THE EFFECT OF CRIME IN MEXICO ON HEALTHCARE ACCESS AND UTILIZATION IN THE UNITED STATES-MEXICO BORDER REGION

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ABSTRACT

KIMBERLEY L. H. GEISSLER: The Effect of Crime in Mexico on Healthcare Access and Utilization in the United States-Mexico Border Region
(Under the direction of George Mark Holmes, PhD)

The United States (US)-Mexico border region is an important and understudied area for research on disparities in healthcare access, quality, and cost. There is a long history of crossing the border for healthcare, in which many US citizens and legal residents from the border region cross into Mexico for medical treatment and/or to purchase pharmaceuticals. Border crossing is common due to a low supply of healthcare services on the US side of the border, cultural preferences, dissatisfaction with care in the US, looser prescription requirements, and more affordable provider options. With increased violence in northern Mexico beginning in late 2006, it was not known whether patterns of border crossing had changed. No prior studies had addressed the impact of crime in Mexico on border crossing for healthcare, and it was not known whether people would continue crossing into Mexico for medical care, substitute care from Mexico with care from a US provider, or forego care altogether.

I used several data sources to measure the impact of the homicide rate in the nearest Mexican municipality on healthcare access for US residents. For each study, I used a difference-in-difference empirical approach, comparing high crime areas to low crime areas and border to non-border counties. In Study 1, I examined rates of total border crossing as measured by legal US entries from Mexico and found evidence that an increase in homicide rates was negatively associated with US entries. I did not find an association between homicide rates and self-reported

healthcare access in the four border states (Arizona, California, New Mexico, and Texas) as measured by self-reports of having a regular healthcare provider, needing medical care but not being able to access due to cost, and cervical/breast cancer screening. In Study 2, I examined the association between homicide rates and hospitalization for ambulatory care sensitive conditions in Arizona, California, and Texas. I found a positive relationship in border counties, indicating that individuals may be suffering from reduced access to ambulatory care in border counties with high crime rates in nearby Mexican municipalities. In Study 3, I examined the association between homicide rates and potentially avoidable emergency department encounters and did not find a statistically significant association.

Taken together, these studies indicate that although there may be some effect of crime in northern Mexico on healthcare access, the effect is likely small and difficult to measure using available secondary data sources.

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PREFACE

This dissertation is organized in a non-traditional format. The first chapter provides an introduction to the significance of the topic and the specific aims of the dissertation. Chapter 2 provides a brief literature review and a conceptual model for the study. Chapter 3 summarizes the results from qualitative interviews with stakeholders in the US-Mexico border region. Chapter 4, 5, and 6 are manuscripts for the three studies. These three studies are designed to stand alone as publishable manuscripts and thus have redundancies with other chapters. Chapter 7 provides a summary of findings, strengths and limitations of the studies, policy implications, and provides directions for future research.

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LIST OF ABBREVIATIONS

ACS – Ambulatory Care Sensitive Condition

ARF – Area Resource File

AZ – Arizona

BRFSS – Behavioral Risk Factor Surveillance System

CA – California

ED – Emergency Department

EDCNPA – Emergency Department Care Needed, Potentially Avoidable

EDCNNPA – Emergency Department Care Needed, Not Potentially Avoidable

EPCT – Emergent, Primary Care Treatable

ICD-9 – *International Classification of Disease, Ninth Edition*

INEGI – Instituto Nacional de Estadística y Geografía (Mexican National Institute of Statistics and Geography)

LPM – Linear Probabiity Models

MSA – Metropolitan Statistical Area

NE – Non-Emergent

NM – New Mexico

TX – Texas

US – United States

ZIP – Zone Improvement Plan

1. INTRODUCTION

I.A. Background

The United States (US)-Mexico border region is an important and understudied area for research on disparities in health care access, quality, and cost. The region has witnessed a rapid growth in population, with most residents being members of racial or ethnic minorities with low income and high rates of uninsurance.[1-3] Many US citizens and legal residents from the border region cross into Mexico for medical treatment and/or pharmaceuticals. Border crossing is common due to inadequate health care services on the US side of the border, cultural preferences, dissatisfaction with the US health care system, looser prescribing requirements, and more affordable provider options.[2,4-7]

Since 2006, violent crime related to drug cartels operating in northern Mexican states along the US border has increased rapidly; victims have included those not involved in drug trafficking.[8] I hypothesized that increasing crime in Mexico would increase the cost (both financial and non-financial) of crossing the border for health care and decrease the likelihood of seeking care in Mexico. I used variation in crime rates over time and geographic area to identify any effects of rising crime on health care access and utilization of US residents in the border region.

I.B. Overall Study Purpose and Approach

The three studies in this dissertation aimed to determine whether access to health services in the border region was compromised by violence, and if so, to quantify the effects. The central hypothesis was that increased crime in Mexico would lead to decreased border crossing (Aim 1),

decreased access to outpatient care (Aim 1), increased probability of ambulatory care sensitive (ACS) hospitalizations (Aim 2), and increased use of emergency department (ED) emergency department services for potentially avoidable conditions (Aim 3). The first study used administrative data on legal US entries and self-reported survey data on healthcare access. The second study relied on inpatient discharge data from three border states; the third study used this inpatient discharge data in addition to ED discharge data.

I.C. Specific Aims

To address the central hypothesis, I pursued three specific aims.

Aim 1: Estimate the impact of the homicide rates in Mexico on total border crossing and on the likelihood of reporting a personal healthcare provider for US residents. *The hypothesis was increased homicide rates would be associated with decreased total border crossing and decreased access to care for those in border counties, as measured by whether the respondent reported having one or more personal healthcare provider(s).* To measure changes in total border crossing, I used data from the Bureau of Transportation Statistics[9] from 2002 to 2010 to determine the association between homicide rates and legal US entries at land border crossings. To quantify effects on healthcare access, I used a difference-in-difference approach with reporting a personal healthcare provider as the outcome variable for the 2002 to 2010 period; this approach compared US regions where there is significant crime on the Mexican side of the border to US regions where crime is lower, and border counties to non-border counties. This empirical approach was designed to identify the causal impact of border crime on reporting a personal healthcare provider. The change in crime rates over time and across geographic space provided variation to control for existing differences in health care access. Data from the Behavioral Risk Factor Surveillance System (BRFSS) measured changes in reporting a personal

healthcare provider.[10,11] Government homicide statistics from Mexico were used to calculate homicide rates.[12,13] As sensitivity analyses, I also explored changes in sample composition over time and the relationship between reporting a personal healthcare provider, individual characteristics, and seeking healthcare in Mexico.

Aim 2: Estimate the impact of homicide rates in Mexico on inpatient hospital utilization for ambulatory care sensitive (ACS) conditions. *The hypothesis was increased homicide rates in Mexico would be associated with increased use of inpatient care in the US for ACS admissions for patients residing in border counties.*

This aim relied on the variation in crime over time and geographic region as described above to identify the effect of increased crime on ACS admissions as compared to a set of marker conditions (i.e., conditions that are not sensitive to changes in access). I used inpatient data from Arizona, California, and Texas for 2005-2010 and identified discharges that were for either an ACS or marker condition.[12-15] I used a method designed by Basu et al (2002)[16] that did not require the use of population rates to determine whether there was an association between an increased likelihood of a discharge being for an ACS versus marker condition and homicide rates. A rise in the likelihood of the discharge being for an ACS condition associated with homicide rates was expected to be an indicator of reduced access to primary care or reduced compliance with prescription regimens due to a decreased ability to receive these services in Mexico.

Aim 3: Estimate the impact of homicide rates in Mexico on ED use for preventable conditions, particularly for uninsured and underinsured populations. *The hypothesis was increased homicide rates in Mexico would be associated with increased use of the ED for*

potentially avoidable conditions for patients residing in border counties, particularly those who are uninsured or on Medicaid.

Using data on ED encounters in Arizona and California, including those that resulted in an inpatient admission,[12,13,17,18] I used a difference-in-difference strategy to estimate the effects of homicide rates in Mexico on the probability that an ED encounter was for a condition that was potentially avoidable. ED encounters were classified using an algorithm that calculated the probability that the treated condition was potentially avoidable – that is, either non-emergent, treatable in a primary care setting, or required ED care but was preventable with access to primary care.[19] For subgroup analyses, I focused on the uninsured and underinsured as these are the populations that may be principally impacted by any changes to access in Mexico. Some studies have found that access to primary care [20-22] and continuity of care [23] are important factors in preventing ED use.

I.D. Summary and Significance

This study was significant because it used population level access and utilization data to determine any effects of rising crime in Mexico on overall health care access for US residents. The objectives were policy relevant because the US health care system may need to adjust to new patterns of usage in this border region to improve health care access and utilization patterns. If violent crime in Mexico is sustained at or above current levels for an extended period of time, and this crime causes people to reduce their use of care in Mexico, specific policy responses may need to be explored. Increased preventable hospitalizations or ED use as a result of rising crime might suggest that more cost-effective ways of improving population health are available, including expanding access to low-cost services at outpatient clinics serving the border population

2. LITERATURE REVIEW AND CONCEPTUAL MODEL

I.A. Background on the US-Mexico border region

Rapid growth in the number of individuals living along the United States (US)-Mexico border has brought attention to concerns about this population's health and health care access.[1-3] The US portion of this region is defined as counties within 100 km (62 miles) of the US-Mexico border [3] and extends approximately 2,000 miles from San Diego, California to Brownsville, Texas (Figure 2.1). Border areas have high rates of disease and inadequate health services.[7] Residents have high levels of obesity and diabetes; the self-reported prevalence of diabetes in the border region was 16.1 percent [3] compared to 11.3 percent nationally.[24]

Almost half of the population in the border region is Hispanic (49% in 2000), mostly of Mexican origin. Additionally, the area includes relatively large populations of American Indians, particularly in Arizona and New Mexico.[3] The border region has a predominately low-income population – in 2007, the per capita income in border counties was about two-thirds that of the border states or the US population. Almost twice as many people live below the poverty line in border counties compared to the general US population.[25] This population also has relatively low rates of insurance – 23 percent of the population in the border region was uninsured, as opposed to 15 percent nationally.[25] Further, ratios of health professionals to the population are generally significantly lower than for the US as a whole; for example, the physician to population ratio in Texas is less than 40% of the ratio for the US.[3]

I.B. Border crossing for healthcare

As a result of low priced provider options and looser prescribing requirements in Mexico, dissatisfaction with the US healthcare system, and cultural preferences,[2,4-6] many US citizens and legal US residents living near the border in Arizona, California, New Mexico, and Texas cross into Mexico for medical treatment or to purchase pharmaceuticals. Cost is a particularly important reason that people choose to seek care in Mexico, with those who could not afford to see a doctor due to cost significantly more likely to seek alternatives to formal care in the US.[26]

The availability of cross-border health care has both positive and negative aspects. The population has access to a second health care system, which may allow use of necessary health services and compliance with recommended prescription regimens. However, patients may be more likely to receive duplicate tests or experience undesirable medication interactions due to having a provider both in the US and in Mexico.[1,2,6] The intersection of a confluence of factors, including easy access to services in Mexico and "informal" health services to substitute in place of formal US healthcare, may make efforts used nationally to increase healthcare access more complicated in the border region.[26]

Recent studies of the rates of border crossing to seek medical treatment find estimates ranging from 11% to greater than 50% of the population in border regions.[2,4-6,10,27,28] The most recent published study of rates of border crossing for healthcare in a population based study conducted by telephone are from early 2008; they showed that in Texas border counties, over a third had crossed into Mexico in the previous year for either a doctor's visit (37%) or medication purchases (43%).[6] A question in the Texas BRFSS in 2007 asked survey respondents in border counties whether they had used services in Mexico in the prior year; 22% reported seeking health

care while 38% reported purchasing pharmaceuticals in Mexico (author's calculations from Texas BRFSS 2007).[10]

Border crossing is more common among the uninsured, low-income households, the non-elderly, and those of Hispanic ethnicity[1,2,27]. Bastida and colleagues (2007) found that very low income households (<$7,000 per year) were less likely than all other income groups to have visited a doctors in Mexico; many of these households reported Medicaid coverage or the use of free or reduced cost medical assistance or the emergency department in case of an emergency.[1] Border crossing was more than twice as likely among the uninsured as people with some insurance coverage.[1,6] Acculturation also matters, with first-generation Mexican Americans being more likely to use care in Mexico than later-generation Mexican Americans even after controlling for insurance coverage, demographic, and socioeconomic factors.[29] Using the 2001 California Health Interview Survey, Wallace et al. (2009) showed that in California long stay Mexican immigrants (>15 years in the US) were most likely to use services in Mexico, followed by short stay Mexican immigrants, US born Mexican-Americans, and then US born non-Latino whites.[30] For Mexican immigrants, care in Mexico provides an important safety net if they encounter accessibility or acceptability barriers in the US.[30] Despite the common use of care in Mexico, US residents are unlikely to access care in Mexico for major health emergencies.[2,6,31]

I.C. Increased violence in northern Mexico

With the election of President Felipe Calderón in 2006, the Mexican government initiated a crackdown on drug trafficking organizations. These organizations have struggled against both the government and rival organizations for control over the trafficking routes. This struggle has resulted in a sharp increase in killings of members of these organizations as well as of innocent bystanders. Reports of the violence indicate that since 2006, large firefights frequently take place

in towns and cities, particularly along the northern border of Mexico, often in broad daylight in public venues.[8,32] Trends in violence have varied geographically, intensifying much more quickly in some areas than others. For example, in the Mexican state of Sonora (adjacent to Arizona), the number of homicides increased 151% between 2005 and 2010, while in the Mexican state of Chihuahua (containing Ciudad Juarez, adjacent to El Paso, TX) the number of homicides increased 830% in the same period.[33,34] The absolute homicide rates along the Mexican side of the border were extremely high, both relative to the Mexican interior and to the US. In 2010, the rate of homicides per 100,000 population in Chihuahua was 183.[33,34] For comparison, in 2010, rates for all of Mexico was 22.2 homicides per 100,000 population.[33,34] The rate for the US in 2009 was 5.0 homicides per 100,000 population.[35] It appears that there was little to no spillover of the violence from Mexico into the US. A recent report from the Government Accountability Office interviewed officials from state and local law enforcement officials in border regions and 31 of 37 officials interviewed said that they had not observed violence from Mexico within their counties.[36] Additionally, rates of violent crimes decreased in border and non-border counties between 2004 and 2011, with rates lower in border counties than non-border counties.[36]

The sudden spike in violence made this problem an interesting natural experiment to analyze the effect of rising crime on access to healthcare for US residents. Since the increase in violence was unexpected, US residents may not have not had time to adjust their health care utilization patterns to adjust for any sudden decreases in access to Mexican providers. The crime increase was a sudden, random shock to factors influencing healthcare access patterns, allowing for identification of effects. Since violence in the region continues even now (in 2013), any changes due to increased crime may continue to have a significant impact on the US health care

system in the border region looking forward. Having an estimate of the impact may be important to find timely policy solutions.

I.D. Estimates of impact of violence on healthcare available in Mexico

Significant anecdotal evidence of reduced crossing for healthcare exists, but there have not been any academic studies attempting to quantify the effect of the violence on border crossing or healthcare access.[37-39] In 2010, the president of the Medical College of Tijuana estimated there was a 50% decline in border crossing for healthcare by Americans to Mexico due to fear and increased border wait times due to stricter security checks.[40] In a qualitative study of HIV positive patients seeking care in El Paso clinics, Shedlin et al (2012) found that decreased ability to cross the border due to violence and increased wait times and border security served as barriers to care.[41] Goldenberg et al (2011) conducted a study examining HIV risk among clients of female sex workers and noted through their field observation in 2008 that the proportion of foreign visitors to Tijuana's red light district declined with escalating violence along the border.[42] Homedes (2012) noted that if there was a reduction in crossing the border for healthcare, it may be that the uninsured who need care continue to seek it in Mexico, but choose providers closest to the border to avoid the danger as much as possible.[38]

The supply of doctors in northern Mexico, which has traditionally been high relative to the Mexican interior, has been compromised by violence as doctors are targeted in kidnappings. An estimated 30 to 50% of private clinics and pharmacies have closed in Juarez and Tijuana;[38,40] official statistics from the government or medical associations are not collected.[40] Additionally, by early 2010, the Mexican Chamber of Commerce estimated that 10,000 small businesses had closed in Juarez as extortion attempts and other types of crimes became more prevalent.[43]

The focus of this study is on those living in the US, although it should be noted that several studies have looked at the health related impacts of the drug-related violence on people living in the border region in Mexico. Beletsky et al (2012) study female sex workers who are also injection drug users in Tijuana and Juarez and found that respondents in Juarez, which had a higher police and military presence, reported significantly higher levels of police abuse including confiscation of syringes, requests for free sexual services, robbery, and financial extortion.[44] Qualitative research of families of young children in Juarez by Hernandez and Grineski (2012) found that social and economic capital declined significantly because of the violence, with decreased opportunities to gain cultural capital.[37] Leiner et al. (2012) found children's exposure to poverty and collective violence in Juarez was associated with higher scores of psychosocial and behavioral problems than exposure to poverty alone in El Paso.[45]

I.E. Conceptual model

The conceptual model for this study (Figure 2.2) theorized that individual, household, and regional characteristics influenced border crossing. Border crossing for healthcare is a subset of total border crossing; as the percentage of crossings for the specific purpose of obtaining healthcare was not available in existing data sources, I was not able to test empirically whether this association changes over time. I was unable to find estimates of the percentage of border crossings that were for health care during this period or for the border region as a whole; the most recent estimate available was that 4.2% of the monthly border crossings in the San Diego-Tijuana region were health related in 1999 [46].

