children provided informed consent that allowed their children to participate in the study and the selected children were asked to provide assent.

Intervention partners

Prior to the intervention, in 2005, the INSP carried out a formative evaluation in 12 schools in Mexico City in order to assess the school environment and identify potential interventions.* For this purpose, the AFSEDF and the Physical Education General Direction of the

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Ministry of Education of Mexico City (*Dirección General de Educación Física*, DGEF) partnered with the INSP to facilitate access to the elementary school system. Once the INSP diagnosed the environment of the schools in Mexico City as obesogenic, the INSP and the Federal SEP / AFSEDF / DGEF authorities participated in a consultative process led by the INSP where a group of experts and the authorities identified potential interventions to be implemented in the schools. Furthermore, the consultative process was also carried out at the school level where teachers and school authorities such as principals and area supervisors identified the most feasible potential interventions reported elsewhere.* Once the project began in 2006, the INSP and the SEP / AFSEDF / DGEF formed a working committee to ensure continuity of the partnership and to create an intervention delivery plan. In concordance with this plan, the working committee advocated for school authorities and school communities participation in the intervention in order to strengthen the collaboration and to identify ways to enhance the commitment of the key actors (school supervisors, principals, teachers, PE teachers, food vendors, parents, and children) at the school level. Thus, the SEP authorities supported the INSP project by their active involvement in the project, by increasing awareness among other sections of the SEP through meetings and memos distributed among authorities about childhood obesity and the need to create a healthy school environment. In addition, they sponsored workshops for PE teachers designed to improve the quality of the PE classes. Overall, SEP / AFSEDF / DGEF actively participated in all meetings organized by the INSP team and collaborated in decision-making about the best ways in which interventions could be delivered.

Intervention design

Intervention description: The intervention was designed according to the formative research findings^{28,32} from the previous phase, literature review of effective strategies,^{20,33-41} a consultative process with the international experts, SEP authorities and schools stakeholders^{‡,28} and a supportive communication/education component based on social cognitive theory

(SCT),⁴² theory of planned behaviour (TPB)⁴³ and health belief Model (HBM).⁴⁴

The intervention duration was seven months during the first year and eight months during the second year. Two main intervention components focusing on nutrition and PA were developed based on formative research findings,¹² and the socio-ecological model.⁴⁵ The intervention strategies sought to establish an environment at school that would give children the opportunity to increase PA and to reduce intake of energy-dense food and sugar-sweetened beverages.

Two distinct intervention programs were implemented: A basic intervention that was considered feasible to implement at low cost (referred to hereafter as “basic intervention”) and a more intensive intervention that would require greater investments (referred to hereafter as the “plus intervention”).

The components of the basic and plus nutrition and PA intervention components as well as the supportive education/communication component are described in the following section and summarized in table I.

Basic intervention: Using existing school infrastructure and resources to ensure sustainability with no additional investment, the basic intervention mainly consisted of the implementation and monitoring of norms or regulations,⁴⁶ consistent with healthy lifestyles. This implementation was based on the willingness and participation of school community actors (teachers, principals, and authorities of the SEP, AFSEDF, DGEF). This set of interventions was established according to feasibility criteria in short-term implementation, and budget constraints. This was in order to make possible a short-term replication without the need of additional resources. It included the three main intervention components: nutrition, physical activity, and communication/education.

Nutrition intervention, basic, year one

- a) *Promoting to increase the availability of healthier food choices and to reducing the availability of energy-dense products (balancing the product sold at the canteen):* Since there were no institutional guidelines or policies to control food intake inside the schools when we implemented the project (and at that time there were no Mexican nutritional guidelines to promote healthy eating in schools), we had to identify a mechanism to promote healthy intake at schools without violating the autonomy of the school cooperative. Therefore, in order to ensure the children's access to healthy food items at school, authorities were asked to balance the availability of products sold in the school canteen by reducing non-healthy

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‡ The consultative process was carried out at the INSP in Cuernavaca with SEP stakeholders, INSP researchers and United Kingdom experts (Tim Lobstein PhD, James Reilly PhD, Ricardo Uauy PhD, Juliana Kain PhD, Anny Anderson PhD and Karen Lock PhD).

