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Emergency Department Use in the US-Mexico Border Region and Violence in Mexico: Is There a Relationship?

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Abstract

Purpose—This study assessed the association between homicide rates in northern Mexico and potentially avoidable use of emergency departments (ED) in the US-Mexico border region. The border region is largely rural and underserved, making the identification and correction of potential barriers to access crucial.

Methods—We used secondary data from state inpatient and ED discharge databases for California and Arizona for 2005–2010. A retrospective observational analysis using generalized linear models was used to determine whether the probability that an ED encounter was potentially avoidable was associated with homicide rates in the nearest Mexican municipality. To conduct the analysis, the location of ED encounters were identified and matched with homicide rates in the nearest Mexican municipality and regional characteristics. The probability that an ED encounter was potentially avoidable was calculated using the Billings ED algorithm.

Findings—We found that 77% of ED encounters were potentially avoidable, with a higher percentage in border counties. There was no statistically significant relationship between homicide rates and the probability that an ED encounter was for a potentially avoidable condition for the full analytic sample ($n = 24,859,273$) and the uninsured and underinsured in the sample ($n = 11,700,123$).

Conclusion—A substantial majority of ED encounters in the US-Mexico border region were potentially avoidable. However, there was not a strong relationship between homicide rates in northern Mexico and the distribution of ED discharges in Arizona and California. Given the large percentage of potentially avoidable ED encounters and the ongoing violence in Mexico, continuing to monitor this relationship is important.

Keywords

access to care; emergency department utilization; medically underserved areas; social determinants of health; US-Mexico border region

Residents of the US-Mexico border region of the United States, defined as those counties within 100 km of the border,¹ face a number of challenges. They have lower income, are less educated, and have higher rates of uninsurance than the rest of the US population.^{1–3} Furthermore, the area is rural and underserved; 73% of the border counties are Medically Underserved Areas.⁴ Previous research has shown that a large proportion of people residing in the border region access outpatient care in Mexico. Border crossing prevalence estimates vary widely from 11% to greater than 50% of the population.^{5–7} In 2008, population representative estimates from the Texas border region showed that 37% of adults had seen a provider in Mexico and 43% had purchased pharmaceuticals in Mexico in the prior year.⁸ Border crossing for health care is more common among, but not limited to, the uninsured, lower-income households, the nonelderly, and Hispanics.^{5–7} Individuals seek this care due to significantly less expensive provider options in Mexico, cultural preferences, and dissatisfaction with the US health care system.^{6,8–11}

Beginning in late 2006, violence in Mexico increased rapidly, particularly in the northern border region adjacent to the United States. In Baja California, the state adjacent to the majority of California, homicide rates increased more than 300% between 2005 and 2010.¹² Figure 1 shows the crime rates of the 11 municipalities that are closest to observed emergency department (ED) visits,ⁱ showing substantial variation in crime rates during this period across both place (municipality) and time. Notably, research has shown that the violent crime rates on the US side of the border did not increase, with little to no evidence of spillover violence from Mexico into the United States.¹³ Border crossing for health care may be sensitive to changes in crime rates for several reasons—increased risk of violence, reduced supply of Mexican health care providers, and increased border security leading to longer travel time. This increase in the “cost” decreases the appeal of border crossing for health care. Because such a large proportion of this vulnerable population has depended on border crossing for its health care needs, the resulting decrease in crossing may lead to lower access to primary health care services. This, in turn, may lead to an increase in preventable ED use due to exacerbated conditions. Previous research on the association between violence in Mexico and health care access in the US-Mexico border region has found limited effects of violence on self-reported health care access, but it did find that there were negative effects on hospitalizations for ambulatory care-sensitive conditions.^{14,15} This suggests that small but significant changes to health care access, particularly outpatient care, were happening in the border region during this period.