Individual, household, regional, and health system characteristics were hypothesized to influence total border crossing, border crossing for healthcare, and healthcare access measures.

Fluctuations in violence may cause changes in the level and intensity of border crossing, including crossing for healthcare services; this may be associated with changes in health care access and utilization (including care obtained both in the US and in Mexico). Several factors related to violence in Mexico may increase the price of care in Mexico, measured in pecuniary and non-pecuniary terms: the perception of increased personal risk during care seeking, a decreased supply of Mexican providers, and increased border security and wait times as a result of the violence. The decreased supply may increase prices of care or make seeking care less convenient due to shorter hours of operations, harder to find locations, or the termination of an existing doctor-patient relationship due to the provider ceasing care provision.

As these prices of care in Mexico rise, individuals may either a) pay the increased (financial and non-financial) price and continue seeking care in Mexico, b) substitute care from a Mexican provider with a US provider with the attendant financial implications, or c) forego care altogether. Since violence in Mexico would not have a direct effect on any of the healthcare access measures for US residents, the only way it should have affected indicators of access was through changes in border crossing. However, although border crossing may be reduced, people may choose to seek health care in the US instead. Empirically, if people were able to continue seeking the same level and quality of health care in the US rather than Mexico, the estimates may understate the total changes to healthcare seeking behavior that occurred due to crime. Changes in healthcare access may be measured along several dimensions; these dimensions may be interrelated (e.g., reduced access to a regular care provider may be associated with increased hospitalization for ACS conditions), although those interrelationships were not presented here. Both border crossing for healthcare and medication use/access were unmeasured in these studies and thus were presented in gray type.

I.F. Figures and Tables

Figure 2.1: Map of Border Region (Source: US-Mexico Border Health Commission)

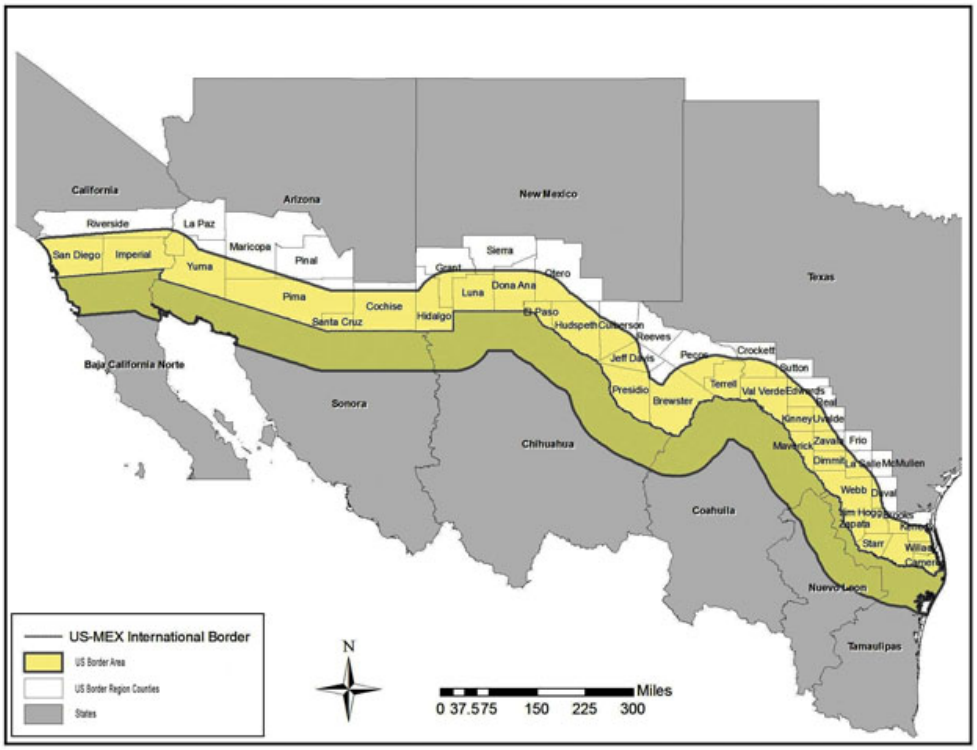
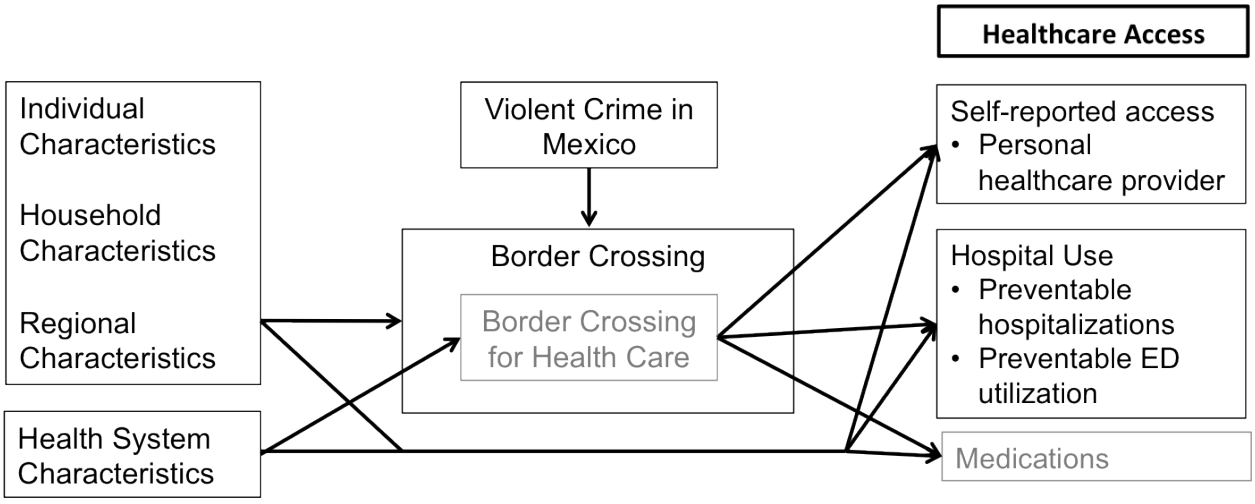


Figure 2.2: Conceptual Model



3. QUALITATIVE INTERVIEWS

I.A. Introduction

To contextualize the quantitative findings, I conducted semi-structured interviews with various stakeholders in the US-Mexico border region. These interviews were conducted in April 2012, and all but two were conducted by telephone (one by email, one in person). The seven people I interviewed were a convenience sample and represented different regions and perspectives. Notably, there was only one respondent from the El Paso-Ciudad Juarez area, who was a researcher in border health. As the violence has been much worse in Ciudad Juarez than in other places along the border, this is an important limitation. I did not conduct any formal analysis on the qualitative findings; I have presented here the main points made by the respondent during the interviews. Information from these interviews provided important context and was incorporated into the quantitative analytical approach (Table 3.1). These comments should not be considered to be representative of thoughts or opinions of those in the border region.

I.B. Responses

Respondent 1 was a retired physician who formerly practiced in an IMSS (formal sector insurance) clinic in Tijuana, Mexico and currently resides there. He practiced in a large clinic where patients were seen for both acute and chronic conditions. We discussed his practice and

characteristics of patients, but as he practiced in the Mexican formal public sector, he did not see many people who crossed the border for health services in his practice.

We discussed border crossing for healthcare more generally rather than based on his experience as a practicing physician. He noted that while it is mostly Hispanics who cross the border for healthcare, it happens across all groups ("everyone crosses"). He noted that people aged 50 and older were more likely to cross, mostly for chronic conditions. He also noted that for emergencies, patients do not come to Mexico. Another reason that some may cross (and continue crossing despite the violence) is to get a second opinion prior to surgery due to the fact that surgery is expensive and invasive. Reasons mentioned for why people would cross into Mexico to seek health care included that it is much cheaper to see a Mexican providers and patients may trust them more, in part due to the fact that the doctors are also Hispanic.

He said that people were absolutely scared of the increased violence. He mentioned that for those who do not continue coming to Mexico due to crime or increased wait times at border crossings, a lot have substituted to "clinicas Latinas" (Latino clinics) in Los Angeles, mostly for chronic conditions. We did not discuss in detail what type of clinics these were. When asked whether there was a difference between the quality of these clinics in Los Angeles and private clinics in Tijuana, he noted that there was not really, at least from a patient perspective, and that patients liked the doctors in the Los Angeles clinics because they were also Hispanic.

We discussed changes in physician practice patterns as a result of the violence, and he noted that while physicians were scared, they were not scared enough to change locations or close their practices altogether. To minimize the danger, he noted that they might close earlier. Additionally, he said that many physicians who used to live in Tijuana had moved with their families to Chula Vista, CA for safety reasons. In particular, specialists are high targets for

ransom, so many of them had moved to the US but continue practicing in Mexico due to licensing requirements and existing client bases. He noted that the violence had been much more severe in Ciudad Juarez, and doctors there may have had stronger responses.

Respondent 2 was an employee of a home health telemonitoring service in the Rio Grande Valley. The primary clients of this service were home health agencies, although he was familiar with the general medical environment for the elderly. He was "pretty aware" of border crossing for health care and knows that it continues to go on. He also knew people who no longer crossed into Mexico for healthcare due to fear. Those people mostly live in border towns that are connected to towns in Mexico that are now suffering economic consequences from the lack of traffic; this is having effects on the economy of the US border towns as well, with general traffic and spending down in these areas. He also noted that in the US, hospitals were particularly concerned with treating undocumented immigrants due to the fact that to receive payment under reimbursements designed to pick up the cost of this care, the hospital is forced to prove that the person is undocumented. This results in patients leaving the hospital before they are formally discharged to avoid problems with immigration authorities.

Most of the rest of the conversation revolved around Medicare policy in the Rio Grande Valley, including changes in managed care penetration and resulting policy effects, and fraud in healthcare reimbursement, which has been a large problem in this region.

Respondent 3 was a young adult resident of the San Diego-Tijuana area. He was not overly familiar with border crossing for healthcare, but being a binational resident, was familiar with reasons people might use services on one side of the border or the other. He mentioned that the exchange rate was an important factor in choosing where to buy goods and services; also, traditionally goods were bought on the US side and services purchased on the Mexican side.

Additionally, some things might only be available on one side or the other – for example, designer jeans were historically more readily available in the US than in Mexico. After the September 11th attacks, there was much more separation between the two towns as immigration enforcement to enter the US increased and border wait times spiked. Now, with normal wait times for cars at the primary border crossings between the two cities of two hours or more, people consider crossing much more carefully. Furthermore, the addition of well-known commercial establishments such as Costco on the Mexican side made it easier to not cross.

We discussed a recent healthcare incident in which he suffered an injury in the US and sought care in Mexico. Although he was covered by US health insurance and assumed it would apply in an emergency situation, he had never used it before and was not sure how to use it or how much the copayments would be. His family was able to recommend a physician in Mexico. He had a friend drive him to the provider, who took X-rays, diagnosed a fracture, set it, and prescribed pain medication. For the entire visit, including fees, medication, and supplies, the total charge was less than $150. The total time elapsed from the time of the injury to leaving the doctor's office was less than two hours, which he speculated was less than the amount of time it would have taken to see a provider in the emergency room. However, he noted that had it been a more severe injury necessitating more immediate care or had he not had access to a car and someone to drive him, he would have used an emergency room in the US.

Respondent 4 was very familiar with the healthcare system in the US-Mexico border region, and worked with a non-profit organization in Arizona working to improve the conditions of migrant and seasonal farmworkers. Although there was a huge increase in violence in Mexico, the nearest Mexican border city had been less affected than other cities in the region. Violence on the US side of the border near her was minimal. The main industry in the region was

agriculture, on both sides of the border, and thus many migrated throughout to follow the crops. In the off season, this population has significantly lower income from jobs and a lack of economic opportunity, resulting in increased substance abuse and domestic violence. Based on the huge influx of people who live in Mexico and commute for work, there are often long wait lines at the crossings, including a two to three hour wait on each side. She also noted that the US region has a huge influx of winter residents from colder climates.

For many of the migrant farmworkers, the remainder of the family stays home in Mexico. She noted that some companies (covering as much as 25-30% of the agricultural population she worked with) offered insurance in Mexico to their employees during the time that they were employed for both the employee and his family. This did not provide any coverage for US healthcare. A lot of the workers do not prioritize healthcare during the season, as if they miss work due to illness or doctor's visits, they are not paid.

We discussed a large annual community health fair organized by the nonprofit she worked for, which had been taking place for more than a decade. During this fair, information was provided to about 5,000 attendees about the healthcare system, immigration, housing, and other items of interest for this population. A lot of attendees report that this is their only source of healthcare. During the fair, there is screening for chronic diseases, including cholesterol checks, body mass index measurements, blood pressure measurements, HIV tests (as supplies are available), and vision and hearing tests. Many doctors in the community participate in this event.

Another important healthcare outreach of the nonprofit is the use of *promotoras*, or community health workers. They are individuals from the community who are recruited and trained; they often have family members who have suffered health problems and they want to pass on their knowledge. They are initially volunteers and then transition to paid positions. They

are culturally proficient and "speak the language" as they are from the communities in which they work. They begin with their immediate communities and as their skills develop, they expand their network. They primarily focus on chronic disease prevention, serving as "cultural brokers" to increase use of healthcare in these communities. The communities they work in may have high rates of tobacco use and HIV infection, and many forego care or use folk medicine, and there is little to no culture around prevention. The *promotoras* teach members in the communities how to access services, and network within the community to find safe referral sources for the recipients. The *promotoras* may also provide information on eligibility for Medicaid and community non-profit services, as the majority of this population is documented and may qualify. As Proposition 200 in Arizona denies services to undocumented immigrants and obligates those identifying undocumented immigrants to report them to authorities, the *promotoras* have established networks of providers where they can refer individuals so that they will not be at increased risk from seeking services. She estimated that only about 15-20% of the population she serves is undocumented, but the proportion may be much higher in some areas.

When asked about how the provision of services may have changed over the last 5-10 years, she noted that services by nonprofits had probably been decreasing as a result of the national economy and resulting funding cuts. Additionally, services in Arizona have been disrupted by strict immigration laws and stereotyping around undocumented immigrants.

Respondent 5 resided in the Rio Grande Valley in Texas and was an employee of an advocacy group working on behalf of seniors for community outreach services. I interviewed her primarily with the perspective of a patient who sought care in Mexico. She mentioned that there were several reasons she and many of her friends sought care in Mexico: time, cost, and effectiveness of services. She noted that instead of a four to six hour wait for care in the US,

there was a 15 minute wait in Nuevo Progreso (a Mexican town on the border between McAllen and Brownsville, TX), and the doctors had much more time to spend with patients. It was $20 to $25 for the doctor's visit, and the provider was definitely a physician rather than an RN or nurse practitioner. Teeth cleanings cost about $10. She mentioned that she changed from a US doctor to a Mexican one despite the fact that she had private insurance because it was the same price or cheaper than her copayment and she was more satisfied with her care. Border crossing was very common among her friends, many of whom lost private insurance with the recession, and it was primarily about saving money; if they could get the same services for a lower cost in Mexico, why would they use them in the US? She noted that she preferred to go to Mexico due to the fact that in the US, it was "machinery medicine" and one might have to be referred to several specialists in order to get a firm diagnosis. In Mexico, providers were much more likely to treat with effective drugs in office; for example, for a case of laryngitis, the physician administered an injection of penicillin and Vitamin A. This brought quick resolution of the problem, so she considered it very cost-effective. She noted that fewer Medicare patients crossed although the ones that did were satisfied with the services because the doctors spent more time with them and were able to resolve their conditions more quickly. She said that when she went to Mexico for healthcare, she went for a specific condition rather than waiting for another reason to combine the trips (e.g., with a trip to visit friends or family). She noted that there was a huge influx of winter Texans from October to May, and many of these people may go to Mexico for care.

In terms of violence and the relationship with border crossing for healthcare, she mentioned that near her town, the Reynosa (a Mexican city along the border near McAllen, TX) and Nuevo Progreso crossings were approximately equidistant. In Reynosa there had been heavy violence over the last six years, while there had been little to none in Nuevo Progreso. Previously

she went to Reynosa for care, but as violence increased she started going to Nuevo Progreso instead. She noted that this was a common transition for many people that she knew. She also mentioned that at the time of the interview there had been a recent decrease in crime in Reynosa and so people were starting to return there. When I asked whether she avoided Reynosa entirely as a result of the violence, she mentioned that the local media kept region residents up to date on the situation; before going to Reynosa, people would seek advice from family and the local media via TV and Facebook. Additionally, at the border, the Mexican consulate would let people know that it was not safe in Reynosa and advise against entering Mexico. People also avoided going at night, and restricted their travel to during the day.

