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ASSOCIATION OF INFANT MORTALITY RATES AND HEALTHCARE RESOURCES IN URBAN AND RURAL COUNTIES ACROSS THE UNITED STATES

Vanessa Guevara

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by

VANESSA GUEVARA

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ABSTRACT

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UNITED STATES

Vanessa Guevara, B.S. Nursing

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Faculty Mentor: Jessica G. Smith

Infant mortality rate, an indicator of community health, was 5.6 deaths per 1,000 live births in the United States in 2019. The purpose of this study was to understand rural-urban relationships between healthcare resources and infant mortality at the county-level. The design was secondary, cross-sectional, descriptive, comparative, and correlational. There were 471 urban and 15 rural counties with infant mortality data. Average infant mortality rate was higher in rural (M=8.99, SD=1.59) compared to urban (M=6.19, SD=1.74) counties. There was a statistically significant difference for infant mortality, total hospitals, hospitals with NICUs, and OBGYNs in rural compared to urban counties. There was a positive, statistically significant correlation between rate of APRNs per 1,000 and infant mortality per 1,000 in urban and rural counties, indicating that more APRNs were

present on average in counties with higher infant mortality. Further research is needed to determine other factors explaining the rural-urban infant mortality disparity.

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CHAPTER 1

INTRODUCTION

1.1 Infant Mortality and Healthcare Access for Women and Infants

For many parents, care for their newborn means the world; however, healthcare access for infants in rural areas is not guaranteed. Disparities in advanced healthcare resource availability across rural and urban counties could influence differences in infant outcomes, namely infant mortality. Infant mortality is high in prevalence with almost 21,000 deaths in the United States in 2018, and it can be an indicator of health in our society (Centers of Disease Control and Prevention, 2021). Multiple indicators of infant mortality rates have been researched (Ehntholt et al., 2020; Ely et al., 2017; Erhenthal et al., 2020; Patel et al., 2018; Womack, et al., 2020). However, associations between healthcare access and infant mortality across rural and urban areas are underexplored. It is important to understand how the availability of healthcare resources could be associated with infant mortality and how these associations may differ across rural and urban counties.

1.1.1 Significance of Healthcare Access for Women and Infants in Rural Communities

Access to healthcare for women and infants is important because having, or not having, access to infant and maternal healthcare could be the difference between life and death for mothers and infants. Researching associations between infant mortality rates and healthcare available to women and infants within rural and urban counties in the United States could bring attention to disparities in infant care. It could be found that inadequate prenatal care in rural settings (i.e., not having enough OB doctors, nurse practitioners, or nurses) is associated with poorer outcomes, leaving family medicine health care providers to do the best they can regardless of potential complications that could arise. If a mom and her baby needed more advanced care than available, there becomes a risk of losing the baby, which contributes to the infant mortality rates in rural counties.

1.1.2. Challenges of Healthcare Access for Women and Infants in Rural America

Since 2010, the rate of rural hospital closures has increased significantly (Kaufman et al., 2016) and many in rural counties do not provide specific types of healthcare such as access to an obstetrics department or neonatal intensive care units. The rural hospitals that do provide specialty care do not have the specialized or board-certified staff in addition to necessary equipment to handle high acuity cases. If problems arise with pregnant women or their babies in these counties, these hospitals must transfer them to more specialized, well-equipped hospitals which creates a risk for both mom and baby.

1.2 Purpose of the Research

The purpose of the study is to analyze empirical data to explain the extent of healthcare access variability for infants across rural counties, and how this may influence infant mortality. This study seeks to answer the following research questions: Is there a difference in county-level infant mortality rates in rural versus urban counties in the United States? If there are differences found, what health service factors at the county-level could be associated with differences in county-level infant mortality rates? If there are no differences in infant mortality rates, are health service factors at the county-level associated with county-level infant mortality rates in counties across the United States regardless of location?

The goal of answering the proposed research questions is to seek to fill the gaps in knowledge about factors at the county-level, between rural and urban populations, that may be contributing to infant mortality differences. By looking at contributing factors such as health service factors in rural versus urban counties, a possible connection could be found regarding rates of infant mortality. After answering the research questions, possible interventions could be posed to potentially decrease the higher rates of infant mortality across United States counties. Analyzing infant mortality rates within rural and urban counties will highlight the missing or lack of resources in these counties. Knowledge can be gained on what some counties could be doing correctly regarding infant mortality over others if there are differences found in infant mortality. Resources could be shared, or policies could be created following this analysis of rural and urban counties and the types of healthcare provided to women and infants.

CHAPTER 2

LITERATURE REVIEW

Inspection of the literature indicates that factors related to infant mortality are broad and include air quality in the environment, maternal characteristics, and socioeconomic status (Ely et al., 2017; Ehntholt et al., 2002; Erhenthal et al., 2020; Patel et al., 2018). Differences in infant mortality depending on location and race have also been documented (Womack, et al., 2020). In this chapter, literature about factors as related to infant mortality will be described, as well as gaps in knowledge that need further research.

Womack et al. (2020) found that there were higher infant mortality rates within nonmetropolitan areas compared to metropolitan areas in addition to finding that Black and non-Hispanic infants had higher levels of infant mortality rates regardless of urbanization level. Meaning that babies born in highly populated and urbanized areas survived more often compared to those born into rural areas. This study accounted for infant mortality rates across all races and ethnicities and further analyzed the infant mortality rates within the different races and ethnicities. Studies have also investigated the relationship between infant mortality and maternal information. This means that maternal data such as mother's age and race and maternal-demographic data was analyzed regarding infant mortality rates. Ely et al. (2017) discovered infant mortality was higher in rural counties when compared to urban counties across the United States when factoring in maternal information. This overview provided information based on the whole country and focused on one year rather than a multi-year time span.

Patel et al. (2018) found associations between poorer environmental quality to higher rates of infant mortality in some races and ethnicities and not in others. This study focused on a timespan of five years and the whole country rather than a specific state. Although the associations varied, infant mortality was noted in higher rates in rural counties where poor environmental quality could be seen than in urban counties with better quality water, air, and land (Patel et al., 2018). Erhenthal et al. (2020) found socioeconomic status as a contributing factor to infant mortality and that infant mortality was higher in micropolitan counties compared to large metropolitan counties due to the socioeconomic status of rural compared to urban counties. Similarly, Ehntholt et al. (2020) found socioeconomic status as a contributing factor to infant mortality rates at the state-level but found little to no correlation at the county-level analysis.

Although studies reviewed about factors related to infant mortality have focused on economic status, racial disparities, and environmental quality, few studies have evaluated the relationship between infant mortality rates and types of healthcare access, types of specialized nursing practices, and facilities available in rural and urban counties (Ehntholt et al., 2002; Erhenthal et al., 2020; Womack et. al., 2020; Patel et al., 2018). There are advantages to identifying contributing factors to infant mortality such as contributing to gaps in knowledge about factors at the county-level, between rural and urban populations. Analyzing contributing factors such as health service factors in rural versus urban counties could potentially identify connections regarding rates of infant mortality.

