Globalization, Binational Communities, and Imported Food Risks: Results of an Outbreak Investigation of Lead Poisoning in Monterey County, California

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Objectives. Although the burden of lead poisoning has decreased across developed countries, it remains the most prevalent environmental poison worldwide. Our objective was to investigate the sources of an outbreak of lead poisoning in Monterey County, California.

Methods. An investigation in 3 county health department clinics in Monterey County, California, was conducted between 2001 and 2003 to identify risk factors for elevated blood lead levels (≥10 μg/dL) among children and pregnant women.

Results. The prevalence of elevated blood lead levels was significantly higher in 1 of the 3 clinics (6% among screened children and 13% among prenatal patients). Risk factors included eating imported foods (relative risk [RR] = 3.4; 95% confidence interval [CI] = 1.2, 9.5) and having originated from the Zimatlan area of Oaxaca, Mexico, compared with other areas of Oaxaca (RR = 4.0; 95% CI = 1.7, 9.5). Home-prepared dried grasshoppers (*chapulines*) sent from Oaxaca were found to contain significant amounts of lead.

Conclusions. Consumption of foods imported from Oaxaca was identified as a risk factor for elevated blood lead levels in Monterey County, California. Lead-contaminated imported *chapulines* were identified as 1 source of lead poisoning, although other sources may also contribute to the observed findings. Food transport between binational communities presents a unique risk for the importation 900–906. doi:10.2105/AJPH.2005.074138)

In the past 25 years, the United States and many other countries have witnessed dramatic decreases in environmental exposure to lead, largely resulting from environmental policies that mandated that lead be removed from gas, paint, and other manufactured products, and through the modification of mining and other extraction processes.[1–4] The success of these programs is evidenced by studies that have reported substantial declines in blood lead levels (BLLs) in population samples of children in the United States over the past 10 years.[5]

Despite these gains, lead exposure continues to be one of the most prevalent and harmful sources of environmental poisoning in much of the world. Recent estimates by the World Health Organization indicate that the percentage of children aged younger than 6 years with elevated BLLs, defined as 10 or more micrograms of lead per deciliter of blood [μg/dL],[4,6] is well over 20% in several regions, including Latin America.[4] The World Health Organization emphasizes that the risk of lead toxicity remains as high as in previous centuries for children in many countries. The insidious attack of lead on the developing nervous system significantly limits the ability of children worldwide to climb out of the poverty in which so many grow up.

Globalization and the regular transnational movement of capital, goods, and people allow migrants to maintain strong ties with their communities of origin. In California, thousands of migrants travel back and forth to small communities in Mexico and other parts of Latin America. This connectedness enables families to communicate regularly, eat and transport foods prepared in their hometowns, and preserve language and customs while living in separate countries, all of which creates binational communities.[7–8] Unfortunately, the same conditions that allow for strong cultural ties to be maintained over vast distances can also lead to the importation of environmental hazards. We investigated an outbreak of lead poisoning in Monterey County, California, in which a localized problem of lead poisoning was found to be associated with contaminated imported foods among community residents from the southern Mexican state of Oaxaca (Figure 1).

In 2000, one of the community doctors (E.S.) affiliated with the Department of Family and Community Medicine at the University of California, San Francisco, asked for help in investigating a large number of lead poisoning cases where he worked. The clinic, in Seaside, Calif, is one of Monterey County Health Department's 3 community-based primary care clinics. There were no epidemiological data from the County or State Health Department that could answer the questions of the doctor and nurse at the Seaside clinic who were seeing "way too many cases of lead poisoning" among their patients who were from Oaxaca. Although there had been prior lead case investigations conducted by the Monterey County Health Department, the more common sources of lead exposure in California, such as lead-contaminated water from old pipes, peeling lead-based paint, lead-contaminated soil, occupational sources, lead-glazed ceramics, or home health remedies containing lead, had not been identified in the majority of these investigations (Donna Staunton, Public Health Nurse, written communication, May 2005).