Respondent 6 was a researcher in Arizona who previously was an active border health researcher. He had transitioned away from this research. We discussed research he was aware of, most of which was conducted in the late 1990s. There were recent changes along the border, as crossings were down due to increased border patrol enforcement and the bad economy, which may have resulted in population loss on the US side of the border. Immigration enforcement in Arizona was particularly tight, and the border was highly policed. There were about 15 roads that travel north from the border, and travelers are regularly stopped on all of them. There might be an increase in people seen at Federally Qualified Health Centers and Community Health Centers due to the violence and immigration enforcement, as before they never asked questions about immigration status.

The Medicare Modernization Act allocated about $250 million nationally to pay unreimbursed costs for immigrants for emergency department use and ambulances. Much of this money had gone unused and estimates based on historical claims were overstated because the hospitals had to show minimal evidentiary support for the claim that the patient was

undocumented. As a result of the policy changes requiring additional documentation, undocumented immigrants were much less likely to use services. He did not think many were deterred from going south based on the violence, and that policy changes including the donut hole in Medicare and Medicaid cutbacks might influence people to continue seeking care (or at least prescriptions) in Mexico. He did note that they now required a physician signed prescription to get back into the US with a prescription, so this might influence people's use. He also noted that there were recent developments in cross border insurance networks, but we did not discuss this further.

Respondent 7 was a researcher in El Paso, who said all of her research on cross border care had been conducted before the upsurge in violence. At the time of the interview, there were Mexican stores in US border cities selling Mexican remedies. As a lot of people from Mexico relocated in the US due to the violence, she was sure many doctors were providing services and selling Mexican remedies but she had been unable to find any of them but a dentist. Most of the others practice in secret and she was not able to identify them. One thing that facilitates this practice is that Mexican prescriptions are honored in the US, so Mexican physicians with a prescription pad can "de facto and illegally practice" in the US, but this is a very risky operation for them and it is thus difficult to identify the specific persons. She noted that many who cross for healthcare do not have a usual source of care in Mexico; a few may, but most will use different providers or only the pharmacy. There is regular access to preventive screening measures such as Pap smears and mammograms through non-governmental organizations in the US and health fairs. Mexican providers are generally used for acute health problems in the adult population, and are not generally used for children, who may have better access to Federally Qualified Health Centers.

She gave further information on her research on pharmacies, which noted that physicians are not supposed to prescribe within the pharmacy but that there are informal arrangements in place. Consultations with a physician in a pharmacy generally cost about $2. Additionally, prescriptions are not retained by the pharmacy and can thus be reused by the patient. The prescription requirement in place (requiring a prescription for many medications that were previously available without a prescription) is only enforced for controlled substances and antibiotics, since August 2010. This enforcement remains relatively lax. People purchase prescriptions in Mexico despite the fact that the price of the top 15 medicines purchased in Mexico tend to be cheaper at Wal-Marts in the US and in the community health centers. Chronic disease patients may not be aware of the fact that their prescriptions would be cheaper in the US.

I.C. Summary of Responses

These qualitative interviews provided contextual insight into the behavior and trends within the border region, both in relation to violence in Mexico and otherwise. Most of the information provided corroborated information found in the academic literature or lay media (e.g., that cost and dissatisfaction with the US healthcare system were important reasons for seeking care in Mexico); however, some of the information was new to me. I was able to locate sources that verified most of this new information in things that had been published between the initiation of my research and the completion (e.g., information about physicians illegally practicing in the US).

I.D. Figures and Tables

Table 3.1: Summary table of qualitative interviews

Respondent	Location of Respondent	Position	Important Points of Interview
1	Tijuana, Mexico	Doctor in formal Mexican national healthcare sector	• People do not come to Mexico for emergencies • Substitution to Latino clinics in Los Angeles due to increased violence • Physicians scared of violence but not enough to close practices, but might change hours • Many physicians relocated families to Chula Vista, CA for safety
2	Rio Grande Valley, TX	Home health telemonitoring company	• Violence and reduced crossing due to violence is definitely happening • Border towns in US and Mexico economically affected by reduced crossing • Hospitals particularly concerned about financial implications of treating undocumented immigrants, because have to prove the patient is undocumented to receive federal reimbursement for care
3	San Diego, CA / Tijuana, Mexico	Resident	• Exchange rate and availability of goods/services important part of general crossing behavior • Normal wait times in Tijuana area are two hours or more, making people consider crossing much more carefully • Cost for comprehensive medical visit for injury was $150, extremely low by US standards
4	Arizona	Expert on border region, worked for non-profit focusing on farmworkers	• Wait times of two to three hours for people crossing for employment • Many migrant farmworkers leave famiy in Mexico, and a moderate proportion have employers who offer coverage in Mexico for family • Annual health fair offers health screenings and information, and is often only source of healthcare for attendees (approx. 5,000) • Use of community health workers

Respondent	Location of Respondent	Position	Important Points of Interview
			common within these populations to improve health risk factors and work with individuals to find safe providers given documentation status • Services by non-profits likely to have decreased over last five to ten years with decreases in government funding
5	Rio Grande Valley, TX	Senior advocacy group	• Cross because of short wait times, low-cost • Many cross because had lost private health insurance with jobs, and because sometimes visits were cheaper than copayments • Seasonal residents go to Mexico for care • Substitution of care from one Mexican town to another due to violence • Information about violence spread through news sources and Mexican consulate
6	Arizona	Former border health researcher	• Undocumented immigrants much less likely to use services due to changes in hospital policies surrounding documentation for reimbursement • Recent developments in cross border insurance networks
7	El Paso, TX	Border health researcher	• Mexican providers practicing in US illegally • Many crossing for healthcare do not have usual source of care in Mexico • Preventive screening may happen through non-governmental organizations and health fairs in US • Children may have better access to Federally Qualified Health Centers • Enforcement lax on requirement for prescriptions in Mexico • Price of medications in Mexico may actually be more expensive than in US

4. STUDY 1 – EXPLORING THE ASSOCIATION OF HOMICIDES IN NORTHERN MEXICO AND HEALTHCARE ACCESS FOR US RESIDENTS

I.A. Overview

Recent increases in homicides in Mexico may impact healthcare access for US residents due to decreased border crossing for healthcare. We used population representative data from California, Arizona, New Mexico, and Texas (2002-2010) to measure healthcare access, matched with homicide rates of Mexican border municipalities. Increased homicide rates were associated with decreased legal entries to the US from Mexico. Multivariate difference-in-difference linear probability models evaluated impacts of homicide rates on healthcare access measured by binary indicators of personal healthcare provider(s), cost as barrier to care-seeking, and cervical and breast cancer screening. Contrary to expectations, homicide rates were not significantly associated with the four healthcare access measures in US border counties. Despite a decrease in border crossings, increased violence in Mexico did not appear to negatively affect access for individuals likely to receive healthcare in Mexico. It is unknown whether individuals continued to receive care in Mexico or substituted domestic care.

I.B. Introduction

Much of the population in the United States (US)-Mexico border region[1] is medically vulnerable with a high burden of chronic disease, a low supply of health professionals, and high rates of uninsurance and poverty.[1,3,25] Almost half the population is Hispanic.[3] The large and

[1] The Border Health Commission defines the US-Mexico border region as the area within 100km (62 miles) of the US-Mexico border. Here, we specifically focus on US border counties.

rapid growth of this population has heightened the importance of addressing healthcare access issues and associated health outcomes.[3,7,25]

Multiple factors, including low-priced provider options and looser prescribing requirements in Mexico, dissatisfaction with the quality of US healthcare, language preferences, and cultural preferences cause US citizens and legal residents residing in the border region to cross into Mexico for medical treatment or to purchase pharmaceuticals.[2,4-6,28] Estimates of the population in border regions crossing from the US to Mexico to receive health care services range from 11% to greater than 50%.[2,4-6,27,28] Crossing is more common among the uninsured, low-income households (but not the very poor), the non-elderly, and those of Hispanic ethnicity.[1,2,27] Many crossing the border for healthcare also seek care in the US,[2] and lack of care coordination is a major challenge for a population with low health literacy.[38]

Recent developments within Mexico may affect patterns of border crossing, both generally and for healthcare. Starting in late 2006, widespread efforts to combat drug trafficking resulted in a rapid increase in violence throughout Mexico[32,47]. There were almost 100,000 homicides from 2007 to 2011, the majority of them attributed to drug-related violence.[48] Rates and trends vary along the border, but some have experienced substantial increases; for example, the homicide rate in Chihuahua, the Mexican state adjacent to El Paso, TX, increased 930% from 2005 to 2010, from 19.7 to 183.0 homicides per 100,000 population.[33,34]

Since having a usual source of care and access to care are correlated with improved use of preventive health services,[49-52] lower rates of disease, improved health status, and decreased mortality,[53] any decrease in cross-border care-seeking in response to increased violence could lead to poorer health for an already underserved population.

This study uses population representative survey data to examine whether increased violence in northern Mexico, as measured by the homicide rate in Mexican municipalities adjacent to legal border crossings, is associated with reductions in healthcare access. Access to care is measured in four ways: report of a personal healthcare provider, identification of cost as a barrier to seeking care, and cervical and breast cancer screening practices.

New Contribution:

Some evidence of reduced crossing for healthcare due to violence exists, but to our knowledge, no studies have quantified the effect of the violence on border crossing or healthcare access[37,38,43]. In 2010, the president of the Medical College of Tijuana estimated a 50% decline in medical tourism by Americans to Mexico due to fear and increased border wait times due to stricter security checks [40]. In a qualitative study of HIV positive patients seeking care in El Paso clinics, Shedlin et al (2012) find decreased ability to cross the border due to violence as well as increased wait times and border security served as barriers to care.[41] Homedes (2012) notes that although there may be reduced border crossing for healthcare, the uninsured who need care may continue to seek it in Mexico but choose providers closest to the border to minimize the danger. In addition to potential border crossers' fear of violence, the supply of doctors in the Mexican border region has been compromised by violence as doctors are targeted in kidnappings.[38] In heavily affected Juarez and Tijuana, 30-50% of private clinics and pharmacies have closed.[34,37]

I.C. Methods

Conceptual Model

Our conceptual model (Figure 4.1) theorizes individual, household, regional, and health system characteristics influence border crossing for healthcare as well as directly influence healthcare access for US residents. As violence increases, the perceived "price" of care in

Mexico also increases in pecuniary and non-pecuniary ways. The perception of increased personal risk during care seeking, increased border security and wait times as a result of the violence, and a decreased supply of Mexican providers (manifesting in increased prices of care or travel time due to shorter hours of operations, harder to find locations, or the termination of an existing doctor-patient relationship) all increase the price of care in Mexico. Those receiving some care from Mexico may either a) pay the increased price and continue seeking care in Mexico, b) substitute care from a Mexican provider with a US provider, or c) forego care altogether. Since violence in Mexico will not have a direct effect on any of the healthcare access measures for US residents not accessing care in Mexico, the only way it affects these indicators is through changes in border crossing.

To empirically test the model, we first assessed whether changes in the homicide rate led to changes in total border crossing rates (Path 1 on Figure 4.1). Since we do not have information on border crossing for healthcare, we are unable to directly estimate Path 2; we empirically tested the joint effect of Path 1 and Path 2.

Effect of Homicide Rate on Entries into the US from Mexico

Data and Measures:

Dependent Variable: The aggregate number of people entering at each port per month was the outcome variable for analyzing total border crossings.[2] US Bureau of Transportation Statistics data (2002-2010) contain the number of people entering at each port of entry. Port-level data are aggregate counts reflecting crossings from any road, tunnel, or bridge in a defined port.[9]

Independent Variables*:* The primary independent variable of interest was the homicide rate, *H,* of the Mexican municipality (similar to a county in the U.S.) adjacent to a port. We calculated

[2] We included pedestrians and those entering by train, bus, or personal vehicles.

monthly homicide rates as the number of homicides divided by the INEGI (Instituto Nacional de Estadística y Geografía; National Institute of Statistics and Geography) Mexican census population estimate.[3,33,34] To match homicide rates to port level border crossing data, we determined the adjacent Mexican municipality to the port using Google Maps.[4,5,54]

Individuals may update their view of the risk of border-crossing with some delay due to factors such as public news reports not being instantaneous and updates to risk perception based on social network effects; there may be an additional delay in behavior change if the reasons for crossing are not discretionary in the short term (e.g., a person must cross to get from his home to his place of employment). We specify a vector of one- to six- month lags all analyses, although we examined the sensitivity of the results to various model specifications. We also include the adjacent US county unemployment rate [55] and the US dollar-Mexican peso exchange rate.[56]

Statistical Analysis: The number of crossings, y, for port j in month t was modeled using a Poisson model:

$$E[y_{jt}] = \exp(b_0 + b_1 H_{j,lag(t)} + b_2 ExRate_t + b2 UnempRate_{jt} + b_2 year_t + m_t + \mu_j + m_t * \mu_j) \qquad \text{(Eqn. 1)}$$

Month fixed effects, m_t, and a linear time trend, *year*, controlled for seasonality and secular trends. The exchange rate, *ExRate,* and US county unemployment rates, *UnempRate,* controlled for cross-border and local economic conditions. Port-level fixed effects, μ_j, controlled for time-invariant port characteristics. Fixed effects for port-month interactions controlled for within-port seasonality. To obtain consistent estimates of standard errors to provide for valid

[3] Census estimates were available for 2000, 2005, and 2010; populations in years between censuses were estimated using linear interpolation.

[4] For ports with more than one entry point (e.g., bridge, road) and all entry points not adjacent to the same municipality, we calculated the mean of these rates.

[5] With the exception of the port of Hidalgo, which has one very small crossing (a hand-pulled ferry) adjacent to a different municipality; Hidalgo was considered to be entirely adjacent to Reynosa, Mexico.

inference, we employed robust standard errors.[57,58] Including six months of lagged homicide rates was preferred to including one month and three months of lagged homicide rates based on Wald tests for model specification; sensitivity analyses were conducted. To meaningfully interpret the six coefficients on homicide rates, we calculated the "combined effect" of a one-unit (1 homicide/100,000 population) increase in each of the lags included in the model and is interpreted as the estimated increase due to a persistent (six month) increase in the homicide rate. This combined effect (instead of the individual coefficients) was considered the outcome of interest in all analyses; significance was assessed using a Wald test.

Effects of homicide rate and border residence on healthcare access

Data:

Measures of healthcare access come from the Behavioral Risk Factor Surveillance System (BRFSS), a cross-sectional national telephone health surveillance survey with individual survey data on demographics, healthcare access, and healthcare utilization [10,11].[6] Sampling weights correct for sampling probability and non-response to make results representative of the non-institutionalized adult population.

The analytic sample was restricted to respondents aged 18 to 64 residing in one of the four US border states (California, New Mexico, Arizona, or Texas) at the time of the interview from 2002 to 2010. Data from border and non-border counties were included to allow for non-border counties to act as controls for trends in access unrelated to violence. We excluded respondents from all analyses if they had incomplete information regarding having a personal doctor or control variables. County of residence was censored in the BRFSS if there were fewer

[6] An error in data collection for January and February 2010 misclassified observations in the border region so the 2010 Texas state version of the BRFSS was used. State added questions from the 2007 Texas state version of the BRFSS were merged to the national version.

than 50 respondents in a given year. The final analytic sample included 151,933 respondents of the total 192,550 respondents from border states aged 18-64 in survey years 2002-2010.

Additional exclusion criteria were applied to certain analyses. Models examining receipt of a Pap smear were limited to women 18-64 with an intact uterus. Analyses for receipt of a mammogram were restricted to women aged 40-64. Questions regarding Pap smears and mammograms were asked for all eligible respondents in even years (e.g., 2004), but were asked for only a small subset of respondents in odd years. The subgroup with chronic conditions included respondents in 2005, 2007, and 2009 who reported they currently had asthma, had ever been diagnosed with diabetes, had ever had a heart attack or been diagnosed with angina or coronary heart disease, or had ever had had a stroke.

US county level estimates of physician supply were obtained from the Area Resource File (ARF).[7,59] Whether a county was part of a metropolitan statistical area (MSA) was determined using US Office of Management and Budget definitions.[8,60]

Measures:

For the primary analyses of healthcare access, we examined the dichotomous variable of the response to "Do you have one (or more) person(s) you think of as your personal doctor(s) or health care provider(s)?" (yes/no). As secondary analyses, three other dichotomous outcomes were examined, including having had a Pap smear in the past three years, having received a mammogram in the past two years, and whether the respondent needed to see a doctor but could not because of cost in the prior year. We included the outcomes related to Pap smear and

[7] Interviews conducted in 2008, 2009, and 2010 were assigned the 2008 physician supply.

[8] Interviews conducted in 2002 were assigned the 1999 status and interviews in 2010 were assigned the 2009 MSA status.

mammogram as we are interested in access and there are limited access measures available; we used these utilization measures as proxy measures for access. Observations were at the respondent level.

The main independent variables were border county residence and homicide rates in the closest Mexican municipality. Forty-eight counties were identified as border counties using the United States-Mexico Border Health Commission definition – any part of the county is within 100 km (62 miles) of the US-Mexico border.[3] We linked individual-level BRFFS survey data with the homicide rate of the closest Mexican municipality, calculated using road distance from county centroids to the closest border crossing. A total of 12 Mexican municipalities were considered adjacent to border crossings.

