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Original

Maternal BMI and migration status as predictors of childhood obesity in Mexico

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Abstract

Objective: **To assess the association of maternal migration to Baja California, body mass index (BMI) status, children's perceived food insecurity, and childhood lifestyle behaviors with overweight (BMI > 85% ile), obesity (BMI > 95% ile) and abdominal obesity (Waist Circumference > 90% ile).**

Methods: **Convenience sampling methods were used to recruit a cross-sectional sample of 4th, 5th and 6th grade children and their parents at Tijuana and Tecate Public Schools. Children's and parents' weights and heights were measured. Children were considered to have migrant parents if parents were not born in Baja California.**

Results: **One hundred and twenty-two children and their parents were recruited. The mean age of the children was 10.1 ± 1.0 years. Forty nine per cent of children were overweight or obese. Children with obese parents (BMI > 30) had greater odds of being obese, Odds Ratio (OR) 4.9 (95% Confidence Interval (CI), 1.2-19, p = 0.03). Children with migrant parents had greater odds of being obese, OR= 3.7 (95% CI, 1.6-8.3), p = 0.01) and of having abdominal obesity, OR = 3.2 (95% CI, 1.4-7.1, p = 0.01). Children from migrant parents have greater risk of higher consumption of potato chips, OR = 8.0 (95% CI, 2.1 -29.1, p = 0.01). Children from non-migrant parents had greater odds of being at risk of hunger.**

Conclusions: **Parental obesity and migration are associated with increased risk of obesity among Mexican children. Children whose parents were born in Baja California have greater odds of being at risk of hunger. Further studies should evaluate the role of migration on risk for childhood obesity.**

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Key words: *Childhood. Obesity. Migratio. Food intake. Hunger.*

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IMC MATERNO Y MIGRACIÓN COMO PREDICTOR DE OBESIDAD INFANTIL DE MÉXICO

Resumen

Objetivo: **Determinar la asociación entre la inmigración materna a Baja California, el índice de masa corporal (IMC), la percepción de inseguridad alimentaria de los niños, y los estilos de vida y el sobrepeso, (BMI > 85% ila), la obesidad (BMI > 95% ila) y la obesidad abdominal (Circunferencia de Cintura > 90% ila).**

Métodos: **Se realizó una muestra por conveniencia, en la que se reclutaron niños de 4.º a 6.º grado de primaria y a sus padres, de escuelas públicas de Tijuana y Tecate. Se midió el peso y la estatura de los niños. Los padres que no nacieron en el estado de Baja California se consideraron inmigrantes.**

Resultados: **Fueron reclutados 122 pares de padres y niños. La edad media de los niños fue de 10,1 ± 1,0 años. Cuarenta y nueve por ciento de los niños presentaron sobrepeso u obesidad. Los niños con padres obesos (BMI > 30) presentaron mayor riesgo de obesidad, Razón de Momios (RM) 4,9 (95% Intervalo de confianza (IC) 1,2-19, p = 0,03). Los niños con padres inmigrantes presentaron mayor riesgo de tener obesidad, RM = 3,7 (95% IC, 1,6-8,3, p = 0,01) y obesidad abdominal, RM = 3,2 (95% IC, 1,4-7,1, p = 0,01). Los niños con padres inmigrantes presentaron mayor riesgo de consumo de patatas fritas, RM = 8,0 (95% CI, 2,1-29,1, p = 0,01). Los niños de padres no inmigrantes presentaron mayor riesgo de hambre.**

Conclusiones: **La obesidad paterna y la inmigración estuvieron asociadas con el aumento de obesidad infantil. Los niños de padres nacidos en Baja California presentaron mayor riesgo de hambre. Se requieren más estudios que valoren el papel de la inmigración sobre el riesgo de obesidad.**

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Palabras clave: *Obesidad infatil. Inmigración. Ingesta de alimentos. Hambre.*

Introduction

Prevention of pediatric overweight (OW) has become a public health priority in the USA.[1] In several European countries, childhood OW and obesity especially among migrant children has also become an important health concern.[2] In Austria, the prevalence of OW and obesity was found to be significantly higher among children whose families migrated from Turkey and former Yugoslavia.[2] In Mexico, higher prevalence of childhood OW associated with food insecurity has been found in the Mexico-US border and among children from Central or Southern Mexican migrant parents compared with the Mexican national prevalence.[3,4] While these reports document the association of migration with higher prevalence of childhood obesity, data are lacking that show evidence that parental migration and food insecurity are risk factors for child OW among population groups of the same genetic origin. In this study we evaluated maternal migration, parental BMI, children's food insecurity, and children's lifestyle behaviors and the associations of these factors with OW and obesity in children.

