CO-OCCURRENCE OF INTIMATE PARTNER VIOLENCE AND OPIOID USE IN NORTH CAROLINA: A COUNTY-LEVEL ANALYSIS

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ABSTRACT

This paper examines the relationship between assault against women and death from unintentional opioid overdose across counties in North Carolina between the years 2010 and 2015. This analysis uses opioid overdose death data as well as assaults against women in North Carolina to examine co-occurrence across counties.

Using county and year fixed-effects, I found a positive relationship between assault against women and opioid overdose death in non-rural counties and a slightly negative relationship in rural counties. This is finding may be due to measurement error created by low levels of assault reporting in some counties over time. Based on findings of the geographical trends of co-occurring overdose and assault against women as well as the limitations of this analysis, this paper makes recommendations for future research and policy initiatives for addressing intimate partner violence in the context of the opioid epidemic in North Carolina.

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This thesis is in memory of my uncle, Dan Broun. I carry with me his passion for rural health, family, and Carolina Basketball.

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CHAPTER I: SIGNIFICANCE AND SPECIFIC AIMS

The opioid epidemic has garnered considerable attention for the high numbers of opioid-related deaths and overdoses that have affected communities across the U.S. Opioids are a category of drug taken to reduce pain. The opioid epidemic refers to a rapid influx of illicit use of prescription opioids such as oxycodone, hydrocodone, morphine, and methadone, as well as illicit opioids such as heroin and synthetic fentanyl. In the United States, more than six out of ten deaths from drug overdose were due to opioids in 2014 (Rudd 2016, p. 1445). Since 1999, the number of people who died due to heroin or prescription opioid overdose has quadrupled (CDC 2017a). While the opioid epidemic first came about due to a rapid increase in physician prescribing and manufacturer distribution of prescription opioids, the epidemic has now morphed to be an issue of illegal markets and illegal drug use.

The opioid epidemic has taken a harsh toll on the state of North Carolina. According to the North Carolina Department of Health and Human Services (DHHS), between 1999 and 2016, opioid-related overdose deaths increased by over 800% (Prescription Drug Abuse Advisory Committee (PDAAC), 2017). In particular, heroin and other synthetic narcotics are a growing concern in North Carolina, with 2,277 emergency department visits related to heroin overdose in 2016 compared to 311 in 2011 (NC DHHS, 2017, p. 2), an increase of 632%.

Women's risk of dying from an opioid overdose is increasing at a greater rate compared to men. Between 1999 and 2010, overdose deaths from prescription painkillers increased more than 400% among women, compared to an increase of 265% among men (CDC 2017b). Women of reproductive age are prescribed opioids at higher rates, with one in four women with private insurance filling a prescription for opioids, and one in two women with Medicaid (Ailes et al., 2015). Compared to men, women are more likely to misuse prescription opioids for issues

related to emotional distress (McHugh et al., 2013, 41) (Back 2011, p. 829). This trend extends beyond legal opioids— between 2002 and 2013, heroin use increased 100 percent among women, twice the rate of men (CDC, 2015a).

Women may become addicted to opioids more quickly than men, after using smaller amounts drugs (NIDA, 2017, p. 1). Women are more likely to experience physical and sexual trauma compared to men, putting them at higher risk for substance abuse disorders. In addition, women are often introduced to intravenous drug use by their sexual partners (Greenfield, 2011, p. 5). In turn, these substance abuse disorders put them at risk for intimate partner violence (Smith 2012, p. 9). Women in rural areas are particularly at risk for opioid use disorders and domestic violence due to economic vulnerability, availability of drugs, and social factors (Lenardson 2016, p. 2) (Cole and Logan, 2010, p. 396) (Keyes et al., 2014).

I hypothesized that as county opioid overdoses increase over time, county reports of violence against women would also increase. I expected that this relationship to be stronger in rural counties compared to non-rural counties given the barriers to access to care and services in those counties. This project uses assault on women as a proxy for intimate partner violence (IPV) and opioid overdose death as a proxy for opioid use. By identifying areas of high co-occurrence in North Carolina, this analysis will expose potential avenues for addressing opioid dependence and domestic violence, thereby helping to protect the health of some of our state's most vulnerable citizens.

The relationship between female victimization and abuse of opioids has been well established. However, little data have been analyzed in the context of the recent dramatic increase in abuse of prescription opioids and other synthetic opioids across the United States. By examining the relationship between domestic violence and overdose at the county level in North

Carolina, this paper will explore the ways violence, addiction, and rurality are linked at a macro as well as micro level.

In the following chapter, I will outline the findings of other studies about the opioid epidemic in the context of women, and the complex links between domestic violence, addiction and opioid use disorders, and geography. Chapter 3 will describe the data sources and empirical methodology used for this project. Chapter 4 will display the empirical results of the data analysis as well as assess the strengths and weaknesses of the empirical design. Lastly, Chapter 5 will make conclusions and policy recommendations based on the findings in the data.

CHAPTER II: BACKGROUND AND CONCEPTUAL FRAMEWORK

Research supports that women's health is particularly at risk in the opioid epidemic. Opioid use disorders increase women's likelihood of experiencing violence. Conversely, women who have experienced violence are at risk for developing opioid misuse disorders. The literature finds that this cycle is particularly difficult to break in rural areas in the United States, where numerous factors put people at risk and hinder their ability to emerge from the cycles of addiction.

Women and Opioid Use Disorders

In general, women tend to progress more quickly than men from the point of initial substance use to problematic use of the substance. This rapid progression from the onset of substance use disorders to addiction is referred to as "telescoping" in the literature and is largely due to physiological differences between men and women. This phenomenon has been observed in alcohol addiction as well as in women who are drug dependent (Hernandez-Avila, 2004: 265). Consistent with the telescoping trend, women may become addicted to opioids more quickly than men, after using smaller amounts of the drug (NIDA, 2017).

Studies have shown women's risk of dying from an opioid overdose is increasing at a greater rate compared to men. Between 1999 and 2010, overdose deaths from prescription painkillers increased more than 400% among women, compared to an increase of 265% among men (CDC 2017b). Women's use of heroin is also a growing concern— between 2002 and 2013, heroin use increased 100 percent among women, twice the rate of men (CDC, 2015a).

Women face certain mental health factors that increase their risk for substance abuse disorders, including opioid use. Emotional and psychological stress is a more pronounced risk factor for addiction in women compared to men. In one study, women were significantly more

likely to use opioids to cope with personal stress compared to men—72.7% of women in the sample versus 27.3% men (Back 2011, p. 5). Women are more likely than men to have co-occurring mental health problems such as anxiety and depression along with substance use disorders. In addition, women often start using drugs in the context of an interpersonal relationship (Greenfield, 2011, p. 5).

Numerous studies have explored the links between substance abuse and trauma in women. Adult experiences of trauma and adverse childhood experiences have been shown to increase a person's likelihood to experience substance use disorders. Women who misuse substances are significantly more likely to have experienced trauma in their lifetimes compared to women in the general population (Najavit 1997, p. 274). Physical and sexual trauma are more likely to be experienced by women struggling with substance abuse disorders compared to men (Covington 2008, p. 380). Cocaine and opioids are significantly more linked to PTSD compared to marijuana and alcohol. Women are more likely to have co-occurring PTSD and substance abuse disorders compared to men, thereby increasing their risk for opioid use disorders—substance abuse disorders also increase a person's risk for PTSD (Najavit 1997, p. 274).

Women's unique roles in family structures impede their desires to seek treatment for opioid misuse disorder. Women who are caregivers are less likely to seek treatment because of the responsibilities associated with caring for children and fear that their children will be taken away. In addition, there is a greater societal stigma associated with substance abuse disorders in women compared to men (SAHMHSA 2009, p. 2). Women's high risks for opioid use disorders as well as co-occurring experiences of violence and mental illness suggest that they are an important vulnerable group to study.

Domestic Violence and Opioid Use Disorders

Intimate partner violence (IPV) and the opioid epidemic are inextricably linked (Smith 2012, p. 1). Trauma and mental health issues put women at risk for opioid misuse disorders while also increasing women's chances of experiencing violence.

Domestic violence is a complex public health issue. Male-perpetrated IPV against women has been linked to traditional gender roles in our society, specifically the norm of male dominance (Santana 2006, p. 576). Domestic violence is widespread—over 1/3 of women will experience domestic violence in their lifetime—including rape, physical violence, or stalking (Black et al. 2010, p. 2). Both domestic violence victimization and perpetration have been strongly associated with mental disorders such as depression and substance abuse.

The directionality of the relationship between domestic violence and substance use disorders has long been disputed. The experience of violence can bring on substance use disorders. On the other hand, substance abuse disorders may bring about victimization or perpetration of violence.