Statistical Analysis:

We used a difference-in-difference approach, comparing high crime areas to low crime areas (continuous) and border counties to non-border counties. This allows us to separate the causal impact of violence from unrelated trends in access. Specifically, we estimated linear probability models (LPM) to predict the report of a personal healthcare provider, *p*:

$$p_{ict} = \beta_0 + \beta_1 border_c + \beta_2 * H_c + \beta_3 * H_c * border_c + \beta_4 * X_i + \beta_5 * C_{ct} + m_t + year_t + \varepsilon_{icm} \qquad \text{(Eqn 2)}$$

Individual demographic characteristics, *X*, county characteristics (including an indicator for whether a county is a border county, *border*), *C*, and a vector of six lagged homicide rates, *H,* for each individual *i* in county *c* interviewed at time *t* were included. Six months of lagged homicide rates were included as separate variables to allow for varying effects of homicides over time. The effects of interest were the interaction terms of the homicide rate variables and border county residence ($H_c * border_c$) to allow different effects of homicide rates on the probability of reporting a personal healthcare provider in border and non-border counties. This was interpreted

using the combined effect described previously. Wald tests for model fit indicated six months of lagged homicide rates and interactions were preferred.

Interview year ($year_t$) and month fixed effects (m_t) controlled for secular trends and seasonality in healthcare access. County level physician supply controlled for local access.[61,62] A binary indicator for MSA status was included. Individual characteristics included sex (binary), age (categorical), race (categorical), state of residence (categorical), income (categorical), educational attainment (categorical), and health status (continuous) measured as number of days in the prior month that poor physical or mental health restricted usual activities. We incorporated the complex survey design of the BRFSS using linearized standard errors and population weights.

We conducted sensitivity analyses for report of a personal healthcare provider by examining four subgroups: 1) the uninsured, 2) persons of Hispanic race, 3) those with chronic conditions, and 4) Texas residents. The uninsured or those of Hispanic race may be sensitive to any changes in access in Mexico as these subgroups are more likely to seek care in Mexico. Respondents with chronic conditions may need to see a doctor more frequently for ongoing treatment and monitoring, and thus may be more sensitive to changes in access in Mexico. We focused on Texas residents to ensure state level policy trends were not driving the results; Texas had adequate sample size and significant variation in the homicide rates of adjacent Mexican municipalities.

Additional models estimated three other binary outcomes of interest, including whether a respondent needed to see a doctor but could not because of cost within the last 12 months, having had a mammogram within the last two years, and having had a Pap smear within the last three

years. We conducted sensitivity analyses regarding sample composition and the empirical relationship between seeking care in Mexico and reporting a personal healthcare provider.

To test differences in means between border and non-border counties, weighted regression tests were used for binary and continuous variables; chi-squared tests were used to test for differences in the distributions of categorical variables. To test the statistical significance of the "combined effect" of lagged homicide rates on outcome variables in the regression models, we used Wald tests.

All statistical analyses were conducted in Stata 12.0 (StataCorp, College Station, TX). Results were considered statistically significant at an alpha of 0.05. To account for testing multiple hypotheses with the same sample, we apply Bonferroni corrections to the set of subgroup tests (n=5) with significance at the 0.01 level; we also apply it to the set of access outcomes (n=4) with significance at the 0.0125 level.

I.D. Results

Border crossings

Poisson regressions show homicide rates in the adjacent municipality were associated with a significant decrease in the number of US entries, with the controls noted in Equation 1 (Table 4.1). A one unit increase in the one through six month lags of the homicide rates was associated with a 0.42% decrease in US entries, holding other factors in the model constant. For the sample from 2002-2010, an increase from the median monthly homicide rate (0.92 homicides/100,000 population) to the 90th percentile (7.66 homicides/100,000 population), persistent over the six months prior, was associated with a 2.8% decrease in US entries.

Healthcare access

Sample Description:

Characteristics of the population weighted analytic sample are shown in Table 4.2. Compared to those in non-border counties, individuals residing in border counties were less likely to report a personal healthcare provider and less likely to have had a mammogram in the prior two years. They were more likely to be uninsured, have a lower education level, have lower annual household income, be of Hispanic race, have lower physician supply, and to answer the BRFSS in Spanish. Populations in border and non-border counties were similar in self-reported health status.

Regression Results:

Population weighted results for the estimation of Equation 2 (Table 4.3; column 2) show no association between homicide rates and reporting having a personal care provider in border counties, and a statistically significant negative association in non-border counties (with and without Bonferroni correction). Holding other things in the model constant, being uninsured was associated with a 37.4 percentage point decrease in the probability of having a personal healthcare provider; residing in a border county was associated with a 1.8 percentage point decrease in the probability of having a personal healthcare provider.

We examined additional indicators of healthcare access by estimating Equation 2 for three additional binary outcome variables (Table 4.4A): 1) needing to see a doctor but not being able to due to cost; 2) having had a Pap smear in the prior three years; and 3) having had a mammogram in the prior two years.[9] Homicide rates were not significantly associated with

[9] Official recommendations by the US Preventive Services Task Force for mammograms changed in late 2009. Prior to this, mammograms were recommended every two years for women aged 40 years and above; the new guidelines recommended mammograms every two years beginning at age 50 (US Preventive Services Task Force. 2009).

outcomes in border counties; homicide rates were negatively associated with having had a mammogram in the prior two years for those in non-border counties, although this was not significant with the Bonferroni correction.

We conducted subgroup analyses for the personal doctor outcome variable with four subgroups expected to be differentially affected by homicides: the uninsured (Table 4.4B; column 1), Hispanics (Table 4.4B; column 2), those with chronic conditions (Table 4.4B; column 3), and Texas residents (Table 4.4B; column 4). We found a statistically significant negative impact of homicides in non-border counties for the uninsured (with and without Bonferroni correction); otherwise, homicide rates were not significantly associated with the probability of reporting a personal healthcare provider in either border or non-border counties.

Sensitivity Analyses:

To address concerns about unmeasured changes in the sample composition (e.g., migration from Mexican border cities to US border counties), we conducted several checks. Region of birth was available for Texas BRFSS respondents in 2007 and 2010 (n=15,681). In border counties, a significantly higher proportion of the population was Mexican born in 2010 than in 2007 (40.5% vs. 34.3%; p=0.004); this is not the case in non-border counties (8.2% vs. 8.3%; p=0.87). To assess the correlation between this compositional change and violence, we regressed a binary indicator of Mexican born on race and six months lags of homicide rates; combined coefficients on homicide rate measures were not significant, providing some evidence that increased violence was not associated with changes in the unmeasured composition of the sample.

Restricting the regression to women aged 50-64, the combined effect of homicides in border and non-border counties were small and non-significant.

As we cannot control for nativity for most respondents, we estimated the same model as in Table 4.3, column 2 including an indicator for Spanish survey administration, which was highly correlated with being Mexican born (corr: 0.75). We found combined coefficients on homicide rates in non-border (-0.0025; p=0.004) and border counties (-0.0001; p=0.69) were similar to results not controlling for Spanish questionnaire. We repeated this regression controlling for Spanish questionnaire and including a Mexican born indicator. Results showed nativity did not have a separate influence on reporting a personal healthcare provider (beta=-.0221, p=0.47; n=15,681) and there was no substantive change in magnitude or direction of the combined coefficients for the homicide rate measure.

A small subset of respondents in Texas border counties in 2007 reported whether they had obtained any healthcare in Mexico in the prior year (n=2,460). We regressed reporting a personal healthcare provider on insurance status, gender, age, race, education, income, health status, physician supply, MSA, Spanish questionnaire, and a binary indicator of obtaining care in Mexico without population weights using robust standard errors. Seeking healthcare in Mexico was negatively associated with the probability of reporting a regular care provider (beta=-0.064, p=0.01). This result holds when we limit the definition of obtaining care in Mexico to those who report having obtained healthcare in Mexico more than once in the last year. We ran the same regression with the outcome of inability to see a doctor due to cost and found a positive association with obtaining healthcare in Mexico (beta=0.114, p<0.01). Repeating the regression for reporting a personal healthcare provider with the inclusion of an indicator for Mexican born and an interaction term of Mexican born and obtaining healthcare in Mexico shows no differential effect of obtaining healthcare in Mexico between those born in Mexico and those born elsewhere.

I.E. Discussion

Using information on legal US entries, we found entries were negatively associated with the homicide rate in the adjacent Mexican municipality, indicating an effect of violence on border crossing generally. Since no studies of border crossing specifically for healthcare have been conducted since 2008, we rely on BRFSS population-representative information for border states and find no significant association between homicide rates and selected measures of healthcare access in border counties (reporting a personal healthcare provider, inability to access care due to cost, and cervical and breast cancer screening). We also conducted analyses for subgroups expected to be more sensitive to violence increases and did not find effects of homicide rates on healthcare access even among them.

Since we do not have an indicator of where respondents' healthcare provider or services were located, we cannot determine the mechanism for this lack of association. Three possibilities we consider are 1) individuals are not changing their behavior with regards to care seeking in Mexico, despite the increase in violence; 2) individuals do not consider a provider in Mexico a personal healthcare provider, thus if access in Mexico is reduced or the individual substitutes a US provider such as a retail clinic or urgent care clinic that the individual may not consider a "personal healthcare provider", it will not be reflected in the survey data; and 3) individuals are migrating from Mexican border regions to US border regions, changing the composition of the analytic sample in an unmeasured way.

Although there was some evidence of behavior change associated with changing homicide rates, we do not know whether crossing for some activities (e.g. tourism) was more affected by homicide increases than for other activities (e.g. health care services). Additionally, although the decrease in legal entries associated with the increase in homicide rates was

statistically significant, the effect is small. It may be the case that the change in border crossing due to violence was too small to have a measurable effect on healthcare access. For some outcome variables, the effect of homicide rate in non-border counties was negative and statistically significant; this may provide some evidence residents of non-border counties who travel to Mexico for healthcare have reduced access.

To address the second possibility, we examined the probability of reporting a personal healthcare provider for the small subset of individuals in border counties who reported obtaining healthcare in Mexico in the prior year. We found these individuals were less likely to report having a personal healthcare provider, which would be consistent with individuals seeking care in Mexico indicating they do not have a personal healthcare provider. In this case, our estimates would not fully capture the effect of homicide rates on changes in border crossing for healthcare. Additionally, we would be less able to separate the impacts of substitution of a Mexican provider with a US provider from that of foregoing care entirely.

Researchers estimate 230,000 Mexicans fled Juarez between 2009 and 2011 to escape violence, with approximately half moving to the US near El Paso. However, almost all are likely to have immigrated to the US illegally.[63] Unmeasured changes in sample composition may change the effects of observed characteristics over time. As there are no markers in the data of immigration status and inconsistent collection of information regarding region of birth, we conducted several analyses to determine whether changes in sample composition affect our results. Using a subset, we found an increase between 2007 and 2010 in the proportion of Mexican born individuals in border regions; this increase was not associated with homicide rate measures. We also did not find an independent effect of being Mexican born on reporting a personal healthcare provider, and the negative relationship between reporting a personal

healthcare provider and seeking healthcare in Mexico was not differentially impacted by nativity. This information combines to show that any unmeasured changes in sample composition are not likely to have a substantial impact on the results.

Our analysis has several limitations. First, we do not have any information on why individuals crossed the border. Since we cannot determine empirically how large a subset of the total entries are for healthcare, this measure may be affected differently by violence than crossing for healthcare. Second, our measures of access, although widely used [50,52,64,65], may not be sensitive enough to measure changes in access for this population nor be robust measures related to health outcomes. In order to study the entire border population, we required data from large samples in both border and non-border counties. We conducted multiple sensitivity analyses, but the full effect on access may still not be captured due to the relatively crude measures used. Third, any compensatory responses occurring on the US side of the border may limit our ability to measure the full impact of violence on changes in access. Homedes (2012) notes some Mexican physicians now living in the US may be illegally offering services in the US, and pharmaceuticals from Mexico are similarly being illegally sold in the US.[38] Additional changes to the US health system, including any increased presence of non-governmental organizations providing health services, expansion of retail clinics, and increased availability of low-priced prescription drugs (e.g., $4 prescriptions) may reduce the effects of violence on healthcare access. We control for physician supply variables, but these may not be robust measures to capture changes in healthcare supply.

Many border residents comprise a vulnerable population with significant risk factors including poverty, low education, and high rates of chronic health conditions[1,3,7,25]. We have shown that there are limited (if any) changes in access to healthcare based on the measures we

have discussed associated with increased violence in Mexico. Further research is needed to examine whether different measures of access, such as hospital and emergency department use or prescription drug use, are affected by violence, and to examine responses by the healthcare system on the US side. As much of the population in the US border region is reliant on care in Mexico due to a lack of availability, accessibility, or affordability of appropriate health services in the US, any changes in geographic access to or availability of ambulatory healthcare services in Mexico may have significant effects for this population. Ongoing monitoring of changes in access as well as health outcomes is important as violence in the region continues to be widespread.

I.F. Figures and Tables

Figure 4.1: Conceptual Model

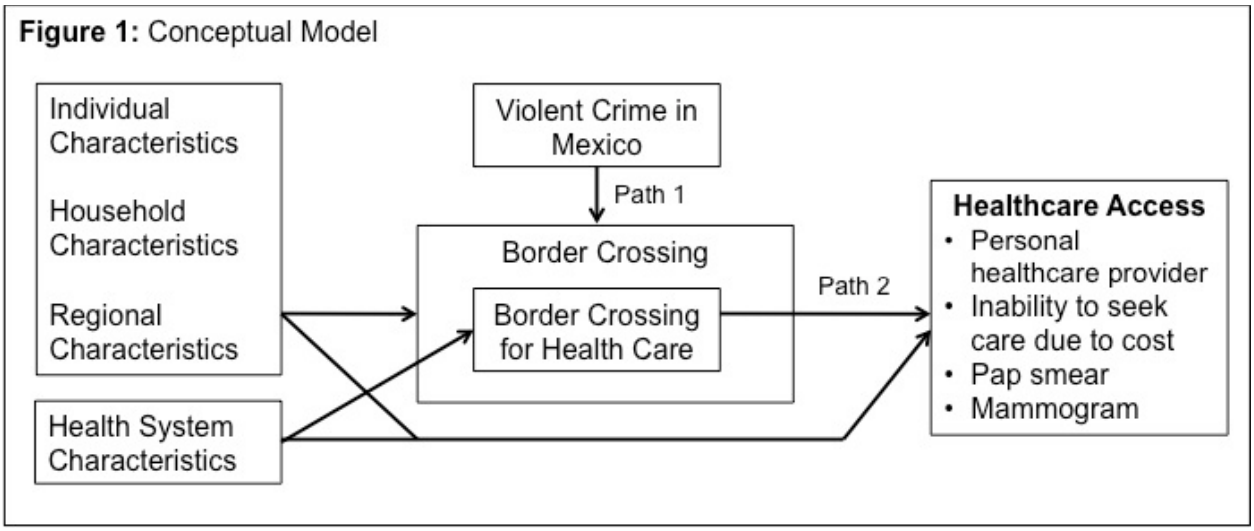


Table 4.1: Poisson model predicting number of US entries from Mexico

	(1)	(2)	(3)
Combined Effect of Homicides	**-0.0042*** **	**-0.0026*** **	**-0.0035*** **
	(0.0006)	**(0.0005)**	**(0.0005)**
1-month lag of homicides	-0.00116	-0.00264***	-0.00148*
	(0.00060)	(0.00052)	(0.00059)
2-month lag of homicides	-0.00047		-0.00095*
	(0.00049)		(0.00047)
3-month lag of homicides	-0.00034		-0.00102
	(0.00053)		(0.00054)
4-month lag of homicides	-0.00046		
	(0.00055)		
5-month lag of homicides	-0.00112*		
	(0.00055)		
6-month lag of homicides	-0.00066		
	(0.00054)		
Year	-0.03934***	-0.03974***	-0.03945***
	(0.00153)	(0.00152)	(0.00153)
US dollar-Mexican peso exchange rate	-0.00175	-0.00249	-0.00217
	(0.00378)	(0.00379)	(0.00377)
Unemployment rate	-0.01221***	-0.01245***	-0.01231***
	(0.00090)	(0.00091)	(0.00091)
Number of Observations	2691	2691	2691

Robust standard errors are in parentheses. Includes fixed effects for port, month, and port-month interactions. For ports that are adjacent to more than one Mexican municipality the mean homicide rate in these municipalities is used (with the exception of Hidalgo). For ports that are adjacent to more than one US county, the mean unemployment rate is used (with the exception of Hidalgo).