CHAPTER 3

METHODOLOGY

3.1 Conceptual Model

This study was guided by the Quality Health Outcomes Model (QHOM) (Mitchell et al., 1998). The QHOM is a conceptual model which proposes that the impact of interventions depends on structural and population characteristics to influence health outcomes (Mitchell et al., 1998). Healthcare systems, therefore, are foundational to health outcomes and need to be equipped for nurses to deliver care that can influence better patient health outcomes. Likewise, population characteristics may influence health outcomes. This study's focus was comparing rural-urban system and population variables as factors that could influence infant outcomes. This study did not include a focus on interventions. Table 3.1 displays how the QHOM informed study concepts and variables from the AHRF Resource Files Technical Documentation, including the field codes, and years from which data were derived (Health Resources & Services Administration, n.d.-b).

Table 3.1: Study Concepts and Variables

Framework Concept	Study Concept	Study Variable	Field Codes	Year
Outcome	Infant mortality	5-Yr infant mortality rate-total	F12669-19	2015-2019
System	Rural-Urban	Rural-Urban Continuum Code	F00020	2013
		Region	F04448	
System	Healthcare facilities	Total Number of Hospitals	F08868-19	2019
		Hospital Beds	F08921-19	2019
		Bassinets Set up and Staffed	F08930-19	2019
		#Hosp w/Obstetric Care	F12564-19	2019
		#Hosp w/ neonatal Intens care	F12567-19	2019
		#Hosp w/ neonatal Intermed care	F12568-19	2019
		Obstetrics Care, Beds Set Up		
		Neonatal Intens Cr, Beds Set Up	F09083-19	2019
		Neonatal Intermed Cr, Beds Set Up	F09145-19	2019
			F09151-19	2019
System	Healthcare personnel	Adv Practice Regist Nurse	F14646-20	2020
		Ob-Gyn, Gen, Total Patient Care	F11685-19	2019
		Adv Pract Nurse Midwives w/NPI	F14645-20	2020
Population	Births	Total births	F12557-19	2019
		Total Births in Hospitals	F09619-19	2019
		3-yr births -preterm	F13608-17	2017-2019
Population		Population	F13182-19	2019
		Female Population 15-19	F06711-10	2010
		Female Population 20-24	F06713-10	2010
		Female Population 25-29	F06715-10	2010
		Female Population 30-34	F06717-10	2010
		Female Population 35-44	F06719-10	2010
		Male Population Under 5	F06704-10	2010
		Female Population under 5	F06705-10	2010

3.2 Design, Sample, and Setting

The design of the study is cross-sectional, descriptive, comparative, and correlational. The sample includes rural and urban counties across America and the unit of analysis is the county. The inclusion criterion is a county in the United States and the available data present in counties for analysis. A cross-sectional design is most appropriate to identify associates in quantitative datasets at one point in time.

3.3 Data Source

Secondary data from the 2020-2021 Area Health Resources Files (AHRF) will be used for this study (Health Resources & Services Administration, n.d.-a). The AHRF includes secondary data collected on healthcare factors. These factors include population characteristics, professions, facilities, economics, and expenditures based on county, state, and national levels. These data components were compiled from over fifty sources and were put into one location. The AHRF is released annually and includes specific years for each data depending on agreements and availability. IRB approval was not required because these data are publicly accessible and available online for download and use.

3.4 Variables

The outcome of interest was the county-level 5-year infant mortality rate. The infant mortality rate over 5 years, from 2015 to 2019, was compared for rural and urban counties. Specialized healthcare personnel such as Advanced Practice Registered Nurses (APRNs), OB-GYN physicians, and Advanced Practice Nurse Midwives (APNMs) were included because of the high acuity care that some infants require. Healthcare resources and facilities related to infant care, such as the Total Number of Hospitals, Hospital Beds, Bassinets, Number of Hospitals with Obstetric Care, and Number of Hospitals with Neonatal

Intensive Care (NICUs) and Obstetric Care were included due to the need for these resources to care for infants needing advanced care. Total births, Total Births in Hospitals, and Total Preterm Births were included to contextualize the need for resources counties require to care for infants. Total Population, Female Population of Childbearing Age, and Male and Female Population of Children under five were included to better understand the number of possible pregnancies as well as the possible continuity of care for children who were born preterm or needing NICU services.

3.5 Data Analysis Plan

Data analysis was performed using SAS software under guidance. This involved writing a SAS program to describe the variables selected and the extent of data missingness. The categorical Rural-Urban Continuum Code was used to determine the rural-urban status of a county. There are 9 categories across the continuum, with 1-3 being "urban" and 4-9 being "rural". These counties can be collapsed to a dichotomous scheme to compare rural and urban counties across America.

Descriptive statistics were provided for variables, including means and standard deviations, stratified by rural or urban counties. Population characteristics, which included the Total Number of Births, the Total Number of Births in Hospitals, the three-year Preterm Births, and the populations these affected were also described. This included the male and female population of those under the age of five individually as well as the sum of the two. In addition to the female population total of women of childbearing age, ranging from 15 to 44, and the female population broken down by age group of women of childbearing ages.

Five-year infant mortality rates were already calculated in the dataset as rates per 1,000. Therefore, rates of healthcare resources and healthcare personnel per 1,000 were calculated for rural and urban counties. Total Hospitals, Total Hospital Beds, Total Hospitals with Obstetric Care, Total Obstetric Beds, Total APRNs, OBGYNs, and APNMs used the denominator "Total Female Population of Women of Childbearing Age" to calculate the rates per 1,000 present in rural and urban counties. Total Bassinets, Number of Hospitals with NICUs, and Number of Hospitals with Neonatal Intermediate Care used the denominator "Total Population for both Females and Males Under the Age of Five". For some variables, like Total Births, Total Hospital Births, and Total Preterm Births, the denominator "Total Population" was used to calculate the rates per 1,000 present in rural and urban counties.

The Mann-Whitney U test was used to compare whether there was a difference in the key variables for two independent groups: rural and urban counties. Due to variables having non-normal distributions, the nonparametric Mann-Whitney U test was determined to be the most appropriate test for comparing differences between the two independent groups. The null hypothesis was that rural and urban counties are equal for the variables being compared. In this study infant mortality is not equal in rural and urban counties. Determining if the p-value is less than 0.05, which is the level of significance set for this study (alpha=0.5), will indicate whether to accept or reject the null hypothesis. Additionally, box plots were created from the Mann-Whitney U test to show data distribution. The box plots for each variable include minimums, maximums, and medians for both urban and rural counties.

Spearman's Rho correlations were calculated for the rates of infant mortalities and all other structural and population variables due to non-normal distributions of variables. Spearman's Rho is a test used to compare correlations between variables. The correlation coefficient indicates the strength of the linear relationship between two variables in the correlation analysis. The p value indicates the probability that the null hypothesis is true. A negative correlation coefficient indicates a negative relationship and the greater the number indicates a stronger correlation.

Correlations were visualized using scatterplots. In order to visually understand the correlations, scatterplots were created between variables and infant mortality for rural and urban counties. The use of scatterplots can determine whether there appears to be a correlation, the direction of the correlation, and how strong the correlation appears to be. A regression line is shown in the scatterplots to further show the correlation in slope form.

CHAPTER 4

RESULTS

4.1 Sample Description

There were 3,221 counties from across the United States included in the dataset with 1,236 of those counties being classified as urban and 1,985 classified as rural. After the analysis it was found that 38.37% of counties were urban while 61.63% of counties were classified as rural. Continuum code 01-03 are classified as metropolitan counties and 04-09 are classified as nonmetropolitan counties. More specifically the frequency of counties in each continuum or the rural urban code are shown in Table 4.1 below.

