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A Test of Criteria for Determining "Optimal" PPOR Model Reference Groups: Measuring Excess Infant Deaths in the Border Region

Alexis Nicole Ramos
University of Texas at El Paso, alexisramos01@yahoo.com

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ALEXIS NICOLE RAMOS

Master's Program in Public Health

APPROVED:

Christina Sobin, Ph.D., Chair

Maria Duarte-Gardea, Ph.D., RD, LD

Jill McDonald, Ph.D., MS

Charles Ambler, Ph.D.
Dean of the Graduate School

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ALEXIS NICOLE RAMOS, B.S.

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Abstract

Background: Infant mortality is one of the strongest indicators of social and economic development in all countries. Understanding infant mortality is critical for understanding the health of nations. Strategies for lowering infant death rates are needed. The Perinatal Periods of Risk Model (PPOR) is an approach that allows communities to determine when infant death and excess death is occurring by categorizing death into four perinatal categories. Excess infant deaths are determined by defining a reference group with the lowest mortality rate, and then comparing the reference group rate to other subgroups. The typical reference group has been defined as white, non-Hispanic females, 20+ years of age, with 13+ years of education. Whether this reference group in fact captures the lowest possible infant death rates is rarely examined. This study examined how changing the criteria for education and ethnicity at the national, external, and internal level altered the estimated infant mortality rate and estimation of excess infant deaths. **Aims:** This study (1) examined the number and rate of infant deaths by perinatal period of risk (PPOR) category for new reference groups defined by maternal education; and (2) tested differences in excess infant deaths calculated using infant death rates for typically and newly defined reference groups. **Methods:** This was a secondary data analysis of the dataset previously collected by the Center for Disease Control and Prevention (CDC). Alternate national, external, and internal reference groups for estimating infant mortality and excess deaths were created Each of the three levels included three reference groups defined according to mother's years of education. **Results:** The data set included 120,777 cases of infant death. In the non-U.S. border states, infant mortality was significantly higher for all of the newly defined groups as compared to the national typically defined group. Significant differences were also found between the external (U.S. border states) typically defined reference group and the newly defined reference group with less than 9 years of education (chi-square=21.815, $p<0.001$); and between the internal (U.S. border counties) typically defined reference group and the newly defined reference group with education between 9 and 13 years (chi-square=8.921, $p<0.012$). Excess infant deaths existed in the almost all newly defined categories. At the national level, education had a marked impact on infant deaths among Hispanic women. Hispanic women with less than nine years education experienced an excess death rate of 10 per 10,000 live births, while Hispanic women with 9-13 years of education experienced an excess death rate of 8 per 10,000 live births. At the internal level, Hispanics residing on the border with 13+ years of education experienced no excess death, while Hispanics residing on the border with 9-13 years of education experienced an excess death rate of 7 per 10,000 live births. **Conclusions and Recommendations:** Excess death rates in all categories were inversely proportional with education. However, excess death rate was more influenced by a mother's education level than by a mother's ethnicity (newly defined reference groups with 13+ years of education did not have meaningful differences in excess death). The completion of phase two PPOR analyses needs to be completed to determine which risk and preventative factors in the maternal health/prematurity category would have the largest impact on improving infant mortality.

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Chapter 1: Introduction

The social and economic conditions of a nation and its demographic characteristics directly influence the health of communities. One example of this is infant mortality. Infant mortality is defined as the death of an infant before the age of one year (CDC, 2017). Infant mortality rate captures the level of socioeconomic development in a country or region because it is directly and indirectly influenced by a country's social and economic conditions, poverty status, and the availability of health services (AMCPH, 2011). Infant mortality can give researchers knowledge of a country's maternal and infant care practices, pre- and post-natal care access, health care system quality, and public health practices (Baumann & Ylinen, 2017). If a nation's infant mortality rate is low, the overall health of the nation is judged to be good or excellent. If the infant mortality rate is high however, the health of the nation is judged to be lacking or poor.

Infant mortality has been studied since the beginning of the twentieth century because of its primary significance for the continuing health of populations (He, Akil, Aker, Hwang, & Ahmed, 2015). Over the past 100 years, research has attempted to understand specific factors that might increase or decrease infant mortality within selected populations, geographic areas, and in different parts of the world. Its causes vary globally, but the leading two factors are understood to be low birth weight and lack of proper pre- and post-natal care (Farmer & Taylor, 2014). Several maternal characteristics are also believed to contribute to infant mortality such as a mother's age, ethnicity, and education (Zakir & Wnnava, 1999).

Infant mortality rates vary broadly worldwide. Countries that have the highest infant mortality rates include Somalia and the Central African Republic. These countries report rates of 94.8 and 86.3 deaths per 1,000 live births, respectively. The countries with the lowest rates of infant mortality are Monaco and Japan reporting less than two deaths per 1,000 live births in 2017. (CIA, 2017). In comparison, the United States reports an infant mortality rate of 5.8 deaths per 1,000, a value that is suboptimal compared to other wealthy nations such as New Zealand, Australia, Greece, Canada, and France, all of whom report lower infant mortality rates than the United States (WHO, 2017). Among 225 countries reported by the CIA, the United States ranks 55th for infant mortality. (54 nations have lower infant mortality rates as compared to that of the United States).

Understanding the rates of infant mortality in different populations and across nations is critical from the perspective of ongoing surveillance. Once it has been determined however that infant mortality rates are not optimal, strategies are needed by which to characterize when in early life excess infant deaths are occurring, so that those periods can be specifically targeted for intervention. The Perinatal Periods of Risk Model (PPOR) is one such approach. Within a given population, the PPOR provides a model for characterizing the stage of development at which excess infant deaths are occurring. In this way, the model allows communities to establish initiatives that are specific to factors that increase risk of infant death at specific perinatal stages.

