Demographic and Socioeconomic Factors Associated with Blood Lead Levels Among Mexican-American Children and Adolescents in the United States

Leo S. Morales, MD, PhD^{a,b} Peter Gutierrez, MA^a Jose J. Escarce, MD, PhD^{a,b}

SYNOPSIS

Objective. This study was designed to assess demographic and socioeconomic differences in blood lead levels (BLLs) among Mexican-American children and adolescents in the United States.

Methods. We analyzed data from the Third National Health and Nutrition Examination Survey, 1988–1994, for 3,325 Mexican-American youth aged 1 to 17 years. The main study outcome measures included a continuous measure (μ g/dL) of BLL and two dichotomous measures of BLL (\geq 5 μ g/dL and \geq 10 μ g/dL).

Results. The mean BLL among Mexican-American children in the United States was 3.45 μ g/dL (95% confidence interval [CI] 3.07, 3.87); 20% had BLL \geq 5 μ g/dL (95% CI 15%, 24%); and 4% had BLL \geq 10 μ g/dL (95% CI 2%, 6%). In multivariate analyses, gender, age, generational status, home language, family income, education of head of household, age of housing, and source of drinking water were statistically significant independent predictors (p<0.05) of having higher BLLs and of having BLL \geq 5 μ g/dL, whereas age, family income, housing age, and source of drinking water were significant predictors (p<0.05) of having BLL \geq 10 μ g/dL.

Conclusions. Significant differences in the risk of having elevated BLLs exist among Mexican-American youth. Those at greatest risk should be prioritized for lead screening and lead exposure abatement interventions.

^aDavid Geffen School of Medicine, University of California at Los Angeles, Los Angeles, CA

^bRAND Corporation, Santa Monica, CA

Address correspondence to: Leo Morales, MD, PhD, 911 Broxton Ave., Los Angeles, CA 90024; tel. 310-794-2296; fax 310-794-0732; e-mail <morales@rand.org>.

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Lead exposure remains a serious health problem among Hispanic children and adolescents living in the United States. Based on data from the Third National Health and Nutrition Examination Survey (NHANES III), approximately 5% of Mexican-American children 1 to 5 years of age have blood lead levels (BLLs) at or above the current intervention threshold of 10 micrograms per deciliter (μ g/dL) and an additional 23% have BLLs of 5 μ g/dL or higher, an intervention threshold currently under consideration by the Centers for Disease Control (CDC).¹ Other research shows that approximately 5% of Mexican-Americans 6 to 19 years of age have BLLs of 10 μ g/dL or higher.²

Exposure to lead can have deleterious effects on multiple organ systems, including the nervous, hematopoietic, renal, endocrine, and reproductive systems.³ Recent scientific evidence suggests that even BLLs generally considered medically insignificant may have adverse effects on the cognitive development of children.³ In particular, BLLs less than 10 μ g/dL have been associated with cognitive and neuropsychological deficits including decrements in IQ, attention,⁴ verbal learning, cognitive flexibility, visuospatial construction,⁵ nonverbal reasoning, working memory,⁶ and visuomotor and finemotor functioning. In response to this and other research, the CDC is considering whether to lower the intervention threshold for lead exposure from 10 μ g/dL to 5 μ g/dL.⁷

Although previous studies have shown that lead exposure is higher among Hispanic children compared with non-Hispanic white children,^{1,2} little is known about how lead exposure varies among Hispanic children. In general population studies, children in low-income families, children residing in homes built before 1946,8 and children enrolled in Medicaid programs are at increased risk for significant lead exposure compared with their respective counterparts.9 Refugee children are more than twice as likely as other children to have significant lead exposures.¹⁰ Children who migrate to the United States from developing countries may also be at elevated risk for significant lead exposures.¹¹ For example, Mexican children are known to have high rates of significant lead exposure.¹² In one study conducted in Oaxaca, Mexico, 55% of school-aged children had BLLs of 10 µg/dL or higher.13

In this study, we examined patterns of lead exposure among Mexican-American children living in the United States using data from a nationally representative health survey and examination study. In particular, we examined associations between BLLs and various demographic characteristics, socioeconomic status, indicators of acculturation, Medicaid program participation, housing age, drinking water source, and residence in a major metropolitan area.