Table 4.1: Rural-Urban Continuum Code for Counties with Infant Mortality Data

Continuum	Frequency	Percent
01	210	43.21
02	165	33.95
03	96	19.75
04	12	2.47
05	3	0.62
06	0	0
07	0	0
08	0	0
09	0	0

Note:
01=Counties in metro areas of 1 million population or more
02=Counties in metro areas of 250,000 – 1,000,000 population
03=Counties in metro areas of fewer than 250,000 population
04=Urban population of 20,000 or more, adjacent to a metro area
05=Urban population of 20,000 or more, not adjacent to a metro area
06=Urban population of 2,500-19,999, adjacent to a metro area
07=Urban population of 2,500-19,999, not adjacent to a metro area
08=Completely rural or less than 2,500 urban population, adjacent to a metro area
09=Completely rural or less than 2,500 urban population, not adjacent to a metro area

In the SAS programming system, the means procedure was run to analyze the Infant Mortality Rate from 2015 to 2019 utilizing data from 471 of the urban counties and 15 of the rural counties. The rural data came from counties in Arizona, Florida, Hawaii, Illinois, Louisiana, Mississippi, New York, North Carolina, Ohio, Pennsylvania, and South Carolina. Due to the differences in the amount of data found on infant mortality in rural and urban counties across the United States, another analysis was conducted to determine where the data came from regionally within the United States. Tables 4.2 and 4.3 show the frequency of data found within these regions.

Table 4.2: Frequency of Urban County Data within Regions of the United States

REGION	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Midwest	104	22.17	104	22.17
Northeast	75	15.99	179	38.17
South	211	44.99	390	83.16
West	79	16.84	469	100.00
Frequency Missing = 2				

Table 4.3: Frequency of Rural County Data within Regions of the United States

REGION	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Midwest	2	13.33	2	13.33
Northeast	2	13.33	4	26.67
South	9	60.00	13	86.67
West	2	13.33	15	100.00

The means procedure was also run to analyze the data for each variable. Table 4.4 summarizes the data analysis found by running the means procedure. Overall, there was a higher infant mortality rate in rural counties compared to urban counties within the United States, as well as fewer overall human and material resources for infant and women's services in rural compared to urban counties. These resources included Total Hospitals, Hospital Beds, Bassinets, Hospitals with Obstetric Care, Hospitals with NICUs, Obstetric Beds, and NICU Beds. For human resources, there was a mean of 583.47 per 1,000 APRNs in urban counties compared to 112.33 per 1,000 APRNs in rural. For OBGYNs, there was a mean of 71.45 in urban counties and 9.13 in rural. For APNMs, there was a mean of 13.37 in urban counties and 3.53 in rural.

Table 4.4: Means and Standard Deviations for Infant Mortality, Healthcare Facilities, and Healthcare Personnel across Rural and Urban Counties

Variable	Rural Mean (SD)	Urban Mean (SD)
Outcome	N=15	N=471
Infant Mortality	8.99 (1.59)	6.19 (1.74)
Healthcare Facilities	N=15	N=471
Total Hospitals	2.67 (1.91)	7.11 (8.50)
Hospital Beds	320.53 (260.37)	1530.96 (2101.94)
Bassinets	23.53 (11.37)	85.96 (115.91)
Number of hospitals with Obstetric Care	0.93 (0.70)	2.52 (2.89)
Number of hospitals with neonatal intensive care	0.20 (0.56)	1.61 (2.35)
Number of hospitals with neonatal intermediate care	0.33 (0.62)	1.01 (1.36)
Obstetric Beds	16.13 (15.09)	80.20 (111.00)
Neonatal Intensive Care Beds	2.27 (5.99)	38.42 (65.81)
Neonatal Intermediate Care Beds	3.27 (7.69)	11.60 (21.46)
Healthcare Personnel	N=15	N=471
APRNs	112.33 (75.69)	583.47 (736.22)
OBGYNs	9.13 (5.17)	71.45 (111.83)
APNMs	3.53 (2.77)	13.37 (19.70)

Table 4.5 indicated that there was overall a higher mean of Total Births, Births in Hospitals and Preterm Births over three years in urban counties compared to rural counties within the United States.

Table 4.5: Means and Standard Deviations for Population Characteristics

Variable	Rural Mean (SD)	Urban Mean (SD)
Population Characteristics	N=15	N=471
Total Births	1259.53 (365.73)	*6043.46 (8620.00)
Total Births in Hospitals	1186.80 (764.04)	6178.01 (8828.76)
3-year Births Preterm	179.00 (49.05)	717.54 (995.19)
Male Population Under 5	3735.47 (1031.61)	16304.90 (24092.44)
Female Population Under 5	3571.33 (997.13)	15624.60 (23099.44)
Total Population Under 5	7306.80 (2026.25)	31929.50 (47190.99)
Female Population 15-19	3889.80 (1055.61)	16696.44 (24839.56)
Female Population 20-24	3457.07 (1032.10)	16941.61 (25370.78)
Female Population 25-29	3288.73 (925.03)	17203.57 (27128.51)
Female Population 30-34	3181.87 (931.18)	16219.60 (25398.03)
Female Population 35-44	6788.60 (1882.73)	32894.88 (49815.32)
Female Population Total	20606.07 (5543.59)	99947.11 (151858.35)

*N=469 due to missing data

The rates of the healthcare facilities variables, healthcare personnel variables, as well as the population characteristics, were calculated. Table 4.6 displays that there were overall higher means of healthcare resources both material and human per 1,000 in rural counties compared to urban counties within the United States. Another finding from this table included that there were close population statistics in rural and urban counties such as a mean of 11.57 Births in rural and 11.71 Births in urban counties, 11.25 Births in Hospitals in rural and 12.35 Births in Hospitals in urban, and 1.69 Preterm Birth Rates in rural and 1.45 Preterm Birth Rates in urban counties.

Table 4.6: Means and Standard Deviations for Health Variables Transformed into Rates per 1,000

Variable	Rural Mean (SD)	Urban Mean (SD)
Healthcare Facilities		
Total Hospitals	0.13 (0.10)	0.09 (0.05)
Hospital Bed	16.72 (16.39)	16.36 (9.35)
Bassinets	3.31 (1.86)	3.00 (1.76)
Number of hospitals with Obstetric Care	0.05 (0.04)	0.03 (0.02)
Number of hospitals with neonatal intensive care	0.03 (0.10)	0.06 (0.05)
Number of hospitals with neonatal intermediate care	0.05 (0.10)	0.04 (0.05)
Obstetric Beds	0.87 (0.91)	0.85 (0.54)
Neonatal Intensive Care Beds	0.38 (1.01)	1.19 (1.39)
Neonatal Intermediate Care Beds	0.51 (1.24)	0.37 (0.63)
Healthcare Personnel		
APRNs	6.09 (4.99)	6.31 (3.63)
OBGYNs	0.45 (0.23)	0.64 (0.36)
APNMs	0.17 (0.14)	0.14 (0.13)
Population Characteristics		
Total Births	11.57 (1.40)	11.71 (1.93)
Total Births in Hospitals	11.25 (7.77)	12.35 (6.58)
3-year Births Preterm	1.69 (0.42)	1.45 (0.50)

The distribution of infant mortality can be seen as a histogram in rural and urban counties by running a univariate code in the SAS program. Category 0 indicates urban counties and category 1 indicates rural counties. In Figure 4.1 there is a skewness in infant mortality rates in the urban counties indicating a nonnormal distribution. There is more of a bell shape in infant mortality rates in rural counties, however due to a small sample of rural county data we performed non-parametric tests such as Mann-Whitney U and Spearman's Rho to further analyze the data.

