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Original

Prevalence of obesity and abdominal obesity from four to 16 years old children living in the Mexico-USA border

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Abstract

The prevalence of obesity among Mexicans is alarming in both the child and adult populations. The objective of this study was to determine the levels of overweight, obesity and abdominal obesity in pre-school (PS), elementary (ES), and middle high (MHS) public school children from Tijuana. From February to April of 2011, a bietapic random sample was selected by cluster method of 30 PS, 30 ES, and 30 MHS children. And a sample of 30 groups for each level was chosen. Twenty elementary teachers and eight graduate students were trained at one central location on how to take anthropometric measurements using a portable scale, a stadiometer, and a measuring tape to determine weight, height, and waist circumference. Body Mass Index values were computed and compared to age/gender BMI percentiles according to WHO criteria. Waist circumference for-age at the 90th percentile from NHANES III (Mexican-American) was used to define abdominal obesity. The sample was composed of 646 PS children, 961 ES children, and 1,095 MHS children. Their ages ranged from 4- 16 years. Results showed an overall prevalence of overweight and obesity in younger than 5y preschool children (> 2 SD) of 23.1%, in ≥ 5 y PS (> 1 SD) of 33.8%, in ES children of 46.3%, and in MHS children of 41.9%. Abdominal obesity in PS children was 18%, in ES children was 16.7%, and in MHS children was 15.2%. These results warrant immediate and comprehensive actions to prevent a critical public health problem in Mexico.

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Key words: *Childhood obesity. Abdominal obesity. Prevalence. Mexico.*

PREVALENCIA DE OBESIDAD Y OBESIDAD ABDOMINAL EN NIÑOS DE CUATRO A DIECISÉIS AÑOS RESIDENTES EN LA FRONTERA MÉXICO-USA

Resumen

En población infantil y adulta, la prevalencia de obesidad entre mexicanos es alarmante. Los objetivos de este estudio fueron determinar los niveles de sobrepeso, obesidad y obesidad abdominal, en pre-escolares (PE), primaria (P), y secundaria (S) de Tijuana. De febrero a abril de 2011, se realizó una muestra aleatoria bietápica por el método de conglomerados, que incluyeron 30 escuelas de PE, 30 de P, y 30 de S. Posteriormente se seleccionó una muestra de 30 grupos de cada nivel educativo. Veinte maestros, y ochos estudiantes de postgrado participaron como encuestadores. Se les entrenó en un lugar central para homogeneizar las mediciones antropométricas para valorar el peso, la estatura, la circunferencia de cintura. Se calculó el IMC y se comparó con las tablas de la OMS para edad y sexo. Como punto de corte para valorar la obesidad abdominal se utilizó la percentile 90 para edad y sexo, del NHANES III para México-americanos. La muestra comprendió 646 niños PE, 961 de P, y 1.095 de S. Las edades oscilaron de 4 a 16 años. Se observó un prevalencia total de sobrepeso y obesidad en menores de 5 años, con DE > 2 de 23,1%, en PE ≥ 5 años, con DE > 1 de 33,8%, en niños de P, de 46,3%, y en niños de S de 41,9%. La obesidad abdominal en niños PE fue de 18%, en niños de P de 16,7%, y en los de S fue de 15,2%. Estos resultados requieren acciones integrales para prevenir un problema crítico de salud pública.

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Palabras clave: *Obesidad infantil. Obesidad abdominal. Prevalencia. México.*

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Introduction

Earlier reports have shown that the city of Tijuana has the highest prevalence of childhood overweight (OW) and obesity (O) in Mexico with 47.1% in elementary public schools and 52.8% in private elementary schools; additionally, in public and private schools, an overall increase of overweight and obesity of 7-percentage points was observed from the 2001-2002 and 2006-2007 periods.[1] Non representative studies conducted in younger than two years of age infants from low income households have reported in two Mexico-US cities and in one city located in the southeast of Mexico, a frequency of OW of 11% and obesity of 8%, which increased with age, from 3% for OW and 6 % for O before 6 months to 13 and 10% between 12 to 24 months respectively.[2] Additionally, the study of the Mexican Indian children and the Mexican non-Indian population show a high prevalence of OW in the population that has high prevalence of at risk for hunger,[3] and the National Nutrition Survey conducted in 2006 shows a prevalence of OW and O among those older than 18 years of age of 69%.[4]

Obesity during childhood has important short-term medical implications, including insulin resistance, adverse effects on blood pressure, blood lipids, glucose metabolism and social stigma, decreased self-esteem and lower health related quality of life.[5-8] In the long-term, medical implications of obesity also include a greater risk of hypertension, diabetes, cardiovascular disease, and gallbladder disease in adulthood.[5-6] The probability that obesity persists into adulthood increases with the child's age.[9] This suggests that childhood is a critical period of opportunity for prevention and intervention. Therefore, knowing the magnitude of OW and O through all ages is important to identify the magnitude of the problem and assess the efficacy of health policies.