Table 1
NUTRITION, PHYSICAL ACTIVITY AND COMMUNICATION/EDUCATION INTERVENTIONS CARRIED OUT AT THE PROMOTING A HEALTHFUL DIET AND PHYSICAL ACTIVITY IN THE MEXICAN SCHOOL SYSTEM PROJECT BY YEAR AND TYPE OF INTERVENTION

	<i>Basic</i>		<i>Plus</i>	
	<i>Year 1</i>	<i>Year 2</i>	<i>Year 1</i>	<i>Year 2</i>
Nutrition	Promoting to increase the availability of healthier food choices (balancing the products sold at the canteen)	Continued in year two	Promoting to increase the availability of healthier food choices (balancing the products sold at the canteen)	Continued in year two
		Prohibiting of eating during lesson time and limit "school breakfast" time to 20 minutes		Prohibiting of eating during lesson time and limit "school breakfast" time to 20 minutes
		Reducing exposure to eating opportunities	Reducing exposure to eating opportunities	Continued in year two
	Ensuring water availability	Continued in year two	Ensuring water availability	Continued in year two
	Limiting availability of sugared beverages in the school	Continued in year two	Limiting availability of sugared beverages in the school	Continued in year two
		Limiting of the sale of certain densely energetic foods		Limiting of the sale of certain densely energetic foods
		Promoting to reduce the availability of candy and sweets		Promoting to reduce the availability of candy and sweets
		Limiting the sale of certain densely energetic foods	Limiting the sale of certain densely energetic foods	Continued in year two
			Promoting of a fruit and vegetable day	Discontinued for year two
	Promoting to modify culinary techniques and ingredients of products sold during recess	Continued in year two	Promoting to modify culinary techniques and ingredients of products sold during recess	Continued in year two
Physical activity	Promoting active recess: Using an activity box	Discontinued in year two	Promoting active recess: Using an activity box	Discontinued in year two
			Organizing PA during recess and free time	Continued in year two
	Improving the school premises and provide sports equipment	Continued in year two	Improving the school premises and provide sports equipment	Continued in year two
	Improving the quality of PE : One lesson 50 minutes/week	Continued in year two	Improving the quality of PE and MVPA time: two lessons 100 minutes/week	Continued in year two
			Activation: 15-20 minutes of activation to all children from Tuesday to Friday	Continued in year two
	Mass communication and marketing targeted to children to promote four basic behaviours through messages and concepts: Fruit and vegetable consumption, water consumption, engage in PA and pack a healthy lunch	Continued in year two	Mass communication and marketing targeted to children to promote four basic behaviours through messages and concepts: Fruit and vegetable consumption, water consumption, engage in PA and pack a healthy lunch	Continued in year two
Communication/ Education	Supportive resources were provided such as pamphlets to PE instructors: to improve the quality of PE classes	Continued in year two	Supportive resources were provided such as pamphlets to PE instructors: to improve the quality of PE classes	Continued in year two
	Supportive resources were provided such as pamphlets to Parents: how to prepare a healthy lunch		Supportive resources were provided such as pamphlets to Parents: how to prepare a healthy lunch	
	Supportive resources were provided such as pamphlets to Vendors: how to improve culinary techniques and sell healthy food		Supportive resources were provided such as pamphlets to Vendors: how to improve culinary techniques and sell healthy food	
		Newsletter for parents and bulletin boards at schools promoting healthy eating and being active		Newsletter for parents and bulletin boards at schools promoting healthy eating and being active
		Supportive resources were provided such as workshops: Food vendors how to improve culinary techniques and sell healthy food	Supportive resources were provided such as workshops: Food vendors how to improve culinary techniques and sell healthy food	Continued in year two
			Supportive resources were provided such as workshops: PE instructors: how to improve the quality of the PE class	Continued in year two
		Educational and skill based workshop with students aimed to achieve energy balance at school, promote fruit and vegetable intake and teach how to pack healthy lunch	Educational and skill based workshop with students aimed to achieve energy balance at school, promote fruit and vegetable intake and teach how to pack healthy lunch	Continued in year two
				Supportive resources were provided such as workshops: School authorities sensitizing on healthy lifestyle and the benefits of healthy eating and PA

PA: Physical activity

PE: Physical education

MVPA: Moderate to vigorous physical activity

food options such as sweets, chips, candies and SSB (including sodas, artificial juices and industrialized beverages) while increasing healthier choices such as fruit, vegetables and low- and non-sugared fruit beverages.

In order to reduce energy-dense products in schools, the research team created a *Recommendations list* of recommended, recommended for consumption no more than twice a week, and non-recommended food products based on the sugar and fat content and the potential nutritional value of each item. The quantity of energy and fat content was obtained from national nutrition tables,^{28, 32-34} food industry nutrition labels, or calculated from the recipes obtained from each school vendor. Based on this information, a list containing potential products was discussed with school authorities and, upon agreement of all participating schools, a comprehensive list of healthy food items with low fat and sugar content was created and the food items were made available for purchase in participating schools. All basic intervention schools were required to comply with the list.

Recommended products are items considered healthy based on their energy content and overall nutritional value such as boiled corn with lemon, "non fried and low-fat tacos" (made of mushroom, cactus, potatoes), vegetables with lemon (cucumber, carrots), fruits (mango, "jícama", melon, pineapple, watermelon), sorbets, low sugar fruit beverage.