METHODS

Data source

Data for this study came from the NHANES III. The NHANES III was conducted by the National Center for Health Statistics (NCHS) and was designed to assess the health and nutritional status of the non-institutionalized population of the United States. The survey oversampled Mexican-Americans and blacks and included a total of 11,834 youth between 1 and 17 years of age. The survey was conducted at 89 locations during two three-year periods: 1989 to 1991 and 1992 to 1994. The survey used stratified multistage probability cluster sampling design. Weights were assigned to each subject, enabling results to represent the entire U.S. population.

Bilingual NHANES III staff conducted surveys in households, administering questionnaires to families, adults, and children in Spanish or English. The most knowledgeable adult in each surveyed household (the household informant) was asked to respond to questions about sampled youth. The survey included demographic, socioeconomic, and housing questions. Following the survey, standardized medical examinations that included the taking of blood samples were conducted by physicians and health technicians in NHANES III mobile examination centers.

Our analysis sample included 3,325 subjects ranging in age from 1 to 17 years who were identified as Mexican-American by the household informant. Subjects less than one year of age were excluded because BLLs were not assessed in this group. Subjects whose surveys were coded as unreliable by the field interviewers (n=2) and subjects whose parents spoke a language other than English or Spanish at home (n=10) were also excluded. An additional 733 subjects were excluded because they were missing information on BLL. Missing values for all other variables were imputed. Overall, less than 2% of subjects had missing data for any given variable with the exceptions of family income (12% missing) and home age (13% missing). We used a hot-deck procedure¹⁴ to impute home age and model-based imputed values provided by NCHS for family income (NHANES III, 2001).

Statistical modeling

We used multivariate regression models to evaluate the associations between BLLs and demographic and socioeconomic variables among Mexican-American youth. For all models the unit of analysis was the individual youth.

Measures of blood lead levels. Blood lead levels were assessed on whole blood samples taken from each subject based on standardized protocols described elsewhere.¹⁵ Blood lead levels were reported in NHANES III as a continuous measure in micrograms per deciliter ranging from 0.07 µg/dL to 71.8 µg/dL. Due to limitations of the laboratory methods used, the lowest detectable BLL was 0.07 µg/dL. We estimated models with the continuous dependent variable using ordinary least squares regression.

In addition to the continuous measure, we also created two dichotomous measures of blood lead: one indicating a BLL $\geq 5 \ \mu g/dL$ and a second indicating a BLL $\geq 10 \ \mu g/dL$. As noted, the current CDC threshold BLL for intervention is 10 $\ \mu g/dL$; however, due to evidence of adverse effects at even lower levels, a threshold level of 5 $\ \mu g/dL$ is under investigation.⁷ We estimated models with the dichotomous measures as dependent variables using logistic regression.

Explanatory variables. Subjects were assigned to one of three categories based on age: 1 to 4 years, 5 to 12 years, and 13 to 17 years. We used measures of generational status and the language spoken at home as indicators of acculturation. Based on the language spoken by the parents at home, subjects were assigned to one of three home language categories: Spanish only, English only, or English and Spanish. Subjects were assigned to one of three categories based on a

subject's place of birth and his/her parents' place of birth: first, second, and third or higher generation. Subjects born outside the U.S. were assigned to the first generation; subjects born in the United States who had at least one foreignborn parent were assigned to the second generation; and subjects born in the U.S. whose parents were both born in the U.S. were assigned to the third generation or higher.

The NHANES III collected several indicators of socioeconomic status (SES). We used the educational attainment of the head of household and poverty-income ratio (PIR) as our primary indicators of SES. The PIR is the ratio of two components: the numerator is the family income and the denominator is an assessment of the income level minimally adequate for a family of that size for that calendar year. We placed subjects into one of four categories based on the PIR: <50%, 50% to 100%, 100% to 200%, and 200% or more. We assigned subjects to one of three categories based on the years of education of the head of household: 6 or fewer years, 7 to 12 years, or 13 or more years. Subjects were also assigned to categories based on the U.S. Census region in which they resided: Northeast, South, Midwest, or West.