The objective of this study was to assess the prevalence of obesity and abdominal obesity in pre-school (PS), elementary school (ES), and middle school (MS) children attending the morning shift from public schools of Tijuana.

Materials and methods

Settings

In 2006, Baja California had approximately 3,155.070 residents. Geographically, it shares a strong economic and cultural relationship with the United States. Of the entire state's population, Tijuana, Baja California had approximately 1,559.683 residents.[10] According to The Instituto Nacional de Estatidistica, Geografia e Informatica (INEGI),[10] during the 2009-2010 academic years, the numbers of PS, ES and MS in Tijuana was 574, 657 and 219 respectively, with 64,686, 189,013 and 77,389 enrolled students.[11] The number of public PS, ES and MS during 2010-1011 periods was 287, 498, and 185 respectively. Mexican public schools may have classes exclusively in the morning or exclusively in the afternoon, or both. Students attending public schools in Mexico are usually from middle and low socioeconomic status (SES) and children attending private schools are usually from middle and high economic status.

Population and sample

Schools were randomly chosen from a list of all the schools registered in the elementary school system. The list of schools was provided by the elementary school system. A bietapic random sample by the cluster method of schools and groups per each education level was conducted. The first step was to select 30 PS, 30 ES and 30 MS, and the second step was to select 30 groups from each educational level. The total sample was composed of 646 PS, 961 ES and 1095 MS children.

Recruitment and training

The purpose of the study was explained to school principals, teachers and parents. Written informed consent was obtained from the parents and the human subjects committee of the Nutrition Academic Group of the University Autonomous of Baja California approved the study. The approval consent form was completed by parents and children as well. Twenty physical education teachers and eight masters of health science students were trained at one central location in taking anthropometrics measurements using a portable scale, a stadiometer, and a measuring tape to determine weight, height, and waist circumference. All teachers and graduate students measured groups of four children (two sets of two randomly assigned to a pair of observers), to assess inter-observer measurement reliability. The inter-observer reliability of height (m), weight (kg) and waist circumference (cm) was 0.94, 0.98 and 0.87, respectively.

Data collection

The children's weight, height and waist circumference was measured and recorded during the 2010-2011-school term.

Anthropometric measurements

Height was measured to the nearest centimeter with a portable stadiometer (model 214 Rod, Seca Corp, Hamburg, Germany) and weight was measured with

Table I
BMI z-score for age and sex

< 5 years of age			
Clasification	*Boys (n = 97)* *N (%)* *(95% CI)*	*Girls (n = 121)* *N (%)* *95% (CI)*	*Total (n = 218)* *N (%)* *95% (CI)*
Low weight < -2 SD	0 (0) 0	0 (0) 0	0 (0) 0
Normal weight -1.99 SD-≤ +1 SD	58 (60) (63.3-56.2)	84 (69) (72.7-66.1)	142 (65.1) 68.1-62.1
Risk of overweight > + 1 SD-≤ +2 SD	32 (33) 36.5-29.5	21 (17) 0.7-2.0	53 (24.3) 26.9-21.7
Overweight > + 2 SD-≤ +3 SD	4 (4) 4.4-3.8	10 (8) 9.1-7.4	14 (6.4) 7.0-5.9
Obesity > +3 SD	3 (3) 3.3-2.8	6 (5) 5.4-4.5	9 (4.1) 4.4-3.8
5 to < 12 years of age			
Clasification	*Boys (n = 557)* *N (%)*	*Girls (n = 562)* *N (%)*	*Total (n = 1.119)* *N (%)*
Low weight < -2 SD	6 (1.1) 1.07-1.00	3 (0.53) 0.56-0.50	9 (0.8) 0.84-0.77
Normal weight -1.99 SD-≤ +1SD	284 (51.0) 52.0-50.0	339 (60.3) 62.1-58.5	623 (55.7) 57.0-54.3
Overweight > + 1 SD- ≤ +2 SD	147 (26.4) 26.9-25.8	136 (24.2) 25.0-23.4	283 (25.3) 25.7-24.9
Obesity > +2 SD	120 (21.5) 22.4-20.7	84 (15.0) 16.3-13.6	204 (18.2) 19.5-17.0
12 to 15 years of age			
Clasification	*Boys (n = 499)* *N (%)*	*Girls (n = 549)* *N (%)*	*Total (n = 1.148)* *N (%)*
Low weight < -2 SD	4 (0.8) 0.84-0.76	9 (1.6) 1.7-1.57	13 (1.1) 1.30-1.20
Normal weight -1.99 SD-≤ +1 SD	276 (55.3) 56.8-53.8	324 (59.0) 31.96-29.86	600 (57.3) 58.6-55.6
Overweight > + 1 SD-≤ +2 SD	110 (22.0) 22.8-21.3	121 (22.0) 23.2-21.00	231 (22.0) 23.2-20.9
Obesity > +2 SD	109 (21.8) 22.5-21.9	95 (17.4) 18.0-16.6	204 (19.6) 20.0-18.9