In a study by Smith et al, opioid use disorders were associated with intimate partner violence victimization in women but not in men. This suggests that a woman having an opioid use disorder increases the likelihood that she will experience violence (Smith et al., 2012, p. 1). Women experiencing violence may also be more likely to turn to opioids to relieve physical and/or emotional pain. As explained by the authors, this difference in victimization between men and women may be due to the fact that the using patterns of opioids are different for women compared to men, and that women are more likely to experience psychological and physical trauma from interpersonal violence compared to men (Smith et al., 2012, p. 9).

Women are at risk in many ways when they are in an environment of addiction. The positive and complex association between domestic violence and opioid use disorders enumerated in the literature further illustrates the importance of considering this link.

Opioids in the Southern United States

This analysis will focus on counties across the state of North Carolina. According to a CDC analysis of a large commercial database of prescriber trends, Southern states have higher rates of overprescribing of opioid pain relievers compared to other regions in the United States. In 2012, North Carolina ranked 13th in the nation for prescribing of opioid pain relievers, with 96.6 prescriptions per 100 people (Paulozzi, 2012, 126). Between 1999 and 2016, over 12,000 North Carolinians died from an opioid overdose.

Opioids in Rural Areas

People living in rural areas in the United States are particularly at risk for opioid misuse disorders. According to a report by the Office of Women's Health, death rates from drug overdose for women are most pronounced in rural areas in the South and Midwest (Office on Women's Health).

In 2015, rates of drug overdose deaths in rural areas surpassed rates in urban areas in the United States, reversing a previous trend. In 2015, the nonmetropolitan rate of overdose was 17 per 100,000 and the metropolitan rate was 16.2. The percentage change in the number of drug overdose deaths for females increased nearly 350% in non-metropolitan areas (Mack, 2017, p. 5).

Certain vulnerable populations are especially at risk in rural areas, including young people, pregnant women, women experiencing domestic violence, and people with co-occurring disorders (Lenardson 2016, p. 2). Rural adolescents are 26 percent more likely than urban

adolescents to engage in non-medical prescription drug use (Havens, 2011, p. 250). Additionally, people with opioid use disorders are more likely to be under the age of 20, have poor health, have low levels of education, be low income, be unmarried, and lack health insurance. People who use opioids in rural areas are more likely to be unemployed compared to those in urban areas (Lenardson, 2016, p. 3). In a sample of women who had recently experienced domestic violence, using opioids was significantly associated with the cumulative amount of interpersonal violence experienced throughout her lifetime as well living in rural Appalachia (Cole and Logan, 2010). Certain factors that put rural areas in the South at risk for non-medical prescription drug use have been identified in the literature. According to Keyes et al., these factors include greater availability of opioid drugs, out-migration of young people, interconnected kinship networks, and economic vulnerability (Keyes et al., 2014, p. e54-e55).

Strengths and Weaknesses of Prior Research

Prior research on this topic has focused on observing the relationship between opioid use disorders and risk for violence at the individual level. However, no research examines this relationship at the macro level. In order to create policies that are cost-effective and successful in reducing opioid use disorders and domestic violence, we must inform public policy using evidence-based approaches at the population level. This analysis will attempt to observe trends discovered in small sample sizes at a larger scale. It is important to observe such trends at the state level in order to identify the policy manifestations of smaller scale trends in individual behavior. By using population-level data, we can pinpoint opportunities for policy intervention—analysis at the broader level considers the collective aspects of these individual-level processes, whereas existing literature identifies the trends in how individuals in a small sample experience opioid use disorders and domestic violence.

Existing literature about the opioid epidemic largely focuses on men. This analysis will examine the impact of the opioid epidemic on women, giving special consideration to the circumstances faced by people living in rural areas. Policies to combat opioid misuse typically are made at the state level. As such, analysis of county-level data is important in order to provide clear and persuasive information on the burden of opioid use disorders and violence against women. This analysis will inform interventions designed to mitigate that burden.

This analysis will not be able to identify the direction of causation due to the bi-directional nature of the relationship between substance use and violence against women—women's experience of violence puts them at risk for substance use disorders. On the other hand, substance abuse disorders may bring about victimization. Many other factors such as socioeconomic status, availability of resources, and other mental health factors are also at play. This analysis will control for county-level measures including unemployment, availability of healthcare providers, and poverty, as well as county and year fixed effects. Regardless of the causality of the relationship, it is important for policymakers to be aware of the co-occurrence of these two phenomena, as both introduce opportunities for intervention.

CHAPTER III: DATA AND EMPIRICAL STRATEGY

Description of Data

In this analysis, I explore the relationship between opioid use and violence against women. To measure this relationship, data from the Injury and Violence Prevention Branch Epidemiology Surveillance Unit of the North Carolina Division of Public Health at the North Carolina Department of Health and Human Services (DHHS) for counts of opioid overdose death. Using a linear regression model (Ordinary Least Squares) and a Poisson count model with fixed effects, the relationship between assault against women and opioid overdose death in counties across North Carolina between the years 2010-2015 will be investigated.

North Carolina has 100 counties, which I observe over a period of 6 years from 2010-2015. For key summary statistics about the available sample when comparing rates of opioid overdose death and assault against women, see Tables 2 and 3. For the Poisson analysis and the linear regression analysis observing the co-occurrence of opioid death and assault against women, the maximum total number of observations was 565, with 445 observations when restricting the analysis to rural counties, and 120 observations for non-rural counties (see Tables 2 and 3).

NC DETECT

Counts of assault against women that present to emergency departments were obtained from the North Carolina Disease Event Tracking and Epidemiological Collection Tool (NC DETECT). Rates are defined as the number of incidences divided by the county population in a given year (obtained from CDC WONDER) and scaled by 100,000.

A statewide mandate requires all civilian emergency departments in North Carolina to submit certain emergency department data elements to this database. NC DETECT is funded by

the North Carolina Department of Health and Human Services (DHHS) as well as through federal grants from the Centers for Disease Control and Prevention (CDC). Counts of opioid overdose deaths are publicly available from DHHS.

Key Variables

Opioid Death: Opioid overdose death rates are used as a proxy for measuring opioid use. Emergency department data on opioid-related visits was gathered, but missing data and restricted availability of years prevented these data from being utilized in this analysis. Opioid use is underreported and difficult to measure (Puja et al., 2018, p. 500). The proxy measure of opioid overdose death is also underreported (Ruhm, 2017).

Rates of opioid overdose death were collected by using the counts of unintentional opiate poisoning deaths by county of NC residents from the years 1999-2016. An unintentional poisoning is defined as occurring "when a person taking or giving too much of a substance did not mean to cause harm" (CDC, 2015b). These deaths included unintentional deaths due to opium, heroin, other opioids, methadone, or other synthetic opioids.

Rates were measured as the count of opioid overdose death divided by the population and scaled by 100,000 by county and year.

Rates of opioid overdose death have increased dramatically across counties in North Carolina over the past two decades. This trend is demonstrated in Figure 1, which includes opioid overdose death rate averages for rural, non-rural, and the overall sample between the years 1999 and 2016. As illustrated in Table 1, the mean opioid overdose death rate is slightly higher in rural areas compared to non-rural counties. In addition, the maximum value is higher in rural areas—58.97 per 100,000 compared to 28.65 per 100,000 in non-rural counties.

The percent change in opioid overdose deaths between 1999 and 2016 demonstrates this

trend. From 1999 to 2016, I found that the percentage increase in opioid overdose deaths was 951.57% overall, 1174.25% for rural counties, and 517.02% for non-rural counties in North Carolina.

Assault: According to the North Carolina Violent Injury Report, assault is defined as "a suspected or confirmed injury or poisoning resulting from 'an act of violence where physical force (or poisoning) by one or more persons is used with the intent of causing harm, injury, or death to another person'" (Harmon et al., 2017, p. 4). Only assaults against women were used in this analysis.

Most cases of domestic violence are unreported (Gracia, 2004). I used assault against women as a proxy for intimate partner violence. In doing so, I assume that this assault data captures changes in violence against women and therefore estimates how opioids affect the victimization of women in partnerships.

I obtained data of counts of assault against women from NC DETECT. I did not restrict these counts to include assaults against women over the age of 18 because the literature suggests many people start using opioids under the age of 18, disproportionately so in rural areas. I wanted to capture the relationship between opioid overdose and violence for this younger population. It should be noted that some of these counts may be instances of child abuse. To create rates, I divided counts by the corresponding female population and scaled by 100,000. As demonstrated by Figure 2, there has been an overall decline in the rates of assault against women. The sharp decline in the year 2015 is due to low E-code reporting as a result of the switch from ICD-9-CM to ICD-10-CM codes. The effect of this inconsistent reporting will be discussed in Chapter 4.

The mean assault rate is much higher in rural counties compared to non-rural with a

higher standard deviation, as well as higher minimum and maximum values (See Table 1).

Other Variables

Population: To create rates consistent with the methods used in the Violent Injury Report, I used the CDC WONDER Bridged Population estimates for women. To create rates of opioid overdose death, I used an overall population value not restricted to women.