The NHANES III also collected information about the age of housing where the subject resided and the primary source of drinking water for the subject's household. Housing age was characterized as built before 1946, built 1946 to 1973, or built in 1974 or later. The primary source of drinking water was characterized as tap water, well water, or bottled water.

Estimation. We defined a base model (Model 1) that included sex, age, generational status, home language, family income, and the educational attainment of the head of household. However, to investigate whether age of housing or source of drinking water might account for differences in BLL, we specified a second model (Model 2) that included these variables. Models 1 and 2 also included indicators of U.S. Census region.

In sensitivity analyses, we estimated the models for the continuous BLL measure using Tobit regression rather than ordinary least squares regression, because our continuous measure of BLL had a lower limit of $0.07 \ \mu g/dL$. Because the results were the same for both estimation methods, we report the findings from the ordinary least squares regressions. In other sensitivity analyses, we added indicators for residence in an urban area of more than 1,000,000 persons and of participation in the Medicaid program to our specification of Model 1. As part of these analyses, we tested for collinearity between Medicaid participation and our other measures of SES. However, because neither of these variables reached statistical significance, they were not included in the models presented here.

All analyses were conducted with Stata 8.0, which is capable of adjusting for the complex NHANES sample design.¹⁶ All analyses (unless stated otherwise) incorporated design weights that adjusted for unequal sampling probabilities and non-response.

RESULTS

Table 1 shows the demographic and socioeconomic characteristics of the analysis sample of Mexican-American youth for this study. Approximately 50% of the subjects were fe-

Table 1. Demographic and socioeconomic	
characteristics of Mexican-American youth fro	m
NHANES III	

	N	Weighted percent (SE)
Sex		
Male	1,624	50 (0.01)
Female	1,701	50 (0.01)
Age (years)		
1 to 4	1,309	27 (0.01)
5 to 11	1,367	43 (0.01)
12 to 17	649	30 (0.01)
Generational status		
First	438	15 (0.15)
Second	1,667	49 (0.03)
Third or higher	1,220	36 (0.31)
Home language		
Spanish	1,778	51 (0.03)
English and Spanish	371	11 (0.01)
English	1,176	38 (0.03)
Family income		
(poverty-income ratio)		
<50%	623	16 (0.02)
50% to 100%	1,113	31 (0.02)
100% to 200%	933	29 (0.01)
200% or more	656	23 (0.02)
Educational attainment of		
household head (years)		
6 or less	1,122	34 (0.02)
7 to 12	1,717	49 (0.02)
13 or more	486	17 (0.02)
Age of housing		
Built before 1946	481	16 (0.02)
Built 1946 to 1973	1,656	46 (0.03)
Built 1974 or later	1,188	39 (0.05)
Drinking water		
Тар	2,562	76 (0.02)
Well	127	4 (0.01)
Bottled	636	20 (0.02)

NHANES III = Third National Health and Nutrition Examination Survey, 1988–1994

SE = standard error

male, 70% were 1 to 11 years of age, 47% lived in families with incomes below the federal poverty line, and 83% lived in families where the head of household had 12 or fewer years of education. Fifteen percent of the subjects were first generation, 49% were second generation, and 36% were third or higher generation. Thirty-eight percent of subjects lived in English-speaking households, 51% lived in Spanish-speaking households. Sixteen percent of subjects lived in homes built before 1946, whereas 39% lived in homes built after 1974. Seventy-six percent of subjects reported drinking tap water.

