Do Critical Access Hospitals Affect Mortality Rates in Rural Indiana Counties?

O'Neill School of Public and Environmental Affairs Honors Thesis

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Abstract

Access to healthcare and healthcare facilities often leads to the thought that the communities with those facilities will have better health outcomes, and more specifically, lower mortality rates. However, what is the effect on a rural community when they do not have access to this healthcare and must rely on smaller facilities. One solution was the emergence of the Critical Access Hospital. This designation is given to rural facilities located more than 35 miles from another hospital, have 25 beds or less, and provide 24/7 emergency care services. This study investigates the relationship between crude and age-adjusted mortality rates and the presence of Critical Access Hospitals in Indiana counties, adding to preexisting research about the effect on CAH designations and the connection to health outcomes. Using data from the Centers for Disease Control and Prevention and the Federal Reserve Economic, I collected information on mortality rates from 1999 to 2019 for each of Indiana's 92 counties for a total of 1,932 observations. With these observations, I investigated the trends in mortality rates for the 35 counties that have a Critical Access Hospital. After analyzing the relationships, the data revealed both crude and age-adjusted mortality rates in these rural Indiana counties increase with presence of a Critical Access Hospital, or simply put, when a county has a Critical Access Hospital, more individuals in the county die. I discuss possibilities of why this occurs and provide input on the effect these facilities have on the communities where they are located.

Introduction

Cost, quality, and access. These are the three core components when examining the healthcare landscape of the United States, often referred to as the Iron Triangle of Healthcare. The challenge with the three components is "at any time, you can improve 1 or perhaps even 2 of these things, but it had to come at the expense of the third" (Carroll). Access to healthcare can be improved with the construction of new facilities, but the cost of these facilities would be a large expense that would need to be recuperated. Sometimes expenses can spiral out of control for hospitals and clinics, and lead to closures, thus affecting the other components of the triangle, leaving a community with no quality medical services available because there are no open facilities.

The effects of these closures can lead to increased adverse health outcomes which lead to higher mortality rates, seen by studies determining a "[p]ersistent lack of access to affordable care undermines health and puts children and adults at risk of complications that could have been prevented" (Schoenbaum). In response to this spiral of high financial costs and numerous closures, at one time being "over 400 rural hospital closures during the 1980s and early 1990s" (*Defining Rural Indiana*), Congress created the Critical Access Hospital designation as part of the Balanced Budget Act of 1997 with two main goals in mind to work to improve healthcare. To qualify for this designation, the hospital must have 25 inpatient beds or fewer, be located more than 35 miles from another hospital (with some exceptions applying), maintain an average length of stay (how long the patient is in the hospital) of 96 hours or less, and provide 24/7 emergency care services. The preexisting and struggling rural Indiana hospitals took advantage of this new CAH designation almost immediately as two hospitals gained designation in 1999, three in 2000, five in 2001, and so on until Indiana had 35 designated Critical Access Hospitals in 2005 (Flex Monitoring Team).

According to the Rural Health Information Hub, the first goal of the CAH designation was to "reduce financial vulnerability" and the second goal was to "improve access to healthcare by keeping essential services in rural communities". My study will deal with the latter goal, investigating how the presence of a Critical Access Hospital in a rural community affects the mortality rates for that county and if there is any kind of positive or negative relationship. Currently, "[f]orty-two percent of the study CAHs were located in counties where less than 2,500 residents live in towns, constituting more than one-half of all hospitals located in these areas" (Dalton). This could be interpreted as 42% of Critical Access Hospitals serve very rural counties, with sparsely populated towns of 2,500 of less, whereas the other 58% of Critical Access Hospitals serve rural counties, however with populations of 2,500 or more.

The U.S. Census Bureau defines rural "as any population, housing, or territory NOT in an urban area". The definition of urbanized areas being places with populations of 50,000 or more, and anything between a population of 2,500 and 50,000 being an urban cluster ("How Does the U.S. Census Bureau Define 'Rural?'"). Nationally, over 60 million people, or about 19% of the population, live in rural parts of the United States.

Indiana has different thresholds when it comes to determining rural counties, cities, and populations. According to data from the Purdue Extension Center for Rural Development, the classifying characteristics of a rural county are a population under 40,000 and the population of the largest city under 10,000 (Ayes, et. al). These parameters apply to 42 of Indiana's 92 counties, but these county populations only account for 14% of Indiana's total population (a similar percentage to what is seen nationally). In comparison, 62% of Indiana residents live in "urban" counties, defined as populations over 100,000 and the population of the largest city over 30,000 (Ayes, et. al.). Despite the seemingly low number of Indiana's population living in rural counties, Indiana is the 22nd most rural state nationally according to an article published by on Stacker.com using United States Census Bureau data. In addition to this ranking, Indiana also ranks as the 20th poorest state overall, according to average household income data from the World Population Review website. This may not come as a surprise though, as it if often reported that rural areas and poverty go together, with "nearly one in five rural working householders lived in families with incomes less than 150 percent of the poverty line" and "in 2015, 9.8 percent of rural…householders were poor, compared with 6.8 percent of their urban counterparts". (Thiede, et al). Even though most of the focus when speaking on poverty is looking in urban areas, those living in rural populations have long suffered from its effects as the "rates of poverty have historically been higher in rural than urban areas. In fact, levels of rural poverty were often double those in urban areas throughout the 1950s and 1960s" (Thiede, et al).

This deep dive in looking at Indiana's rural population and the number of rural counties helps to shine light on the population that is being served by these Critical Access Hospitals and benefits from their services. Despite ranking in the 20s for both rural population and poorest states, Indiana is ranked 15th nationally for the most Critical Access Hospitals, as there are currently 35 open in the Hoosier State. For comparison, Louisiana, the #1 poorest state according to World Population Review, only has 27 Critical Access Hospitals. West Virginia, which ranks #3 nationally for most rural according to Stacker.com, only has 21 Critical Access Hospitals. When looking at the Purdue Extension Center for Rural Development, 20 of the 42 counties they

designated as rural have a Critical Access Hospital located there. Again, looking at data from Stacker.com, 26 of the 50 most rural Indiana counties have at least one Critical Access Hospital, and Clinton and Lawrence Counties both have two. Based on the low number of rural counties that have a Critical Access Hospital, it is not surprising rural residents struggle with accessing healthcare. In the Hoosier State, "rural patients often travel twice as far as urban residents to the closest hospital" (Indiana Hospital Association). This is often a result of sparsely populated counties and the requirement for Critical Access Hospitals to be 35 miles from another, meaning to even get to emergency room services for something minor, an individual might have to travel at least 40-60 minutes to just be at the facility. Research has found that "[r]ural Medicare beneficiaries are disproportionately older, poorer, and burdened by chronic illnesses. As rural hospitals close, CAHs become a site of care for many vulnerable patients" (Kosar, et al).

An additional cause for patients to travel for hours to a healthcare facility because of closures and distance is, for many, access primarily means primary care physicians (PCPs) and routine office visits. According to the Association of American Medical Colleges, only 11% of physicians practice in rural communities despite 20% of the U.S. population living in those areas (Jaret), creating a disparity where there is high demand but low or no supply. Due to lack of access to PCPs, residents begin visiting the emergency departments at their local hospitals (which may still be a far distance away) and adding to the ED patient load. In a 12-year study conducted on trends in emergency department uses by different populations, "rural ED visit rates increased from 36.5 to 46.5 per 100 persons, outpacing urban ED visit rates, which increased from 40.2 to 42.8 per 100 persons" (Greenwood-Ericksen & Kocher). The same study concluded this increase in ED usage "may reflect a deteriorating primary care infrastructure [and] greater fragmentation of care…rural EDs are increasingly serving as safety-net hospitals".

The combination of the lack of Critical Access Hospitals in most rural Indiana counties and the long geographical and time distances between hospitals leads to rural Americans accounting for "for 60 percent of trauma deaths". With such a high number of rural mortalities, it would be logical for more of these facilities to open to serve as rural health hubs to aid their communities. Unfortunately, there seems to be an opposite trend as, since 2010, "80 rural hospitals in the U.S. have closed" (Indiana Hospital Association), with Indiana seeing 2 of its Critical Access Hospitals close, one in Fayette County in 2019 and another in Dubois County in 2007.

Research shows that CAHs are low-complexity facilities due to the relatively small number of beds they have and the number of patients they can see. In one study of how hospital complexity related to mortality rates, "[t]he lowest complexity quintile had a higher proportion of hospitals located in rural areas…" (McCrum, et al.) meaning that a high number of Critical Access Hospitals appeared in that lower complexity category. These low complexity hospitals were looked at and a pattern began to emerge regarding mortality rates, with the researchers finding "low-complexity hospitals exhibited mortality rates 27% higher than the high-complexity hospitals" (McCrum, et al) which could lead an individual to infer lower complexity hospitals, (such as rural or Critical Access Hospitals) have higher mortality rates and worse health outcomes than hospitals located in urban hubs. The study concluded "increasing the overall

complexity of low-volume hospitals should result in lower mortality" (McCrum, et al), however this does not seem to be the current trend in the rural hospital industry.

Another CAH study showed similar findings as the McCrum study revealed. One major revelation was "[a]lthough CAHs provide much-needed access to care for many of the nation's rural citizens, we found that these hospitals, with their fewer clinical and technological resources, less often provided care consistent with standard quality metrics and generally had worse outcomes than non-CAHs" (Joynt). This could be for any number of reasons, but the researchers in this study focused on several different health outcomes and conditions that could be compared across multiple CAHs. The first condition they looked at was Acute Myocardial Infarctions (AMI) which saw patients admitted with AMI "had 7.3% higher absolute 30-day mortality rates" (Joynt). The next common condition the study used was Congestive Heart Failure (CHF) which resulted in a "2.5% higher mortality rate for CHF [when compared to non CAHs]" (Joynt). Lastly, the third common health condition used in this study was pneumonia, which again revealed that patients at Critical Access Hospitals were worse off as there was a "2% higher mortality rate" (Joynt).

There are various outside factors for why patients in CAHs are worse off when it comes to their general health outcomes and more specific health outcomes like AMI, CHF, and pneumonia, and finding one main factor is often difficult. At the conclusion of this study, the authors made it a point to mention this and noted "these institutions face many challenges, remain under resourced in terms of both clinical and technological capabilities, perform worse on process measures, and have higher mortality rates than non-CAHs" (Joynt).

There are many factors that affect the health outcomes at Critical Access Hospitals and there are many factors that affect mortality rates. These can include lifestyle habits like diet, smoking, obesity, physical activity, sleep, and chronic diseases (CDC). As noted earlier, access to healthcare can also be an influencing factor on mortality rates and receiving treatments. There are also even differences between how mortality rates are recorded, with one method using crude death rate. A crude death rate is "the number of deaths occurring among the population of a given geographical area during the same year" (OECD Statistics). This accounts for all deaths in a population and does not account for differences in populations that may be disproportionately older, unhealthier, or have less access to healthcare. Another method of recording mortality rates is to use age-adjusted death rates. An age-adjusted mortality rate is used to compare relative mortality risk among groups over time and use "the number of deaths where the deceased is younger than 75 years of age" as the age of 75 is "the standard consideration of a premature death according to the CDC" (Age-Adjusted Premature Death Rate). Using this mortality rate accounts for those populations who may be disproportionately older, unhealthier, or have less access to healthcare.

One key element that serves as the link between having healthcare and being able to afford it is employment. Ever since the 1940s, when people began returning to a normal post-World War II life, businesses and employers would advertise: "If you come work for us, you will receive health insurance!" Since then, the idea has stuck and become deeply ingrained in American society. The current mindset is: if you are employed, you have health insurance, and if

you are unemployed, you do not have health insurance. My study includes unemployment rates as a factor when looking at the annual trends in mortality, and what the overall relationship is when looking at a county's annual average unemployment trend when compared to their trend in mortality rates. I hypothesize that there will be a positive relationship between unemployment and mortality in these Indiana counties.

Research connects the link to unemployment rates, poverty, and mortality rates, with one study stating "[t]he permanent effect of increasing unemployment rates is to increase mortality [rates]" (Bender & Theodossiou). The inverse could be stated about these two rates, with a decreasing unemployment rate meaning a decreased mortality rate. This relationship is built from the fact that health insurance most often comes from the employer and having health insurance leads to individuals taking advantage of medical services and going to such facilities as Critical Access Hospitals. How strong is this relationship though? The study by Bender and Theodossiou concluded that "if there was a one percentage point increase in the permanent effect of the unemployment rate, mortality would increase by 0.3 per cent". This effect could be even greater in a rural county where healthcare is not as prevalent as urban hubs and access is a challenge due to the great distance between facilities.