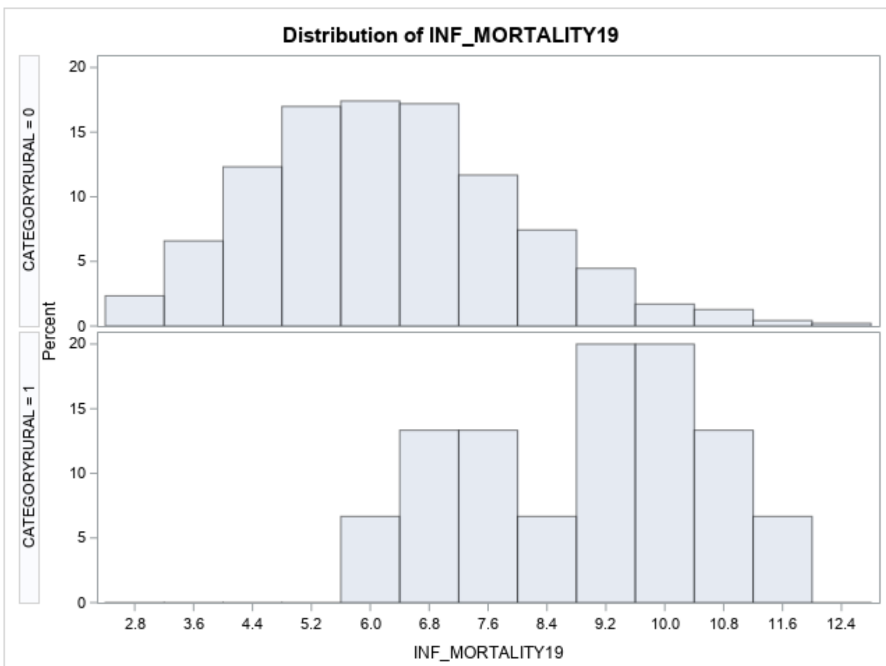

Figure 4.1: Distribution of Infant Mortality in Rural and Urban Counties

The results of the Mann-Whitney U Test for infant mortality, Total Hospitals, Hospitals with Obstetric Care, Hospitals with NICUs, APRNs, and OBGYNs are shown below. Table 4.7 revealed there was a statistically significant difference in infant mortality for rural counties compared to urban counties with a <.001 P value. In addition, there were statistically significant differences in Total Hospitals, Hospitals with NICUs, and OBGYNs for rural compared to urban counties. The P value for Total Hospitals was 0.0467, Hospitals with NICUs was 0.0013, and OBGYNS was 0.0286. The variables Hospitals with Obstetric Care and APRNs did not have a statistically significant difference in rural compared to urban counties. Boxplots were also generated for each Mann-Whitney U test (Figures 4.2-4.7).

Table 4.7: Comparison of Wilcoxon Scores (two sample test) for Variables as Rates per 1,000 by Rural and Urban Counties

	Z Score	P value (two-sided)
Infant Mortality	5.01	<.0001
Total Hospitals	1.99	0.0467
Hospitals with Obstetric Care	1.80	0.0717
Hospitals with NICUs	-3.22	0.0013
APRNs	-1.27	0.2048
OBGYNs	-2.19	0.0286