As will become evident below, use of the PPOR model requires an optimal reference group for comparison to a selected community or subpopulation. Currently, the reference group most commonly used is White non-Hispanic women, who have attained at least thirteen years education, and are at least twenty years of age (Sappenfield, Peck, Gilbert, Haynatzka, & Bryant III, 2010). Although this most commonly used reference group may be “optimal” for many United States communities, there are likely to be many communities for which this most commonly used reference group is either not available or is not in fact the subgroup with the most optimal infant outcomes. This may be true for the southern U.S. border counties. It is crucial that reference groups defined by alternate criteria be tested to determine if changing the standard ("most commonly used") reference group criteria changes the estimation of excess infant deaths for a given community.

Many studies examining excess infant mortality rates using the PPOR model have manipulated the definitions of their reference group to determine which maternal criteria are associated with higher and lower rates of infant deaths. On the other hand, very few if any studies using the PPOR model have been conducted to examine how using alternate criteria for a given reference group may or may not change the estimation of excess fetal deaths.

Due to the growing use of PPOR and the potential value of PPOR to meaningfully decrease infant mortality in urban communities, it is essential to identify if alternate reference group criteria might produce more accurate estimates of excess infant deaths. In addition, it is important to explore groups of individuals that are now producing better than average infant mortality rates, such as those residing on the United States and Mexico border counties.

Focusing on the factor "education", the purpose of this study is to determine whether and how using different educational level criteria might change the estimation of excess infant deaths in one or more of three perinatal stages of the PPOR model. The results could suggest new approaches for determining excess infant deaths in areas with high concentrations of minority families, such as the U.S. – Mexico border region.

Chapter 2: Background and Significance

2.1 The Perinatal Periods of Risk (PPOR) Model

The Perinatal Periods of Risk Model (PPOR) is a tool used by urban communities to investigate and develop solutions to lower infant mortality rates. The approach was originally designed for cities in the United States with high infant mortality rates but is now being used by urban communities to assess newer prevention methods. The PPOR model has been used by such cities as Jacksonville, Florida, Jackson City, Missouri, and Park-City, Kansas.

The PPOR framework was adapted from the Periods of Risk Approach developed by Dr. Brian McCarthy (Lawn J., McCarthy BJ., & Ross SR., 2000). The PPOR model is a six-stage process, divided into a preparation phase and two analysis stages. The PPOR model provides a relatively simple analytic approach requiring only limited resources and minimal need for analytic skills (Sappenfield, Peck, Gilbert, Haynatzka, & Bryant III, 2010). Therefore, small communities with limited funds would not have to pay high-level researchers to analyze and collect data. In addition to being easy to understand and use, the PPOR approach makes full use of small numbers of events. Therefore, you do not need to have thousands of infant deaths in each category to use the model. The model predicts values of infant mortality by the use of epidemiologic data and community process planning. The PPOR model works by allowing a city to use its own data records to predict when infant mortality is occurring based on four perinatal periods of risk. The four periods of risk include maternal health and prematurity, maternal care, newborn care, and infant health. Once the perinatal period with the most infant death is identified, then based on the data obtained, prevention efforts are put into place to prevent infant death from occurring in the future. In addition, the PPOR framework has several suggestions for appropriate actions when developing appropriate prevention methods to reduce infant death risk.

The PPOR framework can be broken down into three parts: analytic preparation, phase 1 analysis, and phase 2 analysis (Burns, 2005).

The first part of PPOR is analytic preparation. The analytic preparation phase is devoted to obtaining, planning, and evaluating vital record files. The vital records recommended for use in PPOR are fetal death certificates, linked birth and infant death certificates, and live birth certificates (Sappenfield, Peck, Gilbert, Haynatzka, & Bryant III, 2010). The data in these types of records is presented in birth or death cohorts and therefore allows for one to gather data from certain time periods. The analytic preparation phase is also used to define key terms, such as infant mortality, birthweight, and gestational age, and the analysis methods the community will use throughout the PPOR Model analysis process.

Infant mortality is defined as the death of an infant before the first year of age (CDC, 2017). The infant mortality rate usually gives researchers and community members the state of maternal and infant health for a given region. For example, an infant mortality rate that is much higher is usually associated with underdeveloped countries compared to developed countries that have lower infant mortality rates.

The infant mortality rate is calculated by dividing the number of infant deaths from a birth cohort by the number of live births for same birth cohort (Callaghan, MacDorman, Shapiro-Mendoza, & Barfield, 2017). In the United States, the infant mortality rate is 5.8 infant deaths per 1,000 live births (CDC, 2017). (The value of calculating infant mortality rates for areas with unique characteristics was recently shown in a report on infant mortality in the U.S.-Mexico border region. In this report it was found that the United States -Mexico Border Region of Texas, New Mexico, Arizona, and California had an infant mortality rate lower than the rest of the

United States. The infant mortality rate in the United States-Mexico Border Region counties was 5.5 infant deaths per 1,000 live births (March of Dimes, 2011).)

The next step of the analytic preparation phase defines the sample size and population. The population is generally defined by a time period and geographical boundary based on a mother's place of residence; the sample size is recommended to be at least five thousand births with a minimum of sixty infant deaths that meet the set birthweight and gestational age. (Sappenfield, Peck, Gilbert, Haynatzka, & Bryant III, 2010). Birthweight and gestational age are used so that the results of a given study can be comparable to other vital statistics reports from within and outside of a community (Sappenfield, Peck, Gilbert, Haynatzka, & Bryant III, 2010). The method of using birthweight and gestational age also serves as a cross check for researchers to compare data mid study.

In PPOR, birthweight is defined as 500 grams or more, while gestational age is defined as twenty-four weeks or more (Sappenfield, Peck, Gilbert, Haynatzka, & Bryant III, 2010). The values for birthweight and gestational age were chosen after multiple analyses of data from several state, region, and national files. It was found that lower values of birthweight (less than 500g) were often not reported (Callaghan, MacDorman, Shapiro-Mendoza, & Barfield, 2017); and therefore, not consistent between the jurisdictions. If the values being used are not consistent the PPOR analysis will be distorted and therefore not useful for communities to predict where gaps are in care.

