Unauthorized Border Crossings and Migrant Deaths: Arizona, New Mexico, and El Paso, Texas, 2002–2003

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Objectives. We examined the major causes of and risk factors for death among migrants who died while making unauthorized border crossings into the United States from Mexico.

Methods. Decedents were included in the study if (1) their remains were found between January 1, 2002, and December 31, 2003, in any US county along the 650-mi (1040-km) section of the US–Mexican border from Yuma, Ariz, to El Paso, Tex; (2) their immigration status was unauthorized; and (3) they were believed to have died during transit from Mexico to the United States. Characteristics of the decedents and causes of and risk factors for their deaths were examined.

Results. Among the 409 decedents meeting our inclusion criteria, environmental heat exposure (n=250; 61.1%) was the leading cause of death, followed by vehicle crashes (n=33; 8.1%) and drownings (n=24; 5.9%). Male decedents (n=298; 72.8%) outnumbered female decedents (n=105; 25.6%) nearly 3 to 1. More than half of the decedents were known to be Mexican nationals (n=235; 57.5%) and were aged 20 to 39 years (n=213; 52.0%); the nationality of 148 (36.2%) decedents was undetermined.

Conclusions. Deaths among migrants making unauthorized crossings of the US–Mexican border are due to causes that are largely preventable. Prevention strategies should target young Mexican men, and focus on preventing them from conceiving plans to cross the border, discouraging them from using dangerous routes as crossing points, and providing search-and-rescue teams to locate lost or injured migrant crossers. (*Am J Public Health.* 2006;96:1282–1287. doi:10.2105/AJPH.2005.075168)

Unauthorized immigration is not uncommon[1–12]; it has been documented from North Africa to southern European countries, from Cambodia and Laos to Thailand, and from Mexico and Central and South American countries to the United States.[1,2,5,7] The US–Mexican border is 1980 mi (3168 km) long and extends from San Diego, Calif, to Brownsville, Tex.[13] It has 43 official entry points through which people and vehicles are authorized to enter the United States.[14] In 2003, there were 246 million authorized entries into the United States from Mexico, making this border one of the busiest in the world.[15]

Although there is no reliable source of data on the number of people who make unauthorized crossings of the US–Mexican border, immigration statistics show that, in 2002, almost 1 million unauthorized migrants were captured and repatriated (hereafter "apprehended") while trying to cross, approximately 1 apprehension for every 250 legal entries.[15] Most of these unauthorized migrants were from Mexico.[16]

Numbers of apprehensions, however, are far lower than actual numbers of unauthorized migrants. Many migrants escape being apprehended, and others make multiple crossings whether they have been apprehended or not. From 1995 to 2000, an estimated 225 to 370 migrants died annually in the United States after making an unauthorized northbound crossing of the US–Mexican border.[11,12] To escape the heightened surveillance of the US Border Patrol and other authorities that guard the border, these migrants often choose dangerous paths through remote desert and mountainous terrains and sometimes cross hazardous rivers.

Although some unauthorized migrants enter the United States to seek asylum, most enter for economic reasons.[1,2,7,10,11] Per capita incomes in the United States are 5 to 7 times higher than those of Mexico and most Central and South American countries.[16,17] Because opportunities for legal entry into the United States to seek employment are limited, people resort to unauthorized attempts to gain entry.[17]

Deaths among unauthorized migrants are emerging as a major public health issue that is intertwined with social, economic, and political factors. Only a few limited studies, however, have examined the characteristics of decedents who have died crossing the border.[11,12] We sought to delineate the demographic characteristics of decedents who died attempting to make unauthorized crossings of the US–Mexican border and identify the major causes of and risk factors for their deaths.

METHODS

We used cross-sectional medical examiner's data to examine the characteristics of people who died attempting to make unauthorized crossings of the US–Mexican border into the 4 Arizona border counties (Yuma, Pima, Santa Cruz, Cochise), the 3 New Mexico border counties (Hidalgo, Luna, Dona Ana), or El Paso County, Texas; these areas cover approximately one third (650 mi) of the US–Mexican border. Time, logistics, and administrative reasons directed the selection of these counties. New Mexico has a centralized statewide medical examiner system. Yuma, Pima, Santa Cruz, Cochise, and El Paso counties have county-based systems. We provided medical examiners with standardized criteria, detailed subsequently, by which to identify possible decedent cases, and we examined the records of decedents medical examiners identified to confirm that our case criteria were met.