In this study, we investigate whether the increase in violence in Mexico led to increased rates of preventable ED visits in Arizona and California, particularly in border counties. ED care is a critical component of health care access, particularly among low-income populations,

ⁱForty-four ED visits matched to Juarez, Chihuahua. Due to the very small number, homicide rates for Juarez are not shown.

and studying the effects of violence on changes in preventable ED visits can provide further evidence on the effects of disruptions in outpatient access on ED care. Previous work has found that reduced access to ambulatory health care is associated with increased use in higher-cost settings, particularly in rural areas. For example, rural counties without Community Health Centers have higher preventable ED use¹⁶ and ambulatory-sensitive hospitalizations.¹⁷ Because residents of the border region are less likely to have a usual source of care,¹⁸ disruptions to their existing providers may leave them with few alternative options.

Background

EDs, which serve as the “safety net of the safety net” for patients who are uninsured or lack access to community services,¹⁹ are increasingly overburdened. Visits increased at more than twice the rate of population growth between 1997 and 2007, with nonelderly adults on Medicaid accounting for a large proportion of the increase.²⁰ A significant proportion of ED visits are for conditions that could be treated in a primary care setting.²¹ The ED may act as a primary care provider, particularly for the uninsured or Medicaid beneficiaries, due to low access to outpatient care;^{19,21,22} lack of access to ambulatory care can also exacerbate conditions to the point that the patient requires ED care.²³ Many of these visits could be treated at a lower cost in an outpatient setting.^{19,24}

Methods

Data and Analytic Sample Construction

Inpatient and ED discharge databases from Arizona and California were used to identify ED encounters for patients aged 18 to 64 years discharged between January 1, 2005, and December 31, 2010. We focused on adults in this age group as they were expected to be more sensitive to changes in access to care in Mexico. The data for Arizona were from the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality.^{25,26} Data for California were from the State of California Office of Statewide Health Planning and Development.^{27,28} These data included all ED encounters, including those resulting in a hospital admission in the same hospital as the ED where the patient initially presented. The data contained limited patient demographic data (eg, age, gender, ZIP code/county of residence) as well as *International Classification of Diseases, Ninth Edition, Clinical Modification* (ICD-9) codes for the ED encounter. The data did not have reliable race or ethnicity indicators.

We excluded records if key data were missing: patient age, patient gender, primary payer, primary diagnosis code, discharge quarter, and location of patient residence (used to determine the homicide rate of the nearest border crossing and socioeconomic characteristics). Missing age, gender, and patient residence were mostly a result of censoring in the California data to protect patient confidentiality based on administrative rules. We excluded ED encounters by patients not residing in the same state as the ED facility. As the California discharge data included only discharge quarter, rather than discharge month, we conducted analyses using quarterly homicide and unemployment rates for both Arizona and California.

We used the ED algorithm developed by Billings²⁹ and validated by Ballard et al³⁰ to classify ED encounters using the primary diagnosis code. The algorithm assigned the probability that the encounter was in each of 4 categories: nonemergent (NE); emergent, primary care treatable (EPCT); emergent, ED care needed, preventable or avoidable (EDCNPA); and emergent, ED care needed, not preventable or avoidable (EDCNNPA). Table 1 presents sample diagnoses. For example, the algorithm classifies hypovolemia (ICD-9 276.5) as being 10.5% EPCT and 89.5% EDCNPA; appendicitis (ICD-9 541) was 100% EDCNNPA; sunburn (ICD-9 692.71) is 100% NE; urinary tract infection (ICD-9 599.0) is 46% NE, 30% EPCT, and 24% EDCNPA. Encounters containing diagnosis codes related to injury, mental health, alcohol, or drugs (excluding alcohol) were excluded from the sample. Encounters with a primary diagnosis code not classified by the algorithm were excluded from the sample.

Outcomes and Covariates

As the primary outcome measure, we calculated the probability that the ED encounter was for a condition that was either nonemergent, treatable in a primary care facility, or preventable by summing the NE, EPCT, and EDCNPA probabilities calculated by the algorithm (Table 1). We termed this the probability of being a “*potentially avoidable*” ED encounter. We also calculated the probability of the encounter being for a condition that did not require care in the ED; this was the sum of the NE and EPCT categories from the algorithm and indicated that the condition did not require treatment in an ED.