In a study done by McCarthy and Colleagues it was found that 25% of a community's overall feto infant mortality was seen in the birthweights and gestational ages below the 500 gram and twenty-four weeks gestational age cutoff for PPOR (2009). Since 25% of the feto infant mortality rates were not examined due to being below the cutoff criteria for the four PPOR perinatal stages, it created the idea that a large number of feto infant deaths are not being accounted for in the PPOR model. However, it was found by Sappenfield, Peck, Gilbert, Haynatzka, and Bryant III in 2010 that communities interested in these percentages should analyze infant gestational age below twenty-four weeks and infant birth weight less than 500 grams in a separate category rather than the standard four perinatal categories. If the approach suggested by Sappenfield and colleagues is used the PPOR model will not become distorted.

The last step of the analytic preparation phase is to determine the study sample size. The study sample size recommended by authors of the PPOR model is a minimum of sixty infant deaths that meet the PPOR birthweight and gestational age limits, and at least five thousand births over the same time period (Sappenfield, Peck, Gilbert, Haynatzka, & Bryant III, 2010). These numeric criteria allow communities to achieve statistical reliability in at least one of the four categories used in the PPOR Phase 1 analysis model. The value requirements of sixty and five thousand infant deaths was obtained after several studies done by Healthy Start in high-risk communities. Healthy Start Projects found that when a minimum of sixty feto-infant deaths were used, the results had statistical reliability (Sappenfield, Peck, Gilbert, Haynatzka, & Bryant III, 2010).

The main objectives of the PPOR analytic preparation phase are to obtain the data records being used for the study, and establish appropriate cutoff values for infant mortality, birthweight, and gestational age. In addition, the analytic preparation phase creates a sample population that is representative of the region, determines risk factors in the area, and meets the minimum expectations for statistical reliability.

Phase one analysis is the first stage of carrying out the PPOR model. (The phase one analysis represents stage two of the six basic stages proposed by Brian McCarthy, see above.)

Phase one analysis estimates the overall mortality in four categories based on an optimal reference group. The four groups are then mapped to easily compare in which categories highest infant deaths may be occurring and thus which areas of infant care may be lacking in the community.

Phase one of the PPOR model breaks down the study population into four perinatal periods of risk. The four groups include maternal health and prematurity, maternal care, newborn care, and infant health. The four groups are then mapped based on two determinants: age at death and birthweight. The determinant age of death is divided into three subsections: fetal (24+ weeks), neonatal (0-27 days), and post-neonatal (28+ days), while the birthweight determinant is separated into two groups 500-1499 grams and 1500+ grams. The four groups on the map can be seen on Figure 1. The maternal health and prematurity group refers to any fetal deaths between 500-1499 grams, and deaths in infants weighing from 500 to 1499 grams, and less than or equal to twenty-four weeks of age. The second group, maternal care, refers to any death occurring in an infant weighing 1500 grams or more. The third group, newborn care refers to deaths occurring in infants weighting 1500g or more and less than twenty-eight days of age, and the last group infant health, refers to any deaths occurring in infants weighing 1500 grams or more with an age between 28 days and less than one year (Sappenfield, Peck, Gilbert, Haynatzka, & Bryant III, 2010).

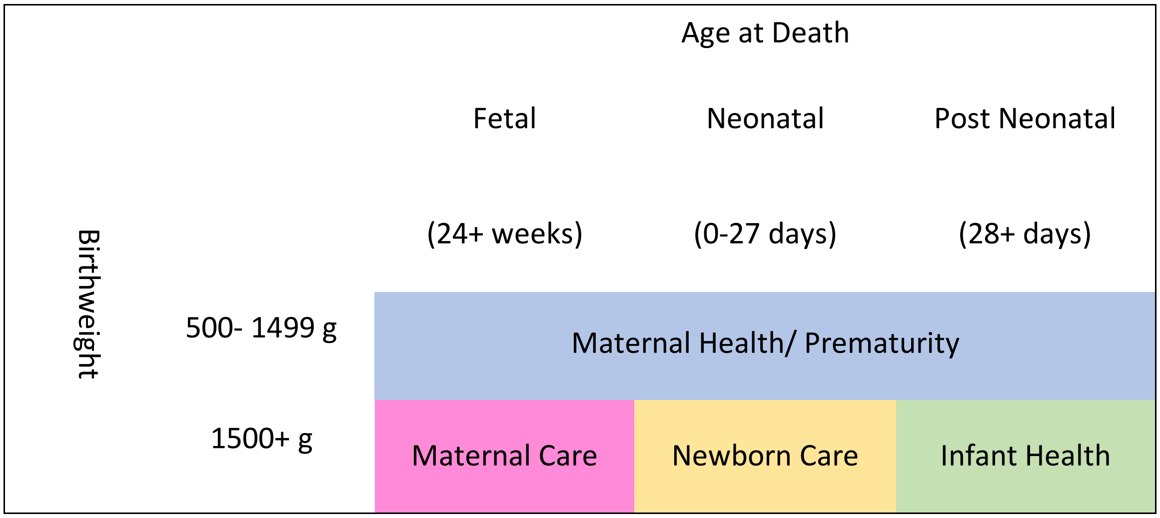

Figure 1: Perinatal Periods of Risk Map for infant mortality

A PPOR map of infant mortality rates easily show where there may be gaps in infant care. For example, if the highest values result in the newborn care category, the community can focus their preventative efforts on screening assessment and referral of high risk care and management rather than emphasizing preconception and prenatal health, an objective that might be considered if the highest rate had been observed in the maternal health/prematurity category.

