Association between obesity and dental caries in a group of preschool children in Mexico

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Abstract

Objective: The aim of this study was to determine the association between obesity and caries by utilizing the data of a cohort of preschool children aged 4-5 years.
Methods: Data were obtained from a cohort of 1,160 children. Dental caries detection was performed according to the World Health Organization criteria. The caries index was measured as the number of decayed (d), extracted (e), and filled (f) teeth (t) (deft), or surfaces (defs). The body mass index (BMI) in units of kg/m^2 was determined, and children were categorized according to age- and gender-specific criteria as normal weight (5th-85th percentile), at-risk overweight (≥85th-<95th percentile), and overweight (≥95th percentile). Odds ratios were determined for at-risk overweight and overweight children using logistic regression.
Results: The prevalence of dental caries was 17.9 percent. A slightly higher percentage of dental caries was found in boys (19.6 percent) than in girls (16.4 percent). From the total sample, the mean BMI was 17.10 ± 3.83. Approximately 53.7 percent of children were classified as normal weight, 14.2 percent as at-risk overweight, and 32.1 percent as overweight. At-risk overweight children were higher among girls (17.1 percent) than among boys (11.3 percent). When adjusted for covariates, the logistic regression model showed that there was a significant association between at-risk overweight children ($P < 0.001$), overweight children ($P < 0.001$), and caries in the primary dentition. Mean (SD) deft value of the sample was 1.08 (2.34), while the corresponding defs value was 1.43 (3.29).
Conclusion: Obesity appears to be associated with dental caries in the primary dentition of preschool Mexican children.

Introduction

Dental caries and obesity constitute important health problems worldwide, and have been associated with a great number of negative health outcomes (1-6). The prevalence of caries in preschool-aged children in developing countries ranges between 27 and 46 percent (4,7,8). In México, caries affects 72 percent of children in the primary dentition, but in some low-economic-status regions, affects 95 percent (9,10). A study of the etiology of dental caries has permitted the identification of some risk factors, such as consuming foods and beverages with a high content of refined carbohydrates, living with smokers in the home (11,12), receiving bottle-feeding for a prolonged period during the first months of life (13), and having deficient hygiene (14).

Similarly, childhood obesity constitutes the most frequent nutritional problem of our time. In the United States, the results of the National Health and Nutrition Examination Survey 1999-2000 (NHANES) show that the prevalence of overweight children between 2 and 5 years of age is 13.9 percent (2). In México, the prevalence of overweight children in preschool is 10.4 percent (9). Multiple studies show that the consumption of foods with a high carbohydrate content constitutes an important risk factor for the development of obesity (8-10).

At present, as a consequence of the high prevalence of obesity and dental caries in children that has been registered

during the past decades, some researchers have studied the relationship between these two conditions, but results to date have been inconclusive. Some authors have found a positive association between high weight and caries in the primary dentition (4,15–16), but other authors have not (7,17).

If the highest prevalence of caries, overweight, and obesity is found in certain population groups, such as those who consume foods and beverages with a high content of refined carbohydrates (8,9,14,18,19), it is feasible to suppose that there is a relationship between the two conditions. The aim of this study was to determine the association between obesity and dental caries by utilizing the data of a cohort of preschool children aged 4-5 years.

Methods

We conducted a cross-sectional study based on a cohort of 1,160 children, 4-5 years of age (mean = 4.5 ± 0.5 years), who had been followed longitudinally from the age of 4 months. Detailed descriptions of the sampling strategy are given elsewhere (20). Briefly stated, the study took place in the area of Tampico-Madero-Altamira, Mexico, located 542 km northwest of Mexico City.

The children who participated in this study were part of a population included in another major multidisciplinary research project in which a series of specialists took part, including a pediatrician, an allergy specialist, a family physician, dentists, general physicians, and dental assistants. The study was conducted in 2005. The children attended nursery school as required by the Scheme of Ordinary Participation and Unique Communitarian Neighborhood Program organized by the Mexican Institute of Social Security (IMSS) and the preschool education school (kindergarten) of the area. Physical examinations were performed as part of the healthcare activities of the nurseries, and included weight and height measurements, vaccinations, and the recording of contagious and noncontagious diseases detected.

Questionnaires were utilized to obtain demographic data, and dietary and toothbrushing habits. We collected information on feeding type during or after the first year of life, breast-feeding frequency during the day and at night, when children were bottle-fed with different milk types (defined when bottle feeding started before 4 months old), or whether the children had exhibited any nonnutritive sucking habit (pacifier or thumb) during or after the first year of life. Part of this information has been analyzed and published previously (20).