Rural vs. Non-Rural Counties: This analysis uses the North Carolina Rural Center's definition for rural, suburban, and urban areas to define counties as rural or non-rural. According to the 2014 United States population estimates, there are 80 rural counties in North Carolina with population densities of 250 people per square mile or less, making up 41 percent of the state population. Suburban counties make up 14 of 100 counties in North Carolina, with population densities between 250 and 750 people per square mile. These counties account for 25 percent of the state population. Six counties with population densities between 750 and 1,933 people per square mile make up the urban counties in North Carolina, accounting for 34 percent of the state population. According to 2010 Census data, North Carolina has the second-largest rural population in the nation. This analysis designated all counties as rural or non-rural. In North Carolina, there were 80 rural counties and 20 non-rural counties.

Poverty: I controlled for poverty using a measure of poverty from the American Community Survey (ACS) by the U.S. Census Bureau. Specifically, I controlled for the percentage of the county population whose income in the past 12 months is below the poverty level. As illustrated in Figure 3, rates of poverty are higher in rural counties compared to non-rural counties in North Carolina. According to this measure, the poverty rate is higher in rural areas compared to non-rural areas (See Table 1).

Provider Availability: Using the North Carolina Health Professions Data System, I

queried the available data for physicians per 10,000 population. These data are derived from the North Carolina Board of Medicine. The counts of physicians include those in practice in the state as of October 31st of each year and do not include residents-in-training or federal employees. The county estimates are based on primary practice location. Population data are from the North Carolina Office of State Budget and Management based on US Census data (North Carolina Health Professions Data System). There is a much lower ratio of physicians to population in rural counties in North Carolina compared to non-rural counties (See Figure 4 and Table 1).

Unemployment: I queried the Local Area Unemployment Statistics (LAUS) program in the Bureau of Labor Statistics (BLS) for county-level unemployment rates for counties in North Carolina. The BLS defines unemployed people as "all persons who had no employment during the reference week, were available for work, except for temporary illness, and had made specific efforts to find employment during the 4 week-period ending with the reference week. Persons who were waiting to be recalled to a job from which they had been laid off need not have been looking for work to be classified as unemployed."

This unemployment rate was provided as the unemployed percent of the civilian labor force—unemployed/civilian labor force times 100 (Bureau of Labor Statistics). Unemployment in rural counties is higher compared to unemployment in non-rural counties in North Carolina (See Figure 5 and Table 1.)

Empirical strategy

I estimated the co-occurrence of assault against women and opioid overdose death by using two fixed effects models, which exploit within-county variation over time while controlling for shocks that may have occurred across time.

The main assumption underlying this approach is that changes in outcomes would have

been the same across North Carolina counties in the absence of differential changes in assaults against women (Cunningham et al., 2017). Using a Poisson approach, I first estimate the co-occurrence of opioid overdose death and assault on women corresponds to the following equation:

$$Y_{ct} = \exp(\beta_0 + \beta_1 opioiddeath_{ct} + \beta_2 provrate_{ct} + \beta_3 povrate_{ct} + \beta_4 unemplrate_{ct} + \theta_c + \pi_t + \varepsilon_{ct})$$

where Y_{ct} is the count of assault against women for county *c* in year *t;* $opioiddeath_{ct}$ is the rate of opioid overdose death for residents of county *c* in year *t;* $provrate_{ct}$ is the rate of physicians for residents of county *c* in year *t;* $povrate_{ct}$ is the percentage of people below the poverty line in county *c* in year *t;* $unemplrate_{ct}$ is the unemployment rate for county *c* in year *t;* Θ_c are county fixed effects, which control for unobserved county characteristics; π_t are year fixed effects, which control for time-varying factors affecting rates of assault in all North Carolina counties in the same manner; and ε is the error term for county *c* in year *t*.

I interpret the results of the Poisson analysis by calculating the percentage change of the counts of assault against women. I convert the natural log of the counts to percentage change by calculating (exp(coefficient)-1)*100.

I use a linear regression with fixed effects as an alternative model with which to observe this relationship. This linear regression model uses rates as the dependent variable while the Poisson model uses counts. I divide the coefficients observed in the linear model by the average assault rates then multiply by 100 to estimate a percentage change.

$$Y_{ct} = \beta_0 + \beta_1 opioiddeath_{ct} + \beta_2 provrate_{ct} + \beta_3 povrate_{ct} + \beta_4 unemplrate_{ct} + \theta_c + \pi_t + \varepsilon_{ct}$$

where Y_{ct} is the rate of assault against women for county c in year t; $opioiddeatht_{ct}$ is the rate of opioid overdose death for residents of county c in year t; $provrate_{ct}$ is the rate of physicians for residents of county c in year t; $povrate_{ct}$ is the percentage of people below the poverty line in county c in year t; $unemplrate_{ct}$ is the unemployment rate for county c in year t; Θ_c are county fixed effects; π_t are year fixed effects; and ε is the error term for county c in year t. I use the cluster command to delineate the counties as groups in the data. By using clusters in this way, I account for repeated county observations over time. These similarities are accounted for in the standard errors in Table 3.

CHAPTER IV: RESULTS

This chapter examines the results of the Poisson and linear regression analysis of the relationship between assault against women and opioid overdose death. The main findings of this research are that the relationship between assault against women and opioid overdose death is statistically significant and positive in non-rural counties and statistically significant and slightly negative in rural counties.

Using county-level fixed effects, I examined within-county variation in the relationship between assault against women and opioid overdose death. County fixed effects allow me to measure county-specific unobservables that do not change over time, while year fixed effects allow me to estimate common time shocks across the state as a whole. Limitations arise when variables do not change much within counties or over time. By focusing on within county variation, we shift our focus from how this relationship differs between counties, relying on changes in counties over time.

Overall Results

I will now present estimates of the overall co-occurrence of opioid overdose death and assault against women based on this research design. I begin in Column 5 of Table 2, with estimates from the Poisson model, controlling for county fixed effects and year fixed effects as well as for poverty, unemployment, and physician availability.

The analysis for all counties estimates a minimally positive relationship—for every one-unit increase of opioid overdose death. This relationship is not statistically significant for the overall analysis, with a p-value of 0.817. I utilized an alternative linear regression model, also controlling for year and county fixed effects. The overall relationship was negative and not statistically significant, with a p-value of 0.781 (see Column 5, Table 3).

The relationship between X and Y was only statistically significant when separated by rural and non-rural counties, suggesting that counties face different circumstances depending on their level of rurality.

Rural/Non-Rural Results

I performed separate analyses for rural and non-rural counties. In non-rural counties, the relationship was positive and statistically significant for the Poisson analysis of counts of assault against women. The positive coefficient suggests that for every one-unit increase of opioid overdose death, there was a 0.0254 increase in the natural log of the count of assault against women. This relationship was statistically significant below the level of 0.05, with a p-value of 0.017 (See Column 6 of Table 2). I calculated a percentage increase of 2.57 percent.

Using a linear regression, I observed that for every one-unit increase in the rate of opioid overdose death per 100,000 people, there was a 5.34 unit increase in the rate of assault against women. Dividing this coefficient by the mean assault rate, I calculated a 0.017 percentage increase. I found the non-rural relationship to be statistically significant below the level of 0.1 (See Column 6 of Table 3).

In rural counties for the Poisson analysis, this relationship was negative with a coefficient of -0.0062 when controlling for county-level fixed effects and year fixed effects. This coefficient suggests that for every one-unit increase of opioid overdose death rate against women, there was a 0.0062 decrease in the natural log of the count of assault against women. This value translates to a -0.62 percentage decrease, with a p-value of 0.028. This relationship was statistically significant, with a p-value below the level of 0.05 (See Column 7 of Table 2). Using a linear model with fixed effects, the relationship in rural counties was also negative, with a coefficient of -0.3617. This value was not statistically significant (See Column 7 of Table 3).

Controlling For Other Variables

Controlling for poverty, unemployment, and shortages of health providers had a minimal effect on the relationship between assault against women and opioid overdose death. When I controlled for these variables using the Poisson model, the overall relationship became slightly more positive but remained statistically insignificant. There was little change in the coefficients for the rural and non-rural analyses and no change in statistical significance was observed (See Table 2).

In the regression model with fixed effects, controlling for provider availability, poverty, and unemployment in the linear regression with fixed effects resulted in no change in the statistical significance of relationship between violence against women and opioid use for overall, rural, and non-rural analyses—overall and rural relationship remained insignificant, and non-rural remained significant to the level of 0.1. In addition, there was little change in the coefficients. Controlling for these factors made the coefficients slightly less negative for the overall and rural analyses (See Table 3).

Poverty was statistically significant for the rural areas using the linear regression model. The coefficient was -8.0442 and was significant below the level of 0.1. Poverty was not significant for the Poisson model.

Limitations

In developing a proxy for violence against women, I chose to not restrict my analysis to counts of assault against women above the age of 18. Opioid use disorders are increasingly common among people below the age of 18. As such, this relationship is important to observe for people below this age range. It should be noted that some of the counts of assault might be counts of child abuse, thus making this measurement a less robust proxy for intimate partner

violence.