Table 2 shows bivariate analyses of mean BLLs and proportions of subjects with BLLs $>5 \mu g/dL$ and BLLs $>10 \mu g/dL$ for the overall sample and by each explanatory variable. The mean BLL for the study sample was 3.47 $\mu g/dL$ (confidence interval [CI] 3.07, 3.87), 20% of the study sample

	BLL (μ/dL) (Mean [95% CI])	BLL >5 μ/dL (Percent [95% CI])	BLL >10 μ/dL (Percent [95% CI])
Overall	3.47 [3.07, 3.87]	20 [15, 24]	4 [2, 6]
Sex			
Male	3.78 [3.27, 4.29]	22 [16, 28]	4 [3, 7]
Female	3.15 [2.84, 3.46]	17 [14, 21]	4 [2, 5]
Age (years)			
1 to 4	4.51 [3.97, 5.06]	29 [24, 35]	6 [4, 9]
5 to 11	3.39 [2.96, 3.82]	19 [14, 25]	4 [2, 7]
12 to 17	2.62 [2.31, 2.93]	12 [9, 16]	2 [1, 4]
Generational status			
First	4.45 [3.77, 5.13]	32 [24, 41]	7 [3, 13]
Second	3.64 [3.07, 4.22]	21 [16, 27]	4 [2, 7]
Third or higher	2.83 [2.52, 3.13]	13 [9, 17]	3 [1, 4]
Home language			
Spanish	4.13 [3.59, 4.67]	27 [21, 34]	5 [3, 8]
English and Spanish	3.38 [2.49, 4.28]	19 [12, 28]	5 [2, 14]
English	2.61 [2.31, 2.91]	10 [7, 14]	2 [1, 3]
Family income			
(poverty-income ratio)			
<50%	4.37 [3.74, 5.00]	31 [23, 41]	5 [3, 10]
50% to 100%	4.05 [3.48, 4.62]	27 [21, 33]	5 [3, 10]
100% to 200%	3.27 [2.71, 3.84]	16 [11, 22]	4 [2, 6]
200% or more	2.30 [2.07, 2.53]	6 [5, 8]	1 [1, 2]
Educational attainment			
of household head (years)			
6 or less	4.15 [3.56, 4.75]	28 [21, 36]	6 [3, 10]
7 to 12	3.38 [2.96, 3.81]	18 [14, 23]	4 [2, 6]
13 or more	2.37 [2.02, 2.71]	8 [6, 11]	1 [0, 4]
Age of housing			
Built before 1946	4.01 [3.17, 4.85]	26 [19, 35]	7 [4, 12]
Built 1946 to 1973	3.69 [3.22, 4.16]	22 [17, 29]	4 [3, 7]
Built 1974 or later	2.98 [2.58, 3.40]	14 [10, 19]	3 [3, 4]
Drinking water			
Тар	3.60 [3.12, 4.08]	21 [16, 27]	5 [3, 7]
Well	3.47 [2.42, 4.52]	21 [10, 39]	5 [2, 14]
Bottled	2.98 [2.73, 3.24]	14 [11, 18]	2 [1, 3]

Table 2. Blood lead levels among Mexican-American children by demographic and socioeconomic characteristics (weighted)

BLL = blood lead level

CI = confidence interval

had BLLs >5 µg/dL (CI 15%, 24%), and 4% of the study sample had BLLs >10 µg/dL (CI 2%, 6%). Table 2 also shows that BLLs varied among subjects by several explanatory variables. For example, the mean BLL among subjects in families with a PIR <50% was 4.37 µg/dL (CI 3.74, 5.00), whereas subjects in families with a PIR of 200% or higher had a mean BLL of 2.30 µg/dL (CI 2.02, 2.71). Further, the mean BLL among subjects in families where the head of household had six or fewer years of education was 4.15 µg/ dL (CI 3.56, 4.75), whereas the mean BLL was 2.37 µg/dL (CI 2.02, 2.71) for subjects in families where the head of household had 13 or more years of education.