In addition to the rates for each category, the community can calculate the overall rate using the PPOR map by adding all the infant and fetal deaths and dividing by the total number of live births and deaths (Sappenfield, Peck, Gilbert, Haynatzka, & Bryant III, 2010). For example, the PPOR model was used in Kansas City, Missouri in 2002. The data found that 47% of infant deaths were in the maternal health/prematurity category. In addition, the study found that blacks residing in Kansas City had an infant death rate of 2.2 deaths per 1,000 live births as compared to whites who had an infant death rate of 0.81 deaths per 1,000 live births (Cai, Hoff, Dew, Guillory, Manning, 2005). Examination of the PPOR map showed that there was a clear gap in care in maternal health. Therefore, strategies in education were implemented to improve these rates. Because the data also showed a large disparity for blacks this sub-group could be targeted for special intervention. The information gathered by PPOR was not only advantageous for the community, but if continued into phase two, could allow for a decrease in the overall infant deaths.

Another purpose of an infant mortality map is to allow the user to calculate infant deaths in a community at different time periods or in different geographical areas. For example, the infant death could be calculated for the 2015 birth cohort in the state of New Mexico but could later be defined to calculate the 2017 birth cohort in the same region. The difference in values would allow the communities to determine if the approaches to care require adjustments. The information may also give insight regarding a specific subgroup or may even highlight a health disparity for a specific ethnic group. The map allows for the community members to easily see where the deaths are occurring, in what category, what birthweight group, and in what gestational age group, and can be used for comparisons over time or across different geographic regions.

In order to use the PPOR infant mortality map and model, a reference group has to be established. The reference group used is chosen according to the study population chosen. The optimal reference group is based on the highest success rates (lowest infant mortality rates) for the four mutually exclusive perinatal risk periods (Peck, Sappenfield, and Skala, 2010). The idea of an optimal reference group is based on the concept that if one group can obtain a certain standard then others should be expected to achieve the same. Therefore, an optimal reference group would have the lowest number of infant deaths in all four perinatal categories. The optimal reference group is then used to calculate excess infant mortality. The excess infant mortality value is then used to determine gaps within the four stages of community-based infant care in phase two analysis.

The second phase of PPOR is seen as the most critical yet is usually not completed by communities. The phase two analysis identifies factors that contribute to the gaps found in phase one and suggest possible prevention strategies. Phase two can also be used to identify sub-groups that are at higher risk due to larger excess mortality rates. In these ways, phase two results suggest new ideas to improve a community's infant mortality rate (Sappenfield, Peck, Gilbert, Haynatzka, & Gilbert III, 2010). In order to design prevention strategies specific to the community, the PPOR mapping suggests the perinatal period with the highest rates of infant mortality. Once the perinatal period with the highest infant mortality rate is identified, risk factors and care mechanisms associated with the time period are compared in the study and reference populations, and a prevention strategy is implemented for the community.

In the second phase of PPOR the perinatal period with the largest infant mortality becomes the population of interest. In addition, the sample size needs to increase from sixty infant deaths to at least eighty-eight deaths for of an outcome occurring to be reliable. Based on the larger number of cases needed and the more difficult math associated with the second phase of the PPOR model it becomes much more time consuming and therefore needs more staff to be completed. Due to the obstacles presented, the second phase of PPOR is often not completed by communities.

The PPOR model has strengths and weaknesses. With regard to strengths, the PPOR framework has allowed communities to identify specific periods of risk during which highest infant mortality rates are occurring, and thus suggesting specific times during development when intervention may be optimal and most needed. In addition, the PPOR model has allowed communities to rule out other periods of risk during which infant death rates are not elevated. The PPOR model can save a community time, money, and resources. Additional strengths of the PPOR model are that it is easy to understand and use. The PPOR model allows for the identification of gaps in health care knowledge among community members. Lastly, the PPOR model helps communities target the resources needed for prevention activities and mobilizes the community to action with these resources.

The possible disadvantages of PPOR is that a phase two analysis must be done in order to fully establish the reasoning and preventative methods for infant death. However, a majority of communities using PPOR do not complete phase two due to the increased difficulty associated with the mathematical formulas. In addition, phase two analyses are not well developed for maternal and newborn care periods (Sappenfield, Peck, Gilbert, Haynatzka, & Bryant III, 2010). Since phase two analysis is not well developed in two perinatal periods, the prevention methods that can be applied are limited because the PPOR framework cannot determine what exactly is causing the feto-infant deaths as it can in the two other perinatal periods. The PPOR framework has been seen to be effective in communities when both phase one and phase two are used.

2.2 Closer consideration of reference groups

As discussed above, reference groups are composed of individuals who share the same demographics, norms, attitudes and behaviors. Bearden and Etzel found that since reference groups are comprised of individuals that share similar characteristics such as education level and thus perhaps decision-making behaviors, they were more likely to have similar health outcomes (1982). For this reason, reference groups are used as a standard for evaluating a behavior or outcome. In addition, reference groups are used for comparison of group and personal characteristics (Thompson & Hickey, 2005). Reference groups are used in experiments, group memberships, or even in simple everyday comparisons. They are also used in business models and sociology models. For example, a reference group can be used to show the characteristics of the "ideal" student in a school setting or a reference group can be used to show the best detergents in the business setting.

In the Perinatal Periods of Risk Model (PPOR), a reference group is chosen to compare with the study population to calculate excess feto-infant death. This is done by comparing the rates of the study population with the rate of the optimal reference group determined. It is important to establish a simple reference group that can be compared to the community being analyzed. The overall purpose of reference groups in PPOR is to ensure the study population is representative and meets sufficient values in each section of the four perinatal categories and overall infant deaths for the PPOR analysis to be statistically significant.