To be included in this study, decedents had to have been found during the 24-month period spanning 2002–2003 in any US county along the 650-mi section of the US–Mexican

border from Yuma County, Arizona, to El Paso County, Texas; their immigration status must have been determined to be unauthorized; and they must have been found to have died during transit from Mexico to the United States. We classified a decedent as "unauthorized" if the decedent was not identified as a legal resident of or an authorized entrant into the United States or was identified as a resident of another country by family members, friends, or officials or through sufficient circumstantial evidence found with the decedent. Such circumstantial evidence included tattoos, items found on or near the body, and documents such as birth and marriage certificates. Decedents were not included in the study if they were known to have resided illegally in the United States for more than a month before their death or if they were determined not to have died while crossing the border.

Medical examiners investigate deaths that are sudden, suspicious, violent, unattended, or unexplained.[18] From the medical examiner records, we were able to determine decedents' confirmed or probable cause of death, confirmed or approximate date of death, age, gender, race/ethnicity, country of origin, and, in some cases, results of toxicological tests for alcohol (ethanol). Medical examiners conclude that deaths are due to environmental heat exposure if they are able to exclude other causes of death at autopsy and find that circumstances support such a conclusion.[19] The body's degree of decomposition affected whether the medical examiners were able to list the cause of death as confirmed environmental heat exposure or as probable exposure.

Although most of the remains of the decedents included in the study were found in deserts, remote mountains, rivers, or canals or along the roadways or trails commonly used by migrants for unauthorized border crossings, some decedents died in a hospital or en route to a hospital. Estimated dates of death were based on circumstantial information and autopsy findings. Data were entered for computer analysis in MS Access (Microsoft Inc, Redmond, Wash) and analyzed with SAS (SAS Institute, Cary, NC).

TABLE 1—Characteristics of Migrants Who Died While Making Unauthorized Crossings of the US–Mexican Border Into Arizona, New Mexico, and El Paso County, Texas, 2002–2003

	Total (n = 409), No. %	2002 (n = 194), No. %	2003 (n = 215), No. %
Gender			
Male	298 (72.8)	145 (74.2)	154 (71.6)
Female	105 (25.6)	46 (23.7)	59 (27.4)
Undetermined	6 (1.5)	4 (2.0)	2 (0.9)
Ethnicity			
Hispanic	306 (74.8)	163 (84.0)	143 (66.5)
Other	2 (0.5)	...	2 (0.9)
Undetermined	101 (24.6)	31 (16.0)	70 (32.5)
Country of origin			
Mexico	235 (57.5)	127 (65.4)	108 (50.2)
Other than Mexico[a]	26 (6.3)	5 (2.6)	21 (9.8)
Undetermined	148 (36.2)	62 (32.0)	86 (40.0)
Age group, y			
0–9	3 (0.7)	1 (0.5)	2 (0.9)
10–19	44 (10.7)	24 (12.4)	20 (9.3)
20–29	122 (29.8)	63 (32.4)	59 (27.4)
30–39	91 (22.2)	49 (25.2)	42 (19.5)
40–49	47 (11.5)	23 (11.8)	24 (11.1)
50–59	13 (3.1)	7 (3.6)	6 (2.7)
≥60	2 (0.5)	0 (0.0)	2 (0.9)
Undetermined	87 (21.3)	27 (13.9)	60 (27.9)
Cause of death			
Heat exposure	149 (36.4)	83 (42.7)	64 (29.8)
Probable heat exposure	101 (24.7)	32 (16.4)	70 (32.5)
Vehicle crash	33 (8.1)	20 (10.3)	14 (6.5)
Drowning	24 (5.9)	11 (5.7)	13 (6.0)
Gunshot wound	9 (2.2)	4 (2.1)	5 (2.3)
Other	27 (6.6)	15 (7.7)	12 (5.6)
Undetermined	66 (16.1)	29 (14.9)	37 (17.2)
State/county			
Arizona	381 (93.1)	181 (93.2)	200 (92.8)
Pima	270 (66.0)	139 (71.6)	131 (60.9)
Cochise	75 (18.3)	28 (14.4)	47 (21.8)
Yuma	24 (5.8)	11 (5.7)	13 (6.0)
Santa Cruz	12 (3.0)	3 (1.5)	9 (4.1)
New Mexico	11 (2.7)	5 (2.5)	6 (2.7)
Texas (El Paso County only)	17 (4.1)	8 (4.1)	9 (4.2)

[a]Argentina, Brazil, Colombia, Costa Rica, El Salvador, Guatemala, Honduras, or Venezuela.