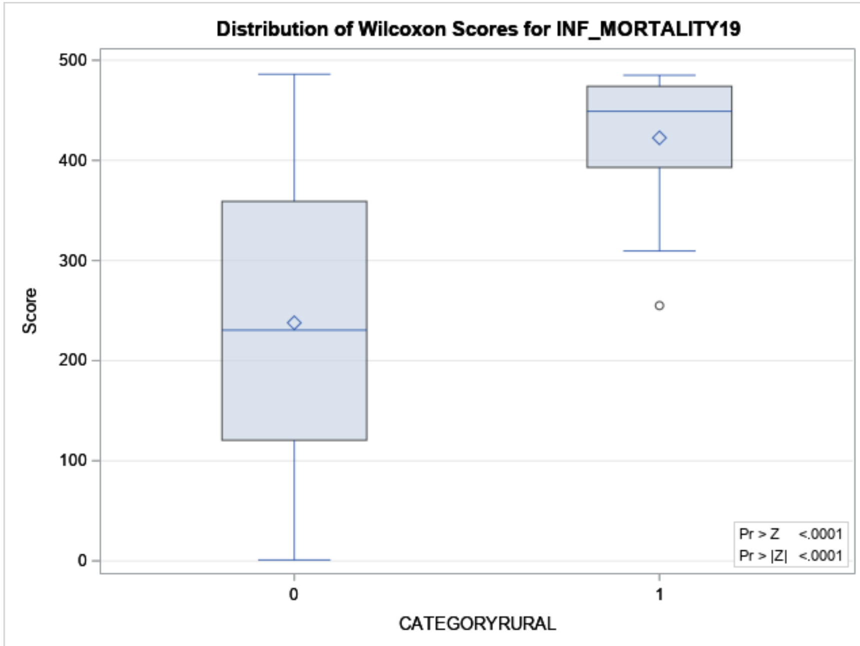

Figure 4.2: Distribution of Wilcoxon Scores for Infant Mortality

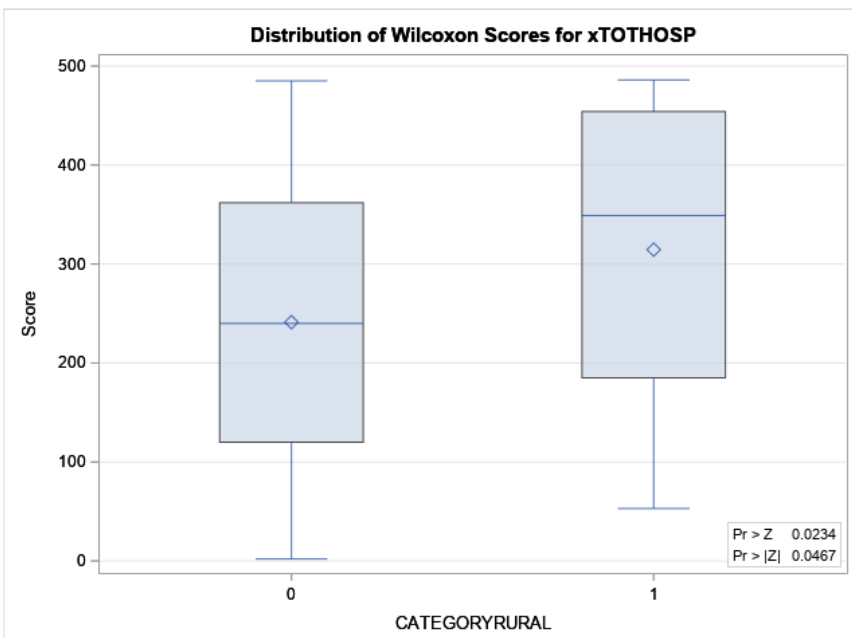

Figure 4.3: Distribution of Wilcoxon Scores for Total Hospitals

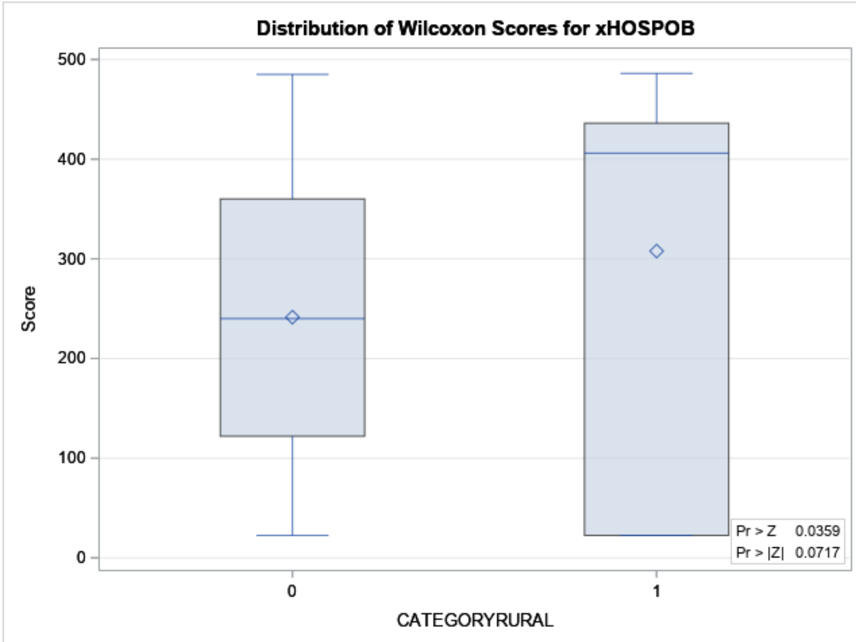

Figure 4.4: Distribution of Wilcoxon Scores for Hospitals with Obstetric Care

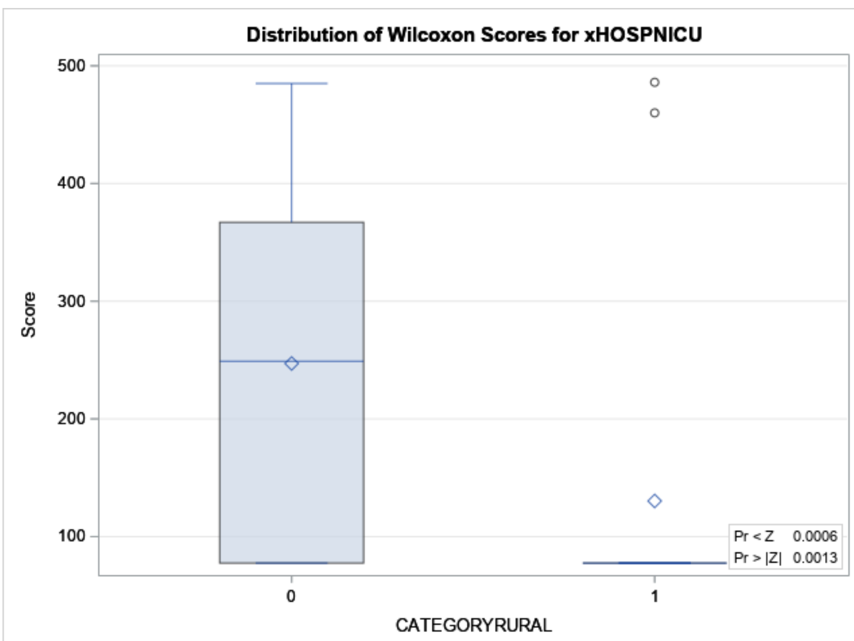

Figure 4.5: Distribution of Wilcoxon Scores for Hospitals with NICUs

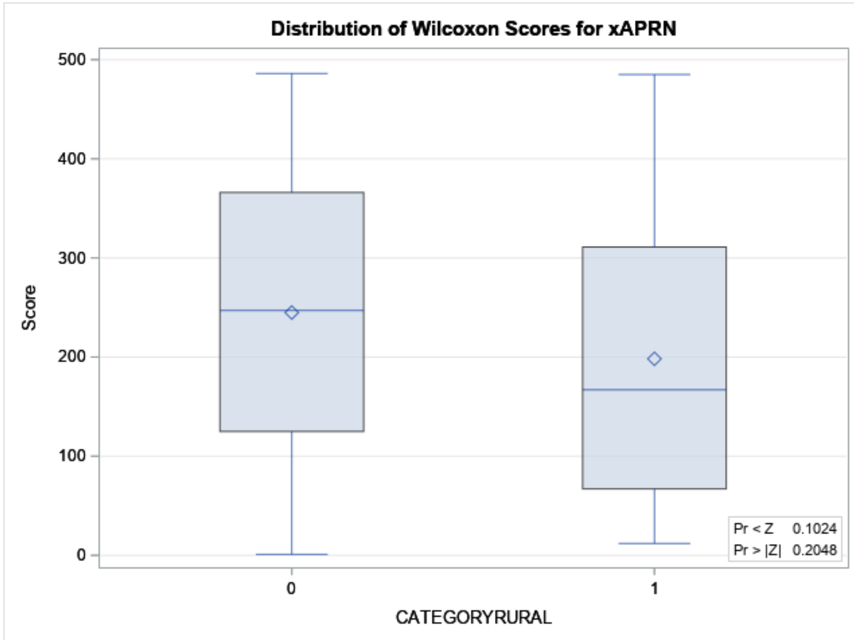

Figure 4.6: Distribution of Wilcoxon Scores for Total APRNs

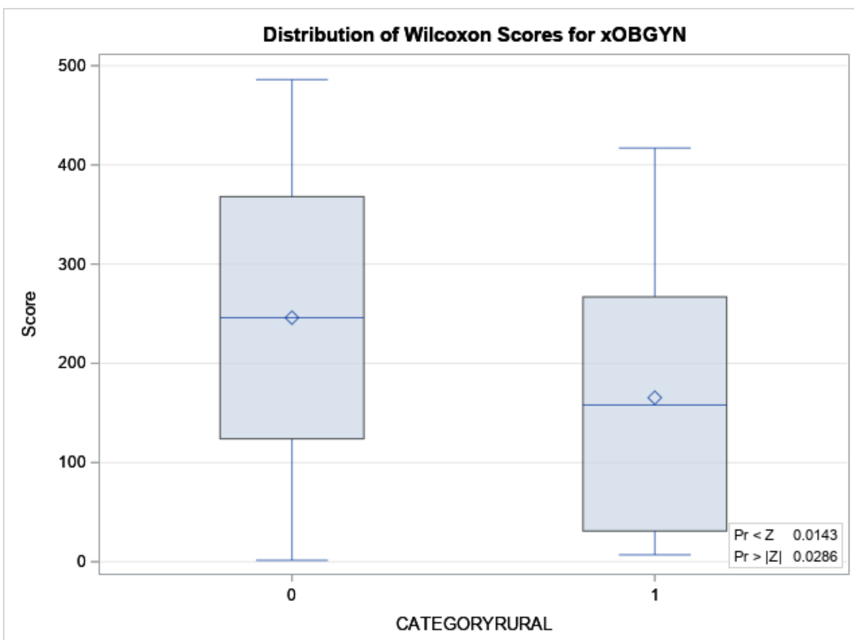

Figure 4.7: Distribution of Wilcoxon Scores for Total OBGYNs

Table 4.8 includes the results of the Spearman's Rho test for the correlation coefficients for mean rates per 1,000 for both the urban and rural counties are displayed. In rural counties there was a strong, statistically significant, positive correlation between rate of APRNs per 1,000 and infant mortality per 1,000 in rural counties.