Other studies have looked at the relationship between unemployment rates and suicide rates, as there is often a connection between the two with scholars even debating "whether being unemployed itself is the driving risk at the individual level" but agreeing on "[b]eing unemployed is viewed as a major risk factor for suicide" (Yip & Caine). Like the preexisting study that connected increasing unemployment rates with increasing mortality rates, Yip and Caine concluded there existed "a robust relationship between increasing unemployment and increasing suicide, and conversely, between decreasing unemployment and the return of suicide rates to their previous level". Using a county-level lens to determine the local effects of unemployment on residents, studies concluded that "higher county-level unemployment rates were associated with decreased likelihood of excellent health. These results reflect other research that finds that poor local economic conditions that are related to diminished health" (Malat & Timberlake). These findings assist in clarify the rural healthcare landscape, and the effect that high or low unemployment rates can have on these communities. If there is a time of high unemployment, people will not have health insurance and may not visit the physician or hospital, leading to high mortality rates. Conversely, if there is a time of low unemployment, people will have health insurance and may visit the physician or hospital, leading to low mortality rates. Thus, even though there are numerous other factors contributing to overall population health, a main driving factor is unemployment rates and their influence on population health.

Literature Review

Access to Healthcare

The United States of America spends the most money on healthcare compared to any other country in the world, with Switzerland and Germany being distant competitors (Schneider, et al). In 2020, the total expenses for U.S. healthcare spending "[reached] $4.1 trillion or $12,530 per person. As a share of the nation's Gross Domestic Product, health spending accounted for 19.7 percent" (CMS). This means that for every one dollar, 19.7 cents are spent on healthcare

services. With this high amount of healthcare spending and outranking every other country in terms of expenses, it would be reasonable to think the U.S. population has access to the highest quality treatments, cutting edge technologies, and the latest and greatest in medical services. This thinking may be logical, but it is not reality, as the United States ranks very poorly when compared to other high-income countries, with the likes of the United Kingdom, France, Canada, and Sweden. In a study performed by The Commonwealth Fund, research shows a large gap between the two variables, healthcare spending and healthcare performance. Out of the eleven countries included in the study, "[t]he U.S. ranks #11…its performance falls well below the average of the other countries and far below the two countries ranked directly above it, Switzerland and Canada."

This disparity between high costs and poor outcomes is a reality for many Americans, but often, this inverse relationship can affect those living in rural communities where access to healthcare is often a monumental challenge. Studies conducted on individuals living in rural areas have found this challenge to be true, as well as other additional factors that contribute to adverse outcomes. This research concluded "[m]any older adults in rural communities face significant challenges that include, among other, inadequate income, limited access to healthcare, social isolation, transportation and accessibility problems, food insecurity, and a severely limited stock of affordable, quality housing" (Weirich and Benson). The older rural populations are often faced with the brunt of this challenge and are often one of the most affected populations. The study conducted by Weirich and Benson defined this population as "people without ready access to much-needed services and supports", not only meaning housing, food, transportation, but specifically healthcare as the population ages and becomes more reliant on hospitals and clinics for assistance.

Ability to access those aforementioned "much-needed services and supports" in the United States is connected to having insurance, but the population of uninsured individuals has rapidly been rising and leading to adverse outcomes in the areas of healthcare access and mortality rates. A study looking at the effects of uninsurance concluded, very bluntly, a "[l]ack of insurance results in limited access to care, which can lead to poor health outcomes and costly financial consequences for uninsured people" (McMorrow). As argued by McMorrow, uninsurance and poor health outcomes go hand in hand because the U.S. healthcare system is built around the prospect that having insurance means having access to healthcare, and not having insurance means not having access to healthcare. These unisured individuals not only face the problem of being unable to visits a clinic or hospital, but McMorrow also found "that perceived quality of care by both doctors and consumers is lower in areas with higher levels of uninsurance", meaning there is a shift in perspective for how people view services in their areas. A sick individual may be uninsured, but then gain insurance through Medicare or Medicaid. Does this individual immediately go to a provider because they are now insured and can afford the treatment, or do they hesitate and not go because they have a distrust or negative perception of the quality treatment they will receive? In a rural area, with less options for providers and services, these "[s]maller markets show a positive, though not statistically significant, association between the local uninsurance rate and Medicare mortality" (McMorrow).

Understanding the stark differences in the U.S. healthcare system assists in understanding how there is a need for improving access for individuals currently living in areas that are not large healthcare hubs and do not have three-of-a-kind of every specialty in medicine.

Rural Healthcare

The next step in the rural healthcare path is looking at the current state of rural healthcare in the United States and determining what impact the preexisting problems in these communities affect the overall level of health in counties and states. Specific studies relating to Indiana's rural counties and health outcomes could not be found, but national studies have been conducted that review different areas of the United States and their rural populations. Looking at the overall quality of healthcare these populations have access to, a study revealed "[t]he quality of healthcare services in rural areas affects both residents of rural areas and those who travel through rural areas and who may unexpectedly need emergency care" (Merwin, et al.). Those individuals who live in rural areas and those individuals who travel through whom may need care are at a disadvantage simply because of their location in both medical and quality terms. In addition to these terms, these individuals find themselves at a disadvantage due to several other barriers, including a "lack of financial resources to obtain care, distance to care, lack of transportation, and a shortage of healthcare professionals that varies by profession, region, and state" (Merwin, et al). The lack of financial resources and an overall difference in a way of life means that these barriers, combined with "[l]ower use of preventative medicine, lack of insurance, difficulty in obtaining emergency or specialty care, and lower likelihood of using seat [and] higher rates of heart diseases, cancer, and diabetes" create this adverse health landscape that exists in the rural United States and does not always exist in the urban United States (Merwin, et al.).

A Critical Access Hospital and other facilities of this nature can have a huge impact when it comes to improving the health landscape of a rural county, as "[r]ural CAHs often provide important rural skilled nursing care options in addition to traditional hospital services" (MacKinney, et al). What is it that Critical Access Hospitals do? At the core of their business is to improve the health and lives of those patients that come through their doors. MacKinney describes this as "Clinical Care – Although not the only determinant of well-being, clinical care remains very important as people age, as they experience increased disease and disability, and as they perhaps require more frequent and intense healthcare services".

A CAH means more than just surgeries and emergency departmetns to the rural community they are located in, shifting the way that healthcare is viewed at a town, county, or state level. "Rural hospitals play an important role as the locus of rural healthcare resources. The rural hospital's role is to provide hospital-based care and associated services (e.g., lab, imaging, and therapies) to rural elders." From jobs to community health initiatives, to preventive screenings to access to healthcare, the hospital can impact the county and health landscape in very large ways. In addition to these benefits, a Critical Access Hospital can also serve to educate and train individuals, as "[r]ural CAHs often provide important rural skilled nursing care options in addition to traditional hospital services" (MacKinney).

The importance of a Critical Access Hospital cannot be understated as they open a new world of opportunities for the community they are in. Recalling the study done by Greenwood-Ericksen and Kocher, the large increase in rural ED visits serves as another indicator of how important hospitals are to the rural towns they are located in. Using Indiana county primary care physician data retrieved from the Area Health Resource File and CountyHealthRankings.org, the average number of primary care physicians per Indiana county with a Critical Access Hospital is 14 and the average number of patients per 1 PCP is 3,567. Ripley County (which has a Critical Access Hospital) is at an extreme disadvantage as they have 1 PCP for 28,520 patients ("Indiana Primary Care Physicians").

Once a Critical Access Hospital does gain designation and begins operations in a county, it can begin offering services and shift in healthcare that has been mentioned by the literature. This facility is for acute inpatient hospital treatment while preexisting clinics or facilities in the county may be primary care physicians. Research done by Liu, et. al. indicates "[p]atients who bypassed their local primary care were significantly more likely to live in CAH areas where the hospital had fewer beds", meaning the presence of the Critical Access Hospital is so appealing to individuals that they immediately go there for treatment instead of first seeking a referral or first opinion from their primary care provider. The problem for a CAH is an influx of patients who may not need acute inpatient care are coming to the emergency room to find treatment, leading to a potential abuse or improper usage of the facility. A problem created from individuals going directly to hospitals instead of primary care providers is "[s]tudies demonstrate lower mortality rates where there are more primary care physicians, but not where there are more specialists" (Liu, et al). This study showed a devaluation of primary care in favor of specialty care (like what would be available at a CAH) results in more adverse health outcomes than what residents may think.

Going to the primary care facility would result in the physician being able to first identify what is wrong with an individual and then set them up with a plan of care that may or may not include a hospital stay. For patients in either primary care or Critical Access Hospital settings, "[s]icker patients need more complex medical services and might be referred or transferred to specialty services or other hospitals outside their local community" (Liu, et al). Mortality rates therefore may be skewed or higher in rural counties due to these factors, as individuals wait and then go directly to the Critical Access Hospital with their potentially severe health problem, or they do not go see a primary care provider until it is potentially too late to correct the course of action for the disease.

Critical Access Hospital Services & Mortality Rates

"Although the number of CAH conversions has grown more rapidly than may have been expected by lawmakers, the participants are, by design, among the smallest hospitals in the country" (Dalton, et al.). With Critical Access Hospitals being the smallest hospitals in the United States (their limit is 25 beds, with most of Indiana's having 25 beds but a few having 15 and 16 beds), their scope of services will be limited. An individual who lives in a rural county may come into the CAH experiencing a heart attack and need immediate care, but the hospital is not set up for that and must work to transfer the patient to a larger facility, or do what they can

before said individual dies in that facility. These hospitals face a problem as studies show they "face many challenges, remain under resourced in terms of both clinical and technological capabilities, perform worse on process measures, and have higher mortality rates than non-CAHs" (Joynt, et al). The difference between quality at CAHs and non-CAHs could have a large impact on whether patients get seen right away at their local community hospital or need to be transferred to a different facility.

This information would get spread by word of mouth or news in the rural county and could lead to residents becoming hesitant to visit the Critical Access Hospital for treatment. If an individual knows they will end up being transferred to another facility because their local one does not have adequate services, and therefore they put off seeking medical treatment until it is too late, or they have died from their ailments. A former healthcare administrator with 25 years of experience managing hospitals and their associated Critical Access Hospitals stated that residents of those rural towns would say "I would not even bring my dog to that hospital". If a negative (or rather apprehensive) perception is created around a hospital, some individuals may put the treatment off and just deal with it by themselves or seeking medical care elsewhere. In the instance that an individual puts off the treatment, they could end up dying and the county mortality rate would increase despite the presence of a Critical Access Hospital.

Despite some studies finding Critical Access Hospitals to perform worse on clinical outcomes, other studies have argued that no concrete conclusions can be made when comparing the quality of rural and urban healthcare facilities. One finding, however, reveals "[s]killed personnel may also be an issue since only 10% of physicians serve rural populations and less than one-third the number of specialists per capita practice in rural settings versus urban settings" (Lutfiyya, et al). This finding ties back into the service aspects and shows facilities are often understaffed and do not have adequate personnel or services to treat everyone who walks into the doors. One recent trend in healthcare serving as a solution for hospitals facing these problems has been mergers and acquisitions performed with large healthcare networks.

In Indiana, 18 of the 35 Critical Access Hospitals are part of a healthcare network, meaning they can take advantage of both advanced medical care knowledge and advanced medical care facilities which are also part of the network. The networks these hospitals are part of are IU Health, Ascension St. Vincent, Parkview Health, and Franciscan Health. These in-network Critical Access Hospitals can transfer that patient experiencing the massive heart attack to another provider in their network who offers those more complicated services. By transferring the patient, the CAH essentially does two things. First, they first help the individual in need of care gain better access to the services they require for improved health outcomes. Second, they move that potential adverse health outcome (i.e., death) out of the county and put that mortality rate number in the county with the more complicated hospital.

An advantage Critical Access Hospitals can have with joining healthcare networks would be "the creation of specific collaborative relationships with medical specialists, thereby broadening available services in local communities" (Liu et al.) Even though every hospital must have a hospital referral agreement in place with a larger acute care hospital and that hospital must accept the transfer, that does not translate to the quality of care being the same across every

facility. In a hospital or healthcare system, the facility will have access evidence-based medicine techniques to ensure the very best in health outcomes for their patients. The other half of Indiana's Critical Access Hospitals are not part of a health network and are standalone facilities. Their outcomes will most likely be different from those hospitals that are in-network, leading to differences in perceived quality of the facility and leading to differences in mortality rates for the county and its residents.