RESULTS

Of 430 potential cases selected by medical examiners, we identified 409 deaths that met the case definition. As shown in Table 1, decedents whose gender could be determined were 3 times more likely to be men (n=298; 72.8%) than women (n=105; 25.6%). Of the decedents whose ethnicity was known (n=308), 306 (99.3%) were Hispanic. The ethnicity of 101 (24.6%) decedents was undetermined. Of the 261 decedents whose country of origin was identified, 235 (90.0%) were citizens of Mexico, and the other 26 (10.0%) were from the Central or South

American countries of Guatemala (n=9), El Salvador (n=6), Brazil (n=5), Honduras (n=2), Argentina (n=1), Colombia (n=1), Costa Rica (n=1), or Venezuela (n=1).

The decedents were categorized in the age groups shown in Table 1. Of the 322 decedents whose age could be determined, 213 (66.1%) were between 20 and 39 years, and there were at least twice as many male decedents as female decedents in every age group. We were able to determine causes of death for 343 (83.9%) of the decedents (Table 1). Confirmed environmental heat exposure was listed as the cause of death for 149 (43.4%) of these decedents, and probable environmental heat exposure was listed for an additional 101 (29.4%). Together, confirmed and probable environmental heat exposure accounted for 250 (72.8%) deaths with determinable causes in 2002 and 2003.

Nine deaths (2.2%) were due to gunshot injuries that occurred during conflicts within or between groups involved in smuggling migrants or during encounters with border patrol agents; 7 deaths were due to environmental cold exposure; 6 deaths were due to cardiac-related causes; and 6 deaths were due to electrocution by lightning (all in a single episode). The cause of the remaining 16.1% of deaths was undetermined. However, 25.4% of bodies (n=104) were found in a skeletal, fragmented, or decomposed state that sometimes limited the ability of medical examiners to draw a conclusion about cause of death. A bivariate analysis of causes of death stratified by age and gender (Table 2) showed that deaths attributable to drownings and gunshots occurred exclusively among men, as did 85.3% of the deaths attributable to injuries from motor vehicle crashes.

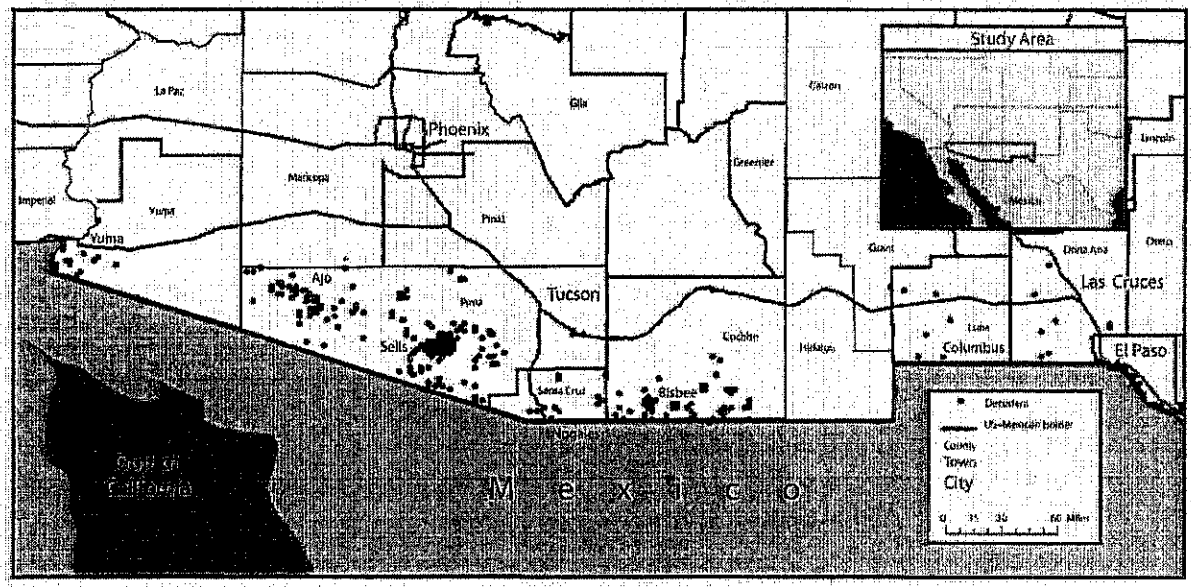
Decedents were found in all 4 Arizona border counties, 2 of the 3 New Mexico border counties, and in the only county examined in Texas. The majority were found in Arizona (n=381; 93.1%); of these decedents, 70.8% were found in Pima County and 19.7% in Cochise County (Table 1). Decedents found in New Mexico accounted for 2.7%, and those found in El Paso County accounted for 4.1%. Figure 1 presents a spatial representation of areas where decedents were found. Drowning deaths occurred exclusively in Yuma County, Arizona, and El Paso County, Texas, both of which share a water boundary with Mexico: the Colorado River in Yuma and the Rio Grande in El Paso.