There was a weak, statistically non-significant, negative correlation between APNMs and infant mortality in rural counties. There was a weak, statistically non-significant, negative correlation between Total Hospitals and infant mortality in rural counties. There were weak, statistically non-significant, positive correlations between infant mortality and other OB resource variables (OBGYNs and OB Beds). There were moderate, positive, non-significant correlations between infant mortality and other NICU resource variables (Hospitals with NICUs and NICU Beds) (Table 4.8).

In addition, Table 4.8 revealed there was a moderate, statistically significant, positive correlation between Total Hospitals and infant mortality in urban counties. There was a weak, statistically significant, positive correlation between Hospitals with Obstetric Care and infant mortality in urban counties. There was a weak, statistically significant, positive correlation between OB Beds and infant mortality in urban counties.

Table 4.8: Spearman Rho Correlation Coefficients for Mean Rates per 1,000

	Infant Mortality	
	Rural Counties N = 15	Urban Counties N = 471
APRNs	0.65	0.39
	p = 0.01	p = <.0001
OBGYNs	0.05	-0.03
	p = 0.87	p = 0.52
APNMs	-0.17	-0.01
	p = 0.54	p = 0.79
Total Hospitals	-0.13	0.34
	p = 0.64	p = <.0001
Hospitals with NICUs	0.38	0.04
	p = 0.17	p = 0.41
Hospitals with Obstetric Care	-0.15	0.16
	p = 0.60	p = 0.0006
NICU Beds	0.39	0.06
	p = 0.15	p = 0.18
OB Beds	0.08	0.13
	p = 0.77	p = 0.0042

In the scatterplots for the variables of APRNs, OBGYNs, and APNMs there appears to be an overall negative correlation with a strong slope. For the rest of the variables such as Total Hospitals, Hospitals with NICUs, Hospitals with Obstetric Care, NICU Beds, and OB Beds there also appears to be a negative correlation with strong slopes. This indicates a negative correlation between infant mortality and the variables listed above. The scatterplots are shown below for each variable.

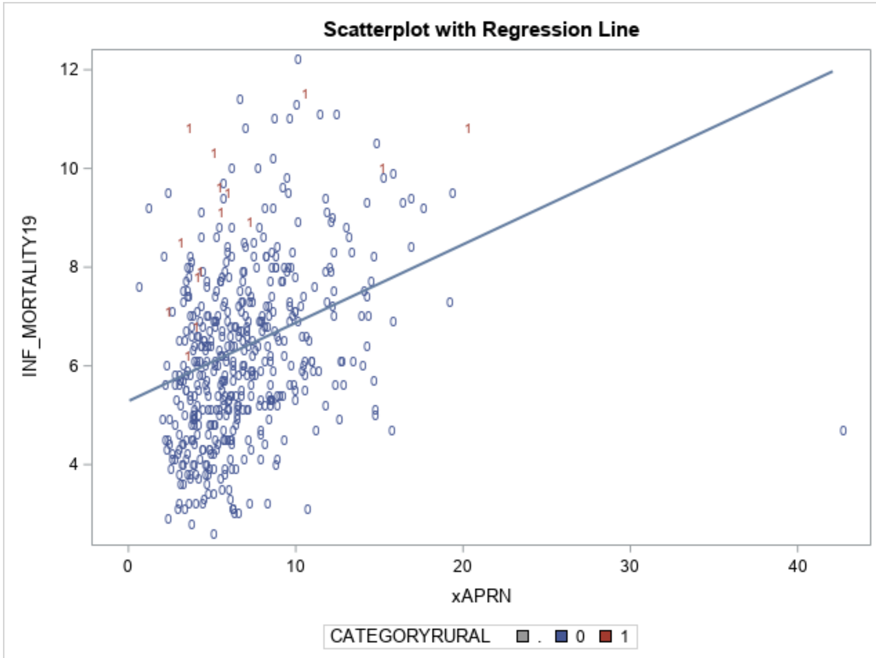

Figure 4.8: Scatterplot with Regression Line Comparing Infant Mortality and APRNs

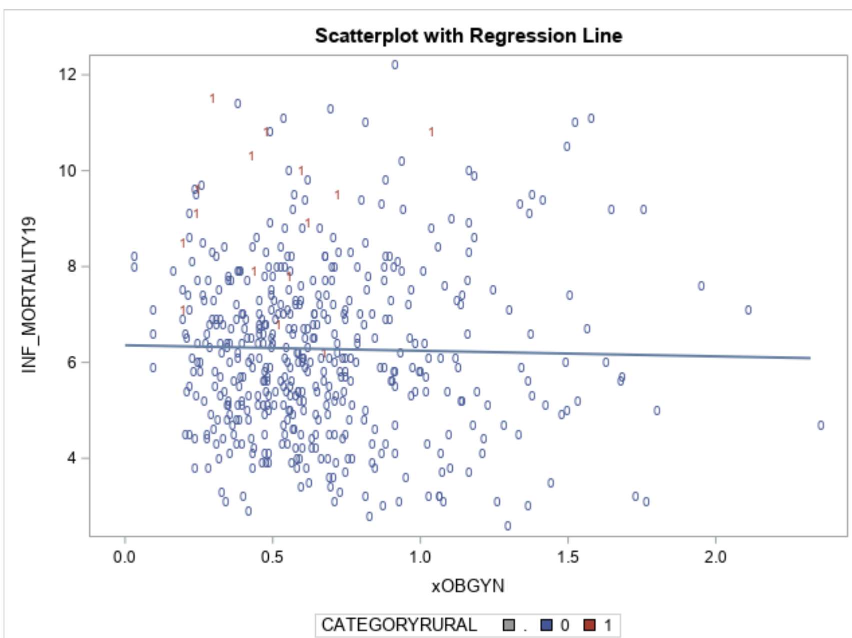

Figure 4.9: Scatterplot with Regression Line Comparing Infant Mortality and OBGYNs

