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Original/*Pediatría*

Modifiable environmental obesity risk factors among elementary school children in a Mexico-US Border City

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Abstract

Background: **The increasing overweight (OW) and obesity (OB) prevalence in Mexican children warrant the assessment of the environmental risk factors.**

Objective: **To assess whether there is an association between food availability in children's environments and their food consumption with BMI z-score and waist circumference (WC).**

Methods: **Six hundred and eighty four children, 264 parents, 22 teachers and cafeteria staff in the schools and street vendors participated in the study. Weight, height, and WC of 5th grade children were assessed. Food frequency, physical activity (PA) and eating habits questionnaires were applied to parents, children and teachers. A food inventory questionnaire was applied to parents, cafeteria staff in the schools, street vendors and stores near the schools.**

Results: **The children's mean age was 10.5. Twenty eight per cent of the children were overweight, 26% obese and 25% had abdominal obesity. A positive correlation was found between energy-dense foods (EDF), fruit and vegetable availability at home and their weekly consumption. Also a correlation between consumption of soft drinks and other EDF was found. The largest contributors to food consumption were the availability at home and at school (R2 = 0.11, p = 0.0001). Children's TV viewing was positively correlated with parents TV viewing time. For each hour of increase (from cero to seven) in daily TV viewing children were more likely to be overweight or obese (OR=1.22 95% CI 1.02-1.45, p=0.026).**

Conclusion: **EDF, fruit and vegetable availability in and near home and school along with hours of TV viewing were positively associated with obesity.**

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Key words: *Childhood obesity. Mexican children. Risk Factors. Elementary School Children. Schools. Energy Dense Foods.*

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ENTORNOS MODIFICABLES DE FACTORES DE RIESGO DE OBESIDAD ENTRE NIÑOS DE EDUCACIÓN BÁSICA EN LA FRONTERA MÉXICO-USA

Resumen

Antecedentes: **El aumento de la prevalencia de sobrepeso (SP) y la obesidad (OB) en niños mexicanos, hace necesario la valoración de los factores de riesgo ambientales.**

Objetivo: **Valorar si existe asociación entre la disponibilidad de alimentos en el entorno de los niños y el consume de alimentos con el puntaje Z de IMC y la circunferencia de cintura (CC).**

Métodos: **Participaron en el estudio 684, 264 padres, 22 maestros, el personal de cafetería de las escuelas, y vendedores ambulantes. Se valoró el peso, la estatura la CC, de niños de quinto año de educación básica. Se aplicaron a los padres, niños y maestros un cuestionario de frecuencia de consumo de alimentos, uno de actividad física y uno de hábitos alimentarios. Un inventario de alimentos se aplicó a los padres, al personal de la cafetería de la escuela, a los vendedores y a las tiendas cercanas a las escuelas.**

Resultados: **La media de edad de los niños fue 10.5 años. 28% de los niños tenían SP, 26% OB, y 25% obesidad abdominal (OA). Se observó una correlación positiva entre el consumo de alimentos densamente energéticos (ADE), frutas, y verduras con la disponibilidad en casa y con el consumo semanal. También se observó una correlación entre el consumo de refrescos y otras ADE. El factor que más contribuía al consumo de alimentos fue la disponibilidad en casa y en la escuela (R2 = 0.11, p = 0.0001). Se observó una asociación positiva entre el tiempo que los niños ven televisión con el de sus padres. Por cada hora de aumento (de 0 a 7) de ver televisión al día, los niños tenían más posibilidades de tener SP o OB (OR=1.22 95% CI 1.02-1.45, p=0.026).**

Conclusión: **La disponibilidad de ADE, de frutas y verduras en o fuera de casa o de la escuela, además de las horas de ver televisión estuvieron positivamente asociadas con la obesidad.**

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Palabras clave: *Obesidad infantil. Niños mexicanos. Factores de riesgo. Niños de primaria. Alimentos densamente energéticos.*

Introduction

Childhood obesity has become a pandemic health problem in the México-USA border region, and has been associated with migration, poverty, TV viewing and low physical activity[1-4]. Several factors have been reported to be associated with childhood obesity, such as genetic and environmental factors[5-8]. Identified modifiable environmental factors include the availability of energy dense food, (EDF) sedentary life[9-11], cultural practices[12,13], and prenatal and postnatal factors[14,15].