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.2: BRFSS Summary Statistics for Analytic Sample

Variable	Weighted Analytic Sample (n=151,933) Mean (std. dev) or %	Population Weighted Estimates for Analytic Sample		
		Border Counties (n=38,693)	Non Border Counties (n=113,240)	p-value
Has one or more personal healthcare providers	70.0%	68.3%	70.5%	<0.001
Could not seek necessary care because of cost[1]	17.7	17.6	17.7	0.80
Mammogram in prior two years[2]	74.1	72.3	74.5	0.03
Pap smear in prior three years[3]	85.5	85.5	85.6	0.94
Monthly Homicides per 100,000 population in matched Mexican municipality	2.70 (5.55)	3.04 (12.19)	2.62 (3.10)	<0.001
Lives in Border County (1=Yes, 0=No)	19.7			
Male	51.2	50.6	51.3	0.18
Uninsured	21.6	24.0	21.0	<0.001
Year of Interview	2006.3 (2.55)	2006.4 (2.83)	2006.3 (2.51)	0.001
Race				<0.001
Non-Hispanic White	47.3	49.4	46.8	(joint)
Hispanic	36.9	41.1	35.8	
Non-white, non-Hispanic	15.8	9.5	17.4	
Education				<0.001
Did not complete high school	16.3	15.6	16.4	(joint)
High school graduate	23.0	23.7	22.8	
Some college	26.4	27.9	26.0	
College graduate	34.4	32.8	34.7	
State of residence				<0.001
Arizona	8.5	37.6	1.3	(joint)
California	60.3	44.4	64.2	
New Mexico	3.1	2.5	3.3	
Texas	28.1	15.5	31.2	
Age				0.30
18-24 years	14.1	14.0	14.2	(joint)
25-29 years	10.8	10.8	10.8	
30-34 years	13.1	13.8	12.9	
35-39 years	12.2	12.1	12.2	
40-44 years	13.0	12.8	13.1	
45-49 years	11.2	11.0	11.2	
50-54 years	10.9	11.0	10.9	
55-59 years	8.2	7.9	8.3	
60-64 years	6.5	6.7	6.4	
Annual Household Income				<0.001
Under $15,000	14.2	13.6	14.3	(joint)
$15,000-$25,000	15.3	16.7	14.9	
$25,000-$35,000	10.4	10.4	10.4	

$35,000-$50,000	13.0	14.1	12.8	
$50,000 or more	47.1	45.2	47.5	
Number of days in poor physical or mental health in prior month	2.12 (6.04)	2.14 (6.97)	2.11 (5.88)	0.42
MDs per 1,000 population	2.44 (0.97)	2.02 (0.87)	2.54 (0.96)	<0.001
Metropolitan Statistical Area	87.6	90.8	86.9	<0.001
Spanish questionnaire (1=Yes, 0=No)[4]	16.8	18.1	16.5	<0.001
Chronic condition(s) (1=Yes, 0=No)[5]	16.0	16.7	15.9	0.15

Note: All analyses limited to BRFSS respondents in border states with complete information. Standard deviations for continuous variables, corrected for complex survey design, in parentheses.
1: n=143,156 overall; n=37,348 border county, n=105,808 non-border
2: n=31,941 overall; n=7,941 border county, n=24,000 non-border
3: n=39,174 overall; n=9,872 border county, n=29,302 non-border
4: n=136,043 overall; n=36,331 border county, n=99,712 non border
5: n=57,798 overall; n=15,577 border county, n=42,221 non-border

Table 4.3: Linear probability models predicting reporting having a personal healthcare provider

	Unweighted	Population weighted
Combined Effect of Homicides in Border Counties	-0.0000	-0.0000
	(0.0002)	(0.0004)
Combined Effect of Homicides in Non-Border Counties	-0.0023***	-0.0022**
	(0.0003)	(0.0008)
Uninsured	-0.359***	-0.375***
	(0.003)	(0.006)
Border County Residence	-0.000	0.002*
	(0.000)	(0.001)
1-Month Lag of Homicides	-0.015***	-0.019**
	(0.003)	(0.006)
Border County Residence * 1-Month Lag of Homicides	0.000	-0.002*
	(0.000)	(0.001)
2-Month Lag of Homicides	-0.000	-0.002
	(0.001)	(0.001)
Border County Residence * 2-Month Lag of Homicides	-0.000	0.002
	(0.001)	(0.001)
3-Month Lag of Homicides	-0.000	-0.001
	(0.001)	(0.001)
Border County Residence * 3-Month Lag of Homicides	0.000	0.001
	(0.001)	(0.001)
4-Month Lag of Homicides	-0.000	0.002*
	(0.001)	(0.001)
Border County Residence * 4-Month Lag of Homicides	0.001	-0.002
	(0.001)	(0.001)
5-Month Lag of Homicides	-0.001	-0.004***
	(0.001)	(0.001)
Border County Residence * 5-Month Lag of Homicides	0.001	0.004**
	(0.001)	(0.001)
6-Month Lag of Homicides	-0.001	0.000
	(0.000)	(0.001)
Border County Residence * 6-Month Lag of Homicides	0.001	0.000
	(0.001)	(0.001)
Male	-0.098***	-0.112***
	(0.002)	(0.004)
Age 25-29 years	0.004	-0.016
	(0.006)	(0.010)
Age 30-34 years	0.040***	0.026**
	(0.006)	(0.009)
Age 35-39 years	0.074***	0.068***
	(0.006)	(0.009)
Age 40-44 years	0.108***	0.110***
	(0.006)	(0.009)
Age 45-49 years	0.131***	0.133***
	(0.006)	(0.009)
Age 50-54 years	0.154***	0.160***
	(0.005)	(0.009)
Age 55-59 years	0.170***	0.179***
	(0.005)	(0.009)
Age 60-64 years	0.199***	0.204***
	(0.005)	(0.009)

	Unweighted	Population weighted
Race - Hispanic	-0.009***	-0.020***
	(0.003)	(0.005)
Race - Other (non-White, non-Hispanic)	-0.006	0.007
	(0.003)	(0.006)
State of Residence = Arizona	-0.006	0.021**
	(0.004)	(0.007)
State of Residence = Texas	0.019***	0.027***
	(0.003)	(0.005)
State of Residence = New Mexico	0.023***	0.041***
	(0.003)	(0.005)
Education Level - Did not complete high school	-0.072***	-0.071***
	(0.004)	(0.008)
Education Level - High school graduate	-0.013***	-0.020***
	(0.003)	(0.006)
Education Level - Some college	0.006*	0.006
	(0.002)	(0.005)
Annual Household Income <$15,000	-0.116***	-0.147***
	(0.004)	(0.008)
Annual Household Income $15,000-$25,000	-0.095***	-0.123***
	(0.004)	(0.007)
Annual Household Income $25,000-$35,000	-0.063***	-0.087***
	(0.004)	(0.008)
Annual Household Income $35,000-$50,000	-0.039***	-0.053***
	(0.003)	(0.006)
Days in Prior Month in Poor Physical or Mental Health	0.004***	0.003***
	(0.000)	(0.000)
County-Level MDs per 1000 Population	-0.002	-0.005*
	(0.001)	(0.002)
Metropolitan Statistical Area	-0.009**	-0.016*
	(0.003)	(0.008)
Constant	0.799***	0.819***
	(0.008)	(0.014)
R-Squared	0.225	0.261
Number of Observations	151,933	151,933

Model 1 is not population weighted and uses robust standard errors (in parentheses). Model 2 uses population weights and linearized standard errors (in parentheses). Omitted categories are age 18-24 years, Race – Non-Hispanic White, State of Residence - California, Annual Household Income Greater than $50,000. Controls for year and month of interview included (not shown).

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.4: Linear probability models results for selected subgroups and different outcomes

Panel A: Different binary outcome measures

	Reports regular care provider(s) (binary)	Could not obtain needed care because of cost in prior year (binary)	Pap smear in prior three years (binary)	Mammogram in prior two years (binary)
Combined Effect of Homicide Rates in Border Counties	-0.0000	-0.0002	0.0011	-0.0007
	(0.0004)	(0.0003)	(0.0006)	(0.0009)
Combined Effect of Homicide Rates in Non-Border Counties	-0.0022**	0.0003	-0.0028	-0.0036*
	(0.0008)	(0.0007)	(0.0016)	(0.0016)
R-Squared	0.261	0.186	0.074	0.095
Number of Observations	151,933	143,156	39,174	31,941

Panel B: Selected subgroups for reporting a regular care provider

	Uninsured	Hispanic Race	Has Chronic Condition	Texas Only
Combined Effect of Homicides in Border Counties	-0.0002	0.0008	0.0002	-0.0017
	(0.0009)	(0.0007)	(0.0022)	(0.0014)
Combined Effect of Homicides in Non-Border Counties	-0.0051**	-0.0025	-0.0039	-0.0011
	(0.0019)	(0.0015)	(0.0036)	(0.0023)
R-Squared	0.093	0.273	0.253	0.265
Number of Observations	30,556	46,875	11,193	43,950

Linearized standard errors are in parentheses. Regression estimates population weighted. Panel A: Controls for year and month of interview, gender (as appropriate), state of residence, MDs per population, MSA, number of days in poor health, age category, race, education level, annual household income category included (not shown). Panel B: Controls for year and month of interview, gender, state of residence, border county residence, physicans per population, MSA, number of days in poor health, age category, race, education level, annual household income category included (not shown; as applicable to subgroup).

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5. STUDY 2 – VIOLENCE IN MEXICO AND HOSPITALIZATIONS FOR AMBULATORY CARE SENSITIVE CONDITIONS IN THE US: EVIDENCE FROM THE US-MEXICO BORDER REGION

I.A. Overview

The objective of this study was to determine if homicide rates in northern Mexico were associated with hospital admissions for ambulatory care sensitive (ACS) conditions for US residents in the US-Mexico border region. We used secondary data from state inpatient discharge databases for Arizona, California, and Texas for 2005-2010. The study design was a retrospective observational analysis using logit models to estimate the association between homicide rates and the relative predicted probability a hospital discharge was for an ACS condition, controlling for patient demographic characteristics and regional economic conditions. To analyze the data, hospital discharges for ACS and marker conditions were identified and compared to homicide rates in Mexican municipalities matched by patient residence. We found that an increase in the homicide rate of one homicide per 100,000 population in the nearest Mexican municipality was associated with a 0.36 percentage point increase (95% CI: [1.00249, 1.00512]) in the relative predicted probability of being discharged for an ACS condition for patients in border counties. The effect was larger for uninsured and underinsured patients, who may be more reliant on the Mexican healthcare system. Increased homicide rates in Mexico were associated with increased hospitalizations for ACS conditions in the U.S., an indicator for poor access to outpatient care. Expanding access in the border region may mitigate these effects by providing alternative sources of care.

I.B. Introduction:

Hospitalizations for ambulatory care sensitive (ACS) conditions, those for which appropriate outpatient care can prevent hospitalization or early interventions can reduce complications, are a costly issue for the US health care system.[66] In 2008, total national costs associated with ACS conditions were $26.4 billion.[66] Rates of ACS admissions at the region level are often considered an indicator of primary care access, with more admissions for ACS conditions indicating lower access. ACS hospitalization rates have been shown to be associated with socioeconomic status, insurance, race and ethnicity, outpatient care access, and primary care supply.[16,67-70]

The US-Mexico border region (US counties within 100 km of the border) is an important region for study of ambulatory healthcare access as the population has many known risk factors for increased ACS hospitalizations. This population, of which almost half is of Hispanic ethnicity, has high rates of uninsurance, poverty, and chronic disease, and low rates of health professional supply.[1,3,25]

A significant proportion of border region residents cross into Mexico to obtain healthcare and purchase pharmaceuticals due to low-priced provider options in Mexico, dissatisfaction with the US healthcare system, and cultural preferences.[2,4-6,26] Estimates from early 2008 showed that among a population-based sample in Texas border counties, over a third had crossed into Mexico in the previous year for either a doctor's visit (37%) or medication purchases (43%).[6] Border crossing is significantly more common among the uninsured, the low-income, the non-elderly, and those of Hispanic ethnicity.[1,2,27] Individuals do not generally seek care in Mexico for inpatient or emergency conditions.[6]

Beginning in late 2006, violence in northern Mexico significantly increased. This increase may have affected patterns of cross-border care, jeopardizing border residents' ambulatory healthcare access at multiple points along the border. Medical tourism in Tijuana was reduced by an estimated 50% in 2010 due to fear of violence and increased border wait times.[40] An estimated 30 to 50% of private clinics and pharmacies in Juarez and Tijuana have closed,[38,40] negatively affecting provider supply on the Mexican side of the border. Previous research on the effect of violence on legal US entries and self-reported healthcare access found reduced border crossing from Mexico into the US associated with increased homicide rates, but no association between homicide rates and self-reported access for residents of border counties (Chapter 4 – Study 1). However, markers of reduced access (such as ACS admissions) may be more sensitive than self-reported data.

We used inpatient discharge databases from three border states (California, Arizona, and Texas) to measure the association between homicide rates in the Mexican municipality (an administrative unit similar to a US county) of the closest border crossing and the likelihood of discharge for an ACS condition.

I.C. Methods:

Analytic Approach and Hypotheses:

Using hospital discharge records from three border states (AZ, CA, TX), we used a difference-in-difference empirical approach at the discharge level to examine the association between homicide rates and admissions for ACS and marker conditions. Marker conditions are nondiscretionary admissions with clear diagnostic criteria, for which the provision of outpatient care has little impact on the medical necessity for hospitalization.[68] Since marker admissions should not be affected by variables related to healthcare access such as physician supply,[16,68]

they provide a control group for discharges with ACS conditions. We hypothesized that for patients residing in border counties, higher homicide rates in the nearest Mexican municipality will increase the likelihood of a discharge being for an ACS condition rather than a marker condition. We hypothesized patients residing in non-border counties would be less sensitive to violent conditions in Mexico as it is less common for non-border populations to seek ambulatory care in Mexico. Additionally, we hypothesized that after controlling for socioeconomic and demographic characteristics of patients in border counties, discharges from these counties would have a lower likelihood of being for an ACS condition given the supply of care available in Mexico not accounted for by the model.

Data and Analytic Sample Construction:

Hospital discharge records from AZ, CA, and TX were used to identify discharges for patients aged 18-64 years between January 1, 2005 and December 31, 2010 with a diagnosis of at least one ACS or marker condition. The sample was limited to non-elderly adults as they were more likely to seek care in Mexico and have a defined set of ACS and marker conditions. Discharges from California hospitals were obtained from the Office of Statewide Health Planning and Development and contained discharges from all acute-care short term hospitals.[18] Arizona discharges were obtained from the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality and contained discharges from all acute-care short term hospitals.[12] Texas discharges were obtained from the Texas Department of State Health Services and contained discharges from acute-care short term hospitals subject to reporting requirements.[10,14] These discharge data contain limited patient information (e.g. age, gender, ZIP

[10] Hospitals located in counties with population less than 35,000; those located in counties with population greater than 35,000 but with fewer than 100 hospital beds and not in a Census-designated urban area; and those that do not seek insurance payment or government reimbursement are exempt from the reporting requirements **71.** Texas

code/county of residence) as well as *International Classification of Diseases*, *Ninth Edition*, Clinical Modification (ICD-9) diagnosis codes for the hospital stay and codes for procedures conducted during the stay.

We included discharges that were identified as ACS conditions using the Prevention Quality Indicators Module of the QI SAS ® software, Version 4.4.[72] These consisted of discharges for diabetes short- and long-term complications, chronic obstructive pulmonary disease or asthma, hypertension, heart failure, dehydration, bacterial pneumonia, urinary tract infection, angina, uncontrolled diabetes, and lower-extremity amputation for patients with diabetes. These conditions are considered preventable with high-quality outpatient care.[66] We also included discharges that were identified as marker conditions.[73] These included discharges for appendicitis with appendectomy (ICD-9 codes 540, 541, or 542 with principal procedure of 47.0 or 47.1), acute myocardial infarction (ICD-9 code 410 with length of stay greater than 5 days or disposition of death), intestinal obstruction (ICD-9 code 560), and hip/femur fracture (ICD-9 code 820 for those ages 45 and older). These conditions are not considered preventable in the short-term (weeks to months) and thus there should be minimal fluctuation in rates across regions.[73] For a very small number of cases (n=61), the discharge contained both an ACS and marker condition; we assigned these to the marker condition.

Discharge records were excluded from the analysis if they were missing key data: age and primary diagnosis code (to identify ACS and marker conditions), and discharge quarter and patient residence (used to determine the homicide rate of the nearest Mexican municipality). Most missing demographic information was a result of censoring by the data providers to protect

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Department of State Health Services Center for Health Statistics. *User Manual: Texas Hospital Inpatient Discharge Public Use Data File.* Austin, TX: Texas Department of State Health Services Center for Health Statistics,;2005-2010.

patient confidentiality. Records were excluded if the source of admission indicated transfer from another hospital to avoid double counting patient stays for the same episode of care. Discharges were also excluded if the patient residence was not in the same state as the hospital as we did not have complete location information for all and we did not have records for neighboring states. In Texas, certain short-term acute care hospitals were not required to report their data. We matched reporting hospitals to a complete list of hospitals as recorded by Centers for Medicare and Medicaid Services Provider of Services files to determine non-reporting hospitals.[74] Hospitals accounting for 98% of acute discharge days in Texas had full data over the study period (authors' calculations). We excluded patients observed in the data who resided in a county that had a non-reporting hospital as we did not observe all hospital discharges for these locations; this was a small subset (0.76%) of the sample with marker or ACS conditions. Additionally, we excluded discharges that had missing gender, primary payer, or length of stay information.