An optimal reference group is one which has ideal outcomes for all factors being compared. The optimal reference group is often referred to as the "best of the best." For example, in the Perinatal Periods of Risk (PPOR) Model, the optimal reference group is one which results in the minimal feto-infant deaths in maternal health and prematurity, maternal care, neonatal care, and infant health categories.

The most commonly used reference group for the PPOR framework usually includes white Non-Hispanic women, who have received at least thirteen years education, and are at least twenty years of age (Cai et al., 2007). In the past, it has been found that these criteria establish the overall best outcomes in each of the four perinatal categories. This reference group has been used in a majority of PPOR models conducted in the United States because it can be compared to the population of many United States communities. There are many other possible reference group compositions that have never been evaluated. It is crucial that other group criteria be examined to determine if an alternate group is more ideal than the most commonly used reference group; in other words, if there is a group of individuals whose excess fetal death rate is more optimal than that of the most commonly used reference group.

Recent data published by the March of Dimes (2011) showed that the United States/Mexico border counties had a lower infant mortality rate than the rest of the United States. The overall rate for the United States was 5.8 deaths per 1,000 live births, while the rate for the border counties on the United States side of the border was 5.5 deaths per 1,000 live births. In addition to infant mortality, the United States border counties also had a lower percentage of low birthweight infants. More specifically, non-Hispanic White women, that is, women used in the "optimal" reference group, had a higher infant mortality rate than Hispanic women living in the United States border counties. The rates were 5.5 and 5.1 infant deaths per 1,000 live births respectively.

In addition to ethnicity, there is also evidence to support the notion that the "optimal age" may not be greater than or equal to twenty years. The data from the March of Dimes showed that women who were between the ages of thirty and thirty-nine had lower rates of infant mortality than those who were thirty years or younger, or forty years and older (March of Dimes, 2011). In another study done by the CDC, the data showed that Asian and Pacific Islanders had lower infant mortality rates than non-Hispanic Whites. The values were 4.2 to 4.9, respectively (CDC, 2015). These data support the idea that alternate groups need to be considered for establishment of an optimal reference group, especially in areas where the commonly used conditions are not met by the community.

In order to determine an ideal reference group, "internal" and "external" reference populations are selected from the study population. For example, an internal reference population would be 15% of a sample, and could be from, for example, a population within an urban community (Sappenfield, Peck, Gilbert, Haynatzka, & Bryant III, 2010). In the case of this study, the internal reference group was made up of infant death cases that occurred in the United States Mexico border counties.

The external reference population is a population from outside the sample population that shares similar characteristics (Sappenfield, Peck, Gilbert, Haynatzka, & Bryant III, 2010). For example, if the sample population was the United States border region, the external reference group would be populations that had similar socio-demographic qualities but did not live on the border such as areas in Texas, like San Antonio. In the case of this study, the external reference group were infant death cases that occurred in the United States Mexico border states.

Reference groups can be established according to a number of different factors, for example, based on personal, social, and/or biological characteristics. The reference group can be defined according to age, ethnicity, education level, or even income. The researchers deciding on the reference group will ultimately make the decision on what factors to use based on community characteristics.

With regards to perinatal health, it has been found that positive outcomes associated with infant and maternal health have been associated with a mother's demographic characteristics including age, ethnicity, and health status, and social characteristics such as income, education level, prenatal care, and health insurance coverage (Gonzales & Gilleskie, 2017). Therefore, it is important to consider using one or more of these factors when designing a reference group for PPOR analysis.

For the study proposed, it was decided that one variable, education, would be manipulated to examine how this variable might influence the estimated mortality rate and estimation of excess fetal deaths in the U.S.-Mexico border region. There are several reasons for this selection. Previous studies have established the idea that education has an independent and positive effect on infant survival in counties with diverse population backgrounds such as the United States (Frenzen & Hogan, 1982). These studies suggested that families with highly educated parents experienced less infant mortality and that education was an indirect buffer against infant mortality.

More specifically, it has been found that mothers of higher education are more likely to know about modern methods of infant care and therefore will be able to provide more adequate care for a newborn infant (Gage, Fang, O'Nell & DiRienzo, 2012). An infant who receives more adequate care is less likely to experience negative health outcomes such as death.

In addition to education level directly affecting infant mortality rates, it has also been shown that maternal education level influences the birth weight of an infant, a major cause of infant mortality (Gage, Fang, O'Nell & DiRienzo, 2012). In this way, the data showed that higher education rates are associated with increased birth weight among infants and perhaps resulted in a decline in infant mortality.

At the same time, there has been recent research examining education levels and infant mortality among individuals of Mexican origin. It seems as if a paradox exists for this subgroup of people. According to Hummer and colleagues, Hispanics have lower infant mortality rates despite lower educational status (Hummer, Powers, Pullum, Gossman & Frisbe, 2007). It is imperative to determine if education level will influence the estimation of infant deaths in the U.S. - Mexico border region, since the priority population in the area is of Hispanic, and specifically Mexican, origin.

2.3 The United States and Mexico border region

The United States and Mexico border region is defined as the land 100 kilometers north and south of the border according to the La Paz agreement (United States Border Health Commission, 2016). The border region spans over 2,000 miles from California to the southernmost edge of Texas and supports over thirteen million residents (United States Border Health Commission, 2016). The region is made up of four states in the United States, and six states in Mexico. In addition, there are a total of forty-four counties and eighty municipalities. The border region has fourteen pairs of sister cities, the location of 95% of the border population. The sister cities share characteristics such as the average age being under eighteen years old, a demographic that is the opposite of that found in the rest of the United States. More than 4.2 million border crossings take place every month, with both Mexican and American nationals crossing every day to see family, seek healthcare, or take advantage of economic opportunities (US Department of Transportation, 2017).

In several ways, the border region has its own demographics, somewhat different from that of the rest of the United States. About 25% of residents across the border region live below the federal poverty line; in Texas 33% of school children live in poverty. The majority of the border population is of Hispanic or Mexican descent and has a lower educational level than the rest of the United States (United States Border Health Commission, 2016).