Food intake and physical activity (PA) habits depend on many obesogenic environments that endorse food consumption and a sedentary life[13], including contingencies within the family, community, school, place of work, along with different cultural habits[16].

Studies that have compared native to migrant children have found a higher prevalence of obesity, anemia and stunting in migrants[21]. Also, children with low family income[17-18] sedentary life styles and adverse dietary patterns[19-20] have seemed to be more vulnerable for developing obesity among Mexican children and adults living in a low-income neighborhoods have shown an association to obesity[2,22].

TV viewing is another risk factor which has been identified[3,23-27] and some studies have shown a positive correlation between hours of TV viewing and BMI[25-27]. TV food advertisement exposure geared to mothers during programs has been associated with increased odds for developing childhood obesity[3,24].

It has also been documented that parents have an important role in their children's attitude towards PA, which suggest that involving parents with children in extracurricular activities such as sport practices or some exercise might help to prevent or reduce overweight[28,29]. It has also been recommended that PA school programs could increase the frequency and quality of the sports practiced[30,31].

We have not found a reported study in the Northwester region of Mexico that assessed home, school and community environmental factors associated with obesity in elementary school children. Therefore, the aim of this study was to assess whether there is an association of food availability in children's environments, their food consumption, BMI z-score and WC seen in a group of elementary school (ES) children residing in a Mexico US border city.

Methods

Population and samples

Schools were randomly chosen from a list of all the schools registered in the public elementary school system of Tijuana, BC, Mexico. A multistage cluster sampling technique was used to select participants from each fifth grade class. The first step was to select 30 ES, from which 16 schools accepted to participate. The second step was to selected 22 groups from the 16 schools. The total sample was composed of 684 children, 264 parents and 22 teachers.

Recruitment and training

The purpose of the study was explained to school principals, teachers and parents. Written informed consent was obtained from parents, children and approval of the study was received from the human subjects committee of the Medical and Psychology School of the University Autonomous of Baja California. Twelve physical education teachers and one nutrition student from the master's program of nutrition were trained at one central location in taking anthropometric measurements using a portable scale, stadiometer, and a measuring tape. Weight, height, and waist circumference of the students were then assessed.

The teachers and the graduate student measured groups of four children (two sets of two randomly assigned to each pair of observers, to assess inter-observer measurement reliability). The inter-observer reliability of height (m), weight (kg) and waist circumference (cm) found was 0.93, 0.98 and 0.86, respectively.

Weight and height status classification

BMI z-score for age/sex and weight/height was classified according to the WHO cutoff points for 5 to 19 years of age as follow: severely wasted (≤ -3 SD); wasted (-2.99 SD-≤ -2 SD); normal weight (-1.99 SD-≤ 1SD); OW (> 1 SD-≤ 2 SD) and O (> 2 SD).

Height-for-age z score was classified according to WHO criteria: severely stunted (≤-3 SD); stunted (-2.99 SD-≤-2 SD); normal (-1.99 SD-≤3 SD); and tall (> 3 DE).

Data collection

The children's weight, height and waist circumference were measured and recorded according to standardized methods, during the 2010-2011-school term. Questionnaires were applied to parents, children, teachers, cafeteria staff within schools and nearby street vendors.

Questionnaires

Six questionnaires were applied: 1) a food frequency questionnaire (FFQ) applied to the parents, teachers and children, which included 13 FFQ eating items ; 2) 10 items of demographic data, food consumption and a PA questionnaire applied to parents and teachers; 3) a food inventory applied to children about food purchased at home, nearby and within the schools; 4) a13 item school food inventory applied to the school cafeteria staff, concerning food availability for children in the school canteens; 5) a 13 item inventory applied to street vendors including food availability sold nearby

the school; 6) a five item data base reporting school infrastructure of PA areas, green areas, vending machines, and potable water availability. These were obtained from direct observation by one of the authors (GLB). Due to high content of sugar, total fat and saturated fat per 100g., the following were considered energy dense products (EDF): soft drinks, processed juice, popcorn, cookies, chips and peanuts. sweets and candies.

Statistical Analysis

Reliability: According to Spearman and Phi analysis, test retest reliability of all questionnaires ranged from 0.65 to 0.91 (p= 0.03 to 0.01). Mean weekly food consumption and the differences between normal weight and obese, plus between boys and girls, hours and days of TV viewing and exercise were calculated using the Mann-Whitney test for independent samples. Spearman or Kendall Tau-b correlation was used to evaluate the association among parents and children, their food consumption and availability, plus reported TV viewing hours. Logistic regression was used to assess the probability of being overweight or obese.