Most bodies were discovered from May through September (Figure 2). However, because 25.4% of the bodies were decomposed, skeletonized, or fragmented when discovered, dates of discovery did not necessarily correspond to dates of death. The monthly number of deaths attributable to environmental heat exposure increased from May through September. Deaths due to environmental cold exposure showed a smaller peak in the winter months, whereas the monthly number of non-exposure-related deaths—those resulting from motor vehicle crashes, drownings, and gunshots—increased during the summer months in a pattern similar to that observed with deaths attributable to environmental heat exposure (data not shown). Numbers of undetermined causes of death exhibited 2 similar peaks, during midsummer and during early and midautumn (data not shown).

Only 72 (17.6%) decedents were known to have been tested for the presence of alcohol; of these decedents, 37 tested positive and 35 tested negative. The bodies of 28 (75.7%) of those decedents testing positive were moderately to severely decomposed. One of the by-products of decomposition is alcohol produced by alcohol-forming bacteria, and this could have caused the majority of alcohol-positive cases.

TABLE 2—Causes of Death Among Migrants Who Died While Making Unauthorized Crossings of the US–Mexican Border Into Arizona, New Mexico, and El Paso, Tex, Stratified by Age Group and Gender, 2002–2003

Age Group, y, and Gender	Exposure	Probable Exposure	Vehicle Crash	Drowning	Gunshot	Other Cause	Undetermined	Total No.
0–9								3
Male	0	0	0	0	0	2	0	
Female	0	0	1	0	0	0	0	
10–19								44
Male	11	4	7	0	1	3	2	
Female	7	5	2	0	0	0	2	
20–29								122
Male	38	18	11	6	6	6	7	
Female	15	12	1	0	0	0	2	
30–39								91
Male	14	18	6	6	1	6	8	
Female	19	10	0	0	0	0	3	
40–49								47
Male	16	13	1	4	1	5	1	
Female	3	2	0	0	0	0	1	
50–59								13
Male	2	4	1	0	0	3	1	
Female	2	0	0	0	0	0	0	
≥60								2
Male	0	1	0	0	0	0	0	
Female	0	0	1	0	0	0	0	
Undetermined age								87
Male	16	12	2	4	0	2	31	
Female	6	2	0	0	0	0	7	
Undetermined gender	0	0	0	4	0	0	1	
Total	149	101	33	24	9	27	66	409



Note. Dots represent locations where decedents were found during 2002–2003. Medical examiners' records provided specific longitude and latitude coordinates for 23.3% of cases and approximate locations for another 55.0% of cases. The dots shown thus represent 78.3% of all decedents found over this span of the US–Mexican border.

FIGURE 1—Locations of bodies of migrants who had attempted unauthorized crossings of the US–Mexican border, found during 2002 and 2003.