Unemployment Rates & Mortality Rates

Current studies about the relationship between unemployment rates and mortality rates have investigated rural counties and towns to see what effect or consequences exist. Studies about Indiana's relationship between unemployment and mortality rates could not be found, but a study observing health outcomes in lower income areas of Columbus, Ohio was conducted which could be used as a near comparison for Indiana. The results found by Hawthorne and Kwan reveal the "Near East has been identified as a Medically Underserved Area by the US Department of Health and Human Services, meaning the health needs of the area's population are not being met." The needs of the population are not being met for several reasons, one being a lack of high-quality clinics in these underserved areas, and another being high unemployment and high uninsurance rates. Unemployed individuals face a different healthcare problem as it was found "[m]ore unemployed men and women are a perceived distance farther from healthcare than employed men and women. This finding makes sense given that most of the unemployed participants in the study area visit free or low-cost healthcare clinics, which the fieldwork data suggest have low-quality healthcare experiences" (Hawthorne and Kwan).

In contrast to this increased distance and low-quality healthcare that unemployed and uninsured individuals experience, those individuals who are employed live at a decreased distance to higher quality facilities as Hawthorne and Kwan note they have more choices in healthcare options. A question could be raised asking why the individuals in these rural or low-income areas do not seek more high-quality healthcare options like their counterparts living in more urban or higher-income areas? The current state of literature reveals there is some evidence "that suggests employed residents may have flexibility in moving to other healthcare providers if they have low-quality healthcare experiences at a nearby healthcare clinic" (Hawthorne and Kwan). Simply put, uninsured individuals are not able to move as freely from clinic to clinic or provider to provider as their insured counterparts. This lack of flexibility could suggest that individuals must go to the rural facilities in their area, for a rural county resident this may mean going to a Critical Access Hospital. If the CAH has lower overall quality outcome indicators, and a person is forced into going here for free emergency care because they do not have health insurance, this could translate to worse health outcomes and higher mortality rates for the population of the county. The claim that Critical Access Hospitals mainly treat lower income and uninsured individuals is currently supported by research done by Lutfiyya, et. al., which says a CAH's main role is to "function as the primary source of health care for a region and may even be the sole provider for a community's Medicare and Medicaid beneficiaries and uninsured individuals".

However, high unemployment rates cannot be the sole explanation for why there are high mortality rates as researchers have mixed views based on their findings. The Bender and Theodossiou journal supports this as "[r]esearchers debate whether unemployment increases or decreases population health. A large, primarily medical and epidemiological literature suggests that unemployment leads to deteriorating health." In addition to this statement about conflicting views, the effects on unemployment versus mortality may not be readily present, such as data taken from two to three years. Bender and Theodossiou claim "[i]f the impact of unemployment on health is not contemporaneous or immediate, then the effects of a change in unemployment on health make take a long time to manifest itself". Studying the relationship between mortality and unemployment is a lengthy process that would require numerous years' worth of data to see if any relationship would form.

Research Gap 1

The gap in research my paper will explore is investigating the relationship between Critical Access Hospitals and mortality rates in all 92 of Indiana's counties. Previous studies similar to my research have been performed in the Appalachian region, as well as various other areas of the United States, however they were mainly investigating the overall mortality rate of the Critical Access Hospital itself, rather than looking holistically at the county level. Results from the Appalachian Study performed by Borak, et. al. described the rural landscape of the southeastern states as full of "economic distress, with concentrated areas of high poverty, unemployment, poor health, and severe educational disparities". In addition to the defining characteristics of the Appalachian region, the study also concluded information about what mortality looks like in a rural area with high unemployment rates and a lack of access to healthcare providers. I hypothesized the Appalachian region is like the Midwest due to the overlap of the region in parts of Kentucky and Ohio. In addition to this, there are similar problems that each region faces, identified as "a high poverty rate, high unemployment, a shortage of physicians, substandard housing, and the departure of youth to employment opportunities elsewhere" (Tribe).

Their study concluded for Appalachian areas, there were "[h]igh rates of premature all-cause mortality, cardiac mortality, and cancer mortality have each been associated with low income, high poverty, high unemployment, and a high percentage of people without health insurance" (Borak, et al). Rural counties tend to follow the pattern of having low income, high poverty, and high unemployment, and when these characteristics are matched with low-quality healthcare providers or a lack of access to facilities, then it would be expected that mortality rates are higher.

Individual data for Indiana's mortality rates at Critical Access Hospital was not able to be found, so I am hoping that my research, data analysis, and results will help provide clarity on how these two variables are related in the rural health landscape of the Midwest and more specifically, Indiana. This paper will provide insight on whether a county's mortality rate is increased or decreased with the presence of a Critical Access Hospital. hospital Current data produced by Joynt et al indicates "by 2010, CAHs had higher mortality rates compared with non-CAHs" with the percentages being "13.3% vs 11.4%".

Research Gap 2

Studies focusing on the relationship between unemployment rates and county mortality rates specifically in Indiana could not be found, and it is my hope this paper will provide insight on whether a county's mortality rate is increased or decreased with higher or lower rates of county unemployment. Preexisting data that looked at unemployment versus mortality discovered that "[f]or overall mortality, if there was a one percentage point increase in the permanent effect of the unemployment rate, mortality would increase by 0.3 per cent" (Bender & Theodossiou). I am hypothesizing this remains true in Indiana and an increase in unemployment rates (or during times of high unemployment) will also see an increase in mortality rates (or a time of high mortality). I do not foresee the data I have collected being used to establish if there is a long-term or permanent effect between increased unemployment and increased mortality, which is a result Bender and Theodossiou discovered.

Research done by Yip and Caine used suicide rates as a comparison for looking at the relationship between unemployment and mortality rates. They "detected a robust relationship between increasing unemployment and increasing suicide, and conversely, between decreasing unemployment and the return of suicide rates to their previous level". When there are high suicide rates, considered as one of numerous factors of mortality rates, there also seem to be high unemployment rates. Conversely, when there are low suicide rates, there are lower levels of unemployment. This study says there is a direct relationship between the two variables. Building off those and rather than solely focusing on suicide rates in comparison with mortality rates, the Malat & Timberlake study concludes "the weight of the empirical evidence suggests that, in the United States at least, when the economy has grown health problems and mortality rates have increased, and when economic growth has slowed, health problems and mortality rates have decreased". This conclusion is contradictory to the results that Yip and Caine found, meaning further research still needs to be conducted in order to determine what the actual relationship between unemployment rates and mortality rates are, which is a gap my study of the rates in Indiana counties will look to contribute to. This information will be useful while examining the data and determining what relationships exist in Indiana and if they are directly related to previous studies or a new pattern emerges based on rural county statistics.

Hypotheses

I hypothesize that counties with a Critical Access Hospital will have lower mortality rates than those counties that do not have a Critical Access Hospital.

I hypothesize that rural Indiana towns that have higher unemployment rates will have higher mortality rates than those counties that have lower unemployment rates. I predict that in a year where a county has a higher mortality rate, that same year will also have a higher unemployment rate.

Data & Methods

Data for this study (covering the period from 1999-2019) were obtained from the Centers for Disease Control and Prevention WONDER online database from the Indiana Rural Health Association, and from a separate database containing critical access hospital certification dates. The dataset collected from CDC WONDER contained entries for county name, county deaths, county population, and crude death rate from all 92 Indiana counties sorted by years 1999 to 2019, for a total of 1,840 observations. I also used age-adjusted mortality rate data, obtained from the Federal Reserve Economic Data website. This data contained entries for county name and the age-adjusted death rate for all 92 Indiana counties sorted by the years 1999 to 2019, for a total of 1,840 observations.

Observations on names and county locations of the Indiana Critical Access Hospitals were collected from the Indiana Rural Health Association and the Flex Monitoring Team. The Flex Monitoring Team's data contained information on critical access hospital certification dates between the same years of 1999 and 2019. Various consistency checks on these CAH certification dates were performed using archival data from CDC WONDER with the select years of 2004, 2007, and 2015 to ensure that the verification years were the same. Data for annual average unemployment rates for the years 1999 to 2019 for each of Indiana's 92 counties was collected and downloaded from the "Hoosiers by the Numbers" operated by STATS Indiana and the Indiana Department of Workforce Development.

With both sets of the collected data (crude and age-adjusted), I cleaned and sorted the figures into a database displaying columns of the county name, the number of deaths for the year, the total population of the county for the year, the death rate (per 100,000) for that year, whether a CAH existed in that county, and then an indicator of when the CAH opened. In the same database, the rows of the data were the years 1999 to 2019, creating a timeline view of how mortality rates changed, and how the county itself changed with the addition or closure of a Critical Access Hospital. The same setup was used when looking at the annual average unemployment rate data for the years 1999 to 2019. The columns were the same but now included the average annual county unemployment rate per year. The rows continued to be the years 1999 to 2019, creating a timeline view of how unemployment and mortality were connected.

The data analysis software I used was R and R Studio. I created plots that displayed at the relationship between crude and age-adjusted mortality rates in all 92 of Indiana's counties, and then specifically in counties with Critical Access Hospitals. I also created plots that displayed the relationship between crude and age-adjusted mortality rates in all 92 of Indiana's counties, and then specifically in counties with Critical Access Hospitals. With the data, I ran regressions that looked at the relationship between the crude and age-adjusted mortality rates, and the annual average county unemployment rates in comparison to the county's mortality rate in counties that both had and did not have a Critical Access Hospital. While using R, I used Fixed Effects which means that any change that a variable can cause to an individual data entry will be the same. For example, any effects from being Adams County, Indiana from the years 1999 to 2019 will not change over time.