Results

Demographic data

Forty one per cent (264) of the parents agreed to participate in the study. Most questionnaires (n=213-81%) were responded to by the mother, 48 (18%) by the father and 3 (1%) by another family member. The mean age of the fathers and mothers was 40.2y and 36.9y respectively. The average years of education of the fathers and mothers were 9.3 and 9.5y respectively. There were 311 boys participating in this study (45.5%) and 373 girls, with an average age of 10.5±0.6 years.Table 1 shows the mean and standard deviation of adiposity markers found. No statistical differences were found between gender.

Prevalence of obesity

According to WHO cut off points, 1%[6] of the sample showed under nutrition (SD <-2); 45% (310) had normal weight (SD ≥-1to ≤1); 28% (191) were overweight (SD >1 to ≤ 2); 26% (177) were obese (SD >2) and 25% presented abdominal obesity.

Food Habits and Consumption

On average families had meals with their children five days a week and 1.8 times per day. The most preferred foods for eating out were Mexican food (42%), fast food (33.0%), Chinese food (30.0%), chicken fast food (20.0%), 7.0% seafood (7%) and Japanese restaurants (3.0%). On an average, parents had breakfast five days per week and 75% of their children had breakfast four days per week. Eighty three per cent of normal weight children and 62% of obese children reported having breakfast before going to school (p=0.005).

Availability of foods around the family home

There was an average of 2.4 grocery stores close by the homes (approximately 109 yards). The foods available at home identified by the children were fruits 5.0, vegetables 5.1, chips 1.9, cookies and pastries 1.6, juices 1.2, and soft drinks 0.6, while the foods available near the homes were chips 1.0, fruits 0.7, juices 0.6, cookies and pastries 0.5, and peanuts 0.5.

The weekly average portions of foods consumed (times per week) in children and their parents respectively was, for water 15.8 and 15.9, for chips 14.0 and 2.0, for milk 11.5 and 11.3, for fruits 9.0 and 7.0, for vegetables 7.0 and 7.0, for juice 6.0 and 8.0, for sodas 3.0 and 4.0.

Girls had more weekly consumption of candies and vegetables than boys (p=0.05), and boys consumed more sport drinks than girls (p=0.0001). Compared to normal weight children, overweight and obese children reported a lower consumption of chocolates (p=0.001), cookies (p=0.002) and sweetened carbonated drinks (p=0.04). Normal weight children consumed EDF an average of 4.5 ± 3.2 portions per day, while overweight and obese children consumed 4.1 ± 3.1 and 3.1 ± 2.4, respectively (p = 0.0001).

Physical activity at home

The total parental involvement of PA was 41%, for an average of 57.0 minutes a day four days a week, and 28% reported that their child performed an average of 82.0 minutes PA per day four days a week.

Parents and children's TV viewing was an average of 2.4 and 2.7 hours a day, respectively, with an association found between parents TV and their children's hours of TV viewing (p= 0.0001). TV viewing in overweight and obese children was an average 2.9 hours a day and for normal weight children was 2.4. For each hour of increase (from cero to seven) in daily TV viewing children were 1.22 more likely to be overweight or obese (OR=1.22 95% CI 1.02-1.45, p=0.026). No significant gender differences were observed.

A positive correlation was found between the hours a day of TV viewing in children and parents (Rho= 0.43, p = 0.0001), and between the number of days per week parents and children were involved in PA (Rho= 0.28, p = 0.0001).

School environment

Twenty two teachers responded to the study questionnaires, nine (41%) men and 13 (59%) women. A total of 16 schools were evaluated. Eleven (68%) had green areas, 13 (81%) had water dispensers in the classroom, and 4 (25%) had a cafeteria. All schools

assessed had sport fields. No vendixng machines were found. An average of 1.5 grocery stores and 2.0 street vendors were found nearby the schools.

Food Availability in the schools

Fruits were sold in all schools, vegetables were available in 14 schools, candies in 16, peanuts in 15, chips in 5, juices in 15, soft drinks and fast food in 10, Mexican snacks in 13 and instant soups in 8 schools. Teachers bought breakfast at school on an average of twice a week and had some kind of snacks three days a week. Sixteen teachers (73%) bought food from the school cafeteria, 4 (18%) consumed chips and pastries, 10 (46%) brought homemade dishes, 6 (41%) preferred salads and 8 (36%) consumed Mexican food.