The location and health infrastructure of the border region makes the area more vulnerable to health risks. The majority of the border region is rural and therefore development is slower than in urban areas (Hummer, Powers, Pullum, Gossman, & Frisbie, 2007). Half of the border counties have no hospitals and there are only six public health departments in the region (Hummer, Powers, Pullum, Gossman, & Frisbie, 2007). The active region is medically underserved, with a population that has concerning health care conditions, high uninsured rates, and high rates of migration, and yet feto-infant mortality rates appear to be below the national level. These characteristics make the region an ideal location to test alternate criteria for defining "optimal" reference groups.

2.4 The population associated with the U.S. – Mexico border region

The majority of the ethnic population residing in the U.S. and Mexico border region are Hispanics, which is now the nation's largest minority group. There are a number of characteristics that are important to consider when defining the U.S. and Mexico border region population. Among these are the fact that individuals residing on the border have a lower average yearly income ($14,560) and lower educational attainment as compared to the rest of the United States (United States Border Health Commission, 2016). These are two factors that are included in nearly all definitions of an "optimal" reference group.

The maternal and infant health profile for the U.S. and Mexico border region published by the March of Dimes (2010) reports data from the forty-four counties that make up the border region. In the region, the majority of births occur to Hispanic women who are older than 20 years of age (March of Dimes, 2010). In addition, the infant mortality ratio is lower in Hispanic vs Non-Hispanic White individuals. At the same time, the same research showed that the Hispanic population is more likely to deliver a low birthweight infant compared to the Non-Hispanic White woman.

The health care conditions on the border region lead to lack of access for maternal and infant health care. In a recent study, it was found that 10.8% of mothers in the Paso Del Norte Region do not receive prenatal care and another 22.1% do not receive adequate prenatal care (Fullerton, Nelson, Shannon, Balder, 2004). However, based on recent values provided by the

March of Dimes, the lack of access may not necessarily be associated with negative outcomes. According to the March of Dimes the live birth rate for the border states is 74.6 per 1,000, and the live birth rate increases when only border region counties are examined. The live birth rate for the four state border region counties is 83 live births per 1,000. In addition, the infant mortality rate for the four border counties was lower than that of the United States (March of Dimes, 2010). The lower infant mortality rates on the border region create the idea that health factors such as low education levels and Hispanic ethnicity might by optimal rather than destructive.

Chapter 3: Goal and Objectives

The goal of this study was to examine how using different levels of maternal education might influence the estimation of reference group infant mortality and excess death in one or more of the PPOR perinatal stages. More specifically, the main objectives of this study were to (1) compare the estimation of infant mortality at each of three PPOR stages for three newly defined internal reference groups (based on maternal level of education) and the typically defined reference group; (2) compare the estimation of infant mortality at each of three PPOR stages for three newly defined external reference groups (based on maternal level of education) and the typically defined reference group; and (3) compare the estimation of infant mortality at each of three PPOR stages for three newly defined national reference groups (based on maternal level of education) and the typically defined reference group.

Chapter 4: Study Aims and Hypotheses

4.1 Aims

Aim 1: Examine the number and rate of infant deaths by perinatal period of risk (PPOR) category and reference groups defined by level of education.

Aim 2: Compare excess infant deaths calculated using infant death rates from typically and newly defined reference groups.

4.2 Hypotheses

Hypothesis 1: As compared to a typically defined internal (local) reference group of non-Hispanic white women, 20+ years of age with 13+ years of education, Hispanic white women, 20+ years of age with 9-13 years of education will have a lower infant mortality rate for each PPOR stage.

Hypothesis 2: As compared to a typically defined external (non-U.S. - Mexico border regions in Texas, New Mexico, Arizona, and California) reference group of non-Hispanic white women, 20+ year of age with 13+ years of education, Hispanic white women, 20+ years of age with 9-13 years of education living in non-border regions in Texas, New Mexico, Arizona, and California will have a lower infant mortality rate for each PPOR stage.

Hypothesis 3: As compared to a typically defined national reference group of non-Hispanic white women, 20+ years of age with 13+ years of education, a national sample of Hispanic white women, 20+ years of age with 9-13 years of education from non-border states, will have a lower infant mortality rate for each PPOR stage.

Chapter 5: Methods and Materials

The current study was a secondary data analysis of the dataset previously collected by the Center for Disease Control and Prevention (CDC) and entitled "Period Linked Birth/ Infant Death Data Set." The data set included infant deaths and live births for the years 2009 to 2013. The data was originally collected for the purpose of national reporting for the United States. This study used the data to determine the extent to which different combinations of reference group characteristics, specifically education, significantly influenced the estimation of excess feto-infant mortality in three of the four perinatal stages. The gestational age section "fetal" was not included in the calculations for the perinatal stage maternal health/ prematurity and the maternal care was not used in the study because the data set for the years 2012 and 2013 did have information on education for feto-infant deaths.

Measuring a health outcome such as infant mortality is an ultimate predictor for the health of a nation, while estimating excess fetal deaths for a given high-risk population is critical for identifying groups in need of interventions. Excess fetal deaths are determined by comparing reported fetal deaths within a subgroup of interest to a "best outcome" reference group. Most commonly, reference groups are created using characteristics that are traditionally assumed to be associated with lowest infant mortality rates. Relatively few studies however have been conducted to quantitatively test whether modifying these characteristics change the estimation of infant mortality. It is import to quantitatively test whether and how the selection of reference group characteristics influences the estimation of excess fetal deaths because optimal estimations are essential for accurately determining risk in a given subpopulation. Ideally, a truly optimal group should always be used.