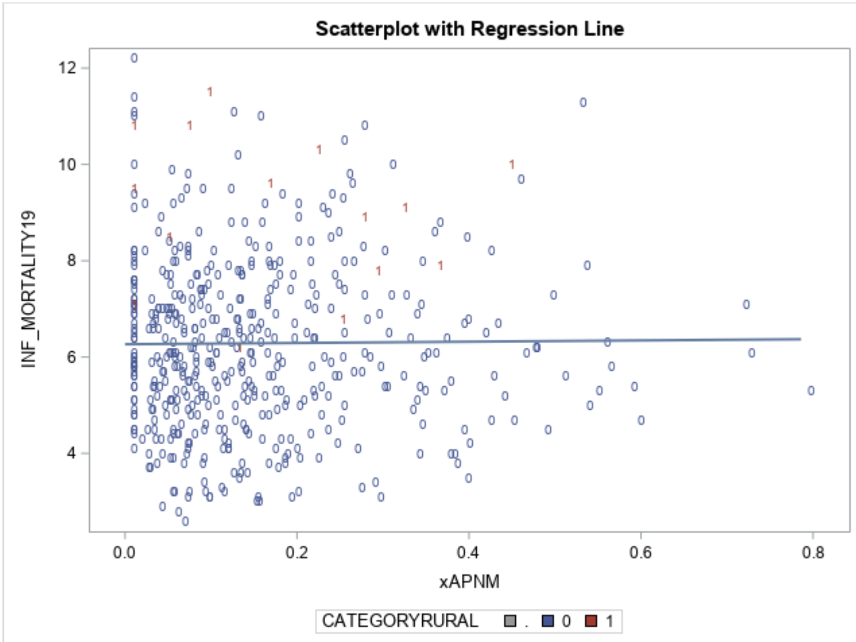

Figure 4.10: Scatterplot with Regression Line Comparing Infant Mortality and APNMs

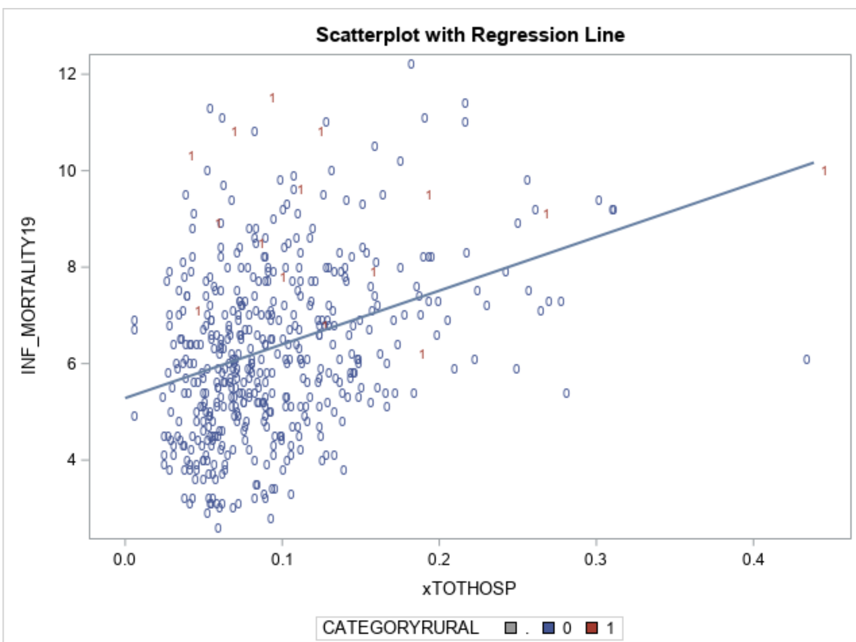

Figure 4.11: Scatterplot with Regression Line Comparing Infant Mortality and Total Hospitals

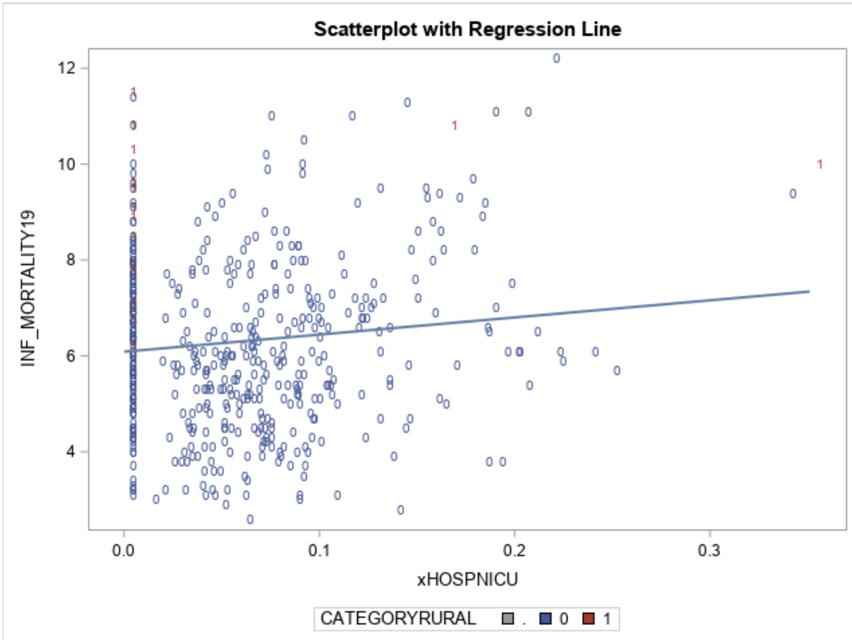

Figure 4.12: Scatterplot with Regression Line Comparing Infant Mortality and NICUs

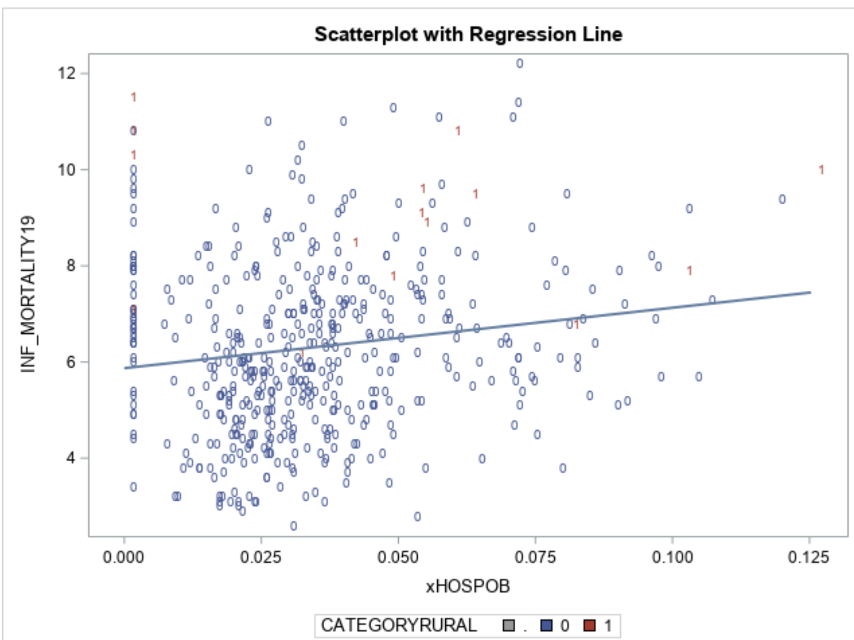

Figure 4.13: Scatterplot with Regression Line Comparing Infant Mortality and Hospitals with Obstetric Care