Teachers weekly food intake was an average, of 17 times per week for water, 9 for vegetables, 8 for milk,7 for fruit, 4.5 for juice, 3.2 for soft drinks. At the third quartile of weekly consumption, the teachers who consumed water reported an intake of 21 times per week; 14 times for fruits, 11 for milk, 5 for juices, 4 times for vegetables; and 3 times for soft drinks.

Physical activity in the school

Teachers reported that children participated in PA classes on an average of 51minutes a day1.6 days per week. They also reported sport practices 6.4 minutes a day, 0.8 days per week.

Food consumption and environments

The number of times each food was consumed weekly correlated with their availability at home, in school or near home and school. The weekly consumption of fruits and vegetables was positively correlated with its availability at home ($\tau = 0.22$, $p = 0.0001$); A positive correlation between weekly consumption of EDP their availability at home, within school and outside the school ($\tau = 0.24$, $\tau = 0.20$, $\tau = 0.18$ $p = 0.0001$) was observed.

Additionally, weekly water consumption was positively correlated with weekly consumption of fruits ($\tau = 0.21$, $p = 0.0001$), vegetables ($\tau = 0.19$, $p = 0.0001$), and milk ($\tau = 0.30$, $p = 0.0001$); while the weekly soft drink consumption in children was positively correlated with the weekly consumption of candies ($\tau = 0.25$, $p = 0.0001$), popcorn ($\tau = 0.25$, $p = 0.0001$), chips ($\tau = 0.24$, $p = 0.0001$), cookies ($\tau = 0.18$, $p = 0.0001$), juices ($\tau = 0.19$, $p = 0.0001$), sport drinks ($\tau = 0.18$, $p = 0.0001$) and peanuts ($\tau = 0.17$, $p = 0.0001$).

Obesity and food availability

Children having fewer breakfast times before school were more likely to be overweight or obese (OR = 2.65, 95%CI 1.32-5.3, $p = 0.006$). Children BMI z-score for age and sex was negatively associated with weekly consumption of EDF foods ($\tau = -0.18$, $p = 0.0001$). Consumption of more than three times a day of EDF decrease the likelihood of being OW/O (OR = 0.65, 95%CI 0.47-0.88, $p = 0.006$). Children with OW/O were more likely to have fruits and vegetables at home (OR = 1.10, 95%CI 1.01-1.19, $p = 0.035$) and less likely to have 5 servings of EDP foods at home (OR = 0.56, 95%CI 0.41-0.78, $p = 0.0001$).

Discussion

According to WHO cut off points, 28% of the children were overweight; 26% obese and 25% presented abdominal obesity. These results are consistent with other studies carried out in Mexico[3,32].On average, parents had breakfast five days per week and their children 4.2 days per week. Similar results were reported recently by Vargas et al[33], who found among third to sixth grade children an average of 4.0 ± 1.6 days a week indicating that breakfast at home and foods taken in lunch packs are important sources of food and calories among this age group.

We also found an average of 2.4 grocery stores within 109 yards of the homes, 1.5 near schools and 2.0 street vendors. Although this study did not evaluate the association between the proximity of grocery stores and children's BMI and WC, this raised an alert of high risk settings nearby schools. Some studies suggest that healthier food availability within a 109 yards buffer zone of schools was associated with lower BMI and WC gain over 1 year[34]. Others have shown that food outlets close to school and home environments contribute to a higher overweight and obesity prevalence in young populations[35,36]. Therefore, it is suggested that food vendors contribute to adverse environments creating an issue that needs to be addressed in Tijuana and perhaps all of Mexico.

In this study an association was also seen between children's extracurricular PA and PA practices of their parents ($p = 0.0001$). These results are consistent with Bandura's learning theory[37,38]. It has been documented that parents have an important role in their children's attitude towards PA and food consumption, showing that children tend to imitate food consumption of parents as well as parents PA habits that play an important support role for their children's extracurricular activities[28,29]. Therefore, prevention programs should promote parent engagement as models.