Table 3 shows regression results for Models 1 and 2 using the continuous measure of BLL as the dependent variable. In Model 1, all variables were statistically significant. For example, subjects 1 to 4 years of age had higher lead levels than subjects 12 to 17 years of age, with an adjusted group mean difference in lead levels of $1.82 \ \mu g/dL$ (CI 1.43, 2.20) (p < 0.01). Also in Model 1, first-generation subjects had higher BLLs than subjects in the third or higher generations, with an adjusted group mean difference of $0.84 \ \mu g/dL$ (CI 0.28, 1.30) (p < 0.01). In Model 2, all variables were statistically significant, including age of housing and drinking water. Subjects living in homes built before 1946 had higher BLLs than subjects living in homes built in 1974 or later, with an adjusted group mean difference of $0.77 \ \mu g/dL$ (CI 0.17, 1.36) (p < 0.05) and subjects who reported drinking tap drinking water had higher BLLs than subjects who reported drinking bottled drinking water, with an adjusted mean difference of 0.48 $\mu g/dL$ (CI 0.13, 0.82) (p < 0.01).

Table 4 shows the results for the multivariate model results without (Model 1) and with (Model 2) variables adjusting for housing age and water source where the dependent variables are dichotomous indicators for BLL >5 µg/dL and

	Blood lead levels μg/dL (β [95% Cl])					
	I	Model 1	Model 2			
Sex						
Male	0.63	[0.41, 0.85]ª	0.58 [0.37, 0.80] ^a			
Female		—	—			
Age						
1 to 4	1.82	[1.43, 2.20]ª	1.76 [1.38, 2.13] ^a			
5 to11	0.78	[0.53, 1.03]ª	0.81 [0.52, 1.09] ^a			
12 to17		—	—			
Generational status						
First	0.84	[0.30, 1.38]ª	0.66 [0.99, 1.22] ^b			
Second	0.08 [[-0.31, 0.47]	0.00 [-0.42, 0.42]			
Third or higher		—	—			
Home language						
Spanish	0.79	[0.28, 1.30]ª	0.83 [0.28, 1.37] ^a			
Spanish and English	0.46 [[-0.17, 1.10]	0.47 [-0.16, 1.09]			
Family income						
(poverty-income ratio)						
< 50%	1 18	[0.60 1.77]ª	1 19 [0 58 1 81]ª			
50% to 100%	0.96	[0 39 1 52] ^a	0.85 [0.29 1.41] ^a			
100% to 200%	0.50	[0 13 0 87] ^b	0.34 [0.02 0.67]			
200% or more	0.00					
Educational attainment						
of household head (vear	s)					
6 or less	0.62	[0.14, 1.09] ^b	0.57 [0.47, 1.10] ^b			
7 to 12	0.39	$[0.04, 0.74]^{\circ}$	0.28 [-0.10, 0.66]			
13 or more						
Age of housing						
Built before 1946			0.77 [0.17, 1.36] ^b			
Built 1946 to 1973			0.51 [0.08, 0.95] ^b			
Built 1974 or later						
Drinking water						
Тар			0.48 [0.13, 0.82]ª			
Well			0.50 [-0.69, 1.68]			
Bottled						

Table 3.	Continuou	s measi	ure o	flead	among
Mexican	-American	youth 1	l to 1	17 yeaı	rs of age

NOTE: Regressions also include indicators for region.

^ap<0.01

^bp<0.05

CI = confidence interval

BLL >10 µg/dL. In Models 1 and 2 where the dependent variable is an indicator for BLL >5 µg/dL, all explanatory variables were statistically significant. In Model 1, for example, children in the poorest households were significantly more likely to have BLLs >5 µg/dL compared with children in the wealthiest households (odds ratio [OR]= 1.41; CI 2.38, 6.68), meaning that the poorest children were approximately four times as likely to have a BLL >5 µg/dL as the wealthiest children. In Model 2, the OR for home built before 1946 was 1.85 (CI 1.21, 2.81) (p<0.01), meaning that children living in homes built before 1946 had approximately twice the odds of having BLLs >5 µg/dL as children living in homes built in 1974 or later. In Models 1 and 2 where the dependent variable was BLL >10 µg/dL, not all explanatory variables were statistically significant. In Model 1, age, generational status, family income, and educational attainment were statistically significant, whereas in Model 2, age, generational status, family income, and home water source were significant.

DISCUSSION

This study identified several factors associated with elevated BLLs in Mexican-American children. Specifically, we found that demographic variables such as age and sex, as well as socioeconomic variables such as the educational attainment of the head of household and family income, are statistically significant and independent predictors of BLLs in Mexican-American children. In addition, we found that age of housing, source of drinking water, and indicators of acculturation such as the language spoken at home and generational status are statistically significant and independent predictors of BLLs.