Recommended for consumption no more than twice a week products are defined as products which have some nutritional value, but given the way they are prepared or the portion size sold, contribute excessive calories or other undesirable elements to a child's diet. All of the foods included in this list could be modified to become healthier options. This includes popcorn with butter, salted peanuts, salted corn, rice with milk and sugar ("arroz con leche"), non-fried high-fat "tacos" (meat, potatoes with sausage, poblano pepper with cream), ham sandwiches, water-based jellios, and boiled corn with mayonnaise.

Non-recommended products are food items with high caloric density and/or high in sugar and fats. Given their preparation, these foods cannot be modified into healthier options. These include home-made deep-fried foods ("tacos", "gorditas"), pizzas, French fries, fried and breaded meat sandwiches ("tortas de milanesa"), hot dogs, caloric carbonated beverages, doughnuts, ice cream, milk-based jellios, cookies, and sweet snacks (cupcakes, cakes and sweet bread).

- b) *Promoting to modify culinary techniques and ingredients of products sold during recess.* The *Recommendations list* also addressed culinary practices and provided suggestions of alternative ingredients to aid food vendors in improving the nutritional value of food sold at school. The aim behind this recommendation was to reduce fat and sugar content in the home-made food items sold by the school food vendors. Food vendors were instructed to replace deep-fried or fried culinary techniques in home-made food preparation by grilling/baking homemade foods. In addition, we promoted the elimination or substitution of fat or sugar laden ingredients by other ingredients (e.g., using lime juice on fruit instead of whipped cream).
- c) *Limiting of food exposure and reducing eating opportunities.* Given that children had more than five opportunities to eat during the school day,^{3,23-26} the intervention promoted a reduction in food exposure and the number of opportunities to eat at school by engaging school staff. The research team encouraged classroom teachers to comply with the policy of not eating during lesson time, (except during the federally sponsored school breakfast), and promoted recess as the only period during which eating would be permitted.
- e) *Ensuring water availability.* Given that drinking water was not available at most schools, the intervention ensured water availability by providing schools with approximately ten 19L water containers per month during the intervention period.

Nutrition intervention, basic, year two

During year two, strategies were targeted at 5th and 6th graders (previously 4th and 5th). The same components as year one were implemented, but with a stringent prohibition against eating during lesson times and a limit of school breakfast time to 20 minutes, this strategy was implemented to limit the opportunities to eat freely anytime during class (regardless if they were items from the Federal Breakfast Program). Improvements were also made to the *Recommendation list*, so as to further restrict the availability of energy dense products: We banned sugar-sweetened beverages and re-labelled the foods that were previously classified as "food recommended less than twice a week" to non-recommended foods.

Physical activity (PA) intervention, basic, year one: In order to increase opportunities to perform PA during the school day and to enhance the quality of the physical education (PE) program, three strategies were used: PA promotion during recess, more active time during

PE, and improvements to the PA environment. These strategies are described below.

- a) *Promoting of PA during recess and free time.* This strategy consisted in using an activity box that contained printed cards that suggested activities with structured games to promote organized PA at recess and free time, designed for and tested on elementary school-aged children. The activity box contains more than 150 cards, each with a different activity to take place during recess time, assuming the necessary space and basic material are available. The activity box was revised and adapted before distributing it to the intervention schools to guarantee that all the activities described could take place in the space available in the public elementary schools of Mexico City. When delivering each activity box, we also included basic material for the implementation of the activities listed in the box (ropes, elastic bands, etc.). All of the activities described in the box are “play oriented”, meaning they are not highly competitive in nature and do not require specific sports-related abilities from the children participating in them. They are also basic enough that they don’t need to be directed by a PE teacher. The most complex activities contained in the box are similar to games such as “4-corners”. The activity box was used to engage 4th and 5th graders in structured PA. Teachers were trained as the primary users and organizers of these activities every day at recess for 15 minutes.
- b) *Improving the quality physical education (PE) at least 50 minutes per week.* In order to increase the quality of PE lessons, we encouraged the PE teachers to use PE time wisely and ensure that at least half of the class (25 minutes) was devoted to MVPA by suggesting strategies on how to maximize the PE time and avoid kids sitting or waiting around their turn to participate in activities.
- c) *Improving the school premises and providing sports equipment.* The INSP improved the PA school premises to facilitate PA engagement by assisting PE teachers to promote the use of PA areas by painting games and sport courts (soccer, volleyball and basketball) on the ground. In addition, each school received PA equipment such as basketballs, soccer balls, jumping ropes, basketball nets, and elastic bands in order to support the PE classes and games and activities contained in the activity box.

Physical activity intervention, basic, year two

The PA during free time became more structured and mandatory. Physical education teachers were trained

by the DGEF in simple PA and kinesiology routines and provided 15 to 20 minutes of “activation” to the school community (including teachers and students) four days a week (from Tuesday to Friday) in the morning before the beginning of classes. Moreover, at the beginning of the second year, PE teachers were sensitized by the INSP on the importance of healthy lifestyles and how to promote healthy lifestyles in the school.