The primary independent variables of interest were whether or not the ZIP code of patient residenceⁱⁱ was in a border county (ie, counties within 100 km of the US-Mexico border) and the homicide rate in the nearest Mexican municipality. The nearest Mexican municipality was adjacent to the closest legal border crossing to the resident’s ZIP code. Distances were calculated using Google maps.³¹ Quarterly homicide rates were calculated using monthly data on homicides from the Mexican National Institute of Statistics and Geography (INEGI; Instituto Nacional de Estadística y Geografía).^{12,32} Population denominators were obtained from the INEGI from national censuses in 2005 and 2010; populations for the years in between were estimated using linear interpolation.³²

Other covariates included patient information from the ED encounter data including age category (18–34 years, 35–64 years), sex, state of residence, and primary payer. Patient socioeconomic status was based on the ZIP code of residence and included county-level unemployment rates,³³ 2008 ZIP code-level income quartile calculated using median household income for the 4 states in the US-Mexico border region,³⁴ residence in a metropolitan area,³⁵ and physician supply as measured by the number of physicians per 1,000 population.³⁶

ⁱⁱThe majority (97%) of ED encounters were matched based on the 5-digit ZIP of patient residence. For encounters that did not have valid 5-digit ZIP information, we matched based on 3-digit ZIP or county of residence as available. For simplicity, we refer to patient residence at the 5-digit ZIP level.

Statistical Analyses

We estimated the relationship between the probability that each discharge was for a potentially avoidable condition and a vector of covariates including patient demographic and socioeconomic information as well as regional characteristics. The empirical model was specified as

$$Pr(Potentially\ Avoidable_{ezst} = 1) = f(\beta_0 + \beta_1 H_{zst} + \beta_2 Border_{zs} + \beta_3 (H_{zst} * Border_{zs}) + \beta_4 X_{ezst} + \beta_5 Z_{zst} + \mu_s + q_t + y_t) \quad (1)$$

where the outcome, $Pr(Potentially\ Avoidable)$, was a probability between 0 and 1. To estimate this equation, we used a generalized linear model with a logit link with a binomial distribution of the error term. The subscript e represented the ED encounter, z the patient ZIP code of residence, s the patient state of residence, and t the quarter in which the encounter occurred. H was the quarterly homicide rate for the matched Mexican municipality, $Border$ an indicator of whether the patient residence is within a border county, X a vector of patient characteristics (age, sex, primary payer), and Z a vector of ZIP and county characteristics (unemployment rate, physician supply, metropolitan status, and income quartile). State, μ , quarter, q , and year, y , fixed effects were included to control for state-level characteristics, seasonality, and secular time trends, respectively.

To account for serial correlation, we calculated standard errors, allowing clustering at the county quarter-year level (eg, Los Angeles County for quarter 1, 2007). To determine whether any changes in the distribution of ED use was due to substituting care in a US ED for care in Mexico versus forgoing care in Mexico (resulting in a higher use of emergent but preventable ED care), we separately estimated equation (1) with the probability of a visit not requiring use of the ED and the probability of the visit being in the EDCNPA category. For the primary association of interest, we calculated marginal effects in border and nonborder counties.

Because the uninsured were more likely to be affected by changes in access to outpatient care in Mexico, we conducted a subgroup analysis of those who are uninsured and underinsured (ie, encounters with the primary payer of self-pay, charity care, no charge, or Medicaid). Medicaid encounters were included as patients may be retroactively insured in Medicaid after a hospital visit;³⁷ additionally, interruptions in Medicaid coverage are common.³⁸ We did not separate the effects for Medicaid and uninsured individuals because there may be differential enrollment in Medicaid based on the type of ED encounter. For example, if an individual presented at the ED with an EDCNPA condition and was subsequently admitted, the hospital would have incentive to assist in enrolling the patient in Medicaid retroactively to collect payment for the inpatient stay. If an individual presented at the ED with an NE condition and was quickly discharged, the hospital has little financial incentive to assist with Medicaid enrollment.