At the time of the interview, the children's parents or guardians were questioned concerning the time devoted by the children to watching television or playing video games during a day of normal activities.

They were also questioned on the type, quality, and quantity of the foods and beverages consumed by the children while they watched television. As well as the frequency with which children consumed snacks (defined as any food consumed between the main meals including breakfast, lunch, and dinner).

We calculated the total energy intake and percentage of energy from fat, registering the type and amount of foods ingested during the 24 hours prior to the study. Questions documenting the children's food consumption habits and lifestyles were taken from the questionnaires applied at the ENSANUT-2006 (9).

Diagnosis of dental caries was established according to the World Health Organization (WHO) guidelines by three calibrated dentists (kappa = 0.93), using disposable gloves, a dental mirror, tongue blade, and optimal artificial illumination of the oral cavity. Cotton swabs and gauze were used for moisture control and removal of plaque on tooth surfaces when necessary. No X-rays were taken. Oral examinations were carried out annually from the second year of life. Diagnosis of dental caries was made according to the criterion recommended by the WHO (21). Caries is recorded as present when a lesion in pit or fissure, or on a smooth tooth surface, has a detectably softened floor, undermined enamel, or softened wall. A tooth with a temporary filling should also be included in this category. The prevalence of caries was obtained by calculating the number of decayed (d), extracted teeth (e), filled (f), teeth (t) (deft), or surfaces (defs). The defs scores included all carious lesions on occlusal, interproximal, and buccal and lingual smooth surfaces. Molars and premolars were considered to have five surfaces, and anterior teeth, four.

The criterion for initial caries was a chalky white spot on the enamel surface. Oral data were recorded on examination forms in accordance with the WHO criteria. For analysis, dental caries was coded as 1 = caries present, and 0 = caries absent.

We employed a platform scale to weigh the children; this scale was calibrated prior to each weight measurement. Weighing was carried out with the child dressed in a minimum amount of clothing, which permitted the children to stand erect and relaxed. Weight was considered to the nearest 100 g. Height was measured via a stadiometer. This measurement was conducted with the child barefoot, maintaining the head in a neutral position, with the neck, spinal column, and knees in physiological extension, and the soles of both feet totally supported on a horizontal surface.

Body mass index (BMI = kg/m^2) was determined using the age- and gender-specific Centers for Disease Control and Prevention definition (22). The children were categorized as follows: normal weight: 5-85th percentile; at-risk overweight: ≥85th and <95th percentile; and overweight: ≥95th. For analysis, these variables were coded as: a) 1 = no normal weight, 0 = normal weight; b) 1 = at-risk overweight, 0 = not at-risk overweight; and c) 1 = overweight, 0 = not overweight.

Questionnaire administration was performed by duly trained personnel for correct data capture.

Children with dental caries, who were overweight or had any other pathology, were referred for care of their disease(s) to the corresponding medical service unit.

Parental written and oral informed consent was requested and obtained. The study was approved by the Ethics Committee of the No. 6 Regional General Hospital of the IMSS, and the Faculty of Medicine of the Autonomous University of Tamaulipas, Mexico.

Gender, sugar consumption antecedent, oral hygiene practices (toothbrushing frequency), and presence of smokers in the home were utilized as covariates for the analysis. We chose these confounders because they have demonstrated a strong association with dental caries in previous studies.

Sugar consumption antecedent was considered present if the children consumed snacks (cookies, candies, chocolate), fruit juice, non-diet or other sugar-containing drinks more than one time per week during the 6 months prior to the study.

Oral hygiene practices were considered adequate if toothbrushing frequency was ≥2 times per day. All children in the study consumed potable water and used fluoride toothpaste for their oral hygiene.

The presence of parents who smoked was documented by the response to the question: Which of the parents smokes at home? The options were: a) the father smokes; b) the mother smokes; c) both of the parents smoke; and d) neither of the parents smoke. Parental smoking was considered present when at least one of the parents smoked. This independent variable was coded as: 1 = smoking parent, and 0 = non-smoking parents.

Data were analyzed by means of the SPSS 10.0 statistical package software. Logistic regression models were performed to study the association between at-risk overweight, overweight, and the outcome variable. Adjusted odds ratios (ORs) and their 95 percent confidence intervals (CI) were calculated. In evaluating the association, we adjusted for the following confounders: gender, sugary product consumption, smoking parents in the home, and oral hygiene habits. A 2×2 contingency table (crude OR and a 95 percent CI) was employed to determine the risk of dental caries caused by the effect of at-risk overweight and overweight. We utilized dichotomous variables for indicating the presence or absence of a certain characteristic. We employed the binomial test to identify differences in proportions of dichotomous variables. Any P value <0.05 was considered significant.