Communication/education, supportive component; basic, year one and two

The purpose of this component was to support the environmental and behavioral interventions by increasing school community awareness and self-efficacy for improving healthy habits by promoting positive attitudes towards healthy lifestyles in order to complement the nutrition and PA intervention/activities. Thus, a massive communication campaign based on formative research and social marketing theory was developed (including name, slogan, image and concept) and pilot tested prior to its implementation.³⁵⁻³⁶ Through the use of posters with comic characters, five healthy behaviours were promoted: a) increasing fruit consumption, b) increasing vegetable consumption, c) promoting water consumption, d) increasing physical activity, and e) bringing a healthy lunch to school.

In the first year, handouts were designed and field-tested for the following stakeholders: 1) parents (how to pack a healthy lunch); 2) school vendors (alternative and improved culinary practices); and 3) PE teachers (tips on how to improve the quality and quantity of the PE classes). Training and motivation sessions were also developed based on social cognitive theory³² and the theory of planned behaviour³⁷ and were field-tested for use in 4th and 5th grade students, school vendors and teachers.

The food vendors’ were recipients of a workshop, which main objectives were to: 1) evaluate their own eating behavior, weight and risk of chronic disease; 2) describe the list of recommendations for the sale of food in the schools; 3) discuss what could be done to improve food offerings in schools in which they worked; 4) commit to changing his/her own products in order to comply with the INSP recommendation list. This first workshop was mostly motivational and based on the health belief model,^{24,26,38} and social cognitive theory. Thus vendors themselves were weighed, had their BMI calculated, their blood pressure taken and their diet evaluated through a 24h recall.

In the second year, some components were implemented the same way as in year 1 (i.e, pamphlets and booklets), but in general, the strategies were

thoroughly revised. The comic characters were made the central icons for all planned communication/education activities, parents received four newsletters throughout the year, and, to improve communication between the INSP and the schools, a bulletin board was set up in each of the schools. These bulletin boards mainly described activities planned and also included a mailbox where feedback on project implementation could be submitted. Compared to year one, these measures required some additional investment of resources.

During this second year we delivered a set of workshops targeted to children of 5th and 6th grades on healthy eating. We also delivered a workshop to vendors where we provided the how-to information for them to be able to implement the improved recommendation list. An example of one of the workshop activities was to have the vendors write down the recipes for the products they sold in schools and then try to modify it so that it would comply with the recommendation list.

Plus intervention: In addition to the implementation of regulations described for the main components of the basic intervention, the plus intervention included activities that required additional financial investment and human resources. It was presumed that this additional investment would yield enhanced effects as compared to the basic intervention. Specific components of the plus intervention are described below.

Nutrition intervention, plus, year one

In addition to the strategies used in the basic intervention and described previously, two additional strategies to improve food availability at schools were as follows:

- a) *Promoting of a designated day to sell only fruit and vegetables in school.* The aim of a designated day to sell only fruits and vegetables (F&V) was to promote the intake of these healthy foods, and to demonstrate that children will accept and eat fruit and vegetables if they are available. Authorities determined the F&V Day and food vendors sold fresh fruits and vegetables and/or vegetable-based home-made foods (such as baked vegetable quesadilla) on that day.
- b) *Limiting the sale of energy-dense food products to one or two days a week.* The sale of energy-dense food items such as sweets, snack, chips, candies and sugar beverages products were limited to one or two days a week.

Nutrition intervention, plus, year two

In the second intervention year, we carried out the same intervention as year one and also banned the daily sale of energy-dense products and improved the food *Recommendation list* by re-labelling the food items into two categories – recommended and non-recommended food items.

Physical activity intervention, plus, year one

The strategies in the plus intervention included the same PA strategies described under the basic component with some additional improvements to the PE classes, and PA “activation”. These additional strategies were:

- a) *Improving the quality PE at least 100 minutes per week.* In order to increase the minutes of MVPA in PE, the PEGD at the central level and the INSP hired eight external PE teachers to assure additional PE classes for children of 4th and 5th grades. Therefore, these students had 100 minutes of PE per week and at least 50 minutes of MVPA. In order to increase the quality of the PE class, workshops for PE teachers on improving the effectiveness of the PE classes were designed and tested.
- b) *Mandatory physical activation: 15-20 minutes of PA engagement four times a week.* External physical educators hired by the DGEF provided a mandatory 15 to 20 minutes of activation to all the children in the plus schools during morning commencements, assuring 15 to 20 minute of PA a day. These physical educators also directed the active recess in those schools, using the activity box.

Physical activity intervention, plus, year two

In year two, the double session PE class continued with children of 5th and 6th grades, and the activation and improvement of the premises at the schools were also implemented, but the activity box implementation at the recess was cancelled when the SEP notified the INSP that internal regulations actually forbid the use of recess for something other than resting. The active recess continued during year two, consisting only in having a specific area on the patio for those students choosing to partake in physical activity during recess time.