In contrast to previous research, we did not find that Medicaid enrollment was a statistically significant and independent predictor of lead exposure in Mexican-American children. A study conducted by the U.S. General Accounting Office (GAO) found that in a general probability sample of children in the United States, children enrolled in Medicaid were more than three times as likely as their nonenrolled counterparts to have BLLs greater than 10 μ g/dL.⁹ By contrast, our study suggests that Medicaid enrollment is not a good predictor of elevated BLLs in Mexican-American children.

Although not widely recognized, drinking water is a potential source of lead exposure in children. Contamination of drinking water may occur through plumbing containing lead such as solder, fluxes, pipes, pipe fittings, and sediments. Buildings constructed before the 1930s often had lead piping, and galvanized pipes were used between the 1920s and 1950s. Prior to 1986, lead soldering was popular. In one study, for example, lead levels in the drinking water in Philadelphia public schools were found to exceed Environment Protection Agency standards of 20 parts per billion.¹⁷ In our study, we found that Mexican-American children with tap water as their principal source of drinking water have higher BLLs than Mexican-American children drinking bottled water, suggesting that plumbing may be an important source of lead exposure in Mexican-American children.

This study is consistent with previous research showing a higher prevalence of elevated BLLs among immigrant children.¹⁰ In this study, we found that first-generation Mexican-American children (immigrant children) have higher BLLs than third-generation children in multivariate analyses. One possible explanation for this finding is that first-generation children may have greater exposure to products from Mexico that contain lead than their third-generation counterparts. Lead contamination among children is a much bigger problem in Mexico than in the U.S.¹³ In Mexico, the use of lead-glazed ceramics and traditional remedies that contain lead have been implicated in lead exposure in children.¹²

We also found that the language spoken at home was a significant and independent predictor of higher BLLs. To our knowledge, this is the first time in the published literature that language has been described in association with

	Blood lead levels >5 μg/dL (Odds ratio [95% CI])				Blood lead levels >10 μg/dL (Odds ratio [95% CI])			
		Model 1		Model 2	٨	Nodel 1		Model 2
Sex								
Male	1.41	[1.17, 1.69]ª	1.40	[1.17, 1.68]ª	1.26	[0.92, 1.71]	1.23	[0.92, 1.64]
Female	1.00	1.00	1.00	1.00				
Age								
1 to 4	3.44	[2.54, 4.64]ª	3.70	[2.73, 5.01]ª	3.00	[1.73, 5.20]ª	3.25	[1.95, 5.43]ª
5 to 11	1.85	[1.36, 2.51]ª	1.90	[1.41, 2.57] ^a	2.04	[1.13, 3.71] ^b	2.13	[1.21, 3.75] [⊳]
12 to 17	1.00	1.00	1.00	1.00				
Generational status								
First	1.91	[1.43, 2.54]ª	1.97	[1.48, 2.64]ª	1.80	[0.90, 3.59]°	1.91	[0.95, 3.84] ^c
Second	1.12	[-0.73, 1.72]	1.05	[0.68, 1.61]	1.21	[0.39, 3.75]	1.16	[0.38, 3.52]
Third or higher	1.00	1.00	1.00	1.00				
Home language								
Spanish	2.07	[1.36, 3.16]ª	2.16	[1.44, 3.24]ª	1.99	[0.63, 6.29]	2.17	[0.70, 6.75]
Spanish and English	1.64	[1.09, 2.47] ^b	1.70	[1.15, 2.50] ^b	2.31	[0.72, 7.38]	2.35	[0.75, 7.35]
English		1.00		1.00		1.00		1.00
Family income								
(poverty-income ratio)								
<50%	4.04	[2.38, 6.86]ª	3.69	[2.18, 6.25]ª	3.75	[1.62, 8.69]ª	3.33	[1.50, 7.38]ª
50% to 100%	3.41	[2.18, 5.32]ª	3.16	[2.10, 4.76]ª	3.79	[1.66, 8.66]ª	3.35	[1.53, 7.34]ª
100% to 200%	2.07	[1.40, 3.06] ^a	1.92	[1.33, 2.79]ª	2.92	[1.47, 5.75] ^a	2.73	[1.45, 5.13] ^a
200% or more	1.00	1.00	1.00	1.00				
Educational attainment								
of household head (years)								
6 or less	1.78	[1.15, 2.75] [⊾]	1.67	[1.08, 2.57] ^b	2.15	[0.64, 7.24] ^b	1.98	[0.61, 6.41]
7 to 12	1.55	[1.02, 2.35] ^b	1.46	[0.98, 2.18] ^c	1.71	[0.53, 5.47] ^b	1.58	[0.49, 5.09]
13 or more	1.00	1.00	1.00	1.00				
Age of housing								
Built before 1946			1.85	[1.21, 2.81] ^b			1.52	[0.83, 2.77]
Built 1946 to 1973			1.66	[1.14, 2.42] ^b			1.30	[0.66, 2.57]
Built 1974 or later			1.00	1.00				
Drinking water								
Тар			1.82	[1.30, 2.55]ª			2.79	[1.44, 5.39]ª
Well			2.00	[0.78, 5.15]			4.81	[1.44, 15.99] ^b
Bottled			1.00					1.00