METHODS

We used epidemiological methods common in outbreak investigations, which incorporated case–control and cohort designs. Qualitative methods, including focus groups, were used to

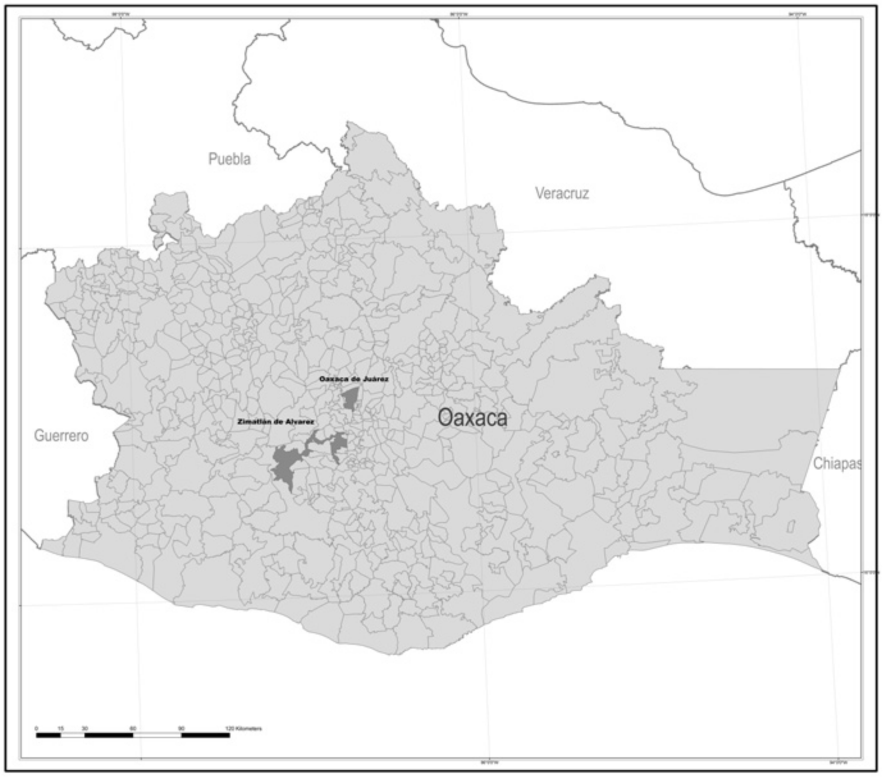

FIGURE 1—State of Oaxaca, Mexico, with Zimatlan District and State Capital (Oaxaca City) shaded.

complement and inform the epidemiological findings.[9,10] Initial steps focused on estimating the prevalence of elevated BLLs among children screened for lead in Monterey County Health Department Primary Care Clinics, including the clinic in Seaside and 2 others in the neighboring communities of Salinas and Marina. A case–control study in Seaside to determine if pediatric lead cases were concentrated among the families from Oaxaca, Mexico, followed. Focus groups with families of lead-poisoned children, Oaxacan community healers (*curanderas*), and pregnant women with elevated BLLs were then conducted in Seaside, to better understand community perceptions about lead poisoning and to inform the next study design. The next study examined risk factors for lead among pregnant women who entered care at 2 of the primary care clinics in Monterey County that saw the majority of prenatal patients in the clinic system.

Food testing was conducted by West Coast Analytic Service, the State of California Food and Drug Administration (State of California, Food and Drug Administration 2003; sample 030675), and by M.V.

Screening Children for Lead in Monterey County

We analyzed laboratory data for children aged from birth to 6 years to estimate the prevalence of elevated BLLs among screened children. State and county policies require all children to be screened for lead at 12 and 36 months (with all children to be screened at least once by age 72 months), in accordance with California's Child Health and Disability Prevention Program guidelines.[6,11] Children are tested for lead through either a venous or capillary blood sample.[12]

Case–Control Study Examining Risk Factors in Seaside

We reviewed charts of pediatric elevated BLL cases and a sample of controls (with BLLs <10 μg/dL) identified from the laboratory database as Seaside clinic patients screened between January 1997 and June 2001. Abstracted information included sex, race/ethnicity, birthplace, BLL, and answers to lead-risk screening questions. We matched subjects on age at first lead screening (3 groups: 0 to <1 years; 1 to ≤ 3 years; and 4 to 6 years) to remove the possible confounding for children who were tested outside the 12- to 36-month screening window. We also abstracted prenatal and primary care charts of mothers of cases and controls to determine whether children were either born in or had families from Oaxaca, Mexico.