Communication/education supportive component, plus, years one and two

The strategies included in the communication component in plus schools included the massive communica-

tion campaign developed to promote the five behaviours already described in basic schools. Furthermore, in addition to the handouts distributed to children, vendors, and PE teachers, children participated in two workshops, and vendors, parents and PE teachers in one workshop during the year.

In year two, in addition to the massive communication campaign and school bulletin boards. Furthermore, 5th and 6th grade children participated in two new healthy eating workshops and two comic strip drawing contests, and parents received four newsletters.

An additional sensitizing workshop on healthy lifestyles was implemented for staff and school authorities, including PE and regular teachers. We invited teachers to take a leading role in their health and join us for half day to hear talks about healthy lifestyles, do some PA and eat healthy. Thus, teachers and principals participated in a welcome brunch at the INSP premises where they learned about the overweight and obesity epidemic in Mexico and about the strategies we were implementing to address the problem in their schools. In addition, school authorities were taught about the importance of healthy lifestyles and obesity prevention. We measured the blood pressure, glucose levels and weight and height of the teachers and principals to provide them with a personalized health profile.

Validation of communication/education supportive materials

To validate the communication component, we carried out interviews with children in order to test the concepts, messages, images and slogans according to the social marketing approach.³⁹ Once we had tested these messages, we validated the communication campaign with focus groups carried out with target age children from schools similar to our intervention schools. Through these focus groups, the concept, characters, slogans and messages were thoroughly tested for comprehension and interpretation. It was an iterative process in which, the creative team and the researchers would revise the materials after every field test and test them again.

A readability test using a modified-for-Spanish Flesch Kinkaid formula was conducted to test the printed materials with teachers, vendors and parents. In addition, the brochures were validated with each target audience through individual interviews and a questionnaire that included questions measuring general comprehension, message recall, language appropriateness, perceived usefulness of the information presented, and image and graphic appropriateness.

Finally, to evaluate the communication strategy, we designed one instrument that aimed to measure knowledge about the characters, recall of the messages

and characters, overall liking of the posters and finally, whether the target audience had tried to follow any of the messages in the posters.

Implementation process

The implementation of strategies and communication/education component was encouraged during meetings with involved actors, including SEP authorities at the federal, central, and local levels. At the school level, INSP staff met with parent associations and teachers to explain the importance of project implementation and to increase awareness and promote children's participation through parental consent. In addition, a workshop was carried out in each of the schools to present the project's target behaviors and to recruit parents in the team effort. In this case, the workshops were mainly focused in motivating them to support the nutrition and PA interventions and to join in the effort. We also asked for the teachers for activity ideas for influencing children's behavior above and beyond the planned interventions.

A team of 12 implementers (three per school) was hired and trained by the project coordinators and was assigned to visit each school two or three times a week in order to support the implementation process and to solve unexpected problems. Implementers participated in technical council monthly meetings to discuss project details and answered questions from teachers and school principals. In order to ensure proper implementation, a monitoring information system specifying minimal standards for compliance (percentage of strategies implemented / week) by strategy / school was developed for each set of strategies. Process indicators were collected three to four times a week in each intervention school and consisted of a simplified checklist capturing whether or not the intervention was being implemented as intended. Implementation integrity was quantified by a percentage of adherence to planned activities.

Evaluation methodologies

We assessed the school environment and physical activity and dietary behaviours of children using quantitative and qualitative methodologies piloted during a formative evaluation conducted in Mexican schools.³⁸⁻⁴¹

Personnel training and instrument standardization: All outcome measures were assessed using methodologies and tools adapted for school-aged children (9-11 years old) from Mexico City. Trained nutrition, social work, nursing, and physical education field workers imple-

mented data collection tools. Re-standardization took place periodically throughout data collection phases according to established protocols.⁴¹

School environment measures: In addition to the specific measures described in this section, the total number of opportunities for eating and being active were recorded at each school during each data collection phase.

1. Availability of healthy foods and beverages and opportunities to eat healthy food at school
 - 1.1 Availability of healthy and non-healthy foods and beverages: An inventory of food items was completed at each school by nutritionists who observed food offerings, weighed all foods available for sale, and/or surveyed independent food vendors allowed on school grounds. Foods were classified into one of the following three categories: Recommended foods; foods recommended for consumption no more than two times a week; and non-recommended foods. A log of purchased foods was also made. Inventories were completed two to three times per week during each data collection phase.
 - 1.2 Availability of water: The total number of water containers (19L) available in 4th to 6th grade class rooms and elsewhere in the school was recorded.
 - 1.3 Opportunities to eat: The total number of opportunities to eat at school was observed using a checklist specifically designed for this study; this included the consumption inside classroom especially before and after recess. In addition, in plus schools, we observed whether or not children had a time limit (20 minutes) or were restricted to eating only during the school breakfast program.
2. Availability of resources and opportunities to be physically active at school
 - 2.1 Availability of PA areas and PE equipment: Trained field workers counted the total number of outdoor and indoor areas (e.g., patios, gyms, auditoriums, painted courts) used for PA and PE classes. An inventory of school-owned sport and physical activity equipment available was also taken at each school during each data collection phase.
 - 2.2 Quality of physical education classes: Trained observers assessed the quality of PE lessons by recording students' levels of physical activity using SOFIT (System for Observing Fitness Instruction Time).⁴² SOFIT allows the observer to quantify the activity level of students during the PE classes in minutes. It also