Table 4.	. Dichotomous	measures of	of lead	among	Mexican-American	vouth	1 to	17 ·	vears of	age

NOTE: Regressions also include indicators for region.

CI = confidence interval

BLLs. The fact that Mexican-American children living in monolingual Spanish-speaking households had statistically significantly higher BLLs than children living in monolingual English-speaking households after controlling for generational status, socioeconomic status, and other potentially confounding variables, suggests that linguistic and cultural barriers may be important to consider when formulating lead screening and abatement interventions for Mexican-American children. Educational campaigns to reduce lead exposure should be tailored for Spanish-speaking immigrant families, taking into account culturally specific causes of lead exposure such as the use of lead-glazed ceramics and traditional remedies still in common use in Mexico today.

Finally, we found statistically significant and independent associations between BLLs and family income, the educational attainment of heads of household, and age of housing. Leaded paint and contaminated dust and soil are the major causes of lead exposure among children in the US.¹⁸ Children ingest lead by eating paint chips or chewing on objects such as cribs coated with leaded paint. Younger children are at greatest risk for ingesting paint chips and contaminated soil due to normal hand-to-mouth behavior. Previous studies have found that children living in low-income housing and public housing are most likely to have elevated BLLs.^{18,19} Our results suggest that low-income Mexican-American children living in older housing, particularly younger children, are at increased risk for elevated BLLs, independent of language, generational status, and other potential confounding factors.

Missing data may limit the generalizability of this study.

^ap<0.01

^bp<0.05

[°]p<0.10

Eighteen percent of Mexican-American youth in NHANES III were missing BLLs. In large part, the biasing effect of this missing data was mitigated by our use of design weights that account for non-response. Furthermore, when we compared Mexican-American youth with and without missing BLLs, we found that they were similar in their distributions of sexes, the educational attainments of heads of household, generational status, and home language, though Mexican-American youth without BLLs tended to be younger. Because younger children tended to have higher BLLs, we may have underestimated the overall mean BLL for our sample and underestimated the association of age to BLLs.

In summary, this study shows that some Mexican-American children are at higher risk for elevated BLLs than others. Public health officials should consider demographic, socioeconomic, housing, cultural, and linguistic factors when designing lead screening and lead abatement interventions for Mexican-American children. In particular, public health officials should be aware of culturally specific sources of lead exposure such as lead-glazed ceramics and traditional remedies in use in Mexico today when targeting immigrant Mexican-American children.

Support for this research was provided by the National Institute of Environmental Health Services (P50-ES012383), the National Institute on Aging (AG-02-004), and the UCLA Project EXPORT (P20-MD00148-01). Dr. Morales also received partial support from a Robert Wood Johnson Foundation Harold Amos Fellowship award.

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