There are fewer observations available for non-rural counties since there are only 20 non-rural counties compared to 80 rural counties in North Carolina.

Emergency departments use E-codes to designate emergency department visits as assault. As demonstrated by Table 4, there are huge fluctuations in the percentage of emergency department visits coded by counties using E-codes, which could create measurement error. The counties that are highlighted in yellow in Table 4 have a mean E-code reporting rate less than 75 percent for the study period.

This issue is particularly dramatic for the counts of assault in the year 2015, due to a switch from ICD-9-CM to ICD-10-CM—only nine months of data are reported. As can be seen from Figure 2, there is a dramatic drop in the number of reported assaults in this year. Year fixed effects control for some of this in 2015.

The statistical significance of the results of this analysis poses opportunities for thinking about how relationships observed at smaller scales may be observed differently at the macro level. In addition, this analysis suggests that opioid overdose death and assault against women for the years 2010-2015 may not be effective proxies in examining this relationship.

Addressing Limitations

To account for gaps in my data, I reconsidered the models denoted by equations 1 and 2. I first ran both the Poisson and linear models excluding the year 2015, in which only nine months of data were reported. The results were qualitatively similar for the Poisson analysis. For the linear analysis, the overall relationship between opioid death and assault against women became slightly positive, with a coefficient of 0.03. However, this value was not significant, with a p-

value of 0.964. The coefficient in non-rural areas was 0.19 with a p-value of 0.93, and the coefficient in rural areas was 0.11, with a p-value of 0.879.

Next, I excluded the 12 counties for which the mean rate of E-code reporting between year X and year Y was less than 75%. The results were not qualitatively different for Poisson analysis. For the linear regression, I observed slight changes in the coefficients—the overall relationship remained negative but insignificant, with a coefficient of -0.33 and a p-value of 0.602. In non-rural areas, the coefficient was 2.99 with a p-value of 0.237. In rural counties, this relationship was still negative, with a coefficient of -0.47 and a p-value of 0.481.

CHAPTER V: CONCLUSIONS

Summary of Findings

The findings of this analysis are not consistent with my original hypothesis. Based off of the literature on the correlation between substance use disorders and interpersonal violence, I expected there to be a positive relationship between violence against women and opioid use in rural areas. I hypothesized that this relationship would be less strong or nonexistent in non-rural areas. To the contrary, I found a negative relationship between assault against women and opioid overdose death in rural counties, and a positive relationship in non-rural counties in North Carolina.

Multiple factors may explain this discrepancy between my findings and the literature—this analysis used macro-level data as well as proxies for intimate partner violence and opioid use. The measures I chose—opioid overdose death and assault against women between the years of 2010 and 2015—may not be effective proxies for observing a co-occurrence of opioid use and violence against women. Despite the fact that this relationship was not observed as expected based off of the literature, this analysis may have policy implications and its limitations are important to consider to inform future research. In this chapter, I will make conclusions based on the results of this analysis and suggest next steps for further research and policies based off of these findings.

Findings in rural areas

In rural counties in North Carolina, effectively no relationship was observed between opioid use and violence against women using the linear regression model. Using the Poisson analysis, this relationship was slightly negative (See Tables 2 and 3). Given the literature suggesting that women in rural areas may be more at risk for opioid use disorders and

interpersonal violence, this relationship should still be monitored closely in rural counties.

Multiple factors may explain why a positive relationship between intimate partner violence and opioid use was not observed. Certain protective factors may exist in rural counties that do not exist in urban counties. For example, interconnected kinship networks in rural parts of North Carolina may prevent this relationship from occurring. In addition, higher levels of stigma in rural areas about opioid use and intimate partner violence may prevent people from reporting events of this nature to emergency departments.

It is also possible that lower levels of E-code reporting for both assaults against women and opioid overdose death occurs in rural areas compared to non-rural counties in North Carolina, thereby falsely suggesting a negative relationship. The impact of low levels of E-code reporting will be discussed further in the limitations section.

Findings in non-rural areas

In non-rural counties in North Carolina, a positive relationship was observed between violence against women and opioid use using the proxies of assault against women and opioid overdose death. As explained by the literature, a positive relationship between violence and substance use may be explained by the role that trauma and mental health play on women's likelihood to use substances and experience interpersonal violence. This leads to a harmful cycle—these experiences, in turn, put women at a higher risk of experiencing psychological trauma and thus more of these adverse experiences. Since opioid use and intimate partner violence are more consistently reported in non-rural areas—of the 12 counties with below 75% E-code reporting, all but two are designated rural—the relationship may be more robust in these counties (See Table 4).

Controls

The fact that no relationship was found in controlling for poverty, unemployment, and rates of providers suggests that the data may have been incomplete. This analysis used the percentage of people below the poverty line, the percent unemployment, and the ratio of physicians to the population as proxies for poverty, economic hardship, and lack of access to healthcare that characterize rural areas. Proximity to physicians may too broad of a specification to have a real impact on the association of violence and opioid use. Further specifying the type of physician may have resulted in statistically significant findings. For example, the proximity to physicians who are certified to provide medication-assisted treatment, or the proximity to domestic violence shelters may be more closely linked to the relationship in question.

Limitations

Multiple biases may exist in the measurement of key variables. In particular, underreporting of assaults and opioid overdose death must be considered. As previously discussed, the low levels of E-code reporting as well as underreporting of opioid overdose death and assault against women likely had a significant effect on my ability of measure the relationship between intimate partner violence and opioid use. The 2015 switch from ICD-9-CM to ICD-10-CM codes led to a decrease in the number of assaults that were coded in that year—this year contains only nine months of data due to the switch in this coding system. While year fixed effects aim to control for such shocks, this may have led to biased results. It is also important to remember that many counties have contributed different levels of E-code reporting over the course of this five-year period. As such, it is possible that apparent increases or decreases in assaults may have been the result of changes in E-code reporting rather than a true trend (See Table 4).

I obtained assault data for the years 2010 to 2015, thereby restricting the analysis despite

the more widespread availability of opioid death data. This limits the amount of within-county variation that I am able to observe. By 2010, the opioid epidemic was already well underway.

My attempts to address these limitations through running the Poisson and linear models excluding the year 2015 and counties with rates of e-code reporting less than 75% were not fruitful for the Poisson analysis. For the linear regression analysis, I found that the coefficients became positive when I excluded the year 2015, despite the fact that all statistical significance was lost. When excluding counties with reporting levels below 75%, there were no changes in the directionality of the relationships. However, the slight changes in the values of the coefficients suggests that low levels of reporting may have an effect on the strength of the relationship observed.

Future Research

Future research on the relationship between IPV and opioid use should focus on developing effective proxies for estimating the key variables of interest. If relying on emergency department data, more years of data should be gathered for opioid-related emergency department visits and assaults against women. By extending this analysis to include assault data before the year 2010—before the dramatic rise of opioid use in North Carolina—researchers will gain a better understanding of this relationship over time.

In addition, data with higher percentages of E-code reporting would allow for more confidence in this analysis. If possible, researchers should query the system to be able to measure emergency department visits below the number ten. Currently, this data is not available due to privacy concerns.

The fact that the relationship between these variables in the overall analysis was insignificant but that splitting counties into non-rural and rural subgroups resulted in statistically

significant results suggests that counties in North Carolina may face different circumstances based on their rurality. Future research should take into account the possibility of sub state-level differences and more data should be gathered about county-level statistics.

More analysis is needed at the macro level—there are different factors at play compared to what the existing literature finds at the individual-level analysis. Given that policies are made at a state level, in order to implement widespread policy changes aimed at combatting these issues, research on the relationship between opioids and intimate partner violence is important. In the process of collecting this data, county-level differences should be taken into account.

Future research may also include studying approaches to best train medical providers and organizations aiming to combat intimate partner violence to help women who are experiencing both intimate partner violence and opioid use disorders. Lastly, future research could explore ways to encourage women to report interpersonal violence and assault.

Policy implications

This analysis found there to be a positive relationship between assault against women and opioid overdose death in non-rural counties in North Carolina. If this relationship is accurate, multiple policy changes are implicated.

The relationship between violence against women and opioid use has been shown by the literature to be bi-directional. In other words, opioid use can put women at risk for experiencing victimization; additionally, women who experience interpersonal violence are more likely to experience substance use disorders including opioid use (Smith et al., 2012). As such, policy interventions should address both sides of this relationship to improve the overall health and safety of women in the context of the opioid epidemic.

Opportunities to stymie this relationship include increasing awareness, especially in non-

rural counties where this may especially be the case. In addition, given the bi-directionality of this relationship, services that aim to address opioid combat violence against women should be aware that their clients or patients may be at a high risk for both. This co-occurrence may lead to other issues that negatively impact their emotional health, leading to increased substance misuse and victimization.

Given the high risks facing rural areas, this relationship should still be monitored in these counties, despite the fact that no positive relationship was observed in this analysis.