provides information on class context and PE teacher behaviour. SOFIT has been shown to be reliable and valid.²³ The detailed methodology of the SOFIT data collection and analysis of this research project have been described elsewhere.³⁸

Child behavioral (healthy eating, PA) and psychosocial measures

Observation and survey methods were used to assess food and beverage intake; food purchases at school; child physical activity at school and at home; and, psychosocial measures are described in this section.

- 1.1 Food and beverage intake and purchases at school: A direct observation protocol complemented by a close-ended survey was used to assess child food and beverage intake and purchasing patterns.⁴³ in a subsample of children. Due to feasibility and budgetary constraints we randomly selected eight children per school (four per grade) for observation of their dietary patterns during recess time.

Before the eating break, during class time, selected study participants were asked to show their lunch boxes to a nutritionist and to describe their composition. The nutritionist recorded the content and portions of food and beverage items contained in the homemade lunches and the amount of money the child brought from home to spend on food at school. Then, during the recess, these same participants were unobtrusively observed by the nutritionist who recorded what they had consumed. Each nutritionist recorded all the foods and beverages and the serving sizes of food items purchased and consumed at recess, according to the portions specified in the Mexican equivalent system.²³
- 1.2 Physical activity at school: The NL-1000 pedometer was used to assess the total number of steps taken during five consecutive days (i.e., from Monday morning upon arrival at school until Friday afternoon at school dismissal). The internal clock on all pedometers was set to restart every day at 08:00 hours, the hour the school day began. This programming set the step count to be zero at the beginning of each school day, thereby allowing us to isolate the steps taken during the school day. The steps in memory corresponded to the 24-hour period from 08:00 of the first day to 07:59 of the next day. We verified the calibration of all pedometers before each data collection phase. The detailed methodology is described elsewhere.³²

- 1.3 Psychosocial measures and self-reported behaviours: A 35-minute questionnaire based on the theory of planned behaviour¹ was used to collect relevant knowledge, attitudes, social norms, perceived behavioural control (i.e., self efficacy), and behavioural intent related only five specific behaviours for the evaluation of the communication/education component.

Child biological (anthropometric and fitness) measures

Prevalence of overweight and obesity were assessed by measuring individual height and weight (to calculate BMI). Anthropometry, physical fitness and sociodemographic measures (i.e., child date of birth, gender, grade, and group assignment) were also recorded.

1. Anthropometric measures

Height (standing height in cm) was measured with a Dynatop stadiometer having a capacity of 2 meters and accurate to 1mm. Weight (in kg) was measured with a portable electronic scale (Tanita). BMI was calculate according IOTF cut off points.⁴³ Skin fold thickness (triceps and sub scapular) were measured with a Harpenden Caliper. Arm and calf circumference were measured with a K-E anthropometric tape. We followed the Anthropometry Procedures Manual for the National Health and Nutrition Examination Survey (NHANES) 2000 for children over 8 years old.⁴⁰ The anthropometry team was standardized according to Habitch methodology.⁴⁴ This method has been employed previously in probabilistic surveys in Mexico.⁴⁷ To avoid confounders of body composition change due to sexual maturation, we measured maturity through non-invasive and non-costly methods, such as self-report of the menarche status of girls.

2. Physical fitness measures

Fitness measures assessed endurance, flexibility, and strength using three types of tests:

- 2.1 A 9-minute distance run: the total number of meters that a child could run during nine minutes.
- 2.2 Sit-and-reach: the total number of times that a child could reach his/her hands beyond his/her feet while sitting on the ground with extended legs and ankles spread apart shoulder-width.
- 2.3 Sit-ups and push-ups: the total number of sit-ups completed in a 60 second time period and the maximum number of push-ups a child could complete without stopping.

The detailed fitness methodology of this research project is described elsewhere.⁴⁸ A score for overall fitness was then calculated using an algorithm that integrates each of these measures. Table II presents the operationalized environmental, behavioral, and biological measures.

Monitoring information

Process indicators were collected weekly during the implementation in the intervention schools; the percentage of compliance to planned nutrition, PA and communication strategies was assessed. During year one, 75% of the nutrition intervention was implemented while 70% of the PA intervention was implemented overall (mainly due to cancellation of PE classes). Ninety percent of the communication/education intervention was implemented. During year two, 80, 70 and 95% of the nutrition, PA and communication/education intervention were implemented as planned across the 16 intervention schools.