We compared descriptive statistics for ED encounters in border and nonborder counties using chi-square statistics for binary variables and t tests for continuous variables. An alpha of 0.05 was considered statistically significant. Dataset construction and application of the

ED algorithm were conducted using SAS 9.2 (SAS Institute Inc., Cary, North Carolina); regression analyses used Stata 12.1 (StataCorp LP, College Station, Texas).

Results

Descriptive Statistics

A total of 24,859,273 ED encounters were included in the final analytic sample (Figure 2). On average, the Billings algorithm assigned a probability of 0.767 of being potentially avoidable. Twenty-seven percent of encounters were for patients residing in a border county (Table 2). Encounters were more likely to be for female patients, younger (age 18–34 years) patients, and patients with private insurance as the primary payer. The majority (97%) of ED encounters in border counties was in California. ED encounters in border counties were less likely to be covered by Medicaid, and they were more likely to be self-pay or uninsured. Encounters in border counties were more likely to be potentially avoidable and less likely to result in a hospital admission. Eighty percent of ED encounters were matched to the Tijuana municipality, indicating that the majority of variation in homicide rates is over time rather than across geographic regions. Eleven percent of ED encounters resulted in an inpatient admission. The exclusion restrictions resulted in slightly more encounters in nonborder counties being excluded from the samples than border counties; 25.4% of encounters classified by the algorithm with any location information were in border counties compared to 26.7% of encounters in the final analytic sample. Since missing data on age and gender were primarily censored for administrative reasons, we did not anticipate it would be related to homicide rates and thus concluded it was not likely to impact the results.

Statistical Analyses

The estimated probability of an ED encounter being potentially avoidable was positively associated with the homicide rate in the nearest Mexican municipality in border and nonborder counties, although the effect was only statistically significant in nonborder counties (Table 3). The probability of an ED encounter being potentially avoidable was also positively associated with being in the younger age category, being in the lowest income quartile, residing in a nonmetropolitan area, and being female. Having a primary payer of self-pay/uninsured was associated with a lower probability of the ED encounter being for a potentially avoidable condition than being privately insured.

When separating potentially avoidable ED encounters into those that did not require ED care and those that were emergent but preventable, we found the probability of an ED encounter being for a diagnosis that did not require ED care was not significantly associated with the homicide rate in either border or nonborder counties. The probability an encounter was for a diagnosis that was emergent but preventable was again not significantly associated with homicide rates in border counties (Table 3).

Subgroup Analysis

We repeated the main analysis for uninsured and underinsured patients and found that the results were similar in direction and magnitude (Table 4). There were slight differences in the statistical significance of the results—the only relationship that was statistically

significant in the uninsured and underinsured subsample was a positive relationship between homicides and the probability of the visit being unnecessary (whether defined as “potentially avoidable” or “ED care not needed”) in nonborder counties.

Discussion

Using a measure of the “potential avoidability” of an ED encounter, we found no association between homicide rates in the nearest Mexican municipality—a proxy for the location of care should a patient opt to seek care in Mexico—and whether an ED encounter was avoidable in border counties. When we separated potentially avoidable encounters into those not requiring ED treatment and those that were emergent but preventable, we found weak evidence in support of an association between increased violence in northern Mexico and substitution of US ED care for acute care in Mexico, although none of the results were statistically significant. Furthermore, the effects observed were very small, with a 1-SD increase in the homicide rate in border counties associated with a 0.0013 increase in the probability that the encounter was for a potentially avoidable condition, a 0.17% increase from the mean probability.

Looking specifically at the uninsured and underinsured, who may be more likely to seek care in Mexico, we found that in border counties, homicide rates were again not associated with the probability of the ED encounter being potentially avoidable or the probability that ED care was not needed in border counties. The effects were still small, with a 1 SD in the homicide rates in border counties associated with a 0.002 increase in the probability the encounter was for a potentially avoidable condition and a 0.003 increase in the probability the encounter was for a condition for which ED care was not needed, which was a 0.23% increase and a 0.42% increase from the mean probability for the full sample, respectively.