Policy changes should reflect county-level circumstances. While state policies should aim to increase the availability of funding for counties to combat the opioid epidemic, there should be ample amount of room for the county-level officials to implement these policies as best fits their community.

Most broadly, there should be an increase in funding to specifically address women's issues in the opioid epidemic. Policymakers should focus on increasing funding for domestic violence shelters as well as treatment centers that focus on the unique needs of women with opioid use disorders. Women are increasingly at risk for addiction and overdose and are less likely to seek treatment. According to a survey by the National Survey on Drug Use and Health, men were significantly more likely to utilize treatment compared to women (Back 2010). There is a need for gender-specific treatment services (Greenfield et al., 2010). Funding for treatment options for women could come in the form of state or federal grants to existing treatment centers and health systems. Treatment centers for women should focus on encouraging more women to receive care by having residential options for women with children while addressing the psychological needs and trauma history that this population is likely to have.

Lastly, policymakers could increase women's access to treatment by addressing barriers

to Medicaid and insurance reimbursement for medication-assisted treatment as well as holistic pain management techniques.

Summary

Literature shows that intimate partner violence and opioid use disorders are linked, with people living in rural areas particularly at risk for this relationship. Using proxies for violence against women and opioid use derived from emergency department data, this study found a potential link between these factors in non-rural counties but not in rural counties. This study attempts to expand the research literature by examining this relationship at the macro level and to shed light on the need for future research in this area.

REFERENCES

Ailes, E. C., Dawson, A. L., Lind, J. N., Gilboa, S. M., Frey, M. T., Broussard, C. S., & Honein, M. A. (2015). Opioid prescription claims among women of reproductive age--United States, 2008-2012. *MMWR. Morbidity and mortality weekly report*, *64*(2), 37-41.

Back, S. E., Lawson, K. M., Singleton, L. M., & Brady, K. T. (2011). Characteristics and correlates of men and women with prescription opioid dependence. *Addictive Behaviors*, *36*(8), 829-834.

Back, S. E., Payne, R. L., Simpson, A. N., & Brady, K. T. (2010). Gender and prescription opioids: Findings from the National Survey on Drug Use and Health. *Addictive behaviors*, *35*(11), 1001-1007.

Black, M. C., Basile, K. C., Breiding, M. J., Smith, S. G., Walters, M. L., Merrick, M. T., & Stevens, M. R. (2011). The national intimate partner and sexual violence survey: 2010 summary report. *Atlanta, GA: National Center for Injury Prevention and Control, Centers for Disease Control and Prevention*, *19*, 39-40.

Bureau of Labor Statistics. 2018. Local Area Unemployment Statistics. https://www.bls.gov/lau/laufaq.htm.

CDC. (2015a). *Today's Heroin Epidemic Infographics*. https://www.cdc.gov/vitalsigns/heroin/infographic.html.

CDC. (2015b). *Poisoning. https://www.cdc.gov/HomeandRecreationalSafety/Poisoning/index.html*

CDC. (2017a). Drug Overdose Deaths in the United States Continue to Increase in 2015. https://www.cdc.gov/drugoverdose/epidemic/index.html.

CDC. (2017b). Prescription Painkillers Overdoses: A Growing Epidemic, Especially Among Women. https://www.cdc.gov/vitalsigns/prescriptionpainkilleroverdoses/index.html.

Cole, J., & Logan, T. K. (2010). Nonmedical use of sedative-hypnotics and opiates among rural and urban women with protective orders. *Journal of addictive diseases*, *29*(3), 395-409.

Covington, S. S. (2008). Women and addiction: A trauma-informed approach. *Journal of psychoactive drugs*, *40*(sup5), 377-385.

Cunningham, S., Lindo, J. M., Myers, C., & Schlosser, A. (2017). How far is too far? New evidence on abortion clinic closures, access, and abortions (No. w23366). National Bureau of Economic Research.

Gracia, E. (2004). Unreported cases of domestic violence against women: towards an epidemiology of social silence, tolerance, and inhibition.

Greenfield, S. F., Back, S. E., Lawson, K., & Brady, K. T. (2010). Substance abuse in women. *Psychiatric Clinics*, *33*(2), 339-355.

Harmon KJ, Waller AE, Harduar Morano L, Ising A. (2017). *A Report on Violent Injuries Treated in Emergency Departments: 2012-2015*. Chapel Hill: NC. Carolina Center for Health Informatics, Department of Emergency Medicine, University of North Carolina at Chapel Hill. Available at: http://ncdetect.org/reports/.

Havens, J. R., Young, A. M., & Havens, C. E. (2011). Nonmedical prescription drug use in a nationally representative sample of adolescents: Evidence of greater use among rural adolescents. *Archives of Pediatrics & Adolescent Medicine*, *165*(3), 250-255.

Hernandez-Avila, C. A., Rounsaville, B. J., & Kranzler, H. R. (2004). Opioid-, cannabis-and alcohol-dependent women show more rapid progression to substance abuse treatment. *Drug and alcohol dependence*, *74*(3), 265-272.

Keyes, K. M., Cerdá, M., Brady, J. E., Havens, J. R., & Galea, S. (2014). Understanding the rural–urban differences in nonmedical prescription opioid use and abuse in the United States. *American journal of public health*, *104*(2), e52-e59.

Lenardson, M. H. S., Jennifer, D., Gale, M. S., John, A., & Ziller PhD, E. (2016). Rural opioid abuse: Prevalence and user characteristics.

Mack KA, Jones CM, Ballesteros MF. Illicit Drug Use, Illicit Drug Use Disorders, and Drug Overdose Deaths in Metropolitan and Nonmetropolitan Areas — United States. MMWR Surveill Summ 2017;66(No. SS-19):1–12.
DOI: http://dx.doi.org/10.15585/mmwr.ss6619a1.

McHugh, R. K., DeVito, E. E., Dodd, D., Carroll, K. M., Potter, J. S., Greenfield, S. F., ... & Weiss, R. D. (2013). Gender differences in a clinical trial for prescription opioid dependence. *Journal of substance abuse treatment*, *45*(1), 38-43.

Najavits, L. M., Weiss, R. D., & Shaw, S. R. (1997). The link between substance abuse and posttraumatic stress disorder in women. *The American journal on addictions*, *6*(4), 273-283.

National Institute on Drug Abuse. (2017, April 6). Substance Use in Women. Retrieved from https://www.drugabuse.gov/publications/drugfacts/substance-use-in-women on 2018, January 21.

NIDA. (2016). Substance Use in Women. Retrieved from https://www.drugabuse.gov/publications/research-reports/substance-use-in-women on 2017, November 12

North Carolina Department of Health and Human Services (NC DHHS). (2017). *Opioid-Related Overdoses*. https://files.nc.gov/ncdhhs/Opioid_Overdose_Factsheet_FINAL_06_27_17.pdf.

North Carolina Health Professions Data System, Program on Health Workforce Research and Policy, Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill. Created February 25, 2018 at https://nchealthworkforce.sirs.unc.edu/.

Office on Women's Health . 2017. *Final Report: Opioid Use, Misuse, and Overdose in Women*. https://www.womenshealth.gov/files/documents/final-report-opioid-508.pdf.

Paulozzi, L. J., Mack, K. A., & Hockenberry, J. M. (2014). Variation among states in prescribing of opioid pain relievers and benzodiazepines—United States, 2012. *Journal of safety research*, *51*, 125-129.

Prescription Drug Abuse Advisory Committee (PDAAC). (2017). *North Carolina Opioid Action Plan (2017-2021)*. https://files.nc.gov/ncdhhs/Opioid%20Plan%20Fact%20Sheet_FINAL_6_27_17B.pdf.

Rudd, R. A. (2016). Increases in drug and opioid-involved overdose deaths—United States, 2010–2015. *MMWR. Morbidity and mortality weekly report*, *65*.

Santana, M. C., Raj, A., Decker, M. R., La Marche, A., & Silverman, J. G. (2006). Masculine gender roles associated with increased sexual risk and intimate partner violence perpetration among young adult men. *Journal of urban health*, *83*(4), 575-585.

Substance Abuse and Mental Health Services Administration (SAMHSA). (2009). *Substance Abuse Treatment: Addressing the Specific Needs of Women*. Rockville, MD: HHS Publication No. (SMA) 09-4426.

Smith, P. H., Homish, G. G., Leonard, K. E., & Cornelius, J. R. (2012). Intimate partner violence and specific substance use disorders: Findings from the National Epidemiologic Survey on Alcohol and Related Conditions. *Psychology of Addictive Behaviors*, *26*(2), 236.