electronic scales (Scale Plus Fat Monitor UM-028 Tanita (Tokyo, Japan) to the nearest 0.1 kg. Body mass index (BMI), in kg/m^2, was calculated. Children were measured without shoes and wearing light clothing.

Waist circumference (WC) was measured at the minimum circumference between the iliac crest and the rib cage. WC was compared from the NHANES III Mexican-American sample,[12] and the cutoff point for abdominal obesity was at the 90th percentile.[13]

BMI z-score for age/gender, weight-for-height and height-for-age indexes were calculated using the ANTHRO program (v 3.2.2, WHO, 2007) and ANTHRO plus (v 1.0.4, WHO, 2007), which have 2006 WHO growth charts for 0 to 5 years of age[14] and 2007 WHO growth charts for 5 to 19 years of age.

BMI z-score for age/sex and weight/height was classified according to the WHO cutoff points for 0 to 5 years of age as follow: severe undernutrition (≤ -3 SD); undernutrition (-2.99 SD -≤ -2 SD); normal weight (-1.99 SD-≤ 1SD); possible risk of OW (> 1 SD-≤ 2 SD); OW (> 2 SD-≤ 3 SD) and O (> 3 SD). BMI z-score for age/sex and weight/height were 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).

Table II
Height-for-age and sex

< 5 years of age			
Clasification	*Boys (n = 97) (95% CI)*	*Girls (n = 121) 95% (CI)*	*Total (n = 218) 95% (CI)*
< -3 SD	0 (0.0) 0	0 (0.0) 0	0 (0.0) 0
-2.99 SD - ≤ -2 DS	2 (0.21) 2.2-1.9	3 (2.5) 2.7-2.2	5 (2.3) 2.4-2.2
> -1.99 SD-≤ +3 DS	95 (98) 98.1-97.8	118 (97.5) 97.7-97.3	213 (97.7) 97.8-97.6
> +3 SD	0.0 (0) 0	0.0 (0) 0	0.0 (0) 0
5 to < 12 years of age			
Clasification	*Boys (n = 557) (95% CI)*	*Girls (n = 562) 95% (CI)*	*Total (n = 1.119) 95% (CI)*
< -3 SD	2 (0.36) 0.37-0.35	0 (0.0) 0	2 (0.2) 0.18-0.17
-2.99 SD -≤ -2 DS	13 (2.3) 2.4-2.2	13 (2.3) 2.4-2.2	26 (2.3) 2.4-2.2
> -1.99 SD-≤ +3 DS	541 (97.1) 97.2-97.0	549 (97.7) 97.8-97.6	1,090 (97.4) 97.5-97.3
> +3 SD	1 (0.18) 0.19-0.17	0 (0.0) 0	1 (0.1) 0
12 to 15 years of age			
Clasification	*Boys (n = 499) (95% CI)*	*Girls (n = 549) 95% (CI)*	*Total (n = 1.148) 95% (CI)*
< -3 SD	2 (0.4) 0.42-0.38	0 (0.0) 0	2 (0.2) 0.2-0,18
-2.99 SD - ≤ -2 SD	10 (2.0) 2.2-2.8	26 (4.7) 0.5-0.4	35 (3.4) 3.7-3.1
> -1.99 SD- ≤ +3 SD	487 (97.6) 97.8-97.4	521 (95.0) 95.4-94.4	1,008 (96.2) 96.5-95.8
> +3 SD	0 (0.0) 0	2 (0.3) 0.38-0.34	2 (0.2) 0.20-0.18

Statistical analysis

BMI z-scores for-age and sex, and height-for-age and sex z-scores were calculated with Antrho and Antrho Plus software. Descriptive statistics were calculated using SPSS v17 software. Confidence Intervals were adjusted for cluster sample.