Methodology

Settings

In 2006, Baja California, which shares a strong economic and cultural relationship with the United States, had approximately 3,460,000 residents. Tijuana and Tecate are the most northwestern border Mexican cities. Tijuana had approximately 1,795 000 and Tecate 118,000 residents, accounting for about 55% of the total population of the state of Baja California.[5] In the 2005-2006 academic years, Tijuana had 563 public elementary schools with 193,600 students, and Tecate had 66 public elementary schools with 13,958 students.[5] Students attending public schools in Mexico are usually from middle to low socioeconomic status (SES).[6]

Subjects and recruitment procedures

Two public elementary schools from Tijuana and three from Tecate, where interviewers had previous collaborations, were chosen to participate in the study by convenience sampling at schools. School principals, teachers and parents were contacted and told about the purpose of the study. Parents were asked to participate before or after school hours. Every child in the 4th, 5th, and 6th grades at these two schools was recruited (n = 512). All parents of these children were asked to participate in the study; 25% (129) parents or relatives agreed to participate. The Human Subjects Committee of the University Autonomous of Baja California approved the study. Written informed consent was obtained from all parents.

Data collection

Two graduate research assistants in Tijuana and Tecate conducted all interviews. They were trained at one central location by two of the authors of this study (AJC, MBG) in taking anthropometric measurements for children and adults and in conducting interviews. Children's and parents' weights and heights and waist circumferences (WC) were measured as part of the interview process.

Anthropometric measurements

Height was measured to the nearest millimeter with a portable stadiometer (model 214 Rodad Rod, Seca Corp, Hanover, MD, USA). Weight was measured with electronic scales (model 2001, Tanita Corp, Tokyo, Japan) to the nearest 0.1 kg. Body mass index (BMI; in kg/m^2) was subsequently calculated. WC was measured at the minimum circumference between the iliac crest and the rib cage. BMI values were compared with age/gender BMI percentiles from the Centers for Disease Control and Prevention Growth Charts (National Center for Health Statistics and National Center for Chronic Disease Prevention).[7] Cutoff points were the 85th and 95th percentiles for OW, ≥ 95th percentile for obesity and ≥ 99th percentile for extreme obesity. WC measurements were compared to CDC growth charts defining > 90th percentile for abdominal obesity for children,[8] and 85 to 95th percentiles for OW and ≥ 95th percentile for obesity in adults. Waist circumference cut points for abdominal obesity in adults was > 35 inches for women and 40 inches for males.[9]

Questionnaires

We developed two questionnaires to measure child intake, food insecurity, migration and health history, parental stress and physical and leisure time activities. One questionnaire was designed for children and the other for parents or the child's primary caregiver. For some sections of the questionnaire we used previously validated instruments as referenced below.[10,11,12] The parent questionnaire included questions on sociodemographic information, health history, food consumption,[10] food insecurity[10] physical activity, stress and family support,[12] and migration history. The children's questionnaire contained questions pertaining to food consumption, food security using the food insecurity questionnaire,[11] physical activity, food and nutrition knowledge, family environment, migration and psychosocial issues. Food security refers to the availability of food and one's access to it. A household is considered food insecure when its occupants perceive hunger or fear of starvation. The Food insecurity questions were: Did your household ever run out of money to buy food to make a meal?, Did you ever eat less tant you felt

you should because there was not enough money to buy food?, Did you ever tell your parent (s) that you were hunger because there was not enough food in the house?, Did you ever go to bed hungry because there was not enough money to buy food? Did you ever cut the size of your meals or did you skip meals because there was not enough money to buy food? Children were classified as "hungry" if they responded affirmatively to five out of five questions, as "at risk of hunger" if they responded positively to one or as many as four of the five food questions.[11] Food Habits: Children were asked questions about frequency of breakfast, lunch, and eating outside. Food frequency questionnaire (FFQ) was administered for all single foods items. The FFQ included the following food items: American Fast Food (burgers, pizzas, etc.), Mexican Fast Food (tacos, tortas), white bread, tortillas, beans, pastries, soft drinks, juices, sandwiches, and high-fat containing snacks (corn and potato chips), and salsa. Children were asked how often they eat each food item or group. Possible answers were never, once a month, one to seven a week. Physical activity questions related with frequency of walking and sports activities in and out school hours, sedentary activities were recorded by questions on frequency of TV, Video games watching. Health History questions were related to weight lost advice and treatment, depression, anxiety or another mental health conditions. Migration History: These questions were associated of migration status of each parent, comfortability at their neighborhood, keeping in touch with their relatives/family members, and visit to their home state, and perception of well-being in Tijuana. However, associations were only performed by the place of origin (born in Baja California or somewhere else).