APPENDIX

Figure 1. Opioid Overdose Death Rates, 1999-2016

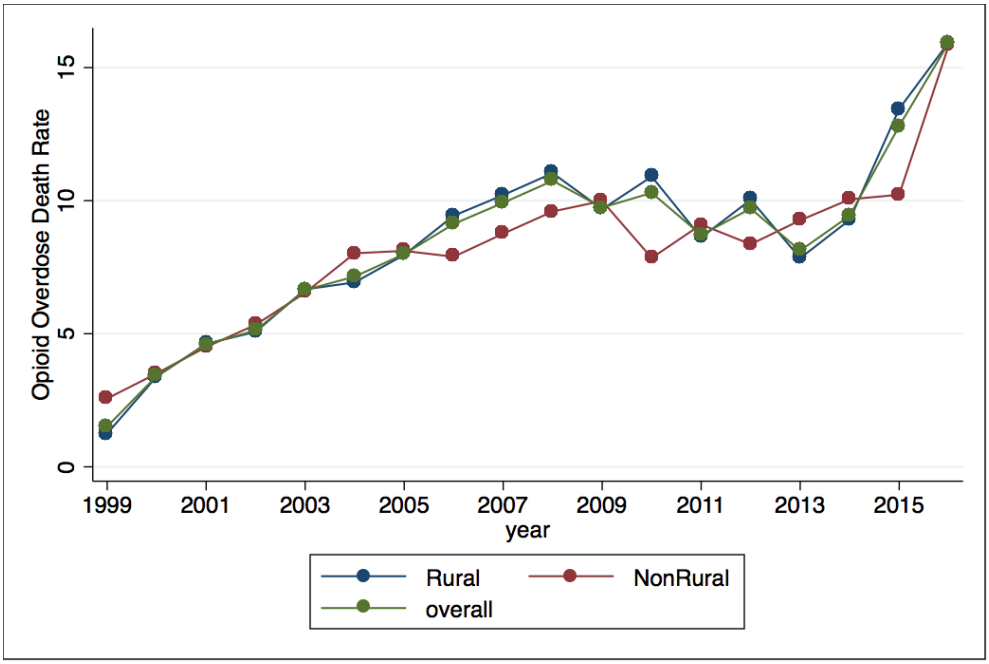

Figure 2. Assault Rates, 2010-2015

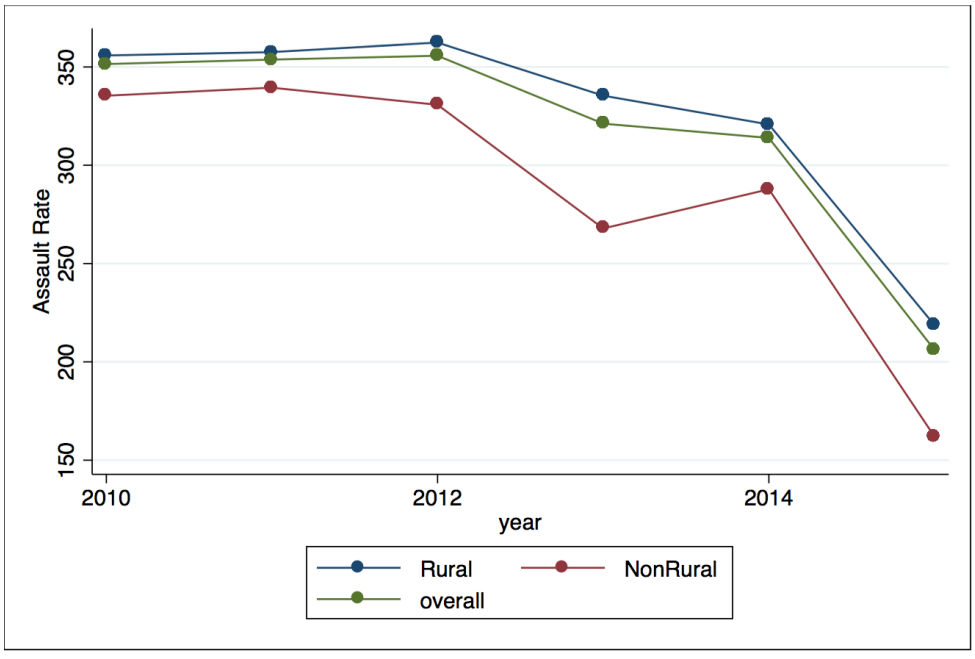

Figure 3. Poverty rates

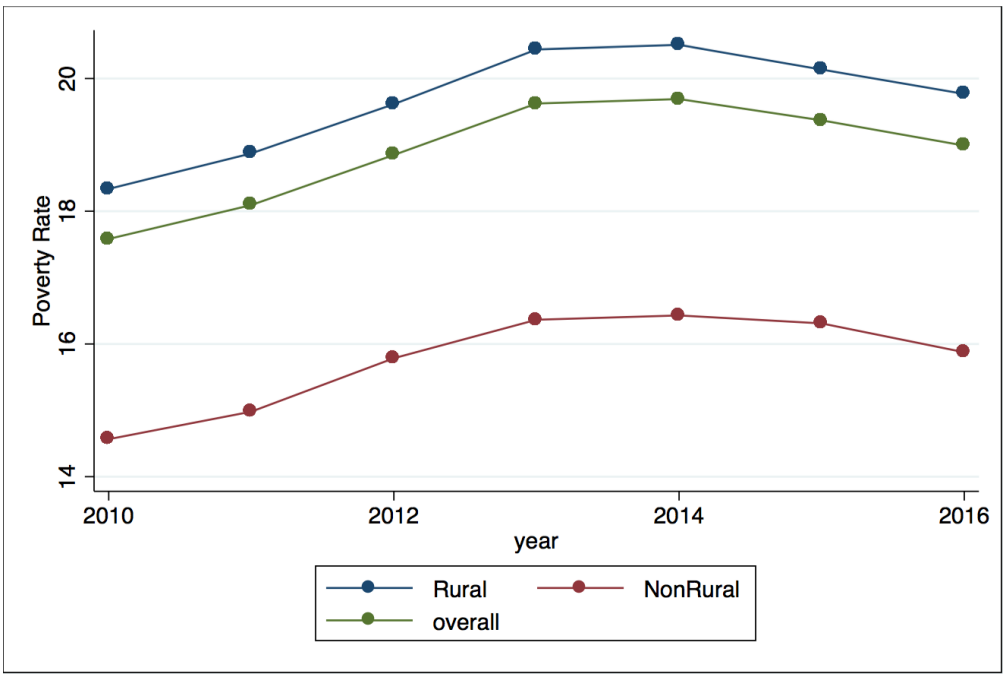

Figure 4. Provider Rate

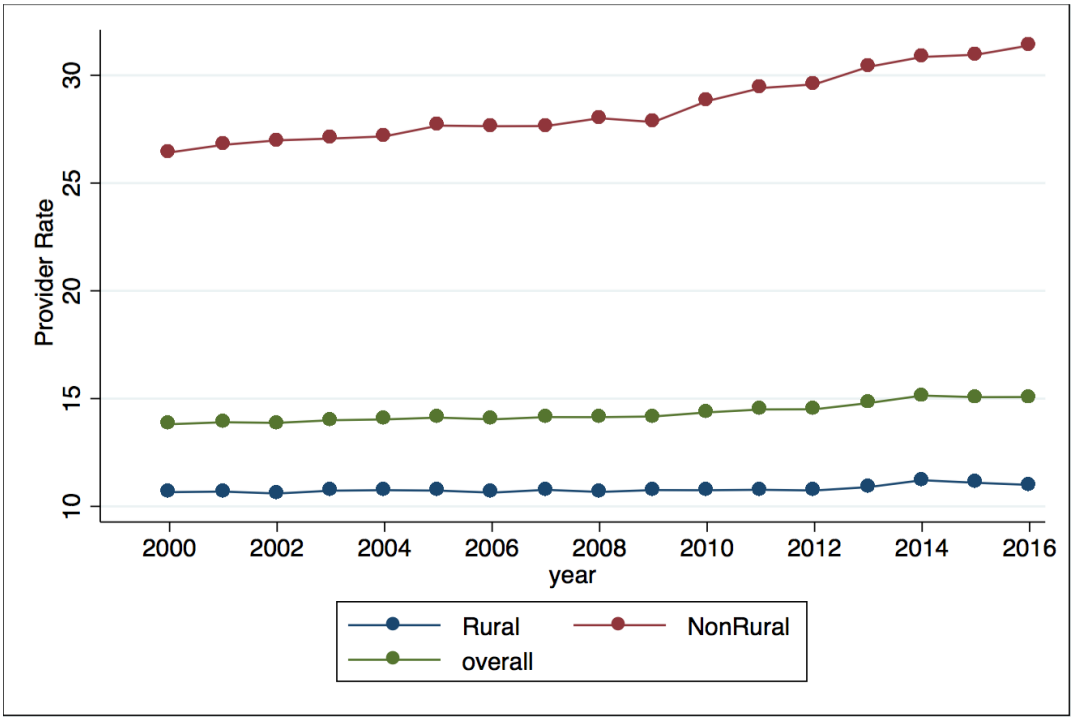

Figure 5. Unemployment Rate

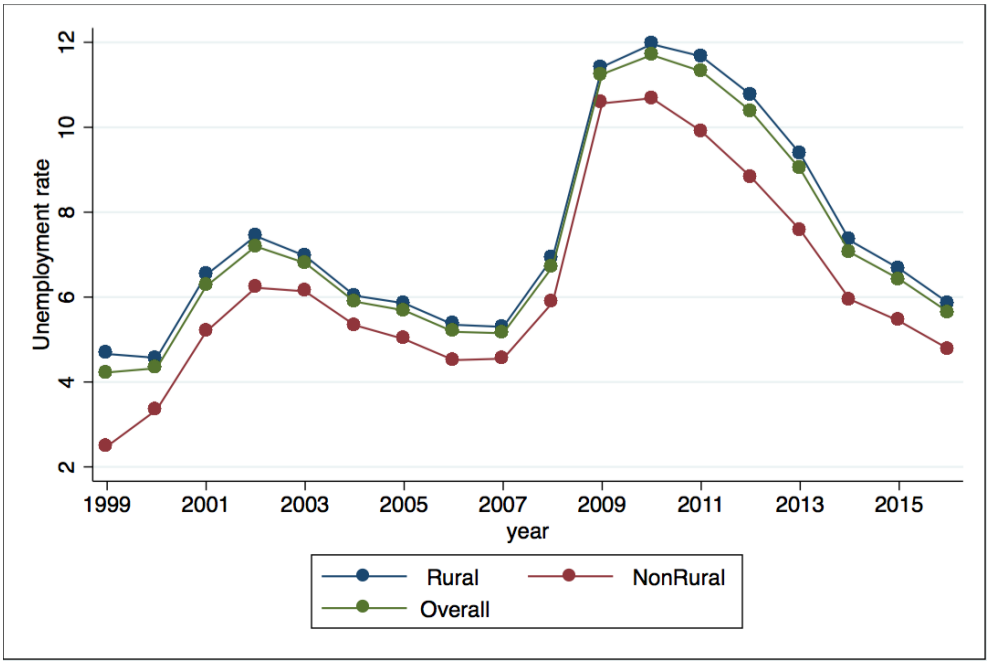

Table 1. Summary Statistics

Available Sample						Analytic Sample				
VARIABLE	Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
Opioid Death Rate										
All Counties	1800	8.38	7.65	0	58.97	600	9.84	7.9	0	58.97
Rural Counties	1,440	8.46	8.18	0	58.97	480	10.02	8.55	0	58.97
Non Rural Counties	360	8.08	5.02	0	28.64	120	9.14	4.39	1.76	21.02
Assault Rate										
All Counties	565	317.93	155.98	9.95	947.82	565	317.93	155.98	9.95	947.81
Rural Counties	445	326.22	163.39	48.97	947.82	445	326.22	163.39	48.97	947.81
Non Rural Counties	120	287.20	120.39	9.95	591.29	120	287.20	120.39	9.95	591.29
Poverty Rate										
All Counties	700	18.89	4.87	6	32.3	600	18.87	4.88	6	32.3
Rural Counties	560	19.67	4.90	6	32.3	480	19.65	4.91	6	32.3
Non-rural Counties	140	15.76	3.22	8.5	25.5	120	15.74	3.21	8.5	25.5
Unemployment										
All Counties	1,800	7.24	2.88	1.1	18.1	600	9.32	2.75	4.4	18.1
Rural Counties	1,440	7.48	2.91	1.4	18.1	480	9.63	2.76	4.8	18.1
Non-rural Counties	360	6.24	2.57	1.1	14.1	120	8.07	2.34	4.4	14.1
Provider Rate										
All Counties	1,700	14.33	13.26	0	115.87	600	14.73	14.09	0	133.56
Rural Counties	1,360	10.79	6.67	0	36.19	480	10.91	6.91	0	34.7
Non-rural Counties	340	28.50	21.26	6.36	115.87	120	30	22.65	6.81	113.56

1. Analytic sample includes years 2010-2015.
2. Opioid death rate: overall sample includes years 1999 to 2016; Source: The Injury and Epidemiology Surveillance Unit of the North Carolina Department of Health and Human Services (DHHS); Definition: Any mention (cod1-cod21) of T40.0 (opium), T40.1 (Heroin), T40.2 (Other Opioids), T40.3 (Methadone) and/or T40.4 (Other synthetic opioid) and unintentional intent (X40-X44).
3. Assault Rate: overall sample includes years 2010-2015; Source: NC DETECT; Definition: Any mention of cutting/piercing, drowning/submersion, falling, fire/burn, firearm, motor vehicle traffic, poisoning, struck by, suffocation, as well as other classifications for women of all ages.