Results

A total of 531 (82% of the sample) PSC children (52% girls), 874 (91% of the sample) ES children (50% girls), and 980 (90% of the sample) MS children (53% girls) were interviewed and measured, which represent 82% of the total sample. Mean age in each group was 4.7 ± 0.6, 8.6 ± 1.8, and 13.6 ± 1.0 years, respectively.

Table I show the BMI z-score for age and sex for younger than five, 5 to 12 and 12 to 15 year old children. Table II, contains the distribution of height-for-age and sex, and in table III shows the distribution of height for-age and sex between d BMI-for-age and sex categories in younger and older than 5 years of age. In table IV the means and SD of anthropometric measurements by age (4 to ≥ 15) are identified. Abdominal obesity in children younger than 5 years old was 22%, 95% CI (20.8-23.7), in children 5-12 years old was 16.1%, 95% CI (15.4-16.8), and in children 12-15 years old was 15.4%, 95% CI (14.7-16.2).

Discussion

The elevated levels of OW and O found in this study (table I) are much higher than the ones reported

Table III
Distribution of height ofr-age and sex between BMI-for-age and sex categories in younger and older than 5 years of age

Younger than 5 years of age		
BMI-for-age-sex	*Height ≤ -2 DS*	*Height > -1.99 DS*
	N (%)	*N (%)*
-1.99 SD-≤ +1 SD	3 (60)	139 (65)
> +2 SD-≤ +3 SD	2(40)	51 (24)
> +3 SD	0 (0)	14 (7)
Total	5 (100)	213 (100)
Older than 5 years of age		
	N (%)	*N (%)*
≤ -2 SD	3 (4.5)	19 (1)
-1.99 SD-+1 SD	52 (79)	1,171 (56)
> +2 SD	9 (14)	505 (24)
> +2 SD	2 (3)	406 (19)
Total	66 (100)	2,101 (100)

in the National Health and Nutrition Survey (MexNHNS) conducted in 2006,[4] but among ES children they are slightly lower (3 percentage points (pp)) than the prevalence found in public school children in 2006.[1] However, the former used the CDC criteria and the latter is using the WHO criteria. In PS children there were no emaciated children (table II) compared to 1.6% found in the MexNHNS, and stunting was less than half of the observed in the northern region of Mexico in the MexNHNS and no children severely stunted were found. Although this study is conducted in children attending public, morning shift schools, which do not represent all children of this age, the results indicate that emaciated and severely stunted children are not a major problem in this Mexico-US border city, in contrast with the high prevalence of OW and O found in this age group (10% compared with 5% found in the northern region in 2006).[4] The prevalences of ROW, OW and O found in the PS children are similar (within the 95% confidence interval) with those, using CDC cutoff points, found in Mexican American infants and toddlers in the USA during 2009-2010.[15] In ES children, the frequency of stunting found in this study was 7.5 pp lower (table II) than the reported in the MexNHNS at the national level, but the prevalence of OW and O (table I) was 8 pp higher than the 35% found in the northern region,[4] which is within the confidence interval of the prevalence among 6 to 11 y of age Mexican Americans during 2009-2010.[15] In the MS children, the frequency of stunting (table II) was 5 pp lower than the reported in the MexNHS at the national level, but the prevalence of OW and O (table I) was 10 pp higher than the 32.6% found at the national level,[4] and within the 95% confidence interval of the prevalence among 12-19 y of age Mexican Americans during 2009-2010.[15]

Two percent (three children with normal weight and two with risk of OW) of the total younger than 5 y of age had low height (≤ -2DS) for age and sex, and three percent of the total population had low height (≤ -2DS) for age and sex. Most of the children who had low height-for-age and sex had normal or low weight, and eleven children were OW or O (table III). In this study it was also found that there is a tendency to increase BMI and waist circumference with age (table IV).