Children and parents average time of TV viewing was consistent with a recent study conducted among preschool and school children in Tijuana[24,39], as well as those observed among middle school children[40]. Díaz et al. observed a correlation between mothers and preschool children[24] food consumption with food advertisements broadcasted on TV. The results suggest that in

Table I
Children adiposity markers of boys and girls

Markers	*Boys (Mean ± SD)*	*Girls (Mean ± SD)*	*Total (Mean ± SD)*
Weight (kg)	44 ± 12	45 ± 12	44.6 ± 12
Height (m)	145 ± 7	146 ± 7	145.5 ± 7
Waist Circumference (cm)	73 ± 12	72 ± 12	72.6 ± 12
Height z-scores for age and sex	0.2 ± 0.9	0.0 ± 1.0	0.1 ± 1.0
BMI z-scores for age and sex	1.1 ± 1.3	1.0 ± 1.2	1.0 ± 1.2
BMI	21 ± 4.0	21 ± 4.0	21 ± 4.0
Total (N)	311	373	684

addition to the outside home environment, home TV viewing with TV exposure to food advertisement enhances the risk of developing obesity. In our study we also observed a positive correlation between parents and children's hours of TV viewing.

We found a higher TV viewing exposure in those children with OW and OB than in children with normal weight ($p = 0.002$). This result is consistent with other studies conducted in Mexico[25] and other countries[26,27]. Reporting a systematic review of the effect of TV advertisement on the consumption of food advertised showed a consistent association between them[42], suggesting the need to focus on the hours of TV viewed and the the possible ban of TV advertising during most of the day.

This study result contrasts with the recommendation made by the Health and the Education Minister regulations[43], launched as part of the strategy against obesity in January 2010, which disapproves of the school availability of EDF with high content of salt, saturated fat and refined sugars[43]. Different authors, all over the world, have indicated the need of banning EDF within and outside of schools[33-36,39,43, and 44].

On the other hand, we also found that the consumption of healthy foods was positively correlated with the availability of these foods in and around home and school. These results are consistent with other studies in public and private schools in Tijuana[39]. In a different study a positive association between fruit and vegetable consumption by children and the availability of foods, as well as with the number of times parents offered healthy foods was shown[45]. An Australian study, also found that the availability of food at home was mediated by the nutritional knowledge of the mothers along with the consumption of fruits, vegetables, salty foods and soft drinks of their children[46].

In our study, we assessed food availability in three environments, home, school and surrounding areas and found the consumption of fruits and vegetables correlated with their availability at home.

The high availability of EDF in and close to home in Tijuana, as well as in and around the schools, was found to be associated with availability and consumption, warranting interventions to reduce the availability of those foods.

We did find a lower probability of EDF availability at home in OW and obese children compared to normal weight children. We also found a higher probability of fruit and vegetables availability in OW and obese compared to normal weigth children. This was consistent with the study conducted by Arcan et al[47]. They found an association between vegetable availability and normal weight preschool children. Those findings might be the results of higher under reporting of EDF and over reporting intakes of healthy foods among OW and O children[48,49,50,51,52]. On the other hand, it might be possible that OW and O at the age of 10y are already imprinted to be OW or O from their pre and postnatal environments, pre-school environments, and early elementary school environments[14]. Therefore, obesity may not be having an association with EDF as has been thought.

There were some limitations of this study. This it is a cross-sectional study, so causality could not be measured. We did not measure food availability by servings as it accounted foods per unit or portions, so the quantity of the foods available was not measured in a precise way. The response of the students and parents was low, thus the representation of the whole community is limited. We did not conduct in depth interviews or focus groups, which might have identified the causes of the availability of foods and their purchase. Among the strengths of the study is that it added to our basic knowledge the availability of healthy and unhealthy foods inside and around schools and homes in the northwestern part of Mexico.

In conclusion, children's OW and OB prevalence was over 50%. Fruits and vegetables, as well as EDF consumed at home are the greatest contributor of their weekly consumption of these foods. Children's intake of EDF within schools is almost daily but the greatest contributor of EDF consumption is their availability at home as well as at school. TV viewing frequency was higher among children with OW or OB compared to

normal weight children. Water consumption was positively associated with an increased intake of healthy foods by children, while soft drink consumption was positively associated with the intake of EDF (juices, chips, candy and cookies).

A ban of all kind of EDF in and nearby schools; as well as intervention programs to promote the availability of healthy foods at home with parental involvement promoting healthy habits to their children is recommended.

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