4. Poverty Rate: overall sample includes years 2010-2015; source: American Community Survey (ACS) by the U.S. Census Bureau; Definition: percentage of the county population whose income in the past 12 months is below the poverty level.
5. Unemployment: overall sample includes years 1999-2016; Source: the Local Area Unemployment Statistics (LAUS) program in the Bureau of Labor Statistics (BLS). See definition on page 18.
6. Provider Rate: overall sample includes years 2000-2016; Source: Physician data are derived from the North Carolina Board of Medicine. County estimates are based on primary practice location. Population census data and estimates are downloaded from the North Carolina Office of State Budget and Management via NC LINC and are based on US Census data.

Source: North Carolina Health Professions Data System, Program on Health Workforce Research and Policy, Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill. Created March 28, 2018 at https://nchealthworkforce.sirs.unc.edu/.

Definition: data include active, licensed physicians in practice in North Carolina as of October 31 of each year who are not residents-in-training and are not employed by the Federal government

Table 2. Poisson analysis: Assault against women and opioid overdose deaths rate

1	2	3	4	5	6	7
VARIABLES	Overall	Non-rural	Rural	Overall	Non-rural	Rural
Opioid Overdose Death Rate	0.0003	0.0241**	-0.0061*	0.0007	0.0254**	-0.0062**
	[0.0033]	[0.0106]	[0.0031]	[0.0032]	[0.0107]	[0.0028]
Provider Availability				-0.0126	-0.0149	-0.0076
				[0.0153]	[0.0261]	[0.0155]
Poverty				-0.0061	0.0507	-0.0239
				[0.0198]	[0.0426]	[0.0190]
Unemployment				-0.013	-0.0177	0.0084
				-0.0126	-0.0149	-0.0076
Observations	564	120	444	564	120	444
Number of counties	95	20	75	95	20	75
Robust standard errors in brackets						
*** p<0.01, ** p<0.05, * p<0.10						

Table 3. Linear regression analysis: Assault against women and opioid overdose deaths rate

1	2	3	4	5	6	7
VARIABLES	Overall	Non-rural	Rural	Overall	Non-rural	Rural
Opioid Overdose Death Rate	-0.2012	5.3561*	-0.3747	-0.1802	5.3407*	-0.3617
	[0.6308]	[2.9256]	[0.6634]	[0.6453]	[2.9360]	[0.6666]
Provider Availability				-1.9395	2.3668	-1.6929
				[2.3251]	[4.4778]	[4.3861]
Poverty				-6.621	16.8299	-8.0442*
				[4.4943]	[14.0916]	[4.6503]
Unemployment				9.2242	2.0942	11.0037
				[7.8899]	[19.5800]	[9.4809]
Observations	565	120	445	565	120	445
R-squared	0.3179	0.5415	0.2799	0.3271	0.5504	0.2941
Number of counties	96	20	76	96	20	76
Robust standard errors in brackets *** p<0.01, ** p<0.05, * p<0.10						