Results & Analysis

Figure 1.1

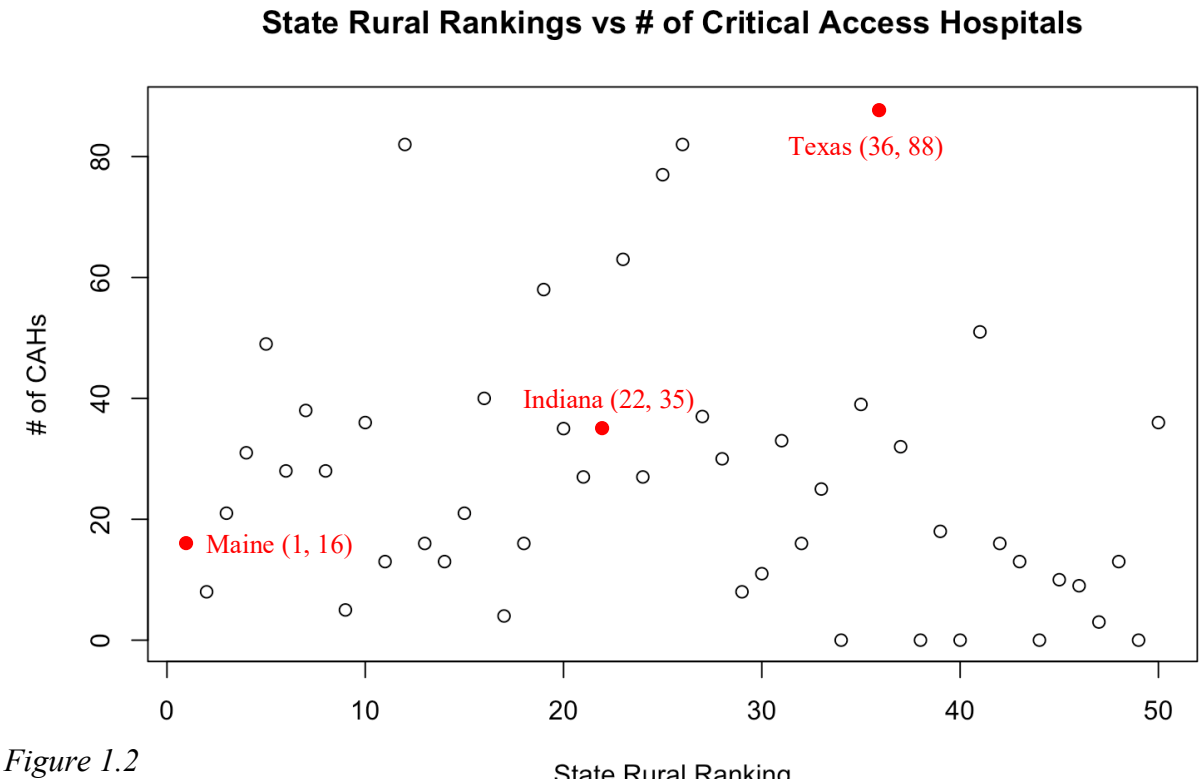
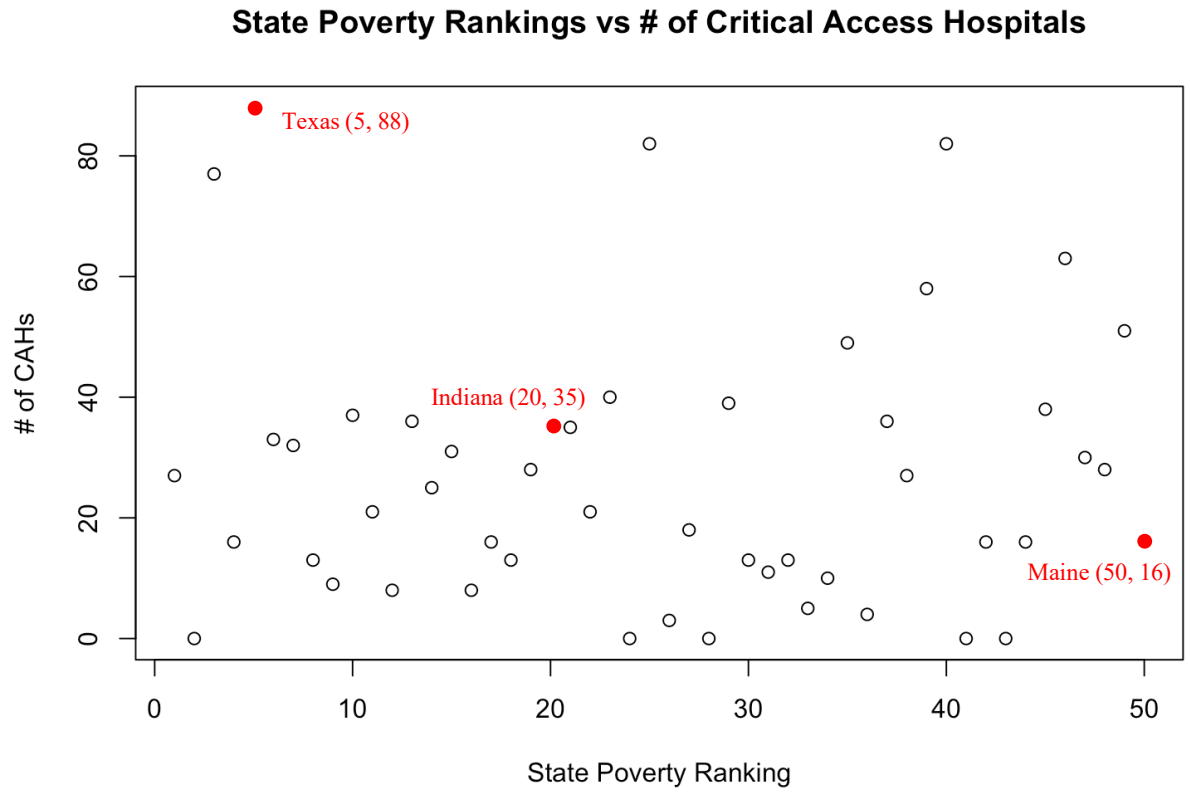


Figure 1.2



An article published with data from the U.S. Census Bureau ranked each of the 50 United States in order from least to most rural. The ranking was determined "by the percentage of its population residing in rural areas" and is further defined as XX people / square mile (Lisa). As Critical Access Hospitals are most often located in rural counties and in geographically isolated towns, I was curious on if there was a relationship between a state's rural ranking and the number of Critical Access Hospitals located in that state. As demonstrated by the Figure 1.1, there seems to be a slight negative relationship, however, I am confident in saying that the number of Critical Access Hospitals within a state is not dependent on that state's rural ranking. Indiana ranks 22nd nationally in rural population and has 35 Critical Access Hospitals. In comparison, Texas who ranks 36th national in rural population has 88 CAHs, and Maine, the number one ranked state for rural population only has 16 CAHs.

Due to no relationship existing between a state's rural ranking and the number of Critical Access Hospitals in the state, I next wanted to investigate if there was a relationship between a state's poverty ranking and the number of CAHs located in it. In this instance, a state's overall poverty was measured as its median household income. I was curious to see if there was any significance between a lower median household income (which could indicate potential unemployment of a household member) and the overall total of CAHs within a state. As demonstrated by the Figure 1.2, there does not appear to be any kind of relationship between the two variables, and I am confident in saying that the number of Critical Access Hospitals within a state is not dependent on that state's poverty ranking. Indiana ranks 20th nationally in median household income and has 25 CAHs. In comparison, Texas, ranked 5th nationally in median household income has 88 CAHs. Maine, who was ranked the number one rural state, has the highest median household income, and has 16 CAHs.

Figure 2.1

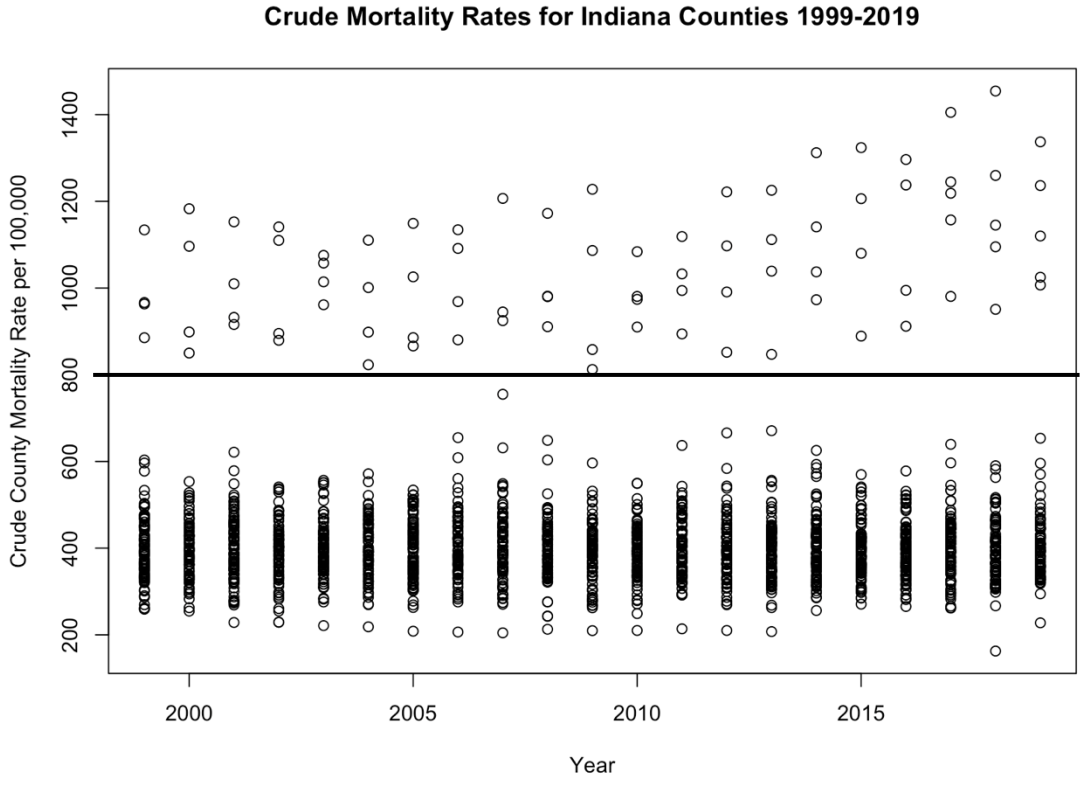


Figure 2.2

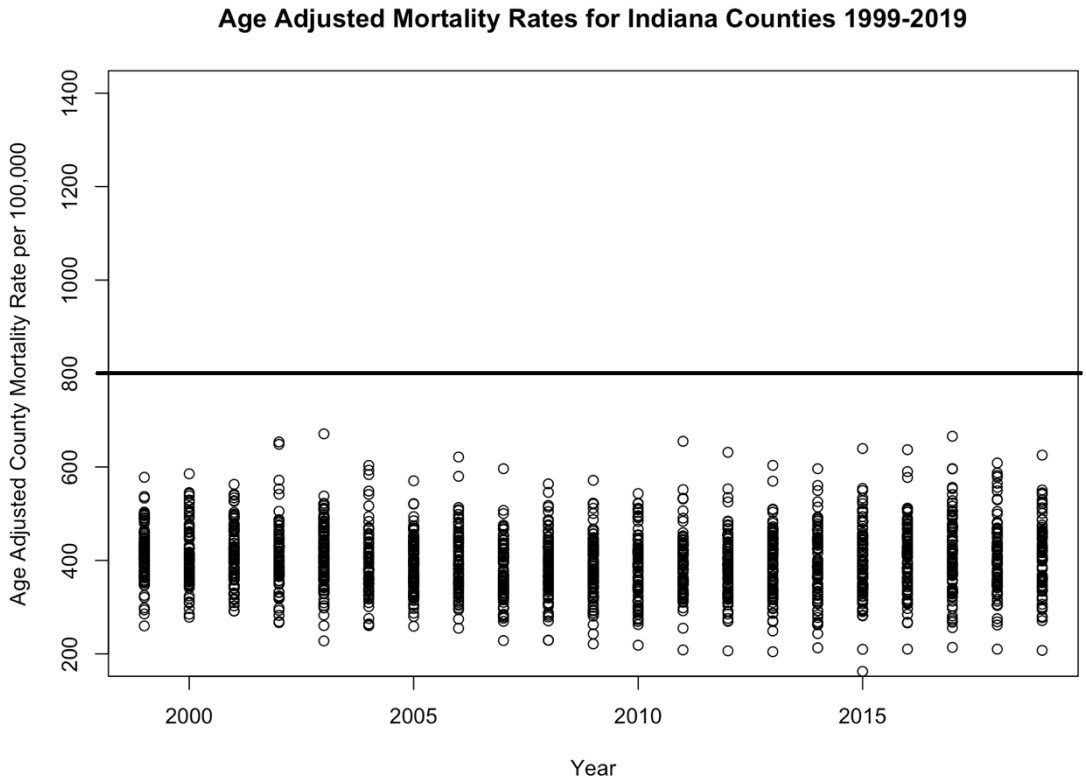


Figure 2.1 shows the annual crude mortality rate per 100,000 people for all 92 of Indiana's counties from 1999 to 2019. A county's mortality rate is tallied when "[t]he physician…verifies the cause of death on the certificate and files it electronically with the local health department in the county where the death occurred not later than 5 days after the process was initiated" ("How to Find a Death Record in Indiana?").

In creating this graph, I wanted to see if the crude mortality rates for all counties were consistent from year to year, or if there was any fluctuation or major changes between counties as time progressed. There appears to be a fluctuating trend as many counties (where the data becomes denser) go up and down from year to year, but overall, counties are seeing an increase in their crude mortality rates. The years of 2017, 2018 and 2019 have increasing rates compared to the years immediately prior to them.

Figure 2.2 shows the age adjusted mortality rate per 100,000 people for all 92 of Indiana's counties from 1999 to 2019. The age adjusted mortality rate is a better indicator of actual mortality as it accounts for those populations that may be disproportionately older, unhealthier, or have less access to healthcare. When comparing the crude and the age-adjusted rates, the values become more consistent and lower; as noted by the black bar set at 800 per 100,000 deaths, there are no outliers above this value on the graph. A similar pattern is seen in the up and down movement of the denser clusters as the years progress. The age-adjusted

mortality rate has now accounted for those counties that may have been disproportionately older and experienced more frequent deaths because of their elder populations.