To validate our questionnaire, 25 fifth grade children and their parents from a different elementary school in Tijuana were recruited and questionnaires were administered twice by direct interview within two weeks. Test-retest was conducted using Spearman correlation, ($r = 0.75$, $p < 0.05$).

Data analysis

Analyses were conducted using the Statistical Program for Social Sciences, version 11.5 (SPSS Inc., Chicago, 2001). Migration was defined as any parent who was not born in the state of Baja California. We assessed the associations between parental migration, child food consumption, OW status, and hunger. The chi square test was applied to test for associations between categories of BMI-age/sex, WC-age of children, and BMI and WC of parents, OW and obesity in children, and weekly consumption of food items, physical activity, migration history, and hunger. Consumption of beans was assessed as a single item and without regard to the type of dish or preparation of the beans. Bivariate and multivariate non-adjusted logistic regression analysis was employed to estimate the odds of a child being OW, obese, or having abdominal obesity in relation to food consumption patterns, physical activity level, migration history, parental BMI and risk of hunger or hunger.[11] Child birthplace was not included in these models.

Results

Population demographics

Mean age of the parents interviewed (n = 122) was 37.0 ± 7.0 (22.0-65.0) years. Of the parents, 5% had a college degree, 66% had less than 10 years of education, and 85% have their own car. The mean age of the school children was 10.1 ± 1.0 (8.6-13.7) years. The prevalence of overweight and obesity and the children questionnaires answers of children whose parents participated in the study were not different from those whose parents did not participate.

Migration status

Interviews were conducted on 122 children and their primary care givers (106 mothers, 10 fathers and 13 relatives with primary responsibility for care of the child) (table Ia, Ib). Most parents (60%) had migrated from different Mexican states (Jalisco, 18%, Mexico City, 12%, Baja California Sur, 12%, Sinaloa, 9%, others 49%), while 40% were native to Baja California. Fifty-eight (55%) of mothers were born outside Baja California. Parents had lived a mean of 19 ± 12 (1-65) years in Tijuana. Seventy-three percent of children were born in Baja California.

Table Ia
Distribution of Children'2 Body Mass Index by Gender

	BMI percentiles							
	5-84th		*84th-94th*		*95th-98th*		*≥ 99th*	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*
Boys	29	(49)	15	(25)	11	(19)	3	(5)
Girls	36	(56)	12	(19)	13	(20)	3	(5)
Total	65	(53)	27	(22)	24	(20)	6	(5)

Table Ib
Distribution of Care Giver's Body Mass Index by Gender

	BMI percentiles											
	Mothers				*Fathers*				*Other*			
	85th-95th		*≥ 95th*		*85th-95th*		*≥ 95th*		*85th-95th*		*≥ 95th*	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*
Boys	13	(28)	10	(21)	–	–	2	(50)	2	(25)	2	(25)
Girls	9	(15)	11	(21)	1	(20)	2	(40)	2	(33)	3	(50)
Total	22	(21)	21	(21)	1	(11)	4	(44)	4	(29)	5	(36)

Prevalence of OW, obesity, and abdominal obesity

Mean BMI of the children was 73.6 ± 25.2 percentile, and mean parental BMI was 28.8 ± 5.7 kg/m^2. Forty-nine percent of boys and 44% of girls were OW or Obese (table Ia, Ib). Most (76%) of parents were either OW (40%) or obese (36%) (table II), and 60% had abdominal obesity. Of the children with WC over the 90%ile, 79% had parents with abdominal obesity.

Childhood OW, obesity, abdominal obesity and hunger

Children with obese parents or with parents with abdominal obesity had greater odds of being obese and having abdominal obesity (table III). Children from migrant parents or with a migrant mother also had increased odds of having obesity and abdominal obesity (table IV). Children from parents born in Baja California (non migrants) had greater odds of being at risk of hunger (table IV).

Childhood OW, obesity, abdominal obesity, food consumption and parental migration

We evaluated the relationship of obesity and abdominal obesity to food consumption patterns and found several significant factors (table III). Children from obese parents had greater odds of being OW or obese, or of having abdominal obesity. Children from parents with abdominal obesity had greater odds of having abdominal obesity. Children with more than seven times consumption of beans per week compared with less than once a week and children with consumption of salsa equal or more than three times a week compared with less than once a week had greater odds of OW or obesity. Children with more than seven times a week consumption of beans and three or more times a week consumption of potato and tortilla chips with salsa had greater odds of being OW or obese. Children who did not consume burritos also had greater odds of being obese compared with children who regularly consumed burritos (table III).