5.1 Acquisition of the data file

The dataset was obtained from the CDC through an application for access to the natality, fetal death, and linked birth/infant deaths databases. The application was submitted to the National Association for Public Health Statistics and Information Systems (NAPHSIS) by Dyanne Herrera, a doctoral student who is using the data for her dissertation research using the PPOR approach to understand feto-infant mortality in the U.S. Mexico Border Region. Access to the databases by county was granted until August 2018.

5.2 Sample population

The sample population consisted of mother and infant dyads. "Cases" consisted of infant deaths in the United States (linked to the birth certificate data) that occurred during the 2013 calendar year. Infant deaths were defined as mortality in infants weighing > 500 grams and/or gestational age of > 24 weeks gestations. Live births with delivery weights less than 500 grams and fetal deaths with gestational ages less than twenty-four weeks were excluded from the study. Terminations, spontaneous abortions, and multiple births were also excluded from the sample population.

5.3 Sample size

The sample size included a total of 120,777 cases of infant death in the United States. Specifically, 25, 955 cases from the United States and Mexico Border Region. Of the 25,955 cases on the United States and Mexico Border Region 11,742 were from California, 2,503 were from Arizona, 752 were from New Mexico, and 10,958 were from Texas.

5.4 Study design

The research design was based on the PPOR methodology; application of the PPOR approach is dependent on the overall number of infant deaths and number of infant deaths per perinatal category. When there are not at least 5,000 infant deaths with 60 infant deaths in each category, the PPOR approach cannot be used. Therefore, the number of infant deaths were recorded to determine if the project can continue.

5.5 Establishment of reference groups

This study created three levels of reference groups for use in determining excess fetal death rates along the U.S. – Mexico border region including internal, external, and national reference groups. Each of the three levels included three different reference groups created according to different educational attainment levels. This variable divided years of education into less than nine years education, nine to less than thirteen years education, and equal to or more than thirteen years education. In addition, all age groups were made up of mothers who are at least twenty years of age and were of Hispanic ethnicity. The internal reference group included living in a border county, while the external reference groups was living in a border state. The national reference group was made up of individuals residing in the non-border U.S. states. The infant death rates of typically defined reference groups were compared to the newly defined groups. The information for each of the reference groups can be seen in table 1.

Table 1: Reference groups to be compared

Reference Group	Typically Defined			Newly Defined		
	Ethnicity	**Age**	**Education**	**Ethnicity**	**Age**	**Education**
National	Non-Hispanic White	20+ years	13+ years	Hispanic living in non-U.S. border states	20+ years	≥13 years
						9-13 years
						<9 years
External	Non-Hispanic White	20+ years	13+ years	Hispanic living in the border states	20+ years	≥13 years
						9-13 years
						<9 years
Internal	Non-Hispanic White	20+ years	13+ years	Hispanic living in border counties	20+ years	≥13 years
						9-13 years
						<9 years

5.6 Calculation of infant mortality

The numbers of infant deaths in the study population were entered into an infant PPOR map for each of the three reference groups by birthweight and age of death. Age of death was divided into two discrete periods: neonatal death (birth to less than twenty-eight days) and post neonatal death (twenty-eight days to 364 days). Birthweight was divided into two separate groups: 500-1,499 grams and 1,500 grams or more. The infant PPOR Map charted the infant death rates in three perinatal stages including maternal health/prematurity, newborn care, and infant care. The three perinatal stages were color coded for ease of interpretation. The infant PPOR Map used can be seen in Figure 2.

The mortality rate for each risk period was calculated for the study population by dividing the number of infant deaths in the period by the total number of live births and fetal deaths. The overall rate for the study population equaled the number of all infant and fetal deaths divided by the same total number of live births and fetal deaths. The mortality rates were calculated for each PPOR stage and the overall rate was calculated for the typically and newly defined reference groups. The calculation of overall rate can be referenced in Figure 2.

Reference Group Calculations*			
Age at Death			
		Neonatal	Post-Neonatal
Birthweight	500-1499g	Maternal Health/Prematurity A	
	1500+ g	Newborn Care B	Infant Health C
Overall rate = (number of deaths in A)/ (total number of live births & fetal deaths) + (number of deaths in B)/ (total number of live births & fetal deaths) + (number of deaths in C)/ (total number of live births & fetal deaths)			

* Same calculations used for internal, external and national reference groups. The letters A-C represent infant mortality value that would be from the study population.

Figure 2: Reference Group Calculations

5.7 Calculation of Excess Mortality

Once the optimal reference population was established, excess mortality rates and the excess number of deaths were calculated. Excess mortality rates and numbers of death were the differences between those of the typically defined groups and those of the newly defined reference groups. The overall excess mortality rate is the study population's overall mortality rate minus the reference population's overall mortality rate. The excess mortality rate for each

PPOR stage was calculated by taking the study population's mortality rate for each specific risk period minus the reference population's mortality rate for the same risk period. Excess death was calculated by multiplying the excess mortality rate of the study population by the number of live births and fetal deaths for the same study population. A chart of these calculations is provided in Table 2. The excess mortality rate was calculated for the local, external, and national reference groups at the three different education levels. The calculation in excess mortality will allow a community to identify in which perinatal stages healthcare is lacking or in which areas more care and education is needed.

Table 2: Excess mortality calculations*

Overall Excess Mortality Rate	= (populations overall mortality rate) – (reference populations mortality rate)
Period Specific Excess Mortality Rate	= (populations overall mortality rate in A) – (reference populations mortality rate in A) = (populations overall mortality rate in B) – (reference populations mortality rate in B) = (populations overall mortality rate in C) – (reference populations mortality rate in C)
Excess Number of Deaths	=(populations overall mortality rate) x (population of total live births & fetal deaths)

**See Figure 2 for definitions of A, B, and C categories.*

5.8 Statistical Analysis

The linked infant death and birth cases were managed in an SPSS Statistics V24.0 database. The data set included 120,777 cases and a total of 340 variables. For the analyses, the following variables were created or recoded: mother's age, border states, mother's Hispanic origin, mother's education level, and if the individual was residing on the border.