Outcomes and Covariates

The outcome variable was a binary indicator for each discharge where a value of one indicates that the admission was ACS and a value of zero indicates that the admission was a marker condition. We estimated the association between this outcome and a vector of lagged homicide rates in the Mexican municipality adjacent to the border crossing nearest the patient's residence. Mexican municipalities were matched to patient residence using Google maps to find driving distances;[54] the match was done using the most specific location information available in the discharge data. The majority of discharges (99%) were matched based on 5-digit ZIP code of patient residence. Where the 5-digit ZIP code was not available due to censoring, we used 3-digit ZIP codes and county of residence. Homicide rates were calculated on a monthly basis using data on the number of homicides from the Mexican National Institute of Statistics and Geography

(INEGI; Instituto Nacional de Estadistica y Geografia) and matched to admission month. For the denominator of the homicide rate, population estimates were available in 2005 and 2010; intercensal year populations were estimated using linear interpolation. Patient demographics including age category (18-39 years and 40-64 years), sex, and primary payer were available from the discharge data. Patient socioeconomic status was measured using the 2008 ZIP code level income quartile calculated using median household income for the four states in the US-Mexico border region (CA, NM, AZ, TX) [75] county level unemployment rates.[55] Regional characteristics included annual county level physician to population ratios [59] and an indicator of whether the county is in a metropolitan area.[76]

Statistical Methods:

We adapt the empirical technique developed by Basu and colleagues (2002) using a model based at the discharge, rather than area, unit of analysis. This approach allows for a careful base case to which for comparison of the presence of ACS hospitalization. The marker conditions are a somewhat homogenous group of conditions unlikely to have substantial variation in incidence over time or be influenced by physician or specialist supply in the region.[16] This technique was used as the border region is growing rapidly in population [25] and thus there may be differential measurement error in population estimates between border and non-border counties. Furthermore, using this technique minimized the impact of missing data due to demographic censoring in California and non-reporting hospitals in Texas.

The empirical model was specified as follows using a logit model:

$$\Pr(\text{ACSadmission}_{dast}=1|X_{dcst}) = \exp\{X\beta\}/(1+\exp\{X\beta\})$$

$$\text{with } X\beta = \beta_0 + \beta_1 H_{as,lag(t)} + \beta_2 \text{Border}_{as} + \beta_3 (H_{as,lag(t)} * \text{Border}_{as}) + \beta_4 X_{dast} + \beta_5 Z_{ast} + \mu_s + m_t + y_t \quad \text{(Eqn 1)}$$

where *d* indexed the discharge, *a* indicated the ZIP code area, *s* indicated the state, and *t* was the time period (admission month). The outcome variable, *ACSadmission*, was a binary indicator where one indicated the discharge contained an ACS condition and zero indicated the discharge contained a marker condition; *H* was a vector of three months of lagged homicide rates in the nearest Mexican municipality (i.e., t-1, t-2, and t-3); *Border* was a binary variable indicating whether the area was within a border county; *X* was a vector of individual characteristics from the discharge data including age, sex, insurance status, and state of residence; *Z* was a vector of regional characteristics including county physician supply, ZIP code level income quartile, county unemployment rates, and county metropolitan status; μ_s were state fixed effects to control for time-invariant state characteristics; m_t were admission-month[11] fixed effects to control for seasonality in hospital utilization; and y_t were year fixed effects to control for secular trends in hospital discharges. In California, only admission quarter was available in the data; we randomly assigned each discharge to a month within a quarter. Robust standard errors were used.

The effect of interest was, for patients residing in border counties, the change in relative predicted probability of a discharge being for an ACS condition rather than a marker condition associated with a one unit increase in the homicide rates for the three months prior. Bias

[11] For Arizona, discharge month and year were available instead of admission. Since the mean length of stay in the sample was 4.4 days, the practical difference between discharge month-year and admission month-year was negligible and we used the discharge date as the admission date.

corrected confidence intervals were calculated for the combined effect using bootstrapping with 100 replications. Additionally, we calculated the average marginal effect for patient residence in a border county and used the delta method to calculate standard errors for this effect.

Dataset construction and ACS/marker identification were conducted using SAS 9.2 (SAS Institute; Cary, NC); regression analyses used Stata 12.1 (StataCorp; College Station, TX). An alpha level of 0.05 was considered statistically significant.

Subgroup Analyses:

We did subgroup analyses to determine whether certain subgroups that were *a priori* expected to be more likely to seek care in Mexico were differentially affected by the increased homicides. Specifically, we examined changes in the relative predicted probability of being discharged for an ACS condition in two subgroups: the uninsured and underinsured (i.e., discharges with the primary payer of self-pay, charity care, no charge, or Medicaid) and those residing in ZIP codes in the lowest income quartile. We combined the uninsured and underinsured categories as patients with a primary payer of Medicaid may enter the hospital without knowledge they are eligible for Medicaid and be retroactively insured in the program;[77] additionally, interruptions in Medicaid coverage are common.[78]

Sensitivity Analyses:

In addition to the subgroup analyses, we conducted three sensitivity analyses. Since individuals may take time to update their preferences surrounding the risk of seeking care in Mexico, it is not immediately obvious how quickly patients update their preferences regarding care in Mexico and thus which homicide rate would have the most effect on patient behavior. The primary analysis and subgroup analyses were conducted using a vector of the three month

lag of homicide; we estimate the sensitivity of these results using a specification with the one month lagged homicide rate (i.e., t-1) as a covariate.

As there was more censoring of patient demographic data (e.g., sex, age, admission month) in the California discharge data than in the Texas or Arizona data, we conducted a sensitivity analysis restricted to these two states and including age in five-year categories.

Information on patient race was available in the discharge data but was not included in the main analysis, as these data are often inconsistent with patient reports of race/ethnicity.[79] We conducted a sensitivity analysis including a categorical indicator of patient race. If race information was missing, we coded race as "Other."

I.D. Results

Analytic Sample:

The final analytic sample included 1,873,407 discharges containing an ACS or marker condition (Figure 5.1). Approximately 10% of total hospital discharges for those aged 18-64 were for ACS or marker conditions. Of these 1,873,407 discharges, 1,503,590 (78%) were for ACS conditions. Patient residences matched to 24 unique Mexican municipalities corresponding to the crossings along the US-Mexico border. The plurality of matches was to Tijuana, with 46.2% of discharges.

Twenty percent of discharges were for patients residing in a border county (Table 5.1). When compared with discharges in non-border counties, discharges in border counties were less likely to be for ACS than marker conditions. Discharges were significantly more likely to be in Arizona, with 49.4% of discharges in border counties in Arizona. Discharges for patients in border counties were more likely to be covered by Medicaid and had shorter length of stay. Discharges were more likely to be for male, younger (18-39 years), and Hispanic patients in

border counties than non-border counties. Discharges in border counties were more likely to have patient residence in areas with higher unemployment rates and lower income quartiles. Physician supply was lower for discharges in border counties.

Analysis:

Results for the estimation of Equation 1 (Table 5.2) showed a significant positive association between homicide rates and the relative predicted probability of being discharged for an ACS versus marker condition in border counties. A one unit increase (1 homicide per 100,000 population) in the homicide rate persistent over the three months prior was associated with a 0.36 percentage point increase in the relative predicted probability of being discharged for an ACS condition versus marker for patients in border counties. Using this effect, an increase of one standard deviation (6.1 homicides per 100,000 population) was associated with a 2.2 percentage point increase in the relative predicted probability of being discharged for an ACS condition versus marker for those in border counties. As expected, in non-border counties there was no association between homicide rates and the relative predicted probability of being discharged for an ACS versus marker condition.

Patient residence in a border county was associated with a 1.3 percentage point decrease in the probability of being discharged for ACS versus marker controlling for covariates included in the model. Patients residing in higher income ZIP codes were less likely to be discharged for an ACS condition, as were men, those with private insurance, those living in a metropolitan area, and younger patients. Higher physician supply in the county of patient residence was associated with a lower likelihood of being admitted for an ACS condition.

Subgroup Analyses:

For the uninsured and underinsured, the effects of homicide rates are similar in direction and significance but of slightly larger magnitude than those in the full sample (Table 5.3; Panel A). For discharges where the primary payer was self-pay, charity care, no charge, or Medicaid, a significant positive association existed between homicide rates and the relative predicted probability of being discharged for an ACS versus marker condition in border counties. In border counties, a one unit increase (1 homicide per 100,000 population) in the homicide rate persistent over the three months prior was associated with a 0.47 percentage point increase in the relative predicted probability of being discharged for an ACS condition versus marker. Patient residence in a border county was, on average, associated with a 1.7 percentage point decrease in the probability of being discharged for ACS versus marker controlling for covariates included in the model.

For patients residing in ZIP codes in the lowest income quartile, the association between homicide rates and the relative predicted probability of being discharged for an ACS condition in border counties was slightly smaller in magnitude and not significant at the 5% level (Table 5.3; Panel B). For this population, patient residence in a border county was, on average, associated with a 2.2 percentage point decrease in the probability of being discharged for ACS versus marker condition controlling for covariates included in the model.

Sensitivity Analyses:

We examined a one month lagged homicide rate in place of the vector of lagged rates used in the primary analyses (Table 5.4; Panel A). For the main analytic sample, the results were qualitatively similar; a one unit increase in the lagged homicide rate was associated with a statistically significant 0.19 percentage point increase in the relative predicted probability of a

discharge being for an ACS versus marker condition in border counties. The effect was not significant in non-border counties.

When the sample was limited to discharges in Texas and Arizona, results were similar in magnitude and direction to the primary analysis (Table 5.4; Panel B). The fact that results were similar for areas that did not match to Tijuana or rely on censored demographic data in California demonstrates that these facts are not likely to be driving the results. For patients in border counties, a one unit increase in the homicide rate persistent over the three months prior was associated with a statistically significant 0.34 percentage point increase in the relative predicted probability of being discharged for an ACS versus marker condition. The effect in non-border counties was smaller but statistically significant, with homicide rates positively associated with the probability of being discharged for an ACS versus marker condition. Patient residence in a border county was, on average, associated with a statistically significant 1.5 percentage point decrease in the probability of being discharged for an ACS versus marker condition.

Finally, we controlled for race in addition to the other covariates in the model using the main analytic sample. Results showed that results of the association with homicides was very similar to the primary analysis (Table 5.4; Panel C), with a significant positive association between homicide rates and the relative predicted probability of being admitted for an ACS versus marker condition. There was a smaller but statistically significant positive relationship in non-border counties as well. After controlling for race, patient residence in a border county was, on average, associated with a statistically significant 0.2 percentage point decrease in the probability of being admitted for an ACS versus marker condition. Being African-American was associated with significantly higher odds of being discharged for an ACS versus marker

condition than being white. Being of Hispanic race is associated with lower odds of being discharged for an ACS marker condition than being white.

I.E. Discussion

We used a common measure of access to ambulatory care with an innovative method using patient level hospital discharge data to examine the impact of homicides in northern Mexico on access to care in US border counties over the period of 2005-2010. Using data on hospital discharges in California, Arizona, and Texas, we found a positive relationship between homicide rates in the nearest Mexican municipality and the relative predicted probability of being discharged for an ACS versus marker condition for patients residing in border counties, but no significant association in non-border counties. To interpret the effect, an increase of one standard deviation (6.1 homicides per 100,000 population) was associated with a 2.2 percentage point increase in the relative predicted probability of being discharged for an ACS versus marker condition. The size of this effect was similar to the change in patient access resulting from a safety net hospital closure near the patient in California during the 1990-2000 period.[80] The association between homicide rates and the relative predicted probability of being admitted for an ACS versus marker condition was stronger for the un- and underinsured, but was not significant for patients residing in a ZIP code in the lowest income quartile among border states. The results in border counties persisted when changing the specification of the homicide rate measure and when controlling for more precise age categories and patient race.

These results suggested two possible relationships: a) access to ambulatory care in Mexico may be reduced due to the violence in northern Mexico, with measurable changes in hospitalizations for ACS conditions, and b) access to ambulatory care in Mexico may contribute to lower than expected rates of ACS conditions in US hospitals. Reducing hospitalizations for

ACS conditions is an important policy priority to reduce healthcare costs,[15] and thus recognizing and ameliorating barriers to accessing outpatient care is important, particularly when such access may be compromised by external events such as violence in Mexico.

Patient residence in a border county was associated with a reduced probability for being discharged for an ACS versus marker condition. This was true after controlling for local economic conditions, patient age, insurance status, and physician supply. The effect was smaller, but still statistically significant, when controlling for patient race. This relationship suggests that while border counties are underserved [3] and affected by reduced access to ambulatory care in Mexico in some regions due to violence, residents are better able to access ambulatory care than is suggested by the regional physician supply. Efforts in border regions to improve access such as through the provision of free care by public health departments in border regions to immigrant communities may be having a measurable positive impact on access for these populations. Additionally, cross border care available in Mexico likely contributes to this improved access, despite changes due to the violence in northern Mexico. The fact that access to care in Mexico has measurable effects on hospitalizations in the US suggests that there may be appropriate policy responses to incorporate this access, including through the expansion of cross-border health insurance products (e.g., insurance that covers care in both Mexico and the US), which to this point have been limited in scope and are only legal in California.[81] However, if access to care in Mexico is limited by violence, these products may be more useful in some geographic areas than others. As the availability of health services outside of formal US healthcare providers exists in this region (e.g., formal care in Mexico and informal care options), options for improving access to care may be more complicated than in other regions.[26] With new requirements for health insurance coverage from the Affordable Care Act, certain cross-border

insurance programs may be a viable alternative for individuals who are not eligible for Medicaid due to immigration status but whose income is too low to purchase private insurance and for undocumented immigrants, although willingness to pay is low.[82,83]

Our analysis had several limitations. First, we were not able to fully control for healthcare access. We included controls for physician supply, but physician supply is not a direct proxy for access to care for individuals.[84] This may be particularly true in the border region, where there may be free or low-cost services provided to certain population subgroups. Second, if there were compensatory responses in the border region to reduced access due to violence, the results will underestimate the effect of changes in access to care in Mexico. There may have been additional changes in outpatient access during this period, including the expansion of retail clinics,[85] reduction in the prices of generic prescriptions in the US (e.g., $4 prescriptions),[86,87] and possible relocation of Mexican physicians and pharmaceuticals to the US with illegal practice and distribution.[38] Third, we had limited patient demographic data and significant censoring of age and gender in California; we conducted analyses to determine whether the results are sensitive to this censoring and found that it was not. We did not test sensitivity for the 13.5% of potential ACS/marker discharges in the data with missing age, as we could not definitively classify whether these discharges were for ACS or marker conditions since pediatric conditions differ. As the censoring was based on administrative rules, we did not expect this would have a differential effect related to the association between homicide rates and ACS/marker conditions. Fourth, there may be macroeconomic trends that influence access as during this time period, the US experienced a severe recession. We controlled for the unemployment rate, which should pick up most of this trend; if the effects of the recession are differential across population subgroups, this control may not completely account for the effect.

In total, this analysis showed an increase in hospitalizations for ACS conditions versus hospitalizations for marker conditions in border counties was associated with increased homicide rates in the 2005 to 2010 period. Increased hospitalizations for ACS conditions may be an indicator of reduced access to ambulatory care in Mexico, which is crucial for a population with high poverty and uninsurance rates that may rely heavily on this care for health needs.[6] Mitigating this reduction in access is a crucial step for policymakers and health professionals in the border region as the violence continues to be widespread, and reducing hospitalizations for ACS conditions may be an important way to improve efficiency and reduce costs in the US healthcare system.[66] Future research should examine options to improve access for this region, particularly in regions where there is significant violence in nearby Mexican areas.