Prenatal Lead Testing and Assessment of Risk Factors

In August 2002 the Monterey County Health Department Clinics instituted a policy of prenatal blood lead testing during the routine prenatal testing done at the first visit. Between November 2002 and August 2003, a subset of the women at the Seaside and Salinas clinics who were screened for lead was also interviewed about risk factors for lead poisoning. Together, these clinics saw more than 95% of all prenatal patients who attended county clinics for prenatal care. Women were asked during a routine visit with a trained comprehensive perinatal services coordinator if they were interested in the study, and those who gave written informed consent were interviewed about risk factors for lead poisoning. Women approached for the study were those who could return for a scheduled visit. All women who received the lead testing were counseled about their test result and given prevention education that was tailored to their literacy and language background. Risk factors included area of birth, consumption of imported foods, use of lead-glazed ceramics, and occupational and environmental exposures to lead. Because we were interested in examining whether women from different areas of Oaxaca had different risk profiles for elevated BLLs, we examined as risk factors both town of birth and the town where the family of the woman or her partner lived.

We next began a prospective investigation of women receiving prenatal care. We believed that if we found a similar prevalence of elevated BLLs and similar risk factors, we would be able to identify some of the potentially preventable exposures occurring in this community. Also, because we were beginning to suspect a food-borne source of lead, we wanted to understand food preparation and importation practices to better develop lead poisoning prevention messages.[14–16]

RESULTS

Prevalence of Elevated Blood Lead Levels

For children tested between January 1997 and June 2001, with 1 observation per child per year, the prevalence of elevated BLLs at Seaside was 3 times that of the clinics in Salinas and Marina (6.0% compared with 1.7% each) and significantly higher than population-based estimates in the United States over the same period (2.2%).[5] Seaside accounted for 47% of pediatric lead tests but 80% of the pediatric lead cases in Monterey County. Lead screening rates for children in this target age group exceeded 97% in each of the 3 clinics.[13] These findings suggested that the lead problem in Monterey County was concentrated in Seaside, so the investigation was focused there.

Case–Control Study Examining Risk Factors in Seaside

The results of the case–control analysis are summarized in Table 1. More than 70% (90/126) of pediatric cases were born in the United States, although the majority of cases born in Mexico were from Oaxaca. Almost all cases (95%) were Latino, compared with 70% of controls. Close to 40% of cases had chart documentation of 1 or more venous-confirmed BLLs equal or greater than 20 μg/dL. We believed that the high proportion of pediatric cases with a BLL of 20 μg/dL or higher suggested an acute exposure, which was consistent with our understanding of the unique foods and importation practices that were taking place between vendors from Seaside and family members living in Oaxaca.

Prenatal Testing and Assessment of Risk Factors

A total of 214 women enrolled in the study between November 2002 and August 2003. All women approached for the study participated. The study population was almost entirely Latina (95%) and born in Mexico (87%). Sixty-six women were from the state of Oaxaca: 32 were from the Zimatlan area (12 from Santa Ynez Yatzeche, 15 from San Pablo Huixtepec, and 5 from Zimatlan) in the western central valley of Oaxaca, and 34 were from towns in the eastern central valley or from the Pacific coast of Oaxaca. These 2 areas of Oaxaca represent culturally distinct communities—the Zimatlan-area Oaxacans are Zapotecans, and the Oaxacans from the eastern valley are primarily Miztecans.[7]

The prevalence of elevated BLLs in the prenatal patients study population was 12%; 18% of the women screened in Seaside and 1% of the women screened in Salinas had elevated BLLs. Table 2 presents demographic and risk factor characteristics of women in the study, by BLL, and associated relative risk (RR) estimates and 95% confidence intervals (CI). Women with elevated BLLs were more likely to be Oaxacan born (96%) (compared with women born elsewhere in Mexico) and from Seaside (96%); more likely to eat imported foods from Mexico, including foods produced locally or home-grown by family members, such as pumpkin seeds, tortillas, chocolate, and *chapulines* (home-prepared dried grasshoppers; 84%); and more likely to report having a friend or relative "with lead in their blood" (28%). In an analysis restricted to the 66 women from Oaxaca, the RR for women born in the Zimatlan area compared with other areas of Oaxaca was 4.0 (95% CI=1.7, 9.5). Women from the Zimatlan area reported similar patterns of imported food consumption as women from other areas of Oaxaca.

Women with elevated BLLs were not significantly more likely than women with normal BLLs to be younger, more recently arrived immigrants (immigration within 1 year compared with more than 1 year or ≤5 years compared with 6 or more years), prepare food in lead-glazed ceramics or to have used lead-glazed ceramics growing up, live in older housing, live in remodeled houses, live with someone who uses lead in their job, or to have been out of the United States in the previous year.