Figure 3.1

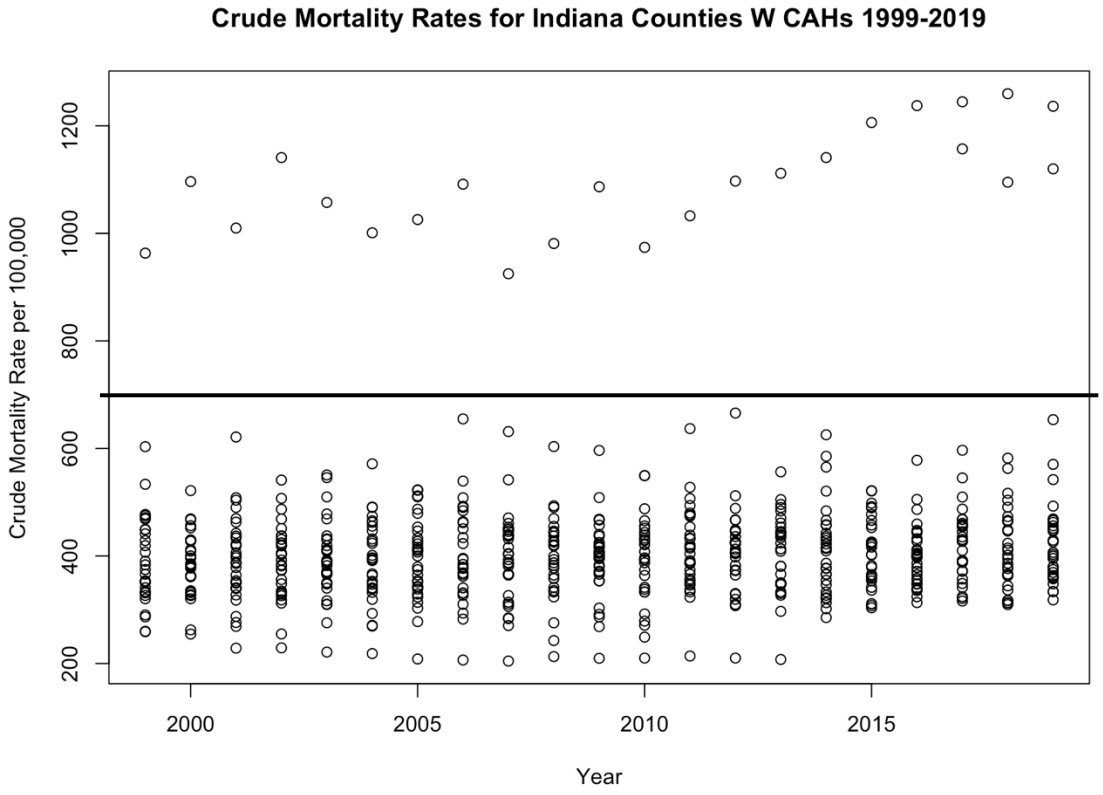
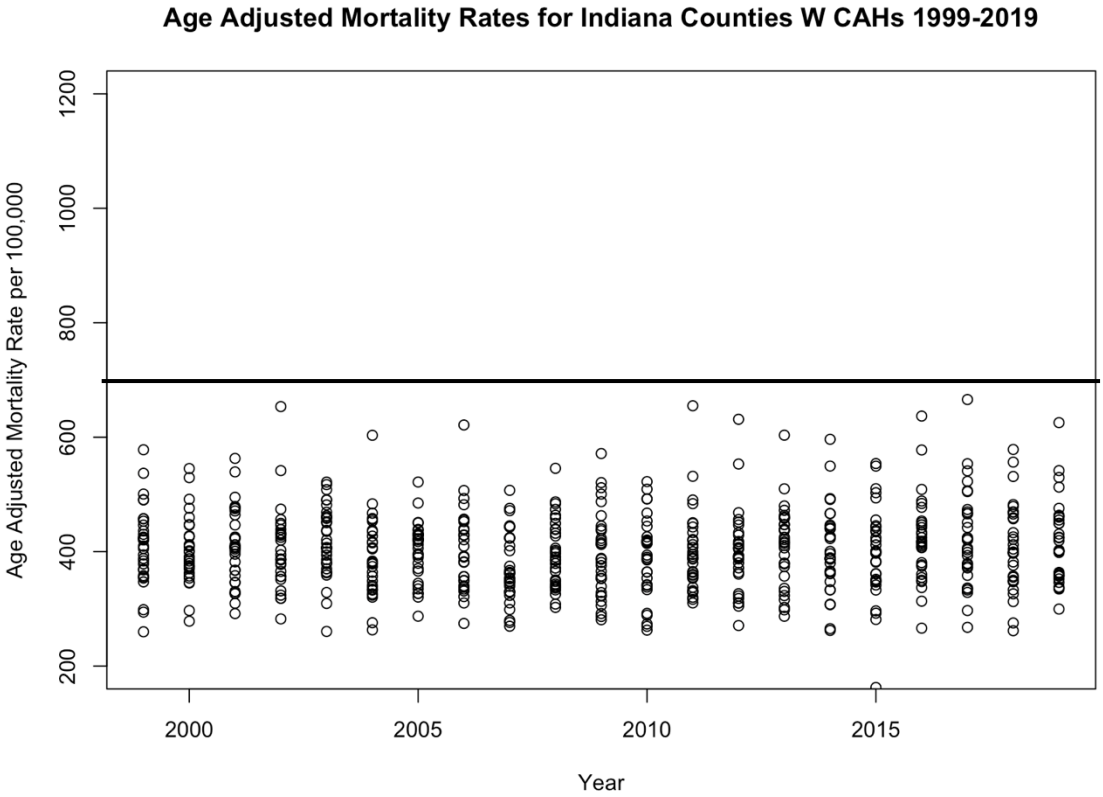


Figure 3.2



As my analysis is focused on the effects of a Critical Access Hospital on a county's mortality rate, I next wanted to investigate the crude and age-adjusted rates in the 35 Indiana counties that do have a CAH.

Figure 3.1 shows the trend between 1999 and 2019 for crude mortality rates in the 35 counties that have a Critical Access Hospital within them. A wide range of rates is shown, with some dipping as low as 200 per 100,000 deaths per year, and others rising to over 1,200 per 100,000 deaths per year. This pattern and wide range were also seen in Figure 2.1, however there were numerous high outliers in the 800 to 1,000 range for the all counties graph and compared with the data for counties with CAHs, the high outliers are now in the 900 to 1,200 range.

Figure 3.2 shows the trend between 1999 and 2019 for age-adjusted mortality rates in the 35 counties that have a Critical Access Hospital within them. The range is much more condensed with the age-adjusted data as it better represents the actual population of each county. The data points are all relatively close together, and there are no data points higher than the 800 per 100,000 deaths range, which was seen with the crude mortality rate data (Figure 3.1)

However, among each dataset, there is still great discrepancy in mortality rates for each county, and there is no one solution that determines the Critical Access Hospital is lowering the death rates. As some of these outlying data points can skew my results and make the findings seem a lot more significant than what they are, I used R Fixed Effects when looking at the relationships for both crude and age-adjusted mortality rates. The fixed effects ignored the year and county, allowing the relationship between crude/age-adjusted mortality rates and Critical Access Hospitals to become the focus of any statistically significant findings.

Figure 4.1

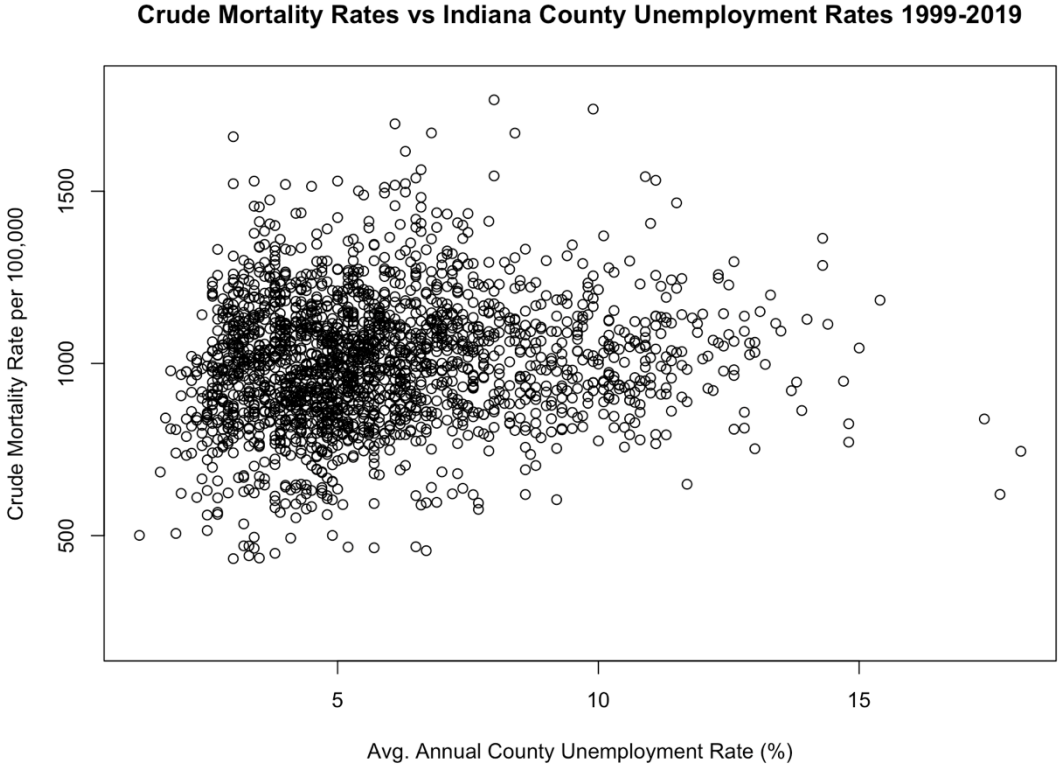
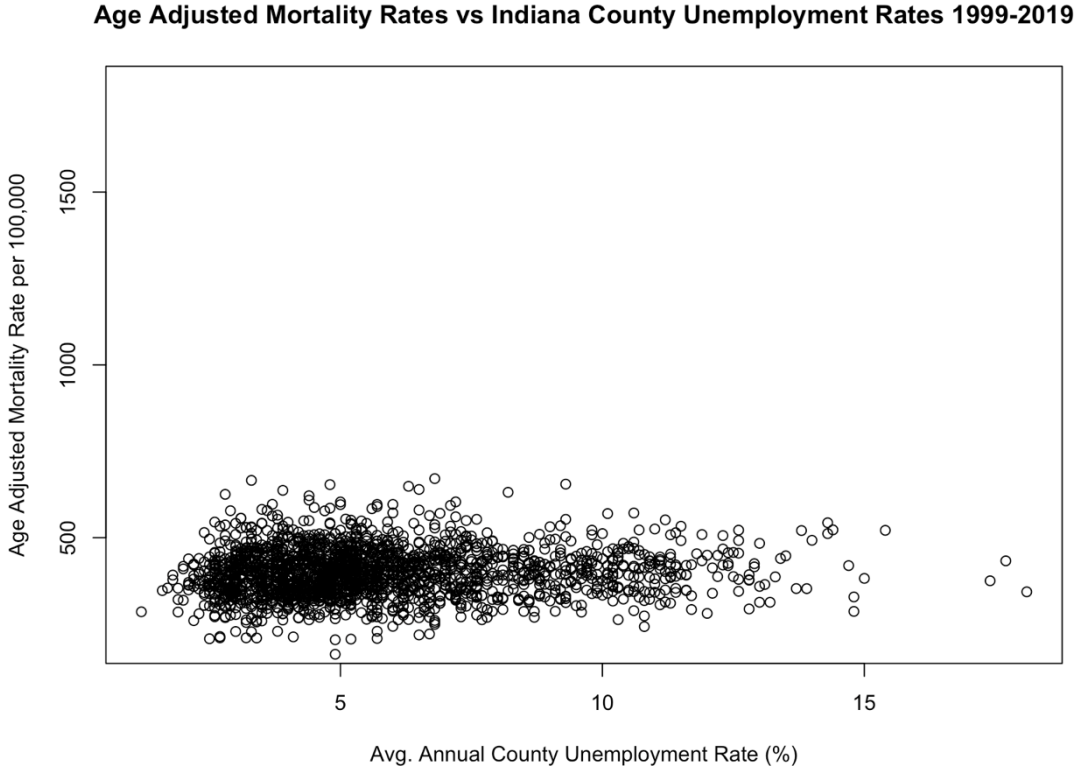


Figure 4.2



The next area of interest in this study came from moving away from crude/age-adjusted mortality rates by county and by year and investigating the relationship between unemployment rates and the different mortality rates in all 92 of Indiana's counties.

Figure 4.1 shows a scatter plot of each county's crude mortality rate against each county's average annual unemployment rate for the years 1999 to 2019. There is a large cluster of data in the 5% average annual unemployment rate and 1,000 per 100,000 crude mortality rate, but there are also large clusters of data to the top, bottom, and right of this area, with some points extending into the 10% and 15% average annual unemployment rates regions. No discernible pattern can be seen, so it unsure what the relationship between average annual unemployment rate and crude mortality rates is.