Results

Dental caries prevalence was 17.9 percent. From the total sample, the mean BMI was 17.10 ± 3.83 (boys 16.77 ± 2.93 and girls 17.44 ± 4.53). Approximately 53.7 percent of children were normal weight, 14.2 percent were at-risk overweight, and 32.1 percent were overweight. A large percentage (45.8 percent) of children had sugar consumption as a risk factor. The mean deft value of the total sample was 1.08 ± 2.34, while the corresponding defs value was 1.43 ± 3.29. Table 1 presents the distribution by gender of the prevalence of dental caries, normal weight, at-risk overweight, overweight, sugar consumption antecedent, smoking in the home, bottle-feeding, and toothbrushing frequency.

Table 2 presents the prevalence of dental caries, sugar consumption antecedent, smoking in the home, bottle-feeding, and toothbrushing frequency in children with and without normal weight, and children who were at-risk overweight and overweight. The percentage of dental caries was higher in boys (19.6 percent) than in girls (16.4 percent); however, this

Table 1 Distribution by Gender of Dental Caries, Normal Weight, At-Risk Overweight, Overweight, Smoking in the Home, Bottle-Feeding, Sugar Consumption Antecedent, and Toothbrushing Frequency of 1,160 Preschool Children

	Boys		Girls			
	Yes		No		deft Index	defs Index
	n	(%)	*n*	(%)	Mean (SD)	Mean (SD)
Dental caries	114	(19.6)	94	(16.4)**	1.08 (2.33)	1.43 (3.28)
Normal weight	336	(53.9)	287	(46.1)*	0.70 (1.94)	0.93 (2.64)
At-risk overweight	66	(11.3)	99	(17.1)**	1.50 (2.57)	1.95 (3.49)
Overweight	180	(30.0)	192	(33.2)**	1.51 (2.71)	2.04 (3.97)
Sugar consumption	302	(51.9)	229	(39.6)**	1.46 (2.62)	1.92 (3.68)
Smoking in the home	137	(23.5)	145	(25.1)*	1.11 (2.40)	1.43 (3.33)
Bottle-feeding	104	(17.9)	106	(18.3)*	2.12 (2.94)	2.85 (4.27)
Toothbrushing frequency						
<1 per day	42	(7.2)	54	(9.3)*	2.51 (2.98)	3.38 (4.36)
≥2 per day	540	(92.8)	523	(90.5)*	0.95 (2.23)	1.26 (3.12)

P value, determined by binomial test. * $P < 0.05$; ** $P > 0.05$.
SD, standard deviation.

Table 2 Gender, Dental Caries, Smoking in the Home, Bottle-Feeding, Consumption of Sugary Products, and Toothbrushing Frequency in the Groups of Preschool Children with Normal Weight and Those Who Are At-Risk Overweight and Overweight

	Normal weight Yes/no (%)	At-risk overweight Yes/no (%)	Overweight Yes/no (%)
Gender			
Boys	246 (42.3)	66 (40.0)	180 (48.4)
Girls	291 (50.3)	99 (60.0)	192 (51.6)
deft Mean (SD)	0.70 (1.94)	1.50 (2.57)	1.51 (2.71)
defs Mean (SD)	0.93 (2.64)	1.95 (3.49)	1.04 (3.97)
Caries present	133 (24.8)	43 (26.1)	90 (24.2)
Caries absent	404 (75.2)	122 (73.9)	282 (75.8)
Sugar consumption (yes)	230 (42.8)	67 (40.6)	163 (43.8)
Sugar consumption (no)	307 (57.2)	98 (59.4)	209 (56.2)
Smoking in the home (yes)	136 (25.3)	36 (21.8)	100 (26.9)
Smoking in the home (no)	401 (74.7)	129 (78.2)	272 (73.1)
Bottle-feeding >1 year	103 (17.2)	37 (22.4)	66 (17.7)
Bottle-feeding <1 year	434 (80.8)	128 (77.8)	306 (82.3)
Toothbrushing frequency			
≤1 per day	53 (9.9)	22 (13.3)	31 (8.3)
≥2 per day	484 (90.1)	142 (86.1)	341 (91.7)

SD, standard deviation; (+), character present; (–), character absent; deft: decayed (d), extracted (e), filled (f), teeth (t). defs, surfaces.

difference was not statistically significant (binomial test, $P = 0.188$). The mean deft in boys was 1.17 ± 2.43, and the corresponding defs was 1.60 ± 3.57. In girls, the mean deft and defs values were 0.99 ± 2.25 and 1.26 ± 2.97, respectively. With relation to BMI, a higher prevalence of children who were at-risk overweight was found in girls (17.1 percent) than in boys (11.3 percent); this difference was statistically significant (binomial test, $P = 0.013$). On the other hand, the overweight percentage was slightly higher in girls (33.2 percent) than in boys (30.0 percent); however, this difference was not statistically significant. The sugar consumption antecedent was higher in boys (51.9 percent) than in girls (39.6 percent).