In an analysis restricted to the 54 Oaxacan-born women screened at Seaside, almost half (n=23; 44%) had elevated BLLs.

TABLE 1—Demographic Characteristics of Pediatric Cases and Controls: Seaside Family Health Center, Monterey County, Calif, 1997–2001

	Cases (BLL ≥ 10 μg/dL), No. (%; n = 146)	Controls (BLL < 10 μg/dL), No. (%; n = 285)	Matched Odds Ratio (95% CI)
Age (matched)			
≤ 1 year	10 (7)	36 (12)	NA
2 to 3 years	98 (67)	183 (64)	NA
4 to 6 years	38 (26)	66 (24)	NA
Male	67 (46)	149 (52)	0.8 (0.6, 1.2)
Ethnicity[a]			
Latino	139 (95)	192 (70)	8.4 (3.8, 18.7)
Other	7 (5)	81 (30)	NA
Birthplace[b]			
Mexico	35 (28)	12 (5)	7.6 (3.8, 15.4)
United States	90 (72)	236 (95)	NA
Region of birth[c]			
Oaxaca, Mexico	26 (74)	4 (33)	5.7 (1.4, 23.9)
Other Mexico	9 (26)	8 (67)	NA

Notes. BLL = blood lead level; CI = confidence interval; NA = not applicable. Charts were reviewed and abstracted for 146 of the 157 cases (93%) and 285 of the 296 controls (96%).

[a]n = 419. Ethnicity information was missing for 12 controls. "Other" includes 1 Asian and 6 White cases, and 33 White, 21 African American, 15 Asian, and 12 other controls.

[b]n = 378. For 20 cases and 33 controls, birthplace information was missing. Only 1 case and 5 controls were from countries outside the United States or Mexico.

[c]Restricted to the 47 children born in Mexico (35 cases and 12 controls).

TABLE 2—Patient Characteristics, Responses to Lead Screening Questions, and Relative Risk Estimates for Elevated Blood Lead Levels (BLLs): Monterey County, Calif, 2003

	All Patients, No. (%; n = 214)	BLL < 10 µg/dL, No. (%; n = 189)	BLL ≥ 10 µg/dL, No. (%; n = 25)	Relative Risk (95% CI)
	Patient characteristics			
Age				
≤ 20 years	42 (20)	35 (19)	7 (28)	1.6 (0.7, 3.6)
21 years and older	172 (80)	154 (81)	18 (72)	
Ethnicity[a]				
Latina	205 (96)	180 (95)	25 (100)	inestimable
Other	9 (4)	9 (5)	0 (0)	
Region of birth[b]				
Oaxaca, Mexico	66 (31)	42 (22)	24 (96)	44 (6.1, 318.0)
Other Mexico	121 (69)	120 (78)	1 (4)	
Region of Oaxaca				
Zimatlan, Oaxaca	32	13	19	4.0 (1.7, 9.5)
Other Oaxaca	34	29	5	
Recent arrival to United States[c]				
≤ 1 year in United States	47 (24)	39 (20)	8 (32)	1.5 (0.7, 3.2)
2 or more years in United States	148 (76)	131 (80)	17 (68)	
Clinic location				
Seaside	135 (63)	111 (59)	24 (96)	14.0 (1.9, 101.8)
Salinas	79 (17)	78 (41)	1[d] (4)	
	Responses to lead screening questions			
How often do you eat food that you prepare or store in clay pottery?[e]				
Any reported frequency	15 (7)	12 (6)	3 (12)	1.8 (0.6, 5.2)
Never	195 (93)	173 (94)	22 (88)	
How often did you use clay pottery growing up?				
Any reported frequency	158 (81)	135 (79)	23 (92)	2.7 (0.7, 11.2)
Never	38 (19)	36 (11)	2 (8)	
Do you have a friend or relative who has had a high level of lead in their blood?				
Yes	19 (9)	12 (6)	7 (28)	4.0 (1.0, 8.2)
No	193 (91)	175 (94)	18 (72)	
Do you live or stay in a house that has recently been renovated?				
Yes	51 (24)	49 (26)	2 (8)	0.3 (0.7, 1.2)
No	161 (56)	139 (54)	22 (92)	
Do you live in house with peeling paint?				
Yes	27 (13)	24 (13)	3 (12)	0.9 (0.3, 2.9)
No	187 (87)	165 (87)	22 (88)	
Do you live or stay with someone who uses lead in their job?				
Yes	10 (5)	10 (5)	0 (0)	inestimable
No	202 (95)	177 (95)	25 (100)	
Have you lived or traveled outside the United States in the past year?				
Yes	45 (21)	38 (20)	7 (28)	1.5 (0.6, 3.3)
No	168 (79)	150 (80)	18 (72)	