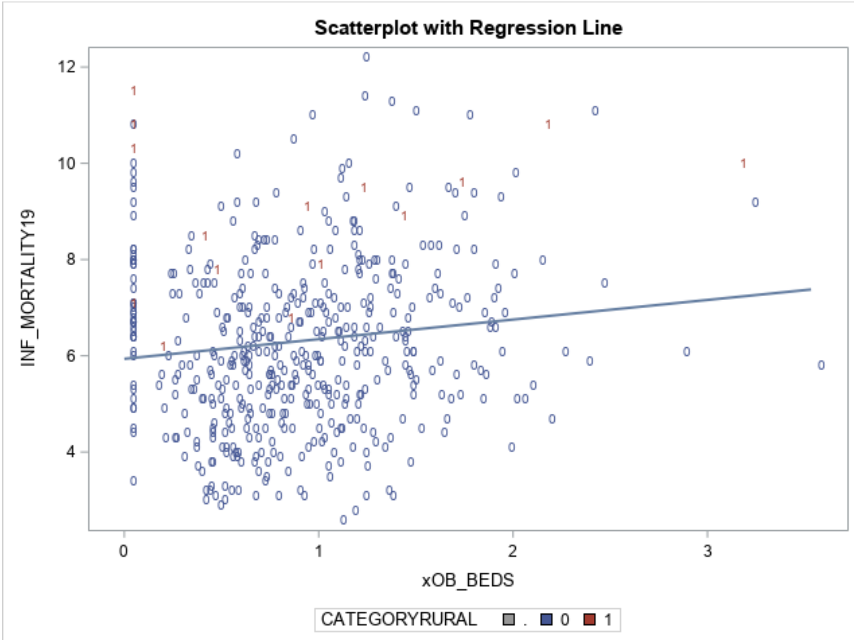

Figure 4.14: Scatterplot with Regression Line Comparing Infant Mortality and NICU Beds

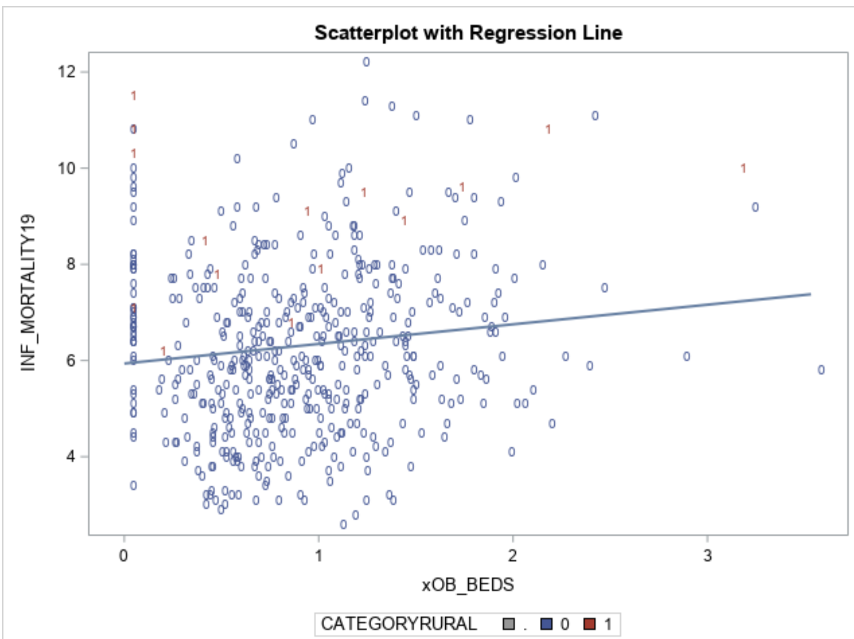

Figure 4.15: Scatterplot with Regression Line Comparing Infant Mortality and OB Beds

CHAPTER 5

DISCUSSION

The purpose of this study was to determine if there was a difference in county-level infant mortality rates in rural versus urban counties in the United States, and what health service factors at the county-level could be associated with differences in county-level infant mortality rates. County-level data from the 2020-21 AHRF indicated that there was an overall a higher infant mortality rate in rural counties compared to urban counties within the United States. The findings of the study were consistent with the findings of the studies discussed above in that there were higher rates of infant mortality in rural compared to urban counties (Ehntholt et al., 2020; Ely et al., 2017; Erhenthal et al., 2020; Patel et al., 2018; Womack, et al., 2020). This further indicates the need for thorough investigation into infant mortality disparities across the United States.

There were fewer overall human and material resources for infant and women's services in rural compared to urban counties. Resources included Total Hospitals, Hospital Beds, Bassinets, Hospitals with Obstetric Care, Hospitals with NICUs, Obstetric Beds, and NICU Beds. Overall higher mean of Total Births, Births in Hospitals and Preterm Births over three years in urban counties compared to rural counties within the United States could indicate that there are fewer resources needed overall in rural compared to urban counties; however, further analysis would need to be completed to test this hypothesis.

The mean rate of population characteristics (i.e., Total Births, Total Births in Hospitals, and Pre-Term Births) are similar in rural and urban counties; however, resources are not. For example, there were statistically significant differences between Total Hospitals, Hospitals with Obstetric Care, and Hospitals with NICUs, with a higher median of each resource in rural compared to urban areas as displayed in the boxplots. Comparatively, the median of APRNs, OBGYNs was lower in rural compared to urban areas, as shown in boxplots. For rural counties, there was a disparity between human resources available for care for women and infants compared to urban counties. Implications for fewer APRNs and OBGYNs in rural areas are limited options for healthcare. Mothers and infants could need specific care based on insurance or specific preferences and the lack of APRNs and OBGYNs could potentially increase their commute to gain the care required. Quality of care could be a potential barrier that mothers and infants could face due to the lack of APRNs and OBGYNs in rural counties. Overall, fewer resources can cause a burden to mothers and infants and could potentially affect the care they receive. Infant mortality rates and burdens mothers and infants face could be further studied to identify the relationships between those factors.

For rural counites, correlations between resources and infant mortality revealed the need for further research to relate infant mortality to other potential factors. For urban counties, there was a moderate, statistically significant positive correlation between APRNs and infant mortality. Overall, the findings from the Spearman's Rho correlations revealed that although there are positive correlations in the data, there could potentially be outside factors that influence infant mortality rates in addition to resources in various areas other than infant and women's health that will be discussed in the conclusion chapter.

Notable limitations for this study include the lack of data found within the AHRF related to infant mortality in both Rural and Urban counties across the United States. There were only 15 rural counties with infant mortality data, compared to 471 urban counties. Due to this limitation, there are unknown data that could have contributed to the findings; therefore, these outcomes should be interpreted with caution.

CHAPTER 6

CONCLUSION

In conclusion, there was a difference in county-level infant mortality rates across the United States. In this study, there were both negative and positive correlations found between infant mortality and healthcare resources despite the initial thought that having fewer resources would indicate higher rates of infant mortality. Therefore, further research is needed to determine other factors explaining rural-urban infant mortality disparity.

In the future there could be further analysis on infant mortality including a greater sample size from both rural and urban counties within the United States. This could create a more accurate representation of the findings from this study. There is also potential for further analysis of infant mortality and including variables from other studies such as socioeconomic status, and environmental status while still analyzing healthcare resources. The potential for future analysis and work with infant mortality could identify specific factors or variables directly related to infant mortality and could reduce the rates of infant mortality within the United States.

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BIOGRAPHICAL INFORMATION

Vanessa Guevara is a senior Nursing student at the University of Texas at Arlington. She joined the Honors College as a freshman and has since earned a minor in Psychology as well. During school, Vanessa was involved in various groups such as Omicron Delta Kappa and the women's soccer team. She plans to work in the Burn/Trauma ICU at Medical City Plano as a Nurse Resident. In the future, Vanessa would like to go back to school and earn her master's degree in Nursing and possibly work on future research projects regarding healthcare resources in various units.