Figure 4.2 shows a scatter plot of each county's age-adjusted mortality rate against each county's average annual unemployment rate for the years 1999 to 2019. The data has now changed, and the cluster of points has become more condensed and stretched horizontally covering the range of ~3% to ~7% average annual unemployment, while being in the y-axis range of 300-500 per 100,000 age-adjusted mortality rates. The data appears to form a flat horizontal line, which would be indicative that the dependent variable of mortality rate does not change when the independent variable of unemployment rate changes.

With multiple crude and age-adjusted mortality rate entries resulting from the same average annual unemployment rate, there is no immediate relationship at the county level among these two variables. This result among crude mortality rates could then be interpreted at the state

level as not having any relationship. Due to these conflicting and confusing results, I again used R Fixed Effects as these outlying data points would skew my results and make the findings seem a lot more significant than what they are. By ignoring the year and county, the relationship between crude/age-adjusted mortality rate and average annual unemployment rates is viewed without changes in year or county over time.

Figure 5.1

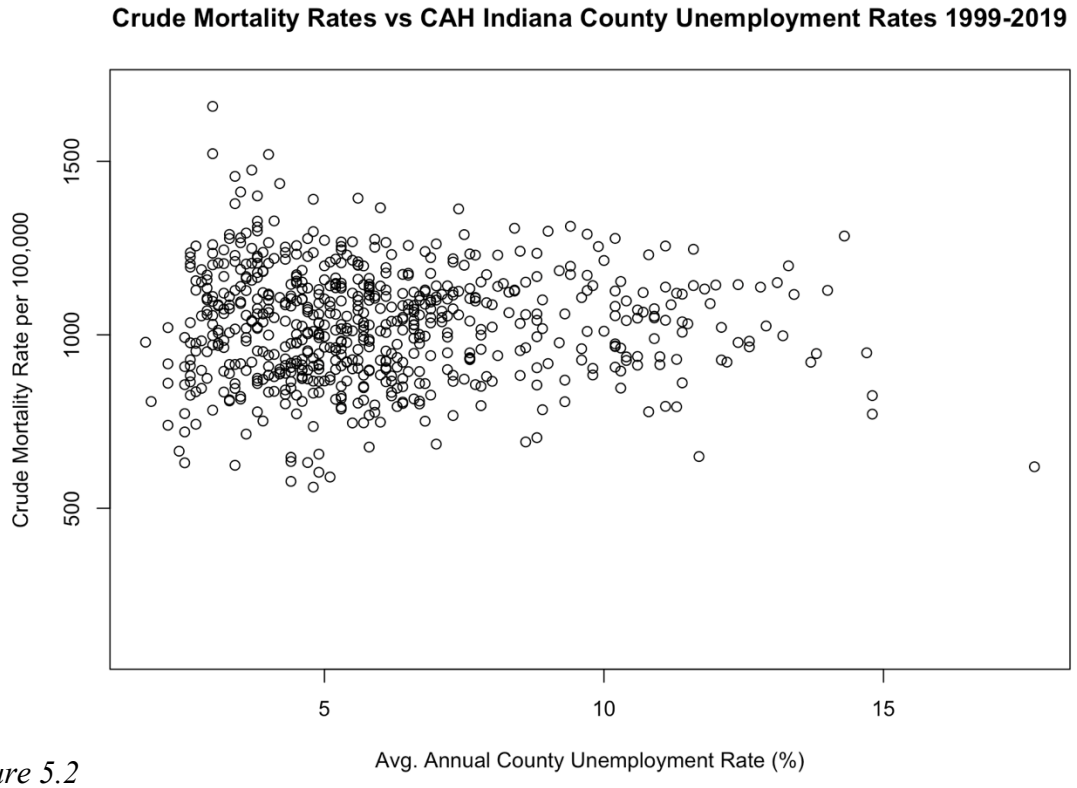


Figure 5.2

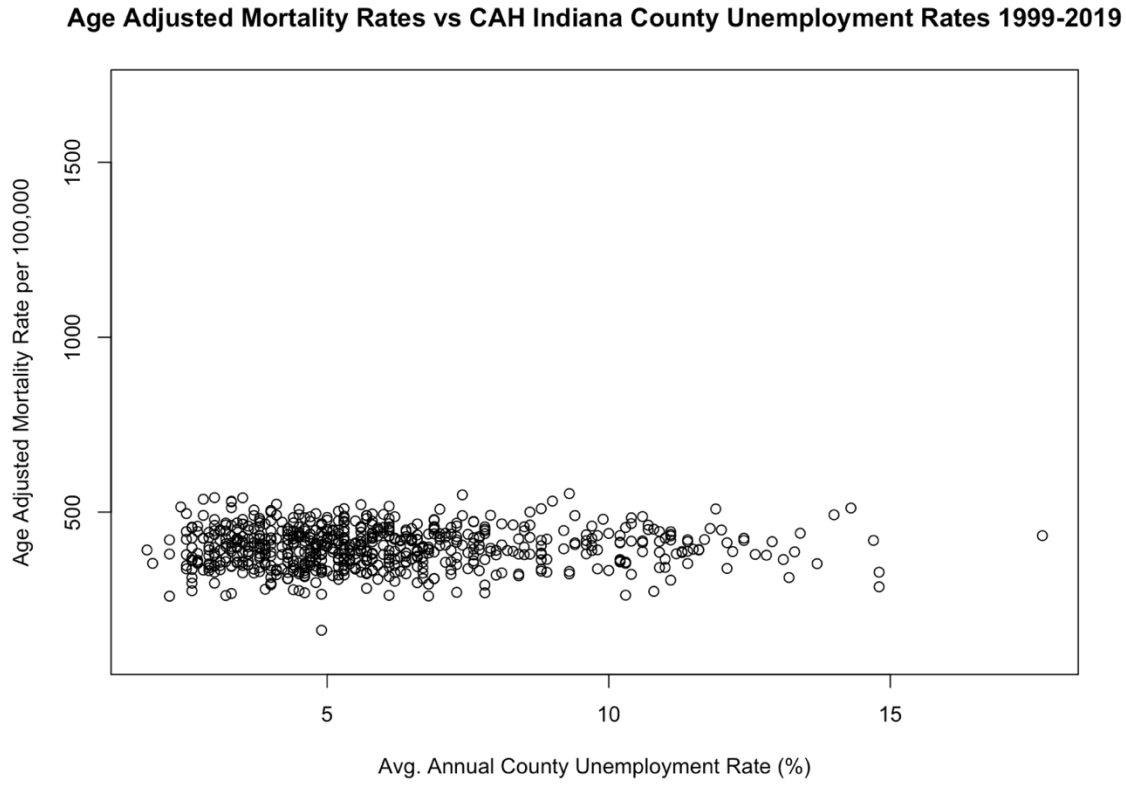


Figure 5.1 and Figure 5.2 show similar scatterplots to the previous figures but are focused on the 35 counties that contain a Critical Access Hospital. Like what was evident in the all-county data, there is a similar relationship among crude mortality rates and average annual unemployment as well as age-adjusted mortality rates and average annual unemployment. The data cluster has become less dense due to the total number of observations decreasing. In Figure 4.1, the lowest values in the data set are below 500 per 100,000 deaths, but in figure 5.1, the lowest values in the data set are above 500 per 100,000 deaths. In Figure 4.2, the range of age-adjusted mortality rates goes from 0 to 700 per 100,000 deaths. Compared to Figure 5.2, this range has been condensed and stays in the values of 100 to 500 per 100,000 deaths.

Figure 6.1

(Intercept)	940.4*** (25.19)	
hospital	83.65** (26.35)	18.40 (13.59)
unemp_rate	6.338* (2.885)	-1.221 (2.024)
Fixed-Effects:	---	---
year	No	Yes
county	No	Yes

Figure 6.1 displays the final comparative results of my study in which the relationship between counties with Critical Access Hospitals and their annual crude mortality rates, as well as the relationship between a county's average annual unemployment rate and their annual crude mortality rate. The data on the left side of the chart is based off an equation that does not account for the fixed effects of year and county and can be interpreted as a "naïve relationship" because of the lack of context that is added to the data when being analyzed.

An interpretation of the data on the left side of the table is that if a county has a Critical Access Hospital, then the annual crude mortality rate will be 83.65 per 100,000 deaths higher than that mortality rate of a county that does not have a Critical Access Hospital. This could be interpreted as the CAH serving a very sick or aging population that utilizes the hospital's services with much more frequency than the population of another county. This increase could also be interpreted as the CAH having lower quality services to treat the patients they are seeing and the patients having worse outcomes than compared to neighboring counties. Another possible interpretation is that the county the hospital is within has a large older or sicker population that dies with more frequency than a neighboring county.

The unemployment rate coefficient on the left side on the table can interpreted as a county that sees an increase in their annual average unemployment rate will also see a 6.338 per 100,000 deaths increase in their annual crude mortality rate. Put in simpler terms, working leads to lower deaths and being unemployed leads to increased deaths. This is a similar result to what concluded in there study with "a one percentage point increase in the permanent effect of the unemployment rate, mortality would increase by 0.3 per cent". The data for both relationships on

the left side of the chart was found to be positive and statistically significant, meaning that the results are unlikely to happen due to chance or randomness, but rather that there is a specific cause between the two variables. Through the "naïve relationship" lens, the presence of a Critical Access Hospital is a stronger predictor of a county's mortality rate than is the county's unemployment rate.

I needed to account for the fixed effects of both year and county, which would then account for the average differences across the years 1999 to 2019 for all the 92 counties included in the dataset. The data on the right side of Figure 6.1 are the new results after accounting for these differences. What is now seen in the relationship between the presence of a Critical Access Hospital in a county and the county's mortality rate is a smaller effect.

Now the data say that if a county has a Critical Access Hospital, the annual crude mortality rate will be 18.40 per 100,000 deaths higher than that mortality rate of a county that does not have a Critical Access Hospital. This still shows an increase in the mortality rate for that county, but it is not as large as the "naïve relationship" result without controlling for fixed effects. In addition, there is not a statistical significance attributed to the result, meaning that this increase could simply be attributed to chance and does not directly support a relationship between CAHs and increased or decreased county crude mortality rates.

Once fixed effects were used through R, there was a change in the result for the relationship between the average annual county unemployment rate and the county's crude mortality rate. The result was now negative, which could be interpreted that any county that sees an increase in their annual average unemployment rate will see a -1.221 per 100,000 deaths decrease in their annual crude mortality rate. This means that in times of higher unemployment, there are fewer deaths and a lower crude mortality rate, which means that conversely, it can be inferred, in times of lower unemployment, there are more deaths and a higher crude mortality rate. This result was also not found to be statistically significant, meaning that the decrease could simply be attributed to chance and does not directly support a relationship between the two variables.

Figure 6.2

(Intercept)	387.2*** (9.182)	
hospital	5.081 (10.36)	-0.0771 (6.200)
unemp_rate	1.752 (1.071)	-2.366 (1.498)
Fixed-Effects:	----------	----------
year	No	Yes
county	No	Yes

Figure 6.2 displays the final comparative results of my study in which the relationship between counties with Critical Access Hospitals and their annual age-adjusted mortality rates, as

well as the relationship between a county's average annual unemployment rate and their annual age-adjusted mortality rate. The data on the left side of the chart is based off an equation that does not account for the fixed effects of year and county and can be interpreted as a "naïve relationship" because of the lack of context that is added to the data when being analyzed.

An interpretation of the data on the left side of the table is that if a county has a Critical Access Hospital, then the annual age-adjusted mortality rate will be 5.081 per 100,000 deaths higher than the age-adjusted rate of a county that does not have a Critical Access Hospital. This could be interpreted as the CAH treating relatively younger and healthier populations compared to another county or compared to the crude death rate. This increase could also be interpreted as the CAH having higher quality services to treat the patients they are seeing and the patients having better outcomes than compared to neighboring counties. Another possible interpretation is that the county the hospital is within has a large young or healthier population that does not die as frequently as a neighboring county.

The unemployment rate coefficient on the left side on the table can interpreted as a county that sees an increase in their annual average unemployment rate will also see a 1.752 per 100,000 deaths increase in their annual crude mortality rate. Put in simpler terms, working leads to lower deaths and being unemployed leads to higher deaths. The data for both relationships on the left side of the chart was not found to be statistically significant, meaning that the results are likely to happen due to chance or randomness. Through the "naïve relationship" lens, the presence of a Critical Access Hospital is a stronger predictor of a county's mortality rate than is the county's unemployment rate.