Characteristics of baseline schools and children

The intervention duration was seven months during the first year and eight months during the second year. On average, the schools had between 316-755 students, between 11-20 teachers and 1-2 physical education teachers, with no difference between intervention groups. Table III shows the baseline characteristics of children included in the evaluation of the intervention. On average, children were almost 10 years old, and had a BMI of 19.8. The combined prevalence of overweight and obesity was 43.5%, with no difference between groups.

Study limitations

To implement the project we had to overcome obesogenic factors rooted in the Mexican school system such as lack of nutritional guidelines regarding the sale of food products in schools, limited awareness and knowledge about healthy lifestyles among key actors (SEP authorities, school supervisors, school directors, teachers and food vendors), and lack of comprehensive regulations to adequately guide healthy eating and physical activity in schools.

Even though the majority of key actors collaborated with the project during year one, we documented through a parallel qualitative research process some resistance to collaboration that compromised the implementation. At the school level, we observed a general lack of motivation to take on additional tasks

Table II
OPERATIONAL DEFINITIONS OF OUTCOME VARIABLES OF PROMOTING A HEALTHFUL DIET AND PHYSICAL ACTIVITY
IN THE MEXICAN SCHOOL SYSTEM FOR THE PREVENTION OF OBESITY IN CHILDREN

Type of impact	Assessment	Data sources	Variables	Indicators %
School environment	Availability of healthy food and/or beverages at schools' co-operatives and concession stands	1) Food and beverage inventories at schools	Number of portions of recommended food items available Number of portions of food for consumption no more than 2/week availability Number of portions of non recommended food items available	Recommended food items at school potentially healthy food items at school Non-recommended food items at school Energy per-capita Fat per-capita
		2) Water container inventories at school	Number of water containers at school/ weekly	Water containers at schools
	Quality and quantity of physical activity instruction at school	Observation of PE classes and recess using SOFIT: Intensity of the class: (Sedentary or MVPA) Lesson context: General content, general knowledge, physical activity knowledge, fitness, skill practice, game play, and free play	Length of PE class in minutes Type of activities done in PE class: instruction, motivation, administrative Minutes of MVPA by context in PE class Minutes of MVPA in PE class Minutes of sedentary activity in PE class Minutes of MPA in recess Minutes of sedentary activity in recess	Class time dedicated to physical activity Children participating in PE class Time spent in moderate to vigorous physical activity during PE class Time spent in sedentary activity during PE class Time and minutes of MVPA at recess Time and minutes of sedentary activity at recess
	Opportunities to eat at school	Observation of food intake in classrooms	Number of children freely eating in the classroom Number of professors promoting the intake inside the classroom Number of children eating the federal breakfast program in the classroom	Children who eat inside the classroom Number of opportunities to eat in the school day
	Opportunities to engage in PA in school	1) Observation of physical activation and recess 2) Inventory of PA equipment and facilities	Number of PA/week and length of PA Number of active recess/week and length of the active recess Availability of equipment and use of facilities to engage in PA	Opportunities to engage in PA Minutes engage in PA at school
	Purchasing/consumption of food and beverages during recess	Observation of children food items purchased and consumed at recess	% of recommended items purchased/ consumed % of recommended for consumption twice a week items purchased/ consumed % of non recommended items purchased/ consumed	The number of food items purchased/consumed Children that increased the consumption of healthy food and/or beverages Children that decreased the consumption of non-healthy food and/or beverages Children's energy (kcal) intake at school Children's fat (g) intake at school
	Quantity of steps taken at school	Steps counts in PE classes and recess (using pedometer)	Number of steps at school (PE class and recess) Number of steps outside school	Number of steps (counts) pre-post Change in steps pre and post Children who reach the PA recommendations
	Psychological (self reported)	Questionnaire on five healthy behaviours	Children's general knowledge, attitudes, social norms, perceived behavioural control (i.e., self efficacy), and behavioural intent related to five behaviours promoted	Change in psychological indicators pre and post in regards promoted behaviours
	Body composition	Anthropometric measurements	Weight (kg) Height (m) Subscapular and Skinfolds (mm) Arm circumference (mm)	Prevalence of overweight and obesity Obese children Overweight children Children with a healthy % of body fat
	Fitness	1) 9-minute distance run 2) Sit-and-reach 3) Sit-ups and pull-ups	Strength Flexibility Endurance	Children with an improved cardio-respiratory fitness Children with an improved flexibility Children with an improved muscle endurance

SOFIT: System for observing fitness instruction time

PA: Physical activity

PE: Physical education

MVPA: Moderate to vigorous physical activity

Table III
DESCRIPTIVE CHARACTERISTICS OF MEASURED CHILDREN OF PROMOTING A HEALTHFUL DIET AND PHYSICAL ACTIVITY
IN THE MEXICAN SCHOOL SYSTEM FOR THE PREVENTION OF OBESITY IN CHILDREN BY INTERVENTION GROUP AT BASELINE OF
YEAR ONE (2006-07)