We found a higher percentage of caries in children who were at-risk overweight (26.1 percent) compared with those who were not (16.6 percent). The risk of dental caries for children who were at-risk overweight was 1.77 (95 percent CI = 1.20-2.60). Dental caries prevalence was higher in the group of children who were overweight (24.2 percent) compared with children who were not overweight (15.0 percent). The risk of dental caries for overweight children was 1.81 (95 percent CI = 1.33-2.46). Table 3 provides unadjusted ORs of dental caries for gender, normal weight, children at-risk overweight or overweight, sugar consumption antecedent, smoking in the home, bottle-feeding, and tootbrushing frequency. Bottle-feeding and oral hygiene practices appear to be more closely associated with dental caries. Our data show that dental caries is more frequent in the groups of children with sugar consumption antecedent (51.9 versus 48.1 percent; OR = 2.34; 95 percent CI, 1.72-3.19), bottle-feeding antecedent (35.2 versus 14.1 percent; OR = 3.31; 95 percent CI = 2.36-4.64), and in those with tootbrushing frequency ≦1 per day (41.7 versus 15.8 percent; OR = 3.81; 95 percent CI = 2.45-5.90).

Results of the logistic regression models that included all confounder variables are shown in Table 3. At-risk overweight (adjusted OR = 1.94; 95 percent CI = 1.30-2.89) and overweight children (adjusted OR = 1.95; 95 percent CI = 1.42-2.64) remained associated with dental caries. Sugar consumption antecedent, bottle-feeding, and tootbrushing frequency ≤1 per day remained strongly associated with caries.

Discussion

In our study, the results appear to show an association between being overweight and the prevalence of dental caries in primary dentition in a group of Mexican children aged 4-5 years. The data showed that preschool children who were at-risk overweight and overweight have a significantly greater risk for developing dental caries. Dental caries prevalence was higher in at-risk overweight children, and in overweight children compared with children with normal weight. Children who were at-risk overweight have a 1.94 times greater risk of dental caries. In overweight children, the risk of caries is 1.95 times greater. Previous reports have provided different results (16,17). Chen *et al.* (23) investigated whether obese children are prone to develop dental caries in a population of 5,133 children aged 3 years, by means of a cross-sectional study. The

Table 3 Results of the Association between Gender, Normal Weight, At-Risk Overweight, Overweight, Sugar Consumption Antecedent, Bottle-Feeding, Smoking in the Home, and the Dependent Variable Dental Caries in 1,160 Children <5 Years of Age

	Dental caries yes/no (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)†
Gender			
Boys	114/468	(19.8) 1.25 (0.92-1.69)*	0.97 (0.65-1.22)*
Girls‡	94/484	(16.3)	
Normal weight (yes)	75/548	(12.0) 0.41 (0.30-0.56)**	0.368 (0.26-0.50)**
Normal weight (no)‡	133/404	(24.8)	
At-risk overweight (yes)	43/122	(26.1) 1.77 (1.20-2.60)**	1.94 (1.30-2.89)**
At-risk overweight (no)‡	165/830	(16.6)	
Overweight (yes)	90/282	(24.2) 1.81 (1.33-2.46)**	1.95 (1.42-2.64)**
Overweight (no)‡	118/670	(15.0)	
Sugar consumption (yes)	302/229	(51.9) 2.34 (1.72-3.19)**	2.34 (1.71-3.20)**
Sugar consumption (no)‡	280/349	(48.1)	
Smoking in the home (yes)	50/232	(17.7) 0.98 (0.69-1.39)*	0.97 (0.62-1.31)**
Smoking in the home (no)‡	158/720	(18.0)	
Bottle-feeding >1 year	74/136	(35.2) 3.31 (2.36-4.64)**	3.46 (2.43-4.95)**
Bottle-feeding >1 year‡	134/816	(14.1)	
Toothbrushing frequency			
≤1 per day	40/56	(41.7) 3.81 (2.45-5.90)**	3.16 (1.98-5.06)**
≥2 per day‡	168/895	(15.8)	

* $P > 0.05$; ** $P < 0.001$.