Table 4. Percentage E-code Reporting by County by Year

County	2010	2011	2012	2013	2014	2015
	% E-code	% E-code	% E-code	% E-code	% E-code	% E-code
Alamance	0.959822304	0.940254069	0.950745564	0.946455958	0.912037355	0.895677473
Alexander	0.909589041	0.89617065	0.890337423	0.890609137	0.874252929	0.857714095
Alleghany	0.905006418	0.915662651	0.881707317	0.886912325	0.816071429	0.695099819
Anson	0.812737643	0.892773893	0.820202519	0.61155181	0.897945659	0.122329428
Ashe	0.922715895	0.915779587	0.911897329	0.930722892	0.664607558	0.777525539
Avery	0.977758007	0.982075865	0.985513421	0.981060606	0.945029776	0.918128655
Beaufort	0.921080113	0.929354265	0.941299166	0.927069645	0.90708205	0.911336132
Bertie	0.904982206	0.897496617	0.924768887	0.921496473	0.899901865	0.896758703
Bladen	0.976724138	0.950187091	0.956164384	0.920204403	0.89298893	0.770962733
Brunswick	0.960692391	0.951780081	0.841786664	0.696012845	0.840204887	0.769576848
Buncombe	0.931133969	0.908434999	0.851191175	0.796946069	0.81094953	0.805494505
Burke	0.964238737	0.958909585	0.9480013	0.63427697	0.934652928	0.208566561
Cabarrus	0.944670614	0.93807769	0.920641306	0.598331094	0.914668652	0.156607285
Caldwell	0.877308707	0.881225033	0.89298893	0.826308345	0.897526502	0.732721311
Camden	0.610169492	0.494863014	0.808510638	0.652439024	0.427941176	0.615523466
Carteret	0.939814815	0.930040645	0.939181718	0.932403568	0.949589246	0.800624133
Caswell	0.755865103	0.737593474	0.859813084	0.917388408	0.917083631	0.881834215
Catawba	0.91624299	0.912076991	0.902868458	0.891226363	0.95502542	0.832822688
Chatham	0.765811966	0.923483456	0.939995437	0.904390935	0.602580645	0.394706559
Cherokee	0.963855422	0.963615023	0.956097561	0.919964029	0.883408072	0.865021771
Chowan	0.956780924	0.939753086	0.957371226	0.936565473	0.919727891	0.925769463
Clay	0.964285714	0.944029851	0.947368421	0.935384615	0.900621118	0.84180791
Cleveland	0.961661736	0.972643357	0.963192797	0.700560633	0.919712903	0.151136994
Columbus	0.931727442	0.926713948	0.934897599	0.879930025	0.919538508	0.764259996
Craven	0.908927885	0.905475432	0.90093633	0.708957237	0.937010181	0.890025326
Cumberland	0.946440704	0.945650079	0.950989954	0.953261042	0.929238775	0.876309492
Currituck	0.74529148	0.735830932	0.884335155	0.788533835	0.683431953	0.756302521
Dare	0.95755814	0.960451977	0.963132324	0.954297821	0.93747853	0.928115695
Davidson	0.973697082	0.966398046	0.960341172	0.891635444	0.780667044	0.598448442
Davie	0.968699839	0.959539865	0.904486252	0.670720854	0.535776236	0.509423655
Duplin	0.934372294	0.928642384	0.877340982	0.875159642	0.861404599	0.875722005
Durham	0.917335874	0.889335027	0.868429905	0.807429797	0.419883041	0.258088006
Edgecombe	0.79304663	0.861037486	0.924013434	0.920728343	0.873031496	0.883306752
Forsyth	0.964136806	0.953332722	0.881437159	0.687197476	0.71500455	0.663946669
Franklin	0.892194254	0.8351214	0.907148407	0.90302134	0.811391844	0.590115199
Gaston	0.765174452	0.881449275	0.870918248	0.780261679	0.796856106	0.437106552
Gates	0.798245614	0.789690722	0.911275416	0.8	0.759765625	0.795045045
Graham	0.953846154	0.934472934	0.928198433	0.936692506	0.94124847	0.940778342

Granville	0.936197094	0.912273722	0.907163886	0.843976028	0.685581806	0.54995417
Greene	0.942257218	0.929024812	0.946167349	0.942711288	0.922453704	0.869627507
Guilford	0.472729797	0.450256303	0.711971724	0.825701231	0.893099322	0.885212366
Halifax	0.924062584	0.942250068	0.966209798	0.964310321	0.956266972	0.862959285
Harnett	0.845885559	0.790149463	0.892934038	0.809727693	0.873652695	0.775664969
Haywood	0.98263362	0.950116009	0.885695835	0.905068516	0.930451428	0.909986257
Henderson	0.946605645	0.934628975	0.923781758	0.91611479	0.895903859	0.857614527
Hertford	0.885798567	0.906430497	0.913989637	0.921421585	0.907612457	0.902887139
Hoke	0.91084268	0.90590155	0.900786449	0.894437799	0.672636992	0.47581024
Hyde	0.90872211	0.931623932	0.951807229	0.958419958	0.878531073	0.935185185
Iredell	0.935207571	0.90582929	0.935597498	0.875314861	0.903774502	0.812626117
Jackson	0.947702976	0.928616551	0.927718416	0.937977099	0.940393152	0.921849427
Johnston	0.93742621	0.925	0.950800717	0.935281976	0.925485138	0.790648871
Jones	0.921193573	0.917050691	0.90880102	0.770599868	0.916014235	0.885110294
Lee	0.880499015	0.890595807	0.869062901	0.439241257	0.755391251	0.633027523
Lenoir	0.966438931	0.967580758	0.972316716	0.965521413	0.959163712	0.887287449
Lincoln	0.915410301	0.918005693	0.89577066	0.626820079	0.898809524	0.275589398
Macon	0.9455195	0.909923664	0.819374369	0.906588308	0.882058971	0.779080252
Madison	0.905206943	0.865517241	0.838662791	0.786259542	0.798773006	0.79015544
Martin	0.919881306	0.934345507	0.91672975	0.867636868	0.510164191	0.764098784
McDowell	0.972891566	0.964672963	0.933743664	0.777274101	0.831701346	0.622105263
Mecklenburg	0.951151976	0.937941368	0.940947901	0.612234748	0.958816436	0.375601431
Mitchell	0.894117647	0.894202899	0.8776267	0.854379977	0.880322209	0.771230503
Montgomery	0.694202899	0.75862069	0.835609756	0.911135796	0.708654906	0.470983723
Moore	0.880069289	0.873632046	0.876321452	0.838828569	0.637941986	0.380592841
Nash	0.597604963	0.675675676	0.924074074	0.913123093	0.753809142	0.627906977
New Hanover	0.92982647	0.916837384	0.434552102	0.038657821	0.550986334	0.758683473
Northampton	0.933811802	0.94470405	0.952702703	0.954423592	0.949652067	0.880213904
Onslow	0.979454927	0.965632004	0.940396939	0.908985805	0.923653489	0.861120719
Orange	0.94791094	0.926107072	0.905051903	0.889239598	0.468713105	0.436739015
Pamlico	0.905316824	0.891467066	0.866914498	0.689655172	0.905263158	0.895040369
Pasquotank	0.562763713	0.496845426	0.824819337	0.637546468	0.469038817	0.612784091
Pender	0.883394212	0.928571429	0.655802862	0.407675195	0.686440678	0.830317335
Perquimans	0.711627907	0.679022746	0.890430972	0.730136006	0.645892351	0.718518519
Person	0.962798937	0.927422768	0.902398332	0.918527043	0.898650144	0.865455665
Pitt	0.921831445	0.92022792	0.921711776	0.908626426	0.883129644	0.879217328
Polk	0.950221239	0.954323002	0.964983713	0.96351137	0.974750132	0.765814266
Randolph	0.914312824	0.909815473	0.933634344	0.94277194	0.910110794	0.784932957
Richmond	0.936446798	0.936813716	0.928634752	0.911820305	0.722042663	0.5391868
Robeson	0.955806279	0.960735171	0.948487052	0.943324123	0.942505133	0.823749346
Rockingham	0.603085554	0.575554936	0.790729545	0.893287827	0.928544901	0.89132948
Rowan	0.929505192	0.917659046	0.929697957	0.870972037	0.944685552	0.593499516

Rutherford	0.958455178	0.979421751	0.969003338	0.942567191	0.93370039	0.662342982
Sampson	0.92503518	0.936268975	0.8619491	0.885092801	0.848312611	0.663618044
Scotland	0.924829157	0.950200244	0.944178901	0.943181818	0.958242495	0.88609215
Stanly	0.186346641	0.191802291	0.248253493	0.874373616	0.982533316	0.743151227
Stokes	0.972493345	0.95732671	0.903950793	0.837995538	0.859306982	0.784987565
Surry	0.951340206	0.952270327	0.937146585	0.900944457	0.897421832	0.81061337
Swain	0.952929875	0.949878345	0.934547031	0.957702582	0.958655157	0.929262394
Transylvania	0.975119377	0.964373464	0.962830593	0.924895158	0.83436853	0.848113208
Tyrrell	0.947521866	0.949554896	0.957104558	0.923076923	0.914675768	0.964980545
Union	0.952749695	0.949084034	0.941276931	0.655441679	0.944901105	0.244252405
Vance	0.924483307	0.928228747	0.930495464	0.906067678	0.892648416	0.776798524
Wake	0.779342534	0.638695861	0.89889383	0.913570877	0.827463345	0.364102014
Warren	0.899548533	0.911285062	0.910490857	0.913693346	0.886635465	0.759570181
Washington	0.926153846	0.937030075	0.97649919	0.932741117	0.866151866	0.785123967
Watauga	0.950081566	0.97621313	0.981399748	0.972184987	0.970174263	0.903293919
Wayne	0.969943273	0.953325468	0.981809103	0.978620983	0.969499855	0.810386699
Wilkes	0.221948691	0.288659794	0.147058824	0.160495716	0.143190095	0.218830018
Wilson	0.946456693	0.947178376	0.955015286	0.950151712	0.925909689	0.903021978
Yadkin	0.943990665	0.953162393	0.898909091	0.775135586	0.775030902	0.673005811
Yancey	0.885993485	0.88030303	0.867362146	0.822368421	0.843181818	0.792372881
Total	0.880110383	0.865876623	0.884524365	0.810461238	0.84699858	0.654304412

Counties with <75% reporting of E-codes for the study period are marked in yellow.
The year 2015 contains only nine months of data due to the transition from ICD-9-CM to ICD-10-CM.