We also evaluated food consumption patterns and child overweight in relation to parental migrant status. A high consumption of beans (more than 7 times a week versus less than one a week) in children from migrant parents was associated with a higher risk for being obese, OR = 16.0 (3.9-65.8; p = 0.01) (table IV). Certain eating patterns such as eating Mexican street foods (tacos, tortas and burritos), soda, or American fast food were not associated with OW, hunger or parent's migration (table IV).

Discussion

Our study is one of the first to show that internal migration of a population within the same ethnic group to a Mexico-US border area is a risk of factor for childhood obesity**.** We determined parent migration status and risk of hunger and hunger as predictors of child obesity and

Table II
Children's weight percentile and parents BMI status

Children's weight percentile	*Parent's BMI*						*Total*
	18.5-24.9		*25-29.9*		*≥ 30*		
	n	*(%)*	*n*	*(%)*	*n*	*(%)*	*n*
5-84	17	(30)	24	(43)	15	(27)	56
85-94	4	(17)	12	(52)	7	(30)	23
95-98	3	(16)	6	(32)	10	(53)	19
≥ 99	0	(0)	1	(25)	3	(75)	4
Totals	24		43		35		102

Table III
Unadjusted odds ratios for overweight, obesity, abdominal obesity, and parent history of obesity and consumption of selected foods

Risk factors	*OR (95% Confidence Interval)*	*p value*
Obesity from having obese parents	4.0 (1.2-13.0)	0.02
Overweight and obesity from having obese parents	3.6 (1.3-9.5)	0.01
Abdominal obesity[1] from having obese parents	5.1 (1.8-13.9)	< 0.01
Abdominal obesity[1] from having parents with abdominal obesity	2.85 (1.2-6.6)	0.02
Overweight and obesity from consumption of beans (≥ 7 times a week *vs* ≤ 1 times a week)	5.9 (1.6 –21.6)	< 0.01
Overweight and obesity from consumption of salsa (≥ 3 times a week *vs* ≤ 1 times a week)	2.5 (1.02-6.2)	0.05
Overweight and obesity from consumption of potato and tortilla chips with salsa (≥ 3 times a week *vs* ≤ 1 times a week) and beans (≥ 7 times a week *vs* ≤ 1 times a week)	6.1 (1.7-21.5)	< 0.01
Overweight and obesity from consumption of potato and tortilla chips (≥ 4 times a week *vs* ≤ 1 times a week)	4.6 (1.6-13.4)	< 0.01
Risk of abdominal obesity from consumption of burritos (never *vs* ≥ 1 times a week)	4.2 (1.4-12.7)	0.01

[1]Child abdominal obesity (WC = > 90th percentile), parent abdominal obesity (WC ≥ 88 cm for women and ≥ 102 cm for men).

parent obesity and found a high prevalence of children OW and obesity (49%), a high prevalence of extreme obesity (5%), a high prevalence of parents' OW and obesity and a high prevalence of abdominal obesity in children (47%) and parents (60%). Additionally, children from parents migrating to Baja California had higher risk of being obese or having abdominal obesity.

These findings likely reflect a physiological drive for catch-up fat accumulation in a migrant population.[13] The phenomenon of catch-up and poor recovery of fat free mass has centered on the observation that the absolute amount of food consumed may exceed the energy requirements for maintenance, tissue synthesis and physical work and underscores an increase in metabolic efficiency (after periods of food deprivation, growth retardation or weight loss) directed towards fat deposition.[13] Furthermore, it supports the psychological need of parents with a past experience of food insecurity to prevent their children from being thin or 'unhealthy'. We found that children from migrant parents are more likely to consume potato and tortilla chips. These energy-dense foods have been associated with diminished satiation, passive over consumption of fats and sweets, and higher energy intakes overall.[14] Dietz (1995) suggests that the increased fat content of food eaten to prevent hunger when a family lacks the money to buy food represents the most likely reason for the association of obesity and hunger, and that either food choices or physiologic adaptations in response to food shortages could cause increased rates of obesity.[15] In Mexico, as in the USA,[14] healthy food (fruits and vegetables, fish and lean meat) is usually less affordable, which might increase the risk for obesity among recent migrants.