† Adjusted for sugar consumption antecedents, smoking in the home, bottle-feeding, and oral hygiene practices (toothbrushing frequency).

‡ Reference category.

(+), Character present; (–), character absent.

authors found that the prevalence of dental caries was not significantly different among different BMI groups. Similarly, Macek and Mitola (7), in their study of 1,719 children, concluded that there was no statistically significant association between BMI by age and dental caries for the primary dentition, as determined by multiple linear regression models, controlling for age, gender, race/ethnicity, and poverty status. Other investigations, however, have reported an association between obesity and dental caries. In the study developed by Willerhausen *et al.* (16), in which the authors found a significant association between high weight and caries in the primary dentition; this association remained statistically significant after adjusting for age. Likewise, Marshall *et al.* (4), on studying the roles of diet and socioeconomic status in dental caries and childhood obesity in 413 children in the primary dentition, reported that the greatest proportion of dental caries was found in the group of obese children. Some research suggests that the quality, quantity, and frequency of feeding habits may also have an impact on the relationship (16,24). The need is evident for carrying out more longitudinal studies to clarify this association.

It is difficult and complex to establish the mechanism by which obesity is associated with dental caries. One attractive hypothesis (7) is that the putative association between obesity and caries is caused by the link between refined carbohydrate consumption and the development of obesity, and to the link between refined carbohydrate consumption and caries development.

Dental caries development is the result of an interaction between genetic and environmental factors. The essential process comprises localized destruction of susceptible dental hard tissues by acidic by-products from bacterial carbohydrate fermentation (25). Sugars contained in soft drinks and snacks are considered highly cariogenic. Marshall *et al.* (4) found that children <5 years of age with dental caries had a higher soft drink intake than children without caries. However, their results show that neither soft drink nor 100 percent juice intake was associated with BMI categories at any age.

For its part, obesity is considered as an energy-positive equilibrium disorder with an excess of energy that enters into the organism, in comparison with the energy that the organism expends. Diverse investigations demonstrate that the caloric contribution conferred by the consumption of milk in some countries has been substituted mainly by the consumption of soft drinks and fruit drinks (26-28). The high rate of consumption of carbohydrate-rich foods has been associated positively with obesity in children (18). Ochoa *et al.* (29), in a case-control study, examined the relationship between consumption of sugar-sweetened drinks and childhood obesity. They found that children who consume sugar-sweetened beverages have a 1.74 times greater risk of being obese as compared with children who do not consume this type of beverage (29).

Our study indicates that 63.0 percent of children with the sugar consumption antecedent have dental caries, and that

41.0 percent of at-risk overweight children and 44.0 percent of overweight children consume fermentable carbohydrates. These results support the hypothesis that the relationship between obesity and caries is established by means of the link between the consumption of fermentable carbohydrates and the development of caries or obesity. Children who consume fermentable carbohydrates have a 2.34 times greater risk for developing caries than children who do not consume these. Bearing this association in mind will permit reinforcement of dental caries prevention program strategies, to exert a positive effect on families so that children do not consume food and drinks containing refined sugar.

Our results demonstrate that bottle-feeding during the first 12 months, and irregular toothbrushing are associated with dental caries in primary dentition. Previous publications agree with this relationship (13,14). These results vouch for the need to establish measures that limit bottle-feeding and that promote habits for adequate oral hygiene. The detrimental effect of smoking in the home on dental caries has been reported previously (12). In this study, we did not find an association between smoking parents in the home and dental caries. The differences in the results may be explained in part by the difference in the prevalence of smoking parents in the home, with variations in study design, and also with the complexity of the diseases. Notwithstanding our results, it is important to reinforce strategies to eliminate smoking in the home.

This study possesses the following methodological limitations that should be taken into consideration on generalizing its results: a) Dental caries detection was carried out visually and no X-rays were taken; and b) these results cannot be generalized to the general population because the children who participated in the study attend day-care centers that possess a preventive dental and nutrition program.

We conclude that obesity appears to be associated with dental caries in preschool children. Children with obesity have more caries than children with normal weight. The prevalence documented for each of these variables indicates that there is a clear need for establishing community health programs to identify and limit risk factors for dental caries and obesity in children. Likewise, strategies spread among populations that espouse the benefits of maintaining adequate oral hygiene should be reinforced. Fluoride application campaigns should be maintained for children, as should access for the entire population to odontological services in health units. Further longitudinal studies are required to confirm the results of the present study, and to determine the mechanisms of the association between obesity and dental caries.

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