I needed to account for the fixed effects of both year and county, which would then account for the average differences across the years 1999 to 2019 for all the 92 counties included in the dataset. The data on the right side of Figure 6.2 are the new results after accounting for these differences. What is now seen in the relationship between the presence of a Critical Access Hospital in a county and the county's age-adjusted rate is an even smaller effect than without the fixed effects.

Now the data state that if a county has a Critical Access Hospital, then the annual age-adjusted mortality rate will be -0.0771 per 100,000 deaths lower than that mortality rate of a county that does not have a Critical Access Hospital. This shows a decrease in the mortality rate for that county, but it is less than zero and has decreased to be smaller than the value without fixed effects. In addition, there is not a statistical significance attributed to the result, meaning that this decrease could simply be attributed to chance and does not directly support a relationship between CAHs and increased or decreased county age-adjusted rates.

Once fixed effects were used through R, there was a change in the result for the relationship between the average annual county unemployment rate and the county's age-adjusted mortality rate. The result was now negative, which could be interpreted that any county that sees an increase in their annual average unemployment rate will see a -2.366 per 100,000 deaths decrease in their annual crude mortality rate. This means that in times of higher unemployment, there are fewer deaths and a lower age-adjusted mortalities, which means that conversely, it can be inferred, in times of lower unemployment, there are more deaths and a

higher age-adjusted mortalities. The value of -2.366 is a greater decrease than the crude mortality rate value of -1.221 from Figure 6.1 meaning that average annual unemployment rates are more affected by age-adjusted mortality rates than by crude mortality rates. However, this result was also not found to be statistically significant, meaning that the decrease could simply be attributed to chance and does not directly support a relationship between the two variables.

Hypotheses Summaries

In Hypothesis 1, I theorized that an Indiana county with a Critical Access Hospital will have lower mortality rates than a county that does not have a Critical Access Hospital. From the crude death rate data I analyzed, my hypothesis is not supported as a county with a Critical Access Hospital will have a crude mortality rate 18.4 per 100,000 deaths higher than a county that does not have a CAH within it. This is a positive but not statistically significant relationship, which means that the positive relationship may be attributed to chance or other external factors.

When using age-adjusted death rate data, my hypothesis is supported, as a county with a Critical Access Hospital will have an age-adjusted mortality rate -0.0771 per 100,000 deaths lower than a county that does not have a CAH within it. Although the age-adjusted mortality rate decreases, the value is less than one and is not significant enough of a decrease to conclude if the age-adjusted mortality rate is decreasing due to the Critical Access Hospital or if the rate remains the same. This is a negative but not statistically significant relationship, which means that the negative relationship may be attributed to chance or other external factors.

In Hypothesis 2, I theorized that rural Indiana counties with higher average annual unemployment rates will also have higher annual crude mortality rates. From the data collected and the analysis performed, my hypothesis is not supported as a county that has higher average annual unemployment rates will have lower annual crude mortality rates. A county that sees an increase in their annual average unemployment rate will see a -1.221 per 100,000 deaths decrease in their annual crude mortality rate. This is a negative but not statistically significant relationship, which means that the negative relationship may be attributed to chance or other external factors.

When using age-adjusted death rate data, my hypothesis is also not supported as an Indiana county that has higher average annual unemployment rates will have lower annual age-adjusted mortality rates. A county that sees an increase in their annual average unemployment rate will see a -2.366 per 100,000 deaths decrease in their annual age-adjusted mortality rate. This is a negative but not statistically significant relationship, which means that the negative relationship may be attributed to chance or other external factors.

Limitations

This study only looks at counties in Indiana with Critical Access Hospitals and is not a nationwide study of all counties that have Critical Access Hospitals. This study only looks at the years 1999 to 2019, as data for all variables was unable to be found before and after these years, therefore I am unable to predict relationships before 1999 and after 2019. This study did not account for external factors, like lifestyle habits, obesity rates, smoking rates, vaccination rates,

COVID cases, etc. that may alter mortality rates and lead to more premature deaths. This study did not account for hospital quality metrics in determining death rates in counties.

Discussion & Conclusion

The presence of a Critical Access Hospital in a county led to that county have an 18.4 per 100,000 higher crude mortality rate than a county without a CAH. This is because the crude mortality rate accounts for all deaths in a population in a given time during a year. These counties with CAHs may have disproportionately older or sicker populations (often called the Medicare beneficiary group) that are dying with more frequency than another county that would be considered younger or healthier. 16.5% (or 1,122,987 people) of Indiana's population is 65+ and would be considered in that older or Medicare beneficiary group ("Indiana"). There are other factors that could lead to this increase such as lifestyle habits, age, race, ethnicity, socioeconomic status, chronic diseases and more that are not accounted for in this study.

Past research has shown that people who live in areas without hospitals or without primary care physician will travel as far as necessary to go to a hospital to be seen in the emergency room and then be admitted for further treatment. This influx of people coming to the hospital, whether they be young, middle-aged, or part of the Medicare population, would adversely affect the county's crude mortality rate due to deaths in Indiana being recorded in the county where the death happened. Research supports the assumption that rural areas have older populations and Critical Access Hospitals take on the responsibility on trying to treat them. "Rural Medicare beneficiaries are disproportionately older, poorer, and burdened by chronic illnesses. As rural hospitals close, CAHs become a site of care for many vulnerable patients" (Kosar, et al). With Critical Access Hospitals being at the disadvantage of treating these disproportionately older and more vulnerable populations, it does seem logical that (despite not being statistically significant), the crude mortality rates for counties with a CAH increase when accounting for every death that occurs and not adjusting for age. A study looking at emergency department usage found the average age of those patients has increased from 43.8 years in 2005 to 48.2 years in 2014 (Liston, et. al). Based on that study, and if the average age increased at the same rate, the average age of an ED patient would be 52.1 years in 2022.

The Critical Access Hospital does not necessarily cause mortality rates to be higher, but it appears as though the presence of it attracts a sicker or older population that ends up dying in the facility which in turn causes the crude mortality rate to be higher than those counties without a CAH. As a death is recorded in the county in which it occurred, counties with Critical Access Hospitals are at a disadvantage when comparing crude mortality rates of counties without a CAH or comparing the crude rate with counties that have higher complexity hospitals with more beds. The crude mortality rate, as previously mentioned, is "the number of deaths occurring among the population of a given geographical area during the same year" (OECD Statistics). This would mean that any death, even if it was in the age group of Medicare beneficiaries or adolescents, would be counted and could be attributed to the presence of a hospital.

Quality of the hospital and the services it provides is also a key factor that can determine patient outcomes. Research has shown that quality measures in Critical Access Hospitals are lower than higher-complexity facilities, leading to increased adverse outcomes and higher crude

mortality rates. Research done by Joynt states “CAHs provide much-needed access to care for many of the nation's rural citizens, we found that these hospitals, with their fewer clinical and technological resources, less often provided care consistent with standard quality metrics and generally had worse outcomes than non-CAHs”. These lower quality services and sub-benchmark metrics may also be adversely affecting the county’s crude mortality rates. I did not include quality metrics as one of the factors in my study however, so more research would need to be done to determine a relationship between the quality of Indiana’s Critical Access Hospitals and their county’s crude mortality rates.

According to the age-adjusted mortality rates, which are more representative of the actual population and any deaths occurring in the county, it appears that the presence of a Critical Access Hospital in an Indiana county does not affect the age-adjusted death rate for that county. There is a -0.0771 per 100,000 decreases in the death rate in these counties, but it could also be interpreted as no overall change because the value is less than one death per 100,000. For the rate to equal -1 (and not -0.0771) there would need to be 1,297,016 total deaths, a number that is greater than Indiana’s population of those 65+.

When compared to the crude mortality rate, this insignificant decrease may be seen because younger populations are healthier than the Medicare populations, and do not need to be admitted to a hospital as frequently as those age 65 and older. According to STATS Indiana, the median age of the Indiana population is 38, which is significantly lower than the 65-year-old threshold and would not even be considered middle age. The database also shows that 60.3% of Indiana’s population is between the ages of 18 and 64. As more than half of the population is in this range and may be considered healthier, the slight decrease in age-adjusted mortality rate seems to make sense as these populations are not utilizing the Critical Access Hospitals as frequently as the 65+ population.

According to the data, it appears that an increase in average annual unemployment rate will lead to both a decrease in the crude mortality rate and a lower age-adjusted mortality rate in an Indiana county. This result is like what was seen in the Malat & Timberlake study, where they concluded “when the economy has grown health problems and mortality rates have increased, and when economic growth has slowed, health problems and mortality rates have decreased”. The decrease (-2.366 per 100,000) for the relationship between the age-adjusted mortality rate and unemployment rate was greater than the decrease (-1.221 per 100,000) for the relationship between the crude mortality rate and unemployment rate. This may be attributed to the fact that the crude mortality rate accounts for all individuals and all deaths in a population; but not everyone in a county population works or holds a job. According to Pew Research Center in the third quarter of 2019, 64% of people 65+ were retired, and in the third quarter of 2021, 66.9% of people 65+ were retired (Fry). This means that most of the Medicare beneficiary population is retired, a statistic that is not calculated in the equation when looking at the annual unemployment rate. Due to this, the crude mortality rate sees a smaller decrease compared to the decrease seen in the age-adjusted mortality rates. The age-adjusted mortality rate is more representative of a population and would include employed or unemployed individuals (who are included in the calculation) rather than those who are retired and not a part of the calculation. This increase is

more likely to be what the actual relationship is as the age-adjusted statistics are more representative of the actual population.

Implications

The presence of a Critical Access Hospital seemingly increases an Indiana county's crude and age-adjusted mortality rate, but the relationship is not statistically significant to solely attribute that increase to the CAH alone. Rather it appears the location of the Indiana CAHs is not random, and they are strategically placed in rural areas where there is an actual need for healthcare, which is supported by past studies that show how disadvantaged rural areas are in both overall access and quality of healthcare. The elevated rates and the presence of a Critical Access Hospital indicate facilities are important to the communities they are in, and they serve the intended purpose of bringing in patients and providing them with healthcare, whether they end up receiving treatment and leave healthy, they receive treatment in the hospital and later die in their home, or they die in the hospital during their stay.

It would be beneficial to replicate this study and determine how mortality rates in counties in other states are affected by the presence of a Critical Access Hospital. This would create more data and could lead to determining the status of rural healthcare in the country, and what work can still be done to raise the levels of quality, availability, and access to hospital care for those disadvantaged populations.

Despite the value these hospitals bring in, there is still a gap in the rural healthcare landscape as people are increasingly moving towards urban hubs and building those areas up, while rural areas get left behind and those who are there may face more adverse outcomes. Hospitals and health networks provide more benefit to the community than just inpatient and outpatient care. From jobs to community health initiatives, to preventive screenings to access to healthcare, the hospital can impact the county and health landscape in very large ways. These facilities can also serve to attract other healthcare providers to the area, such as specialists, primary care physicians, or other skilled individuals and potential clinics. In addition to these benefits, a Critical Access Hospital can also serve to educate and train individuals, as "[r]ural CAHs often provide important rural skilled nursing care options in addition to traditional hospital services" (MacKinney). Although a rural area may not be able to support a standalone hospital, healthcare systems, like Indiana has seen with IU Health, Ascension St. Vincent, Parkview Health, and Franciscan Health, are constantly merging, and acquiring new facilities to add to their networks. Not only would this expand services, being in a network would give the hospitals access to evidence-based medicine and streamlined clinical processes. This model can provide support to rural communities and allows healthcare to continue expanding in terms of more access, lower costs, and higher quality, the parts of the Iron Triangle of Healthcare and the factors that can lead to improved healthcare outcomes for not only rural Americans, but also be useful for all Americans.

A county's average unemployment rate has mixed values on the crude and age-adjusted mortality rates, but the overall effect of an increase in unemployment rates leading to a decrease in mortality rates is the same. Despite these relationships not being statistically significant to solely attribute that decrease to the mortality rates alone, there are some important implications

that can be found from the results. The age adjusted mortality rate may be the better predictor of the relationship between unemployment and mortality rates because of the population in that data being considered “working class” and not in the retired population. The data results of a -1.221 per 100,000 deaths decrease in crude mortality rate appears to be great news for the retired, unemployed, and non-working populations as there is a slight decrease in the crude mortality rate for those groups. This may mean that if you are not working because you are retired, you are living a happier or less stressful life than when you are employed and may not be as at risk for dying because you are no longer working.