The higher risk of hunger among children from at least one parent born in Baja California is inconsistent with the limited job opportunities of recent migrants. Although migration to Tijuana from rural or urban Mexican areas is usually based on economic necessity, and is likely a proxy for lower SES, perhaps more children from parents born outside Baja California with better salaries are taken to public schools. Tijuana is one of the largest urban centers of economic development in Mexico, with better job opportunities and salaries. Our study evaluates children from public schools and did not determine length of time since migration to Baja California, which may be an important component of SES. Future studies of pediatric obesity in Mexican populations should evaluate the relationship between children's SES and migrant status.

Table IV
Unadjusted odds ratios for overweight, obesity, abdominal obesity, hunger in relation with migration[1]

Risk factors	*OR (95% Confidence Interval)*	*p value*
Obesity from having migrant mother	7.4 (2.3-23.7)	< 0.01
Obesity from having migrant parents	7.7 (2.1-28.2)	< 0.01
Overweight and obesity from having migrant parents	3.6 (1.6-8.3)	< 0.01
Overweight and obesity from having migran parents and consuming beans 7 or more times a week	16.0 (3.9-65.8)	< 0.01
Risk of hunger and hunger in relation to having a father born in Baja California	3.1 (1.3-7.4)	< 0.01

[1]Migration is defined as the parent not having been born in Baja California.

Obesity has been linked to poverty.[14,16,17] In Europe, obesity has also been shown to be higher in immigrant populations than in natives.[2,18] Weight gain is associated with years of migration into Canada,[19] and in the USA the numbers of years of residence and acculturation to American culture is associated with higher BMI among different immigrant subgroups.[20] The prevalence of obesity among US adult migrants has been found to be lower among recent immigrants; however, after living 15 years in the US, the prevalence approaches that of US-born adults.[20] Additionally, among newly arrived Hispanic immigrants, the prevalence of obesity is more than 2.5 times higher after living 15 years in the USA.[21] The high prevalence of obesity and extreme obesity observed in this study is consistent with the prevalence found among a representative sample of school age children in Tijuana and Ensenada,[22] cities with high immigration rates.[5] Our study is the first to show that internal migration to an urban area in a developing country is associated with higher risk of childhood obesity and abdominal obesity among populations with the same genetic background. These findings suggest that specific aspects of the migrant experience including socioeconomic factors need to be further evaluated in studies that assess the development of childhood obesity.

Our data also reveal that obese migrant parents with higher consumption of beans more than seven times a week or potato and tortilla chips more than four times a week compared with less than once a week increases the risk for childhood obesity. Energy dense foods such as chips represent the lowest-cost option to the Mexican consumer, and may also be associated with a lower SES status. The transition from consumption of boiled beans, a traditional Mexican dish and low cost option, to fried or stewed beans might suggest an acculturation process to urban Tijuana. Although the beans are one of the healthiest traditional foods, containing high amount of fiber and low glycemic index,[23] the consumption of fried or stewed beans would increase the consumption of energy and promote obesity. As we did not assess the consumption of different dishes in relation to pediatric obesity, the type of beans that were consumed is unknown. The environmental explanations for the high prevalence of OW and obesity among children living near the Mexican-US border and their relation to migration might be explained by the wide availability and affordability in Mexico of energy dense foods. The lack of association with American fast food might be due to its high cost in Mexico compared with traditional Mexican foods sold outside home. Chips, soft drinks, and burritos are more affordable. Influences specific to living in a border town were not evaluated in this study, as both cities are located on the US-Mexican border.

Our report has several limitations. This is a cross-sectional study, thus, it provides no information on weight or food insecurity prior to migration to Baja California, and could not know if parent or child obesity occurred prior to or after migration. Based on a convenience sample of five previously selected schools with participation of only 24% of the parents, it is neither a representative sample of the population of Mexico nor the migrant population. Additionally, we did not assess the SES of the population, except as implied by enrollment in a public school. Our findings highlight a need for more research to examine the role of migration and SES status on childhood obesity. In particular, more studies are needed to evaluate the relationship between migrating from areas with different levels of urbanization and economic development to Baja California and pediatric obesity. Other limitations include reliance on mothers' reports of their children's habits and from children's reports of their own habits. Mothers' and children's reports of food consumption and physical activity might be biased by their perceived weight status. Finally, further studies should evaluate other types of internal Mexican migration as Tijuana and Tecate are heavily influenced by their proximity to the US border including American lifestyle and diet patterns. Our findings warrant more complete measures of cultural and economic processes that may be contributing to obesity among the migrant community.

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