The use of the ED algorithm to measure changes in access to care is debated in the academic literature. Although the algorithm has been validated as a predictor of hospitalizations and death for a sample that was primarily covered by commercial insurance,³⁰ some have found that it is a less sensitive measure than a simpler measure of access to care.^{39,40} Others have found, however, that the algorithm can be used to detect changes in ED use with changes in insurance status and rates^{41–45} and the presence of community health clinics¹⁶ or free health clinics.⁴⁶ As the effect of homicides on health care access is relatively small as evidenced by other studies,^{14,15} it may be the case that this measure of access is not sensitive enough to detect any changes in access to care in Mexico. This study, combined with results from prior studies that found no change in access to care based on self-reported measures but did find changes in access measured by ambulatory care-sensitive conditions, suggests that there may be some substitution of ED care in the US for acute care in Mexico, and that there may be delays in care that lead to treatment in the ED or an inpatient admission as an ambulatory care-sensitive condition.

There were several limitations to this analysis. The primary limitation was due to censoring in the California data; with information on the timing of the encounter limited to quarterly information, we are unable to more precisely match the timing of the ED encounter with the homicide data. Additionally, due to censoring of demographic data, 4.5% of the original

sample was excluded due to missing age. Of those patients aged 18 to 64, 7.2% were excluded due to missing gender, missing location information, the ED facility being in a different state than that of patient residence, or several other reasons. Although the censoring was based on administrative rules and was thus not likely to be related to the independent variables of interest, if rates of ED use changed significantly, the amount of censoring would change as well, as the reason for censoring is to ensure that observations are not individually identifiable. This censoring also limited our ability to calculate changes in total ED usage rates over time. As the majority of our data were from California ED encounters, these limitations may have a consequential effect on results. However, there was no obvious reason that censoring would be systematically related to homicide rates and/or border status, so the bias was likely small, if at all.

As the discharge data do not include patient identifiers, we were not able to account for the correlation in error terms for individual patients seen in the ED multiple times during the period. There may also have been compensatory responses on the US side of the border. For example, if public health clinics in border counties offered more free services to the uninsured in response to reduced ability to receive care in Mexico, this would offset the effect of violence from both an (unmeasured) empirical perspective and a policy perspective. It is possible that the effect was modified by patient-level factors (such as number of chronic conditions or frequency of visits across the border for nonmedical reasons); these data were not available.

In this sample, we saw that a large percentage of the ED encounters over this time period were for conditions that were either potentially avoidable and/or did not require care in the ED. Reducing unnecessary ED care is an important policy priority to reduce health care costs in the United States, and it is of particular importance in rural areas.^{19,24,47} Although it does not appear that ED encounters were strongly impacted by the increased violence in Mexico during this time period, it is important to monitor ongoing changes in access in this border region.

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Figure 1.
Homicides in Matched Mexican Municipalities.

Figure 2.
Construction of Analytic Sample.

Table 1

Categorizations of Sample Diagnoses by Billings ED Algorithm

Algorithm Category		Hypovolemia (ICD-9 276.5)	Appendicitis (ICD-9 541)	Sunburn (ICD-9 692.71)	Urinary Tract Infection (ICD-9 599.0)
Potentially avoidable ED	Did not require ED	Nonemergent		100.0%	46.0%
		Emergent, primary care treatable			30.0%
		Emergent, preventable			24.0%
		Emergent, not preventable	100.0%		
		Potentially avoidable ED	100.0%	100.0%	100.0%
		Did not require ED	10.5%	100.0%	76.0%

Table 2

Descriptive Statistics for ED Encounters in Arizona and California (2005–2010)