	Total			Intervention group								
	N	Mean*	SD [‡]	N	Basic Mean	SD	N	Plus Mean	SD	N	Control Mean	SD
Total	860			252			254			354		
Boys (n,%)	429 49.9			130 51.6			117 46.1			182 51.4		
Age (y)	860	9.7	0.7	252	9.7	0.7	254	9.7	0.7	354	9.8	0.8
Weight (kg)	860	38.6	9.8	252	37.5	9.8	254	38.9	10.0	354	39.1	9.6
Height (cm)	860	138.8	7.1	252	137.9	7.1	254	139.0	6.8	354	139.3	7.1
BMI	860	19.8	3.7	252	19.5	3.7	254	19.9	3.7	354	19.9	3.6
Weight status [§]												
Adequate	486	56.5		156	61.9		144	56.7		186	52.5	
Overweight	257	29.9		62	24.6		73	28.7		122	34.5	
Obese	117	13.6		34	13.5		37	14.6		46	13.0	

* Mean or percentage comparison adjusted for study design. No difference among groups ($p>0.05$)

[‡] Standard deviation or as specified

[§] According to International Obesity Task Force

and a general apathy towards the childhood obesity problem. The resistance issues observed were related to lack of resources (human and financial), lack of time by those charged with implementing intervention, and a lack of incentives for school staff; this was especially true for the PE teachers trying to implement the PA intervention. Other resistance issues that impaired the implementation were the teachers' lack of knowledge about healthy lifestyle practices. In addition, competing curricular commitments, issues related to responsibility, and interpretation of SEP's internal regulations also affected the implementation. For example, a lack of clarity concerning issues of jurisdiction resulted in uncertainty about whether or not active recess could be implemented or whether food items at school canteen could be modified. At the federal level, even though we had been able to establish partnerships and raise awareness about the obesity issue, a lack of resources (e.g., not enough budget to hire more PE teachers or to provide sports materials) limited their ability to enforce policies and regulations. Another important limitation was the lack of continuity between school intervention activities and family practices; teachers' motivation to change the school environment was hampered by parents' reluctance to modify family practices.

Since this was a real-world effectiveness research trial, strategies were not always implemented as planned as conditions differed across the schools. For instance, in some schools over 30% of the scheduled PE classes

were cancelled during the intervention period either because they didn't have PE teacher or they had other priorities.²³ The prioritization of other activities over PE has been reported elsewhere⁴⁸⁻⁴⁹ and remains a constant challenge for schools in the Mexican school system. Finally, during year two we lost a plus school due to changes in the school curriculum policy; therefore, this school became a full time school and no longer met the study inclusion criteria of being a half time school. This change was beyond our control. Overall, many of the limitations observed were not unique to our project and have been encountered by others attempting to change the school food and PA environment.¹²

To overcome the above mentioned limitations, we modified the original project plan and implemented and evaluated a communication/education component to support the nutrition and PA intervention, increase awareness, promote participation, and reduce resistance. We believe that the implementation of this component helped us reduce the political, organizational, and personnel resistant constraints at school.

Conclusions

Extensive research reveals that the school environment plays an important role in sustaining the energy imbalance that leads to overweight and obesity in school children.⁴⁸⁻⁴⁹ Consequently we implemented two intervention strategies over two school cycles:

Nutrition, physical activity, and one communication education supportive component. Together, these strategies will give us the opportunity to address the problem comprehensively and to learn how much can really be accomplished relative to the number and type of resources invested. To our knowledge, this is the first institutional multilevel, multifactorial project carried out in Mexico to prevent childhood obesity in schools. Consistent with the best practices available in current literature,^{48,50} the project addresses both physical activity and diet, with the benefit of partnerships among different entities.^{20,22} The evaluation will address different levels of factors to assure that even intermediate effects can be detected. If these strategies prove to be successful and can be properly regulated and institutionalized, assuring full implementation, the outcomes could be of significant magnitude in the prevention of childhood obesity through the promotion of healthy environments at schools. Furthermore, the documentation of the design and rationale, implementation, and evaluation of an obesity prevention strategy has a great value in emerging countries where few experiences have been documented.

Our aim was to promote energy balance through healthy lifestyles and impact public policies to prevent childhood obesity at school level; however, we recognize that multipronged approaches including education, PA and family involvement are necessary for optimal effectiveness and that establishing guidelines to govern the types of foods that can be sold in and around schools can improve student health.

Several policy strategies that have been derived from this study, among other studies, such as the Mexican National Guidelines for Healthy Eating in Schools, which regulates food availability and portion sizes in schools as well as promoting the intake of water and the improvement of PE classes.

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