Continued

Among Oaxacan-born women, women from the Zimatlan area were more likely to have elevated BLLs than women from other parts of Oaxaca. Nineteen of the 32 Zimatlan-born women had elevated BLLs (59%), compared with 4 of the 22 women (18%) from other areas of Oaxaca screened at the Seaside clinic (RR=3.3; 95% CI=1.3, 8.3). By comparison, the prevalence of elevated BLLs among women from other parts of Mexico who participated in the study and were screened at Seaside was less than 1% (1/161)—this woman reported that she was not born in Oaxaca but that her family lived in Zimatlan. In Salinas, no women screened for lead were from Zimatlan, but the 1 woman with an elevated BLL was from another area of Oaxaca.

In the 6 months after the introduction of prenatal lead testing by the county health department, we estimated the prevalence of elevated BLLs among all new prenatal patients seen in the Salinas and Seaside clinics. This was done to determine how representative the subset of interviewed study participants was of all women entering care in the clinics during this period. Between August 2003 and February 2004, we conducted a chart review of all women who entered prenatal care at these 2 clinics. Demographic information, including birthplace and lead test results, were abstracted for 420 of the 450 women (93%) entering prenatal care. In this sample, 402 women had complete lead test results and demographic data. The prevalence of elevated BLLs was 13% in Seaside and 0% in Salinas. All 27 cases were from Oaxaca, although the town or area of origin was not recorded in the charts. Women in the chart review study were similar to women in the interview study with regard to age, ethnicity, and time in the United States.

Confirmation of Food-Borne Lead Contamination

In September 2003, a 2-year-old boy screened as part of his Child Health and Disability Prevention Program visit in Seaside had a BLL of 36 µg/dL, after having a much lower lead test result the preceding November (4 µg/dL). The child was born in the United States, but his parents had previously immigrated from San Pablo Huixtepec in Oaxaca. The child's mother provided samples of foods

TABLE 2—*Continued*

	How often do you eat ____ from Mexico?			
Imported foods[f]				
Any reported frequency	130 (61)	109 (58)	21 (84)	3.4 (1.2, 9.5)
Never	84 (39)	80 (32)	4 (16)	
Imported pumpkin seeds				
Any reported frequency	59 (28)	48 (25)	11 (44)	2.1 (1.0, 4.3)
Never	155 (72)	141 (75)	14 (56)	
Imported tortillas				
Any reported frequency	65 (30)	45 (24)	20 (80)	9.2 (3.6, 23.4)
Never	149 (70)	144 (76)	5 (20)	
Imported mole				
Any reported frequency	41 (19)	36 (19)	5 (20)	1.1 (0.4, 2.6)
Never	173 (81)	153 (81)	20 (80)	
Imported chocolate				
Any reported frequency	51 (24)	40 (21)	11 (44)	2.5 (1.2, 5.2)
Never	163 (76)	149 (79)	14 (56)	
Imported tamarind candy				
Any reported frequency	21 (10)	21 (11)	0 (0)	NA
Never	193 (90)	168 (89)	25 (100)	
Imported *chapulines*[a]				
Any reported frequency	37 (17)	24 (13)	13 (52)	5.2 (2.6, 10.4)
Never	177 (83)	165 (87)	12 (48)	

Note. NA indicates data is not applicable. Chapulin = seasoned dried grasshopper. Screening questions were adapted from Centers for Disease Control and Prevention–recommended lead screening questions for children. Additional pediatric screening questions were asked, including questions about living in a house built before 1960, the use of home health remedies, eating nonfood items, and living with someone who uses lead in their hobby, but the frequency of positive responses for these questions was too small to calculate risk estimates.

[a]Relative risk estimates were inestimable for ethnicity because of zero cell frequencies for non-Latina cases with elevated BLLs.