	Patient Residence in Border County			<i>P</i>
	Overall (<i>N</i> = 24,859,273)	Border County (<i>N</i> = 18,216,347)	Nonborder County (<i>N</i> = 6,642,926)	
	Mean (SD) or %			
Potentially avoidable ED visit (continuous)	0.767 (0.298)	0.768 (0.298)	0.765 (0.299)	<.001 ***
Visit not requiring ED care (continuous)	0.660 (0.308)	0.660 (0.309)	0.662 (0.306)	<.001 ***
Homicide rate per 100,000 population in matched municipality (quarterly)	4.079 (4.567)	3.662 (2.897)	5.223 (7.297)	<.001 ***
Patient state of residence				<.001 ***
Arizona	18.2	3.4	58.8	
California	81.8	96.6	41.2	
Patient gender				<.001 ***
Male	38.7	38.9	38.1	
Female	61.3	61.1	61.9	
Age category				<.001 ***
18–34 years	51.6	50.6	54.2	
35–64 years	48.4	49.4	45.8	
Primary payer				<.001 ***
Medicare	7.8	7.8	7.8	
Medicaid	27.7	26.8	30.1	
Private insurance	38.1	38.3	37.5	
Self-pay/uninsured	18.8	19.3	17.4	
No charge	0.6	0.7	0.5	
Government	2.4	2.6	1.7	
Other	4.7	4.5	5.1	
Patient discharged from ED after inpatient stay	11.1	10.7	12.5	<.001 ***
County unemployment rate (quarterly, %)	7.990 (3.885)	8.227 (3.658)	7.338 (4.382)	<.001 ***
Income quartile of patient residence (5-digit ZIP)				<.001 ***
0 to 24th percentile (less than \$48,850)	19.5	19.0	20.7	
25th to 49th percentile (\$48,850–\$63,953)	25.8	25.1	27.9	
50th to 74th percentile (\$63,954–\$88,000)	30.6	28.6	35.8	
75th to 100th percentile (\$88,001 and greater)	24.1	27.3	15.6	
County physicians per 1,000 population	2.415 (1.040)	2.526 (1.100)	2.110 (0.777)	<.001 ***
Metropolitan county	95.9	95.2	97.6	<.001 ***

P values by *t* test for continuous variables and chi-square test for binary/categorical variables.* *P* < .05,** *P* < .01,

 $P < .001$.

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Table 3

Estimation Results for Full Analytic Sample

	Potentially Avoidable ED Encounter	ED Care Not Needed	ED Care Needed for Preventable Condition
Marginal effect of homicide rate in border county on estimated probability of outcome	0.0004526 (0.0006514)	0.0009527 (0.0009878)	−0.0005383 (0.0003774)
Marginal effect of homicide rate in nonborder county on estimated probability of outcome	0.0010199 (0.0004179) *	0.0013064 (0.0005257) *	−0.0002582 (0.0002069)

N=24,859,273. SE clustered at the county quarter-year level are in parentheses. Controls for age category, sex, primary payer, residence in border county, county unemployment rate, income quartile, metropolitan area, physicians per 1,000 population, state of residence, and month and year fixed effects were included.

* $P < .05$,

** $P < .01$,

*** $P < .001$.

Table 4

Estimation Results for Sample of Uninsured and Underinsured Patients

	Potentially Avoidable ED Encounter	ED Care Not Needed	ED Care Needed for Preventable Condition
Marginal effect of homicide rate in border county on estimated probability of outcome	0.000607 (0.0005612)	0.0011328 (0.0008778)	−0.0005846 (0.0003645)
Marginal effect of homicide rate in nonborder county on estimated probability of outcome	0.0007526 (0.0004717)	0.0011533 (0.0005608) *	−0.0003548 (0.0002182)

N=11,700,123. SE clustered at the county quarter-year level are in parentheses. Controls for age category, sex, primary payer, residence in border county, county unemployment rate, income quartile, metropolitan area, physicians per 1,000 population, state of residence, and month and year fixed effects were included.

* $P < .05$,

** $P < .01$,

*** $P < .001$.