I.F. Figures and Tables

Figure 5.1: Construction of Analytic Sample

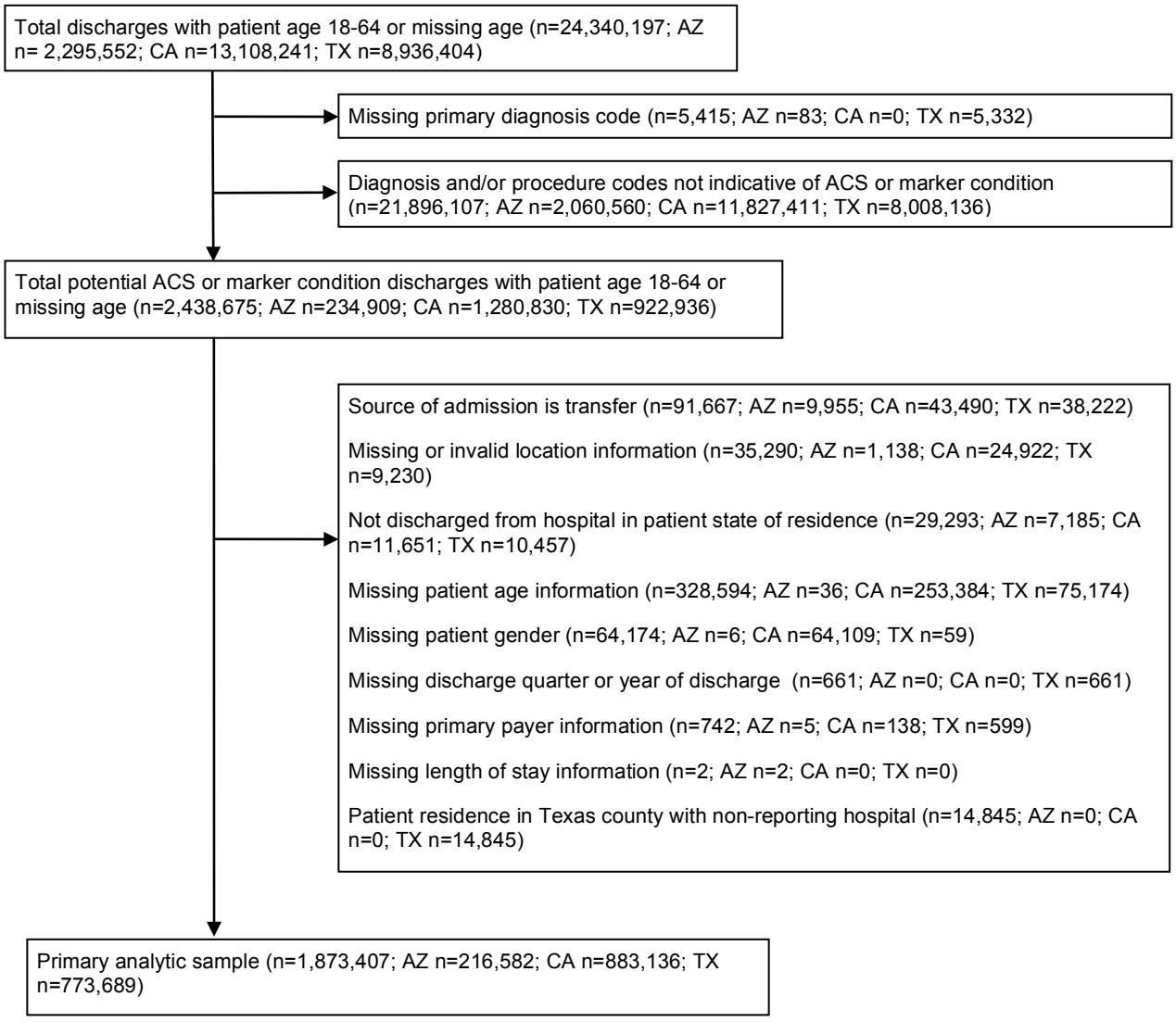

Table 5.1: Summary Statistics for Analytic Sample

	Patient Residence in Border County			
	Overall (N= 1,873,407)	**Non-Border** (N= 1,489,611)	**Border** (N= 383,796)	p
	Mean (Standard Deviation) or %			
Ambulatory Care Sensitive Condition (1) versus Marker (0)	78.0	78.3	76.9	<0.001***
Homicide Rate per 100,000 Population in Matched Municipality	3.1 (6.5)	2.6 (5.6)	5.1 (9.1)	<0.001***
Patient State of Residence				<0.001***
AZ	11.6	1.8	49.4	
CA	47.1	51.2	31.5	
TX	41.3	47.0	19.0	
Primary Payer				<0.001***
Medicare	19.3	19.5	18.4	
Medicaid	23.2	21.8	28.6	
Private Insurance	36.5	36.6	36.3	
Self-Pay/Uninsured	11.0	11.7	8.6	
No Charge	5.4	5.9	3.5	
Other	2.6	2.5	3.2	
Government	1.9	2.0	1.5	
Patient Gender				<0.001***
Male	46.4	46.2	47.4	
Female	53.6	53.8	52.6	
Age Category				<0.001***
18-39 years	24.6	23.9	27.3	
40-64 years	75.4	76.1	72.7	
Patient Race/Ethnicity				<0.001***
White	48.3	48.0	49.3	
Black	14.8	16.9	6.7	
Hispanic	19.3	16.4	30.6	
Asian/Pacific Islander	2.2	2.4	1.4	
Native American	0.7	0.5	1.7	
Other or Missing	14.6	15.7	10.3	
Length of Stay (Days)	4.4 (5.3)	4.4 (5.4)	4.3 (4.9)	<0.001***
Year of Discharge	2007.5 (1.7)	2007.5 (1.7)	2007.6 (1.7)	<0.001***
Admission Month	6.4 (3.5)	6.4 (3.5)	6.4 (3.5)	<0.001***
County Unemployment Rate	7.1 (3.3)	7.0 (3.1)	7.3 (3.8)	<0.001***
Income Quartile of Patient Residence (5-digit ZIP)				<0.001***
0 to 24th percentile (less than $48,850)	28.5	27.2	33.7	

25th to 49th percentile ($48,850-$63,953)		27.2	27.7	25.2	
50th to 74th Percentile ($63,954-$88,000)		26.1	25.6	28.0	
75th to 100th percentile ($88,001 and greater)		18.2	19.5	13.0	
County is in Metropolitan Area		92.8	92.1	95.6	<0.001***
County MDs per 1,000 Population	2.3 (1.0)		2.4 (1.1)	1.9 (0.8)	<0.001***
Driving Distance (km) to Nearest Border Crossing	430.6 (263.7)		506.3 (238.9)	136.9 (96.9)	<0.001***
Any ACS Condition Discharge		78.0	78.3	76.9	<0.001***
Acute ACS Condition Discharge		27.8	27.5	28.9	<0.001***
Dehydration		6.5	6.3	7.2	<0.001***
Bacterial Pneumonia		13.0	13.1	12.8	<0.001***
Urinary Tract Infection		8.3	8.1	9.0	<0.001***
Chronic ACS Condition Discharge		50.2	50.8	48.0	<0.001***
Diabetes Short Term Complication		6.2	6.2	6.3	0.004**
Diabetes Long Term Complication		9.8	9.6	10.6	<0.001***
COPD or Asthma in Older Adults		12.4	12.7	11.1	<0.001***
Hypertension		3.5	3.5	3.4	0.06
Congestive Heart Failure		12.4	12.9	10.5	<0.001***
Angina		1.9	2.0	1.7	<0.001***
Uncontrolled Diabetes		1.4	1.4	1.6	<0.001***
Asthma in Younger Adults		2.1	2.1	2.3	<0.001***
Lower Extremity Amputation in Diabetic		1.2	1.2	1.1	<0.001***
Any Marker Condition		22	21.7	23.1	<0.001***
Appendicitis with Appendectomy		11	10.8	12.0	<0.001***
Acute Myocardial Infarction		2.8	2.8	2.9	<0.001***
Intestinal Obstruction		6.8	6.8	6.7	0.17
Hip Fracture		1.4	1.4	1.5	<0.001***

P-values by t-test for continuous variables and chi2 test for binary / categorical variables

* p<0.05, ** p<0.01, *** p<0.001

Table 5.2: Regression estimation results

Panel A: Marginal effects and change in predicted probabilities		
		95% Confidence Interval §
Marginal effect of patient residence in border county	-0.01306*	[-0.01494, -
Combined change in relative predicted probabilities based on lagged homicide rates in border county	1.003623*	[1.00249, 1.00512]
Combined change in relative predicted probabilities based on lagged homicide rates in non-border county	1.00061	[0.9997, 1.0016]

Panel B: Full regression results for primary sample		
Variable⬩	**Odds Ratio**	**Robust Standard Error**
Patient residence in border county	0.9134*	(0.0060)
1-month lag of homicide rate	1.0005	(0.0004)
1-month lag of homicide rate * border county	1.0009	(0.0007)
2-month lag of homicide rate	1.0003	(0.0005)
2-month lag of homicide rate * border county	1.0002	(0.0007)
3-month lag of homicide rate	0.9998	(0.0005)
3-month lag of homicide rate * border county	1.0019*	(0.0007)
Age Category (18-39 years)	0.4808*	(0.0019)
State		
Arizona	1.0037	(0.0080)
Texas	1.2187*	(0.0061)
Unemployment Rate	0.9942*	(0.0010)
Income Quartile (reference group = 1st – lowest quartile [less than $48,850])		
2nd [$48,850-$63,953]	0.9148*	(0.0049)
3rd [$63,954-$88,000]	0.7831*	(0.0042)
4th – highest quartile [$88,001 and greater]	0.5885*	(0.0034)
Metropolitan Area	0.9745*	(0.0082)
Physician Supply (physicians per 1,000 population)	0.9643*	(0.0020)
Male	0.7670*	(0.0028)
Primary Payer (reference group = private insurance)		
Medicare	2.9591*	(0.0177)
Medicaid	2.8101*	(0.0150)
Self-Pay/Uninsured	1.5884*	(0.0096)
No Charge	1.7373*	(0.0146)
Other	1.3526*	(0.0151)
Government	1.2378*	(0.0156)
Number of Observations	1,873,407	
Psuedo-R^2	0.071	

* indicates significance at a 95% confidence level.

§ Confidence interval for marginal effect of patient residence in border county is calculated using the delta method. Confidence intervals for combined changes in relative predicted probabilities based on lagged homicide rates are calculated using bias corrected bootstrapping methods with 100 repetitions.
◆Controls for month and year of admission/discharge were also included. Omitted categories are Patient Residence - California, 18-39 years, Lowest Income Quartile, and Primary Payer - Private Insurance. Robust standard errors were used.

Table 5.3: Subgroup Analyses

Panel A: Uninsured and underinsured subgroup (N=741,680)		
		95% Confidence Interval §
Marginal effect of patient residence in border county	-0.01752*	[-0.02025, -0.01482]
Combined change in relative predicted probabilities based on lagged homicide rates in border county	1.00476*	[1.00217, 1.006904]
Combined change in relative predicted probabilities based on lagged homicide rates in non-border	0.99936	[0.9979, 1.0015]

Panel B: Lowest income quartile subgroup (N=534,123)		
		95% Confidence Interval §
Marginal effect of patient residence in border county	-0.0220*	[-0.0251,-0.0189]
Combined change in relative predicted probabilities based on lagged homicide rates in border county	1.0022	[0.9996, 1.0042]
Combined change in relative predicted probabilities based on lagged homicide rates in non-border	0.9975	[0.9944, 1.0003]

* indicates significance at a 95% confidence level.

§ Confidence interval for marginal effect of patient residence in border county is calculated using the delta method. Confidence intervals for combined change in relative predicted probabilities based on lagged homicide rates are calculated using bias corrected bootstrapping methods with 100 repetitions.

Table 5.4: Sensitivity Analyses

Panel A: One-month lag of homicides		
		95% Confidence Interval §
Marginal effect of patient residence in border county	-0.0129*	[-0.0148, -0.0110]
Combined change in relative predicted probabilities based on lagged homicide rates in border county	1.0019*	[1.0010, 1.0028]
Combined change in relative predicted probabilities based on lagged homicide rates in non-border county	1.0005	[0.9997, 1.001]

Panel B: Arizona and Texas with five-year age categories		
		95% Confidence Interval §
Marginal effect of patient residence in border county	-0.0159*	[-0.0189, -0.0129]
Combined change in relative predicted probabilities based on lagged homicide rates in border county	1.0034*	[1.0019, 1.0051]
Combined change in relative predicted probabilities based on lagged homicide rates in non-border county	1.0028*	[1.0014, 1.0037]

Panel C: Inclusion of categorical race indicators		
		95% Confidence Interval §
Marginal effect of patient residence in border county	-0.0023*	[-.0041339 -
Combined change in relative predicted probabilities based on lagged homicide rates in border county	1.0033*	[1.0022, 1.0048]
Combined change in relative predicted probabilities based on lagged homicide rates in non-border county	1.00179*	[1.00078,1.00281]

* indicates significance at a 95% confidence level.

§ Confidence interval for marginal effect of patient residence in border county is calculated using the delta method. Confidence intervals for combined change in relative predicted probabilities based on lagged homicide rates are calculated using bias corrected bootstrapping methods with 100 repetitions.

6. STUDY 3 – POTENTIALLY AVOIDABLE EMERGENCY DEPARTMENT USE IN THE US AND VIOLENCE IN MEXICO: IS THERE A RELATIONSHIP?

I.A. Overview

The objective of this study was to determine if there is an association between homicide rates in northern Mexico and potentially avoidable use of emergency departments (ED) in the US. We used secondary data from state inpatient and ED discharge databases for California and Arizona for 2005-2010. The study design was a retrospective observational analysis using generalized linear models was used to determine whether the probability an ED encounter was potentially avoidable was associated with homicide rates in the nearest Mexican municipality. To conduct the analysis, ED encounters were identified and matched with homicide rates in the nearest Mexican municipality and regional characteristics. The probability an ED encounter was potentially avoidable was calculated using the Billings ED algorithm. We found that there was no statistically significant relationship between homicide rates and the probability 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). There was not a strong relationship between homicide rates in northern Mexico and the distribution of ED discharges in Arizona and California.

I.B. Introduction

Emergency departments (ED), which serve as the "safety net of the safety net" for patients who are uninsured or lack access to community services,[88] 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.[89] A significant proportion of ED visits are for conditions that could be treated in a primary care setting.[90] The ED may act as a primary care provider, particularly for the uninsured or Medicaid beneficiaries, due to low access to outpatient care;[88,90,91] lack of access to ambulatory care can also exacerbate conditions to the point that the patient requires ED care.[73] Many of these visits could be treated at a lower cost in an outpatient setting[88,92].

Access to care in the US-Mexico border region of the United States is of increasing importance given the demographic and socioeconomic characteristics of this population, which has lower income, is less educated, and has higher rates of uninsurance than the rest of the US population.[3,25,31] A large proportion of people residing in the border region, defined as those counties within 100 km of the border,[25] access outpatient care in Mexico. Estimates of the prevalence of border crossing vary significantly from 11% to greater than 50% of the population;[1,2,27] the most recent 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.[6] Border crossing for healthcare is more common among, but not limited to, the uninsured, lower income households, the non-elderly, and Hispanics.[1,2,27] Individuals seek this care due to significantly less expensive provider options in Mexico, cultural preferences, and dissatisfaction with the US healthcare system.[2,4-6,26]

Beginning in late 2006, violence in Mexico increased rapidly, particularly in the northern border region adjacent to the US. In Baja California, the state adjacent to the majority of California, homicide rates increased more than 300% between 2005 and 2010.[33] Border crossing for healthcare may be sensitive to changes in crime rates for several reasons – increased risk of violence, reduced supply of Mexican healthcare providers, and increased border security leading

to longer travel time. Approximations by stakeholders in the border area estimate medical tourism by Americans to Tijuana was down 50% in 2010,[40] and that 30-50% of private clinics and pharmacies in Tijuana and Juarez had closed by 2010.[38,40] Thus, increased violence may have diminished border crossing for health care and therefore decreased access, which may manifest in lower self-reported access and/or increased incidence of hospitalization for preventable conditions. Indeed, previous research on the effects of this violence on healthcare access found evidence of associations between increased homicide rates and reduced total border crossing as measured by legal US entries but no association with self-reported access (Chapter 4 – Study 1), and an association between increased homicide rates and increased preventable hospitalizations (Chapter 5 – Study 2). Here, we extend previous work by using ED encounter data from Arizona (AZ) and California (CA) to evaluate the association between homicide rates in the nearest Mexican municipality (i.e., administrative unit similar to US county) and the probability that an ED encounter was for a potentially avoidable diagnosis.

I.C. Methods

Analytic Approach and Hypotheses:

We used a difference-in-difference approach to compare ED visits for patients for whom the closest Mexican municipality had a high homicide rate to those with a low homicide rate, and those in border counties to those in non-border counties. Variation in the homicide rate of the nearest municipality was both across geographic space and over time. We hypothesized ED encounters for patients in border counties with high homicide rates would have a higher probability of being for a potentially avoidable condition. We hypothesized ED encounters for patients in non-border counties would not be associated with homicide rates in Mexico as populations in non-border counties are less likely to seek care in Mexico. The rationale for these

hypotheses was that if individuals, particularly those who are uninsured, were unable to access care in Mexico, they would be more likely to present at an ED due to either an inability to access care at a lower-level US facility or due to a delay in seeking care, necessitating use of the ED.

Data and Analytic Sample Construction:

Inpatient and ED discharge databases from AZ and CA 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 AZ were from the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality.[12,17] Data for CA were from the State of CA Office of Statewide Health Planning and Development.[13,18] 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 (e.g. 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.

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 CA 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 CA discharge data included only discharge quarter, rather than discharge month, we conducted analyses using quarterly homicide and unemployment rates for both AZ and CA.

We used the ED algorithm developed by Billings [19] and validated by Ballard et al. [93] to classify ED encounters using the primary diagnosis code. The algorithm assigned the probability that the encounter was in each of four categories: non-emergent (NE); emergent, primary care treatable (EPCT); emergent, ED care needed, preventable or avoidable (EDCNPA); and emergent, ED care needed, not preventable or avoidable (EDCNNPA). For example, hypovolemia (ICD-9 276.5) was classified 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 classified by the algorithm but excluded from the analytic sample as they are not assigned probabilities in being in the four categories of ED use. 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 non-emergent, treatable in a primary care facility, or preventable by summing the NE, EPCT, and EDCNPA probabilities calculated by the algorithm. We termed this the probability of being a potentially avoidable ED encounter. We also calculated the probability of the encounter being for condition that did not require care in the ED; this was the sum of NE and EPCT categories from the algorithm and indicated the need for care in an ED.

The primary independent variables of interest were whether or not the ZIP code of patient residence [12] was in a border county and the homicide rate in the nearest Mexican municipality. The nearest Mexican municipality was determined by calculating the distance from the centroid of the patient's ZIP code to legal border crossings and assigning the Mexican municipality adjacent to the border crossing with the minimum distance. Distances were calculated using Google maps.[54] Quarterly homicide rates were calculated using monthly data on homicides from the Mexican National Institute of Statistics and Geography (INEGI; Instituto Nacional de Estadistica y Geografia).[33,34] Population denominators were obtained from INEGI from national censuses in 2005 and 2010; populations for the years in between were estimated using linear interpolation.[34]

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,[55] 2008 ZIP code level income quartile calculated using median household income for the four states in the US-Mexico border region,[75] residence in a metropolitan area,[76] and physician supply as measured by the number of physicians per 1,000 population.[94]

Statistical Analyses:

We estimated the relationship between the probability 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

[12] The 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.