[b]Restricted to the 187 women born in Mexico. Values in brackets indicate the birth regions within Oaxaca. Relative risks presented for Oaxaca-born compared with born elsewhere in Mexico (n = 187), and for Zimatlan-born compared with born elsewhere in Oaxaca (n = 66).

[c]n = 195. Eighteen women born in the United States and 1 for whom time in United States was missing were excluded. Relative risks for < 5 years compared with > 5 years in the United States were almost identical (2.0; 95% CI = 0.7, 5.0).

[d]This woman indicated that her parents were from Oaxaca, although she was born elsewhere in Mexico.

[e]n = 210. Examples of clay pottery were shown to study subjects during the interview. Data for past use of clay pottery were restricted to the 196 women born outside the United States.

[f]"Any imported food" was coded from any frequency reported to the food-specific questions. Imported herbs and herbal remedies were also asked about but were only reported by 7 women.

received from her family in Oaxaca for testing. Tortillas and a bag of *chapulines* that she had received 2 weeks previously, through an importer that relayed foods directly from families living in Oaxaca to families in Seaside, were tested. The mother reported that the child had consumed about a small baby food jar's worth of *chapulines* in the previous few days (about 4 ounces). Food analyses indicated that the *chapulines* contained 2300 ppm of lead, and the tortillas contained less than 0.1 ppm. The mother was counseled to remove the food source, and a state-wide health alert was issued by the California Department of Health Services with regard to imported *chapulines*.[17] The investigation of the child's home by the Monterey County Childhood Lead Prevention Program did not find common lead-containing sources such as home health remedies, lead-glazed pottery, or food sources known to have lead such as tamarind candy (Donna Staunton, Public Health Nurse, written communication, May 2005).

Between August 2003 and June 2005 we collected and tested several samples of *chapulines* obtained from vendors in Seaside who reported that the samples were from Zimatlan, from vendors in the marketplace in Zimatlan, and from fields in the Zimatlan area (Table 3). Products were not labeled and had no indication that they were produced commercially. Several *chapulin* samples had extremely high amounts of lead. Additional *chapulin* samples that were boiled but not seasoned contained 580 ppm and 3 ppm of lead. Eating foods with lead levels like these would result in daily intake levels that exceeded the Food and Drug Administration's provisional tolerable intake level for children of 6 μg of lead per day by many orders of magnitude (based on an estimate of 5 to 15 ounces consumed daily).[18] Additional samples of pumpkin seeds and tortillas had no detectable lead (less than 1 ppm), and 1 sample of *mole* (a prepared and condensed sauce) contained 40 ppm.

DISCUSSION

We found a significant public health problem of lead poisoning among a group of immigrants who have come to Seaside, Calif, from Oaxaca, Mexico. The high prevalence of elevated BLLs in both children and pregnant women over several years, as well as the association between elevated BLLs and at least 1 food that is widely eaten within this community, suggests an even greater problem among the Oaxacan community in Seaside, and possibly among other communities that have not yet been identified. The majority of Oaxacans who live in Seaside are from indigenous Zapotecan communities that are distinct from other Oaxacans who live in Monterey County, and it is possible that they may have unique sources of lead exposure that have not been determined. The fact that reports of eating imported foods, including tortillas (with a RR higher than 9), were associated with elevated BLLs among prenatal patients needs to be substantiated with wider testing of imported foods. That several *chapulin* samples obtained in Seaside and in Zimatlan contained high levels of lead suggests that the home community in Oaxaca has significant ongoing lead exposure. There have been no studies of this area to date to determine the extent of lead poisoning or to pinpoint the lead sources so that widespread lead poisoning can be prevented.

Although there is strong evidence that the origins of the elevated BLLs in Seaside are associated with lead contamination of food in

TABLE 3—Lead Levels in *Chapulin* Samples Originating From Zimatlan, Oaxaca

Sample Origin	Date Collected	Lead Level
Collected in Seaside		
Seaside market—reported to be from Zimatlan, Oaxaca	August 2003	40 ppm
	October 2003	none detected
Family of child with elevated BLL—imported from family in San Pablo Huixtepec, Oaxaca	October 2003	2300 ppm
Collected in Zimatlan		
Zimatlan market	February 2004	13 ppm
	March 2005	157 ppm
	March 2005	2500 ppm
	March 2005	none detected
	August 2005	1500 ppm
Field outside Zimatlan (boiled but not seasoned)	December 2003	580 ppm
	February 2004	3 ppm

Note. Chapulin = seasoned dried grasshoppers. BLL = blood lead levels.
[a]Seasoned dried grasshoppers.