The results confirm alarming high levels of OW, O and AO in children 4 to 15 years, which is consistent with the results observed in a non-conventional sample among 5 to 24 month olds,low income infants, which showed a frequency of OW and O of 11% and 8%, respectively: this increases with age, from 3% for OW and 6% for O before 6 months to 13 and 10% between 12 to 24 months, respectively.[2] These results are also consistent with the 15.7% found among Mexican American infants and toddlers in 2009-2010.[15] Indicating that the risk factors facing infants, toddlers, elementary school children and MS adolescents in this Mexico-US border city are similar to those found in Mexican Americans in the USA, the population which has the highest prevalence of obesity in the USA.[15]

This indicates that the major risk factors for obesity in this population might be initiated during pregnancy and early infancy, from prenatal to postnatal factors, such as inadequate food habits and weight control during pregnancy, lack of exclusive breastfeeding during the first six month of life, early ablactating, introduction of sugar beverages and snacks early in life, lack of knowledge about health risk factors, etc.[16-17] Additionally, other environmental factors during pre-school and elementary school years expose children to increasing risk factors.[16-18] The results also indicate a stabilization or slight reduction of OW and O among public ES children compared to children from public schools attending in the morning during 2006-2007 period.[1] However, this could not be assured due to the lack of confidence intervals from the 2006-2007 survey, and no surveys among 2 to 5 year olds or 12 to 15 year olds were previously published. Therefore, there was no change in obesity prevalence among 5 to 11year olds and new data of the high prevalence of obesity among 2 to 15 year old children was found.

The main limitation of this study is the relatively small sample data, the lack of inclusion of private schools and children not attending to schools, which might be as much as 50% among PS children and 5 to 10 percent in older children.

Although the lack of change in the prevalence of obesity among those 6 to 11 years of age is encouraging, the high prevalence of obesity among younger children

Table IV
Means and SD of anthropometric measurements by age

	Years of age											
	4 *n = 218*	*5* *n = 272*	*6* *n = 133*	*7* *n = 237*	*8* *n = 115*	*9* *n = 147*	*10* *n = 147*	*11* *n = 68*	*12* *n = 203*	*13* *n = 348*	*14* *n = 285*	*≥ 15* *n = 210*
Weight (kg)	18.5 ± 2.7	19.9 ± 3.2	23.2 ± 4.0	27.5 ± 6.0	31.7 ± 8.4	36.9 ± 10.7	38.2 ± 9.4	45.8 ± 12.4	51.1 ± 12.7	56.3 ± 14.5	59.8 ± 15.1	60.6 ± 14.0
Height (cm)	105.9 ± 4.0	110.4 ± 4.7	116.7 ± 5.1	124.1 ± 51	129.1 ± 5.1	136.0 ± 7.0	139.7 ± 6.8	147.7 ± 7.3	153.8 ± 7.5	157.7 ± 7.6	161.1 ± 7.8	161.8 ± 8.0
Waist Circumference (cm)	53.3 ± 5.3	54.1 ± 5.4	56.8 ± 6.4	59.4 ± 8.5	62.9 ± 9.6	68.2 ± 11.8	67.7 ± 10.6	73.0 ± 11.6	73.4 ± 11.0	75.7 ± 11.9	77.0 ± 12.6	78.4 ± 11.7
BMI (kg/m^2)	16.4 ± 1.8	16.3 ± 1.8	17.0 ± 2.3	17.7 ± 3.1	18.8 ± 3.8	19.7 ± 4.2	19.5 ± 3.8	20.8 ± 4.3	21.4 ± 4.1	22.5 ± 4.9	22.9 ± 4.8	23.1 ± 4.8
BMI-age-gender z-score	0.73 ± 1.1	0.60 ± 1.1	0.84 ± 1.3	0.92 ± 1.3	1.1 ± 1.4	1.1 ± 1.4	0.88 ± 1.2	0.95 ± 1.3	0.86 ± 1.2	0.89 ± 1.3	0.77 ± 1.2	0.62 ± 1.2
Height-age-gender z-score	-0.32 ± 0.8	-0.33 ± 0.8	-0.28 ± 0.9	-0.08 ± 0.9	0.07 ± 0.9	0.08 ± 1.1	-0.17 ± 1.0	0.05 ± 1.0	-0.02 ± 1.0	-0.16 ± 1.0	-0.35 ± 0.94	-0.59 ± 0.9

and the high exposures to risk factors via television exposure to high calorie and salty snacks, the high availability of snacks at schools, among street vendors and in the supermarkets, warrant stricter measures to prevent and change this toxic environment.

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