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

where the outcome, Pr(*PotentiallyAvoidable)*, was a probability between zero and one. 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.

Given the fact that much of the variation in homicide rates resulted from variation over time, the error term was not likely to be independent identically distributed (i.i.d.); error terms were likely to be serially correlated over time. Serial correlation can cause difference-in-difference standard errors to be severely underestimated and cause the null hypothesis to be rejected when it is true.[95] Thus, there was a need to correct the standard errors. However, as serial correlation likely occurs at the Mexican municipality level, the number of groups was too small to use the most robust form of correction for this problem. ED encounters were matched to 12 municipalities, although four of these municipalities accounted for 98.5% of ED encounters. Thus, we used standard errors clustered at the county-quarter-year level (e.g., Los Angeles county for quarter 1, 2007). As the standard errors were likely to be biased with a small number of clusters,[95] this was a compromise between the more restrictive assumption of no clustering

(i.e., robust standard errors) and the generalized structure of clustering at the municipality level. 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 foregoing 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 non-border counties.

We compared descriptive statistics for ED encounters in border and non-border counties using chi-squared 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; Cary, NC); regression analyses used Stata 12.1 (StataCorp; College Station, TX).

Subgroup Analysis:

As 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 (i.e., 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;[77] additionally, interruptions in Medicaid coverage are common.[78]

I.D. Results

Descriptive Statistics:

A total of 24,859,273 ED encounters were included in the final analytic sample (Figure 6.1). On average, the encounters were assigned a probability of 0.767 of being potentially avoidable. Twenty-seven percent of encounters were for patients residing in a border county (Table 6.1). Encounters were more likely to be for female patients, younger (age 18-34 years)

patients, and have private insurance as the primary payer. The majority (97%) of ED encounters in border counties were in California. ED encounters in border counties were less likely to be covered by Medicaid, and 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 non-border counties being excluded from the samples than border counties; for encounters classified by the algorithm with any location information, 25.4% were in border counties while 26.7% were in border counties in the final analytic sample. Since missing data on age and gender were primarily censored for administrative reasons, we did not anticipate this is related to homicide rates and thus 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 non-border counties, although the effect was only statistically significant in non-border counties (Table 6.2). 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 non-metropolitan 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 non-border 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 6.2).

Subgroup Analysis:

We repeated the main analysis for uninsured and underinsured patients and found that the results were similar in direction and magnitude (Table 6.3). 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 in non-border counties.

I.E. 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 potentially 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 one standard deviation 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, which was 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 one standard deviation 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 were 0.23% increase and 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,[93] some have found that it is a less sensitive measure than simpler measure of access to care.[96,97] Others have found, however, that the algorithm can be used to detect changes in ED use with changes in insurance status and rates [98-102] and the presence of community health clinics [103] or free health clinics.[104] As the effect of homicides on healthcare access is relatively small as evidenced by other studies (Chapter 4 – Study 1; Chapter 5 – Study 2), it may be the case that this measure of access is not sensitive enough to detect any changes in access to care in Mexico.

There were several limitations to this analysis. The primary limitation was due to censoring in the CA 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. Since the majority of our data were from CA 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.

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 healthcare costs in the US.[88,92,105] 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 region.

I.F. Figures and Tables

Figure 6.1: Construction of Analytic Sample

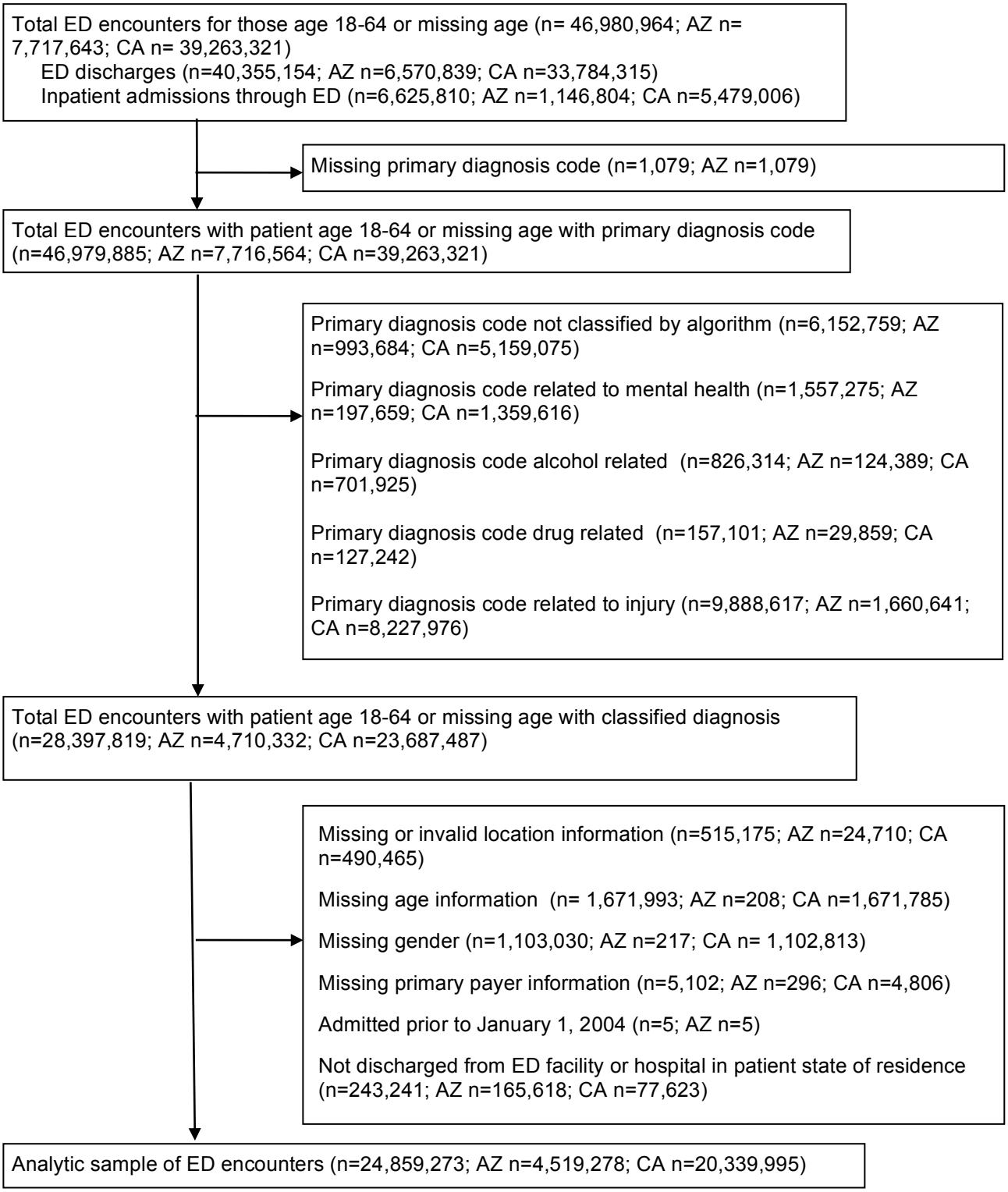

Table 6.1: Descriptive Statistics for ED Encounters in Arizona and California (2005-2010)

	Patient Residence in Border County			
	Overall (N=24,859,273)	**Border County (N=18,216,347)**	**Non-border County (N=6,642,926)**	**p**
	Mean (Standard Deviation) or %			
Potentially Avoidable ED Visit (Continuous)	0.767 (0.298)	0.768 (0.298)	0.765 (0.299)	<0.001***
Visit not requiring ED care (Continuous)	0.660 (0.308)	0.660 (0.309)	0.662 (0.306)	<0.001***
Homicide Rate per 100,000 Population in Matched Municipality (Quarterly)	4.079 (4.567)	3.662 (2.897)	5.223 (7.297)	<0.001***
Patient State of Residence				<0.001***
AZ	18.2	3.4	58.8	
CA	81.8	96.6	41.2	
Patient Gender				<0.001***
Male	38.7	38.9	38.1	
Female	61.3	61.1	61.9	
Age Category				<0.001***
18-34 years	51.6	50.6	54.2	
35-64 years	48.4	49.4	45.8	
Primary Payer				<0.001***
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	<0.001***
Year of Admission	2007.589 (1.715)	2007.586 (1.714)	2007.596 (1.718)	<0.001***
Admission Quarter	2.561 (1.041)	2.505 (1.102)	2.715 (0.831)	<0.001***
County Unemployment Rate (Quarterly)	7.990 (3.885)	8.227 (3.658)	7.338 (4.382)	<0.001***
Income Quartile of Patient Residence (5-digit ZIP)				<0.001***
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)	<0.001***
Metropolitan County	95.9	95.2	97.6	<0.001***
Driving Distance (km) to Nearest Border Crossing	421.504 (301.447)	516.037 (296.140)	162.273 (88.666)	<0.001***

P-values by t-test for continuous variables and chi2 test for binary / categorical variables

* p<0.05, ** p<0.01, *** p<0.001

Table 6.2: 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 non-border county on estimated probability of outcome	0.0010199 (0.0004179)*	0.0013064 (0.0005257)	-0.0002582 (0.0002069)

N=24,859,273 Standard errors 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<0.05, ** p<0.01, *** p<0.001

Table 6.3: 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 non-border county on estimated probability of outcome	0.0007526 (0.0004717)	0.0011533 (0.0005608)*	-0.0003548 (0.0002182)

N=11,700,123 Standard errors 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<0.05, ** p<0.01, *** p<0.001

7. DISCUSSION

Using population level secondary data sources, I investigated the relationship between violence in northern Mexico and healthcare access in the US-Mexico border region. Historically, a large proportion of the population in border areas cross into Mexico to seek healthcare and purchase pharmaceuticals, and it was unknown how these patterns of care seeking would be affected by the recent upsurge in violence in Mexico. Taken together, the results of the studies in this dissertation suggested some evidence of behavior change and an effect on preventable hospitalizations; however, the total effects of the violence on healthcare access were small, or for some measures, non-existent.

I.A. Results

In Study 1, I used data from the Bureau of Transportation Statistics (for legal US entries) and the BRFSS (for healthcare access) to measure associations between homicide rates, border crossing, and healthcare access. I found some behavior change in border crossing as evidenced by the negative association between homicide rates and legal US entries. An increase from the median monthly homicide rate (0.92 homicides/100,000 population) to the 90^{th} percentile (7.66 homicides/100,000 population), persistent over the six months prior, was associated with a 2.8% decrease in US entries. Despite this change in border crossing, I did not find an association between self-reported access on four measures and the homicide rate in the nearest Mexican municipality in border counties. The lack of association held for subgroups that were (based on the literature) more likely to seek care in Mexico: the uninsured, Hispanics, and those with

chronic conditions. Using subsamples containing additional data not available for the entire sample, I explored whether an increase in the percentage of the population in border counties that was born in Mexico affected the results and found there was no evidence for this. Some evidence showed that the main outcome measure, reporting a personal healthcare provider, might not be an ideal self-reported access measures to evaluate changes in cross-border healthcare access. Respondents who sought care in Mexico in the prior year were less likely to report having a personal healthcare provider, meaning this indicator may be less sensitive to changes in access than other measures used.

From a practical standpoint, the lack of a strong effect on self-reported measures of access led to a deviation from the proposed dissertation. Originally, I intended to use the increase in homicide rates as an instrumental variable for "access to primary healthcare" in determining the effect of access on hospitalizations for ACS conditions. This would have been a novel approach to determine whether access was associated with more appropriate healthcare use. Unfortunately, the weak (and in most cases, nonexistent) evidence linking increases in homicide rates to access rendered this approach intractable. As such, I did not pursue this line of research and instead augmented the analysis in Study 1, examining effects on subgroups and the effects of sample composition on the results.

In Study 2, I used inpatient hospital data for Arizona, California, and Texas for 2005 to 2010 to examine the association between homicide rates and the probability of being discharged with an ACS condition. The results showed a positive association between homicide rates and the probability of being discharged from the hospital with an ACS condition for patients residing in border counties. An increase of one standard deviation (6.1 homicides per 100,000 population) was associated with a 2.2 percentage point increase in the probability of being discharged for an

ACS versus marker condition for patients in border counties. The effect was larger for uninsured and underinsured (i.e., Medicaid) patients, who may be more affected by any changes in access in Mexico. The effect was not significant for those in the lowest income quartile among border states. Additionally, I found that residence in a border county was associated with a lower probability of being discharged for an ACS condition after controlling for physician supply, indicating that public health interventions and cross-border care may potentially alleviate some of the healthcare access issues in these counties.

Study 3 used ED discharge data in Arizona and California from 2005 to 2010 to evaluate the association between homicide rates and potentially avoidable ED visits. ED visits were assigned a probability of being potentially avoidable (i.e., non-emergent, emergent but primary care treatable, or emergent but avoidable) by the Billings ED algorithm. The results showed that there was no association between this probability and homicide rates in border counties. The results were similar for the uninsured and underinsured as for the full sample. When separating the analysis into the association with an ED visit being for a diagnosis not requiring ED care and that of ED necessary but avoidable, no additional information was found to suggest that ED care was being used as a substitute for ambulatory care.

I.B. Limitations

These studies were limited by several limitations common to all, as well as additional data limitations applying to each of the three studies. Major common limitations were a lack of information regarding a) supply side in the US or Mexico, b) compensatory responses in US border counties, and c) pharmaceutical purchase and use. To control for supply side factors influencing healthcare access, I included indicators of US county-level physician supply for each study. However, physician supply may not be a direct proxy for access to care for individuals.[84]

This is particularly true in the border region, where there may be free or low-cost services provided to certain population subgroups through community health fairs.[39] Additional changes in outpatient access during this period included the expansion of retail clinics,[85] reduction in the prices of generic prescriptions in the US (e.g., $4 prescriptions),[86,87] and possible relocation of Mexican physicians and pharmaceuticals to the US with illegal practice and medication distribution.[38] No information was available on physician supply in Mexico, which could give further information about responses to violence. The study design used difference-in-difference uses non-border areas as controls for border areas, so if there were changes in outpatient access happening throughout border states, then these should be adequately controlled for. However, if these changes were more intense in border areas than non-border areas, this may contribute to finding a lack of effect.

If there were compensatory responses to the violence in US border counties and resulting substitution of services in Mexico with services in the US, then the lack of large effects may not reflect the reality of changing patterns of care seeking behavior as a result of the violence. For example, if county public health departments in highly affected areas provided free healthcare to uninsured residents, then they may continue to consider themselves to have a personal healthcare provider, have access to care that prevents ACS admissions, and use this outpatient care rather than the ED. A substitution effect rather than continuing to seek care in Mexico or foregoing care altogether may be a positive effect for healthcare access, if the US healthcare system provides better care or care coordination than that in Mexico.

Due to a lack of information or data on pharmaceutical purchases or use, I was not able to determine the effects of violence on access to medications. Lack of access to medications may

contribute to increased hospitalizations for ACS conditions and increased use of the ED for potentially avoidable conditions.

Each individual study had limitations specific to the data used, which have been discussed within each chapter. Briefly, these limitations include the use of measures that may not be sensitive enough to capture changes in access, censoring of individual patient information in discharge data in California, and censoring at the hospital level in Texas. More broadly, Study 1 examined associations between violence and US entries and healthcare access for all four border states. Study 2 addressed access only for Arizona, California, and Texas, while Study 3 was limited to analysis of Arizona and California.

I.C. Policy Implications and Future Directions

As it appears that there was a small but significant change in healthcare access in the border region related to violence in Mexico as measured by ACS hospitalizations, it is important to monitor ongoing changes in the region. Although there was no association detected between violence and having a personal healthcare provider or ED utilization, it may be that these measures were not sensitive enough to detect small changes in healthcare access occurring in the region. The results from Study 2 suggest that hospitals in border regions where violence has been high may want to consider ways of increasing access to outpatient care for the uninsured and underinsured, as the hospitals may see an increase in uncompensated care related to these patients. Ways of increasing access may include partnering with community health centers or federally qualified health centers, forging relationships with non-governmental organizations in the community to reach affected populations, or working with public health clinics. If violence reduced access in Mexico, proposed cross-border health insurance products may not be effective in encouraging proper use of outpatient services. Other researchers have noted that due to the

presence of substitutes to formal US healthcare services, improving access to care in the border region may be more complicated than for other populations.[26]

Future directions of this research may include examining disparities in access between border and non-border regions, examining inpatient quality of care in border hospitals, and further exploration of the use of the ED algorithm in different patient populations.

I.D. Summary

These studies indicated there was a negative association between homicide rates in Mexico and border crossing, and a negative association between homicide rates and healthcare access as measured by preventable hospitalization but not by reporting a personal healthcare provider or the probability of ED use for potentially avoidable conditions. The combined results indicated that there was likely a small effect of violence in Mexico on healthcare access in that people went without care rather than substituting care from a Mexican provider with care from a US provider. The effects were small, but given the expense of hospital care, may have significant health and economic implications in highly affected areas.

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