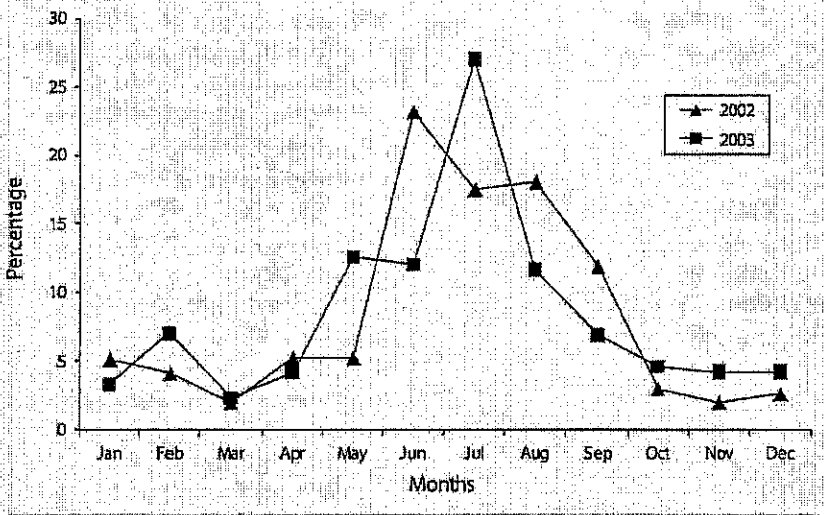


FIGURE 2—Percentages of decedents found each month of 2002 and 2003 who had attempted unauthorized crossings of the US–Mexican border, from Yuma, Ariz, to El Paso, Tex.

DISCUSSION

People who attempt an unauthorized northbound crossing of the US–Mexican border are at risk of dying from causes that are largely preventable. Most of the deaths found in this study occurred among young Mexican men. These deaths were detected most frequently in the summer and were most frequently due to environmental heat exposure. Most of the study area is desert, with average daytime maximum temperatures in May through September ranging from 90°F to 109°F (32°C to 43°C) in some areas of southern Arizona, from 81°F to 95°F in some areas of southern New Mexico, and from 87°F to 95°F in El Paso, Tex.[20–22]

It is unclear why deaths not related to environmental exposure also occurred more frequently in the summer months. Perhaps unauthorized migrants attempt to cross the border more often during the summer months because of economic factors (e.g., employment opportunities in agriculture) or the bodies of decedents are more likely to be discovered during these months. Although there is no data source available for determining the actual monthly number of migrants making unauthorized crossings, data are available on the number of apprehensions of unauthorized migrants. Because these data indicate that the number of apprehensions during the study period was highest during February and March,[15] the summer increase in the number of fatalities was probably a result of causes other than increased unauthorized traffic during these months.

We were unable to determine why fewer deaths were recorded in the border counties of New Mexico or in El Paso County, Texas,

than in Arizona. Where a death occurs is probably a function of numerous factors, including migration paths, economic conditions, border patrol pressure, geographic features, proximity to roadways, and climate. Southern New Mexico is generally cooler than southern Arizona because of the difference in elevation. Also, although we did not assess these factors, migrants' underlying health status and the supplies they carry might affect their risk of dying.

Because only 17.6% of decedents were tested for the presence of alcohol and because alcohol formed by bacteria during the process of decomposition was the probable source in the majority of those testing positive,[23–26] we were unable to determine the extent to which alcohol consumption contributed to the deaths of unauthorized migrants.

This is the first study, to our knowledge, in which medical examiner's data have been used to examine factors associated with deaths among unauthorized migrants. Although the protocol of medicolegal death investigations differs among jurisdictions, medical examiners' conclusions are generally based on an investigation of the circumstances of the death, autopsy results, and other laboratory findings, and medicolegal death investigations include an attempt to identify the decedent.

Previous studies examining the deaths of unauthorized migrants have involved other data sources such as the vital registration system[11] and Mexican consulates.[12] Although these alternate sources provide helpful information, they are limited. The information included in the vital registration system, which is based on death certificate data, is less detailed than that included in medical examiner records. Studies that have used vital registration system data have not included decedents with undetermined countries of origin. Data from Mexican consulates are not standardized, in that different consulates use different record-keeping systems. Furthermore, they document deaths only among Mexican nationals.

Several limitations of this study deserve mention. First, we did not include deaths among unauthorized migrants that occurred in California, in much of the Texas segment of the US–Mexican border, or on the Mexican side of the border. The distribution of causes of deaths at these other locations might differ from that reported here because of differences in geographic features or other variables. Second, the remains of some of the migrants who died in remote areas during the study interval might not have been discovered. Third, because there currently is no standardized practice for determining the immigration status of decedents, medical examiners might misclassify some unauthorized migrants as legal residents and some legal residents as unauthorized migrants.