Oaxaca, there are also 3 lines of evidence showing that the exposures are occurring in Seaside: (1) the high proportion of pediatric lead cases that were born in the United States (70%); (2) the data that indicate that recent immigration or recent travel outside the United States were not associated with elevated BLLs among prenatal women studied; and (3) the food test results (from foods obtained in Seaside) and the case report of the child who had an initially low BLL followed by an extremely high one after eating lead-contaminated foods in Seaside that were sent by his family in Oaxaca. We believe that the lead exposures in the Seaside community result from both ongoing exposures from imported foods that contain lead and from past exposures that may have resulted in the storage of lead in bone and other organs that is later released into the blood, including during pregnancy.[19]

That elevated BLLs were not strongly associated with current or past use of lead-glazed clay ceramics among prenatal patients is surprising because their use has been associated with higher mean BLLs in studies in Mexico.[20–21] Our outbreak investigation was focused on risk factors for elevated BLL (rather than for mean BLL), which might partially account for this difference. However, our focus group interviews confirm that women do not widely use Mexican pottery in the United States, and our finding of past use of lead-glazed ceramics among women in our study is consistent with studies in Mexico.[22]

If lead-glazed ceramics had been a strong risk factor for elevated BLLs in the women in the prenatal study, it would have been likely to affect all Oaxacan-born women, rather than primarily those from the Zimatlan area. There is no known local production of lead-glazed ceramics in this area, with the majority of lead-glazed ceramics produced in eastern Oaxaca and distributed to other parts of Oaxaca and Mexico.[23] Lead-glazed ceramics are available, however, in local markets in Monterey County and some women did report using them for preparing certain types of foods. We suspect that use of lead-glazed ceramics does contribute to the elevated BLLs in this population but that it is not the primary source of lead exposure. It is possible that lead-glazed ceramics are being used in Zimatlan in a manner that is increasing the amount of lead in food, and it is also possible that ingredients themselves are contaminated with lead, through food preparation practices (such as the drying of ingredients or grinding and milling practices).[24]

Environmental contamination is also a possible source of lead because the Zimatlan Valley has a history of silver mining,[25] in which lead-contaminated mine tailings have been dispersed throughout the area. One study that examined soil, plant, and invertebrate samples in an area of Wales contaminated with mine tailings found similar lead levels in local species of grasshopper to those found in the *chapulin* samples collected in this study, which raises the possibility that lead could be bioaccumulated in locally harvested foods, including *chapulines*, in Oaxaca.[26] These potential routes of exposure will be examined in future studies we are developing with relatives of case families in Zimatlan.

We are not aware of any studies that have previously identified an outbreak of lead poisoning from home-prepared and locally produced foods. Clearly, there is an extensive system of transporting foods between binational communities that remains outside the international surveillance systems designed to identify food contamination in imported products. These epidemiological findings highlight the importance of the collection of community-level data that is disaggregated both geographically and within ethnic groups,[27,28] because without them, the elevated BLLs in Seaside among Oaxacans would have been diluted in county-level prevalence assessments. They also demonstrate the importance of community-oriented primary care that is engaged with binational communities,[29,30] and of the increasing relevance of globalization in the examination of health outcomes. We were able to identify the lead problem in Seaside as a result of the insightfulness of the clinicians who noticed the cases with high lead levels and were aware of the binational nature of the lives of Oaxacans living in Monterey County. An understanding of the different indigenous groups, towns of origin, the fluidity of migration patterns, and of the importance of food importation in this community was critical to the development of the outbreak investigation. The problem of elevated BLLs in Monterey County reflects a binational problem. It is our hope that by determining the origins of the lead exposure in this community, many more cases of lead poisoning will be averted, both among migrant communities and among their communities of origin. ■

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Contributors

M.A. Handley originated the study, supervised all aspects of its implementation and data analysis, and led the writing. C. Hall and E. Sanford originated the study, conducted data collection, and provided writing support. E. Diaz and K. Drace conducted data collection. E. Gonzalez-Mendez and M. Croughan originated the study and provided writing support. R. Wilson conducted data analysis. M. Villalobos conducted sample analyses.

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Human Participant Protection

This study was approved by the institutional review board at the University of California, San Francisco, and the Monterey County Division of Primary Care.

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