There are other factors attributed to this as well that were not accounted for in the data but looking at this big picture can lead to saying that being unemployed and older is better for your health. Despite not having access to employer sponsored health insurance, the Medicare population has access to Medicare. As one of the largest insurance providers in the United States these individuals will have expanded access to healthcare services and specialists at hospitals and clinics. This could also be an attributing factor to the decrease in crude mortality rate when there is an increase in unemployment, and why the decrease is not in the tens, twenties, or even the hundreds.

It would be beneficial to replicate this study and determine how mortality rates in counties in other states are affected by unemployment rates. This would create more data and could lead to determining what an overall national trend in the relationship for healthcare, health insurance, and unemployment is. It may also lead to discovering what else can be done by employers to decrease the mortality rates of those who are employed.

For the age-adjusted mortality, there is also a decrease in those rates when there is an increase in the average annual unemployment rate. Compared to the decrease in crude death rate, the decrease in the age-adjusted death rate (-2.366 per 100,000 deaths) is a greater decrease and may mean even better news for the working-age population compared to those retired, unemployed, or not calculated into unemployment. If you are in that working age population, this means that you may also be living happier or less stressful lives than when you were employed and may also be a slightly greater decreased risk of dying because you are no longer working. Possible explanations for why there is an increase in unemployment rates and a decrease in age-adjusted death rates may be that people are often taking more mental and physical breaks, quitting jobs they do not want to work at anymore, working more on their health, wellness, and diets, going on vacations, retiring earlier, or changing lifestyle habits in general.

This dynamic is strange to investigate because of how linked employment and health insurance are, and how linked health insurance and access to healthcare are. Employers sometimes take on the responsibility of creating health fitness and wellness programs for employees to participate in, incentivizing individuals to stay healthy. Preventive screens and wellness checks are also important and are often scheduled throughout the year by the employer. Where they offer the option for employees to visit these services while on the clock or paying the employee with a bonus or with a discount on insurance costs. When looking at the dynamic between the two variables, it would appear those employer sponsored healthcare initiatives are

working because there is not an increase with unemployment and a subsequent increase in mortality rates. However, those are usually only available for the employee when they are employed, so when the employee becomes unemployed, they no longer have access to those employer sponsored services. A replacement for these services may be visits to free clinics or checkups offered by the local Critical Access Hospitals or local clinics and may be how individuals are able to keep up on their health and ensure they are staying healthy. Again, showing the importance of a CAH and hospitals in general, and how they can do more than just inpatient and outpatient services for their communities. With the decrease in age-adjusted mortality rate not being statistically significant, there are other attributing factors that may lead to this relationship, as well as other national studies that have seen that the two variables increase simultaneously in a direct relationship, so it is a unique dynamic to look at and see that for the Indiana population, working leads to more deaths, and not working or being unemployed leads to less deaths.

Notes

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References

"Age-Adjusted Premature Death Rate." *FRED*, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/release?rid=433.

Bender, Keith A., and Ioannis Theodossiou. "A Reappraisal of the Unemployment-Mortality Relationship: Transitory and Permanent Effects." *Journal of Public Health Policy*, vol. 36, no. 1, 2015, pp. 81–94, http://www.jstor.org/stable/43288067.

Borak, Jonathan, et al. "Mortality Disparities in Appalachia: Reassessment of Major Risk Factors." Journal of Occupational and Environmental Medicine, vol. 54, no. 2, Lippincott Williams & Wilkins, 2012, pp. 146–56, http://www.jstor.org/stable/45010036.

Carroll, Aaron. "The 'Iron Triangle' of Health Care: Access, Cost, and Quality." JAMA Forum Archive, JAMA Network, 3 Oct. 2012, https://jamanetwork.com/channels/health-forum/fullarticle/2760240.

CDC. "Lifestyle Risk Factors." Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, 21 Oct. 2020, https://www.cdc.gov/nceh/tracking/topics/LifestyleRiskFactors.htm.

CMS. *Critical Access Hospital - Centers for Medicare & Medicaid ...* https://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/Downloads/CritAccessHospfctsht.pdf.

CMS. "Historical." *CMS*, 15 Dec. 2021, https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/NationalHealthAccountsHistorical.

Dalton, Kathleen, et al. *Choosing to Convert to Critical Access Hospital Status.* 2003. https://doi.org/10.17615/thcz-n251

Defining Rural Indiana—The First Step - Purdue University. Purdue Extension - Center for Rural Development, https://ag.purdue.edu/agecon/fambiz/Documents/defining_rural_indiana.pdf.

Fry, Richard. "Amid the Pandemic, a Rising Share of Older U.S. Adults Are Now Retired." *Pew Research Center*, Pew Research Center, 4 Nov. 2021, https://www.pewresearch.org/fact-tank/2021/11/04/amid-the-pandemic-a-rising-share-of-older-u-s-adults-are-now-retired/#:~:text=In%20the%20third%20quarter%20of,the%20same%20quarter%20of%202019.

Greenwood-Ericksen, Margaret B, and Keith Kocher. "Trends in Emergency Department Use by Rural and Urban Populations in the United States." JAMA Network Open, American Medical Association, 5 Apr. 2019, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6481434/#:~:text=(ED)%20visits%3F-,Findings,42.8%20visits%20per%20100%20persons.

Hawthorne, Timothy L., and Mei-Po Kwan. "Using GIS and Perceived Distance to Understand the Unequal Geographies of Healthcare in Lower-Income Urban Neighbourhoods." The Geographical Journal, vol. 178, no. 1, Wiley, 2012, pp. 18–30, http://www.jstor.org/stable/41475787.

"How Does the U.S. Census Bureau Define 'Rural?"." *Mtgis*, https://mtgis-portal.geo.census.gov/arcgis/apps/MapSeries/index.html?appid=49cd4bc9c8eb444ab51218c1d5001ef6#:~:text=The%20Census%20Bureau%20defines%20rural,NOT%20in%20an%20urban%20area.

"How to Find a Death Record in Indiana?" *State Records*, https://indiana.staterecords.org/deathrecords.

"Indiana." *InDepth Profile: STATS Indiana*, https://www.stats.indiana.edu/profiles/profiles.asp.

Indiana Hospital Association. "Bringing Better Health Care to Indiana's Smallest Communities." *Rural Health*, Indiana Hospital Association, https://www.ihaconnect.org/about/indiana-hospitals/Pages/Rural-Health.aspx.

"Indiana Primary Care Physicians." *County Health Rankings & Roadmaps*, https://www.countyhealthrankings.org/app/indiana/2021/measure/factors/4/description?sort=sc-3.

"Indiana Population 2022." *Indiana Population 2022 (Demographics, Maps, Graphs)*, https://worldpopulationreview.com/states/indiana-population.

Joynt, Karen E., et al. "Mortality Rates for Medicare Beneficiaries Admitted to Critical Access and Non–Critical Access Hospitals, 2002-2010." *JAMA*, JAMA Network, 3 Apr. 2013, https://jamanetwork.com/journals/jama/fullarticle/1674237.

Kosar, Cyrus M., et al. "Association of Diagnosis Coding With Differences in Risk-Adjusted Short-Term Mortality Between Critical Access and Non–Critical Access Hospitals." *JAMA*, JAMA Network, 4 Aug. 2020, https://jamanetwork.com/journals/jama/fullarticle/2768976.

Lisa, Andrew. "States With The Biggest Rural Populations." *Stacker*, 8 Apr. 2019, https://stacker.com/stories/2779/states-biggest-rural-populations?page=5.

Liston, P, et al. "Age Is Only a Number?-Time in the Emergency Department (ED)." *Emergency Medicine Journal*, BMJ Publishing Group Ltd and the British Association for Accident & Emergency Medicine, 1 Dec. 2015, https://emj.bmj.com/content/32/12/994.1.

Liu JJ, Bellamy G, Barnet B, Weng S. Bypass of local primary care in rural counties: effect of patient and community characteristics. Ann Fam Med. 2008; 6(2): 124–130. https://www.annfammed.org/content/annalsfm/6/2/124.full.pdf

Lutfiyya, M. Nawal, et al. "Comparison of US Accredited and Nonaccredited Rural Critical Access Hospitals." International Journal for Quality in Health Care, vol. 21, no. 2, Oxford University Press, 2009, pp. 112–18, http://www.jstor.org/stable/45127428.

MacKinney, Clinton, et al. "Aging Well in Rural America—the Role and Status of Healthcare." Generations: Journal of the American Society on Aging, vol. 43, no. 2, American Society on Aging, 2019, pp. 46–54, https://www.jstor.org/stable/26760114.

Malat, Jennifer, and Jeffrey M. Timberlake. "County-Level Unemployment Change and Trends in Self-Rated Health." Sociological Focus, vol. 46, no. 1, Taylor & Francis, Ltd., 2013, pp. 25–46, http://www.jstor.org/stable/24579382.

McCrum, Marta L., et al. "Beyond Volume: Does Hospital Complexity Matter? An Analysis of Inpatient Surgical Mortality in the United States." Medical Care, vol. 52, no. 3, Lippincott Williams & Wilkins, 2014, pp. 235–42, http://www.jstor.org/stable/24465842.

McMorrow, Stacey. "Spillover Effects of the Uninsured: Local Uninsurance Rates and Medicare Mortality from Eight Procedures and Conditions." Inquiry, vol. 50, no. 1, Sage Publications, Inc., 2013, pp. 57–70, http://www.jstor.org/stable/23480897.

Merwin, Elizabeth, et al. "Differential Access to Quality Rural Healthcare: Professional and Policy Challenges." Family and Community Health, vol. 29, no. 3, Lippincott Williams & Wilkins, 2006, pp. 186–94, http://www.jstor.org/stable/44954508.

OECD Statistics. "Crude Death Rate." *OECD Glossary of Statistical Terms - Crude Death Rate Definition*, 18 Apr. 2013, https://stats.oecd.org/glossary/detail.asp?ID=491.

Schneider, Eric C., et al. "Mirror, Mirror 2021: Reflecting Poorly." Commonwealth Fund, 4 Aug. 2021, https://www.commonwealthfund.org/publications/fund-reports/2021/aug/mirror-mirror-2021-reflecting-poorly#:~:text=Health%20Care%20System%20Performance%20Rankings&text=The%20U.S.%20ranks%20%2311%20%E2%80%94%20last,above%20it%2C%20Switzerland%20and%20Canada.

Schoenbaum, Stephen C., et al. "Mortality Amenable to Health Care in the United States: The Roles of Demographics and Health Systems Performance." Journal of Public Health Policy, vol. 32, no. 4, Palgrave Macmillan Journals, 2011, pp. 407–29, http://www.jstor.org/stable/41342695.

Stacker. "Most Rural Counties in Indiana." *Stacker*, 1 Feb. 2022, https://stacker.com/indiana/most-rural-counties-indiana.

"Rural Health Information Hub." Critical Access Hospitals (CAHs) Overview, https://www.ruralhealthinfo.org/topics/critical-access-hospitals.

Thiede, Brian, et al. “6 Charts That Illustrate the Divide between Rural and Urban America.” *PBS*, Public Broadcasting Service, 17 Mar. 2017, https://www.pbs.org/newshour/nation/six-charts-illustrate-divide-rural-urban-america.

Tribe, Deanna L. “Appalachia or the Midwest? Appalachian Cultural Awareness in Southern Ohio.” *ERIC*, 28 Feb. 1989, https://eric.ed.gov/?id=ED307089.

Weirich, Mandy, and William Benson. “Rural America: Secure in a Local Safety Net?” Generations: Journal of the American Society on Aging, vol. 43, no. 2, American Society on Aging, 2019, pp. 40–45, https://www.jstor.org/stable/26760113.

“What Is Rural?” *USDA ERS - What Is Rural?*, U.S. Department of Agriculture, 23 Oct. 2019, https://www.ers.usda.gov/topics/rural-economy-population/rural-classifications/what-is-rural.aspx.

World Population Review. *Poorest States 2022*, World Population Review, https://worldpopulationreview.com/state-rankings/poorest-states.

Yip, Paul S. F., and Eric D. Caine. “Employment Status and Suicide: The Complex Relationships between Changing Unemployment Rates and Death Rates.” Journal of Epidemiology and Community Health (1979-), vol. 65, no. 8, BMJ, 2011, pp. 733–36, http://www.jstor.org/stable/23050944.