Fourth, because the total number of people who make unauthorized border crossings is unknown, we could not calculate fatality rates. Although data are available on the number of apprehensions made by the US Border Patrol, these figures are underestimates of the true numbers of unauthorized northbound border crossings and depend on factors such as trends in border patrolling efforts in given periods. Finally, the date a decedent was discovered did not always correspond with the date of death; 25.4% of decedents' remains were skeletal, fragmented, or decomposed. The rate at which a human body decomposes and skeletonizes after death depends on the environment and can vary from a few weeks in summer to a few months in winter.[27] It is challenging to determine the cause of death, age, ethnicity, nationality, and sometimes gender of severely decomposed, skeletonized, or partial remains.

Unauthorized immigration is a complex sociopolitical issue. The success of efforts to prevent injuries and fatalities among unauthorized immigrants will depend in large part on the cooperative efforts of local, state, and international officials, including health and law enforcement officers on both sides of the border. We hope that the findings of this study will help these officials better understand the epidemiology of deaths among unauthorized migrants and provide information to better target susceptible individuals.

These officials should pursue both short- and long-term strategies for preventing deaths among unauthorized migrants, including preventing potential migrants from conceiving plans for unauthorized crossings (e.g., by conducting robust public awareness campaigns addressing the potential risks of such crossings). Our data suggest that young Mexican men and their family members would be appropriate targets for such a campaign. Secondary prevention strategies might include interventions designed to discourage use of dangerous entry points for unauthorized crossings (e.g., by posting warning signs). Tertiary prevention strategies could include enhanced search and rescue efforts to locate lost or injured migrants, especially during the summer months; however, officials should be cautious in using this strategy (or at least publicizing it), because it could have the unintended consequence of encouraging crossings by leading would-be migrants to feel confident that they will be rescued if they become lost or injured while attempting to cross the US–Mexican border.

A plan of action for the prevention of deaths among unauthorized migrants is already in place and has been endorsed by the governments of both Mexico and the United States.[28] Strategies recommended in the "Plan of Action for Cooperation on Border Safety" include alerting potential migrants to the dangers associated with unauthorized entries into the United States, implementing actions to keep them from entering high-risk crossing areas, enhancing search and rescue efforts to locate and rescue migrants in dangerous areas along the border, and increasing efforts to apprehend human smugglers and traffickers on both sides of the border.[28]

Because environmental heat exposure is the leading cause of death among unauthorized migrants attempting to cross the US–Mexican border, efforts to prevent deaths need to focus on this cause. The Border Safety Initiative, an operation of the US Border Patrol, has been instrumental in implementing the actions described in the Plan of Action for Cooperation on Border Safety on the US side and has been active in search and rescue efforts to locate and treat migrants in distress.[28,30] Personnel from the Border Safety Initiative have recently erected 30-ft (9-m) towers with strobe lights at several locations, which has helped substantially in these efforts.[31] By pressing a button on one of the towers, migrants in distress can send a signal to the nearest border patrol station.[31] Another intervention focusing on locating unauthorized migrants includes an unmanned aerial vehicle that flies along the US–Mexican border.[32]

Finally, there is a need for more consistency in the way in which deaths among unauthorized migrants are monitored. Current differences among jurisdictions impede efforts to measure trends or assess the effects of interventions. A standardized registry or a surveillance system would be useful toward this goal. Furthermore, the data collected through such a system would be valuable in measuring trends and assessing the effects of interventions. ■

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Note. The opinions expressed in this article are solely those of the authors and do not necessarily reflect those of the Centers for Disease Control and Prevention or other organizations/agencies for which we work.

Contributors

S. Sapkota and H.W. Kohl III originated and designed the study. J. Gilchrist, B. England, T. Flood, C.M. Sewell, D. Perrotta, and D. Zane provided valuable inputs. S. Sapkota led the field investigations with support from H.W. Kohl III, J. Gilchrist, B. Parks, B. England, T. Flood, C.M. Sewell, D. Perrotta, M. Escobedo, C.E. Stern, D. Zane, and K.B. Nolte. B. Parks, C.E. Stern, and K.B. Nolte provided local mortality data. All authors contributed to data interpretation, and the writing and revising of the article.

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