In order to summarize the characteristics of the reference groups, descriptive statistics were generated for infant deaths in the United States for the years 2009 through 2013 and infant deaths in the United States and Mexico Border Region from 2009 to 2013. If normally distributed the descriptive statistics provided were mean and standard deviation for scale variables, if not normally distributed the descriptive statistics reported were median and interquartile range. For categorical variables frequency of variables was given.

In addition to the descriptive statistics, chi-square tests were used to determine whether there were any statistically significant differences between overall group infant mortality rate in the reference groups. The chi-square test was used to determine if there was a significant difference in the infant death rates between the typically defined reference groups and the newly defined reference groups for the national, external, and internal categories. If a difference was found, an odds ratio was used to determine by how much there was a difference.

Chapter 6: Results

The goal of this study was to examine whether changing the typically used criteria for Perinatal Periods of Risk (PPOR) category reference groups would change the reference group estimation of infant mortality and "excess infant deaths." PPOR reference group values are usually based on infant deaths observed among white non-Hispanic women, 20+ years of age who completed 13 years or more of schooling. Whether these criteria yield lowest excess infant death estimates is not frequently examined. For this study, the education criteria was manipulated and the different excess infant death calculations that resulted from using different levels of education, were compared.

The results below include descriptive statistics and chi square comparisons of infant deaths, and odds ratios for groups that differed significantly with regard to infant deaths. Maternal and infant clinical and demographic characteristics were also considered.

The results are organized by typically defined and newly defined national, external, and internal reference groups. The descriptive statistics below are based on aggregated data from 2009 to 2013 (Table 3).

6.1 Descriptive Statistics

The frequency and percentages, medians, (Q1, Q3), or mean (SD) for the variables and categories considered are shown in Table 3 below. There were 120,777 cases of infant deaths reported in the United States from 2009 to 2013. The descriptive statistics for the United States and Mexico Border Region are shown in Table 4.

Table 3: Clinical and Demographic Characteristics for U.S. Infant Mortality Cases from 2009 to 2013.

	Infant Deaths		
	N	Mean	SD
	N	Frequency	%
	N	Median	(Q1,Q3)[a]
Maternal Sociodemographic Characteristics			
Age	120,777	27.03	6.466
Race	120,777		
White		77,903	64.5%
Black		35,591	29.5%
American Indian/ Alaskan Native		1,895	1.6%
Asian/ Pacific Islander		5,388	4.5%
Hispanic Origin	118,393		
Hispanic		23, 741	19.7%
Non-Hispanic White		54, 881	45.4%
Non-Hispanic Black		33,696	27.9%
Non-Hispanic Other Race		6,621	5.5%
Missing		1,838	1.55%
Education Level	92,655		
Less than 9 years education		4.489	3.7%
9-13 years of education		46, 118	49.8%
13+ years of education		42,048	45.4%
Missing		28,122	30.35%
Residing on Border	120,777		
Border		25,955	21.5%
Non-Border		94,822	78.5%
Marital Status	120,777		
Married		54,930	45.5%
Not Married		65,847	54.5%
Maternal Health During Pregnancy			
Number of Prenatal Visits	120,777	8.00	(4,12)
Gestational Diabetes	96,853		
Yes		3,441	2.8%
No		92,357	76.5%
Unknown		1,055	1.09%
Previous Preterm Birth	96,853		
Yes		5,666	4.7%
No		90,132	74.6%
Unknown		1,055	1.09%
Tobacco Use	14,984		
Yes		2,329	15.5%
No		12,509	83.5%
Unknown		146	1%
Diabetes	96,853		

Yes		1,484	1.2%
No		94,314	78.1%
Unknown		1,055	1.09%
Pre-Pregnancy Hypertension	96,853		
Yes		2,617	2.70%
No		93,181	97.37%
Unknown		1,055	1.09%
Gestational Hypertension	96,853		
Yes		4,964	5.12%
No		90,834	93.79%
Unknown		1,055	1.09%
Eclampsia	96,853		
Yes		442	.45%
No		95,356	98.4%
Unknown		1,055	1.09%
Chronic Hypertension	120,777		
Yes		3,374	2.8%
No		116,175	96.2%
Unknown		1,228	1.0%
Labor Characteristics			
Premature Rupture of Membrane	96,853		
Yes		14,873	15.35%
No		80,937	83.56%
Unknown		1,043	1.12%
Abruption of Placenta	93,215		
Yes		4,820	5.17%
No		90,990	97.61%
Unknown		1,043	1.12%
Prolonged Labor	96,853		
Yes		1,182	1.22%
No		94,628	97.70%
Unknown		1,043	1.07%
Steroids	96,853		
Yes		8,193	8.45%
No		87,920	90.77%
Unknown		740	.76%
Antibiotics	96,853		
Yes		23,355	24.11%
No		72,758	75.12%
Unknown		740	.76%
Anesthesia	96,853		
Yes		52,910	54.6%
No		43,203	44.6%
Unknown		740	.76%
Attendant	120,777		
Doctor of Medicine (MD)		108,093	89.5%

Doctor of Osteopathy (DO)		6,224	5.2%
Certified Nurse Midwife (CNM)		3,788	3.1%
Other Midwife		343	.3%
Other		2,023	1.7%
Unknown		306	.3%
Delivery Method	120,777		
Vaginal		73,180	60.6%
C-Section		47,257	39.1%
Unknown		340	0.3%
Infant Sociodemographic Characteristics			
Sex	120,777		
Female		53,369	44.2%
Male		67,408	55.8%
Weight at Birth (Grams)	120,777	1,242	(510,2835)
Gestational Age (Weeks)	120,777	30	(23,28)
Age of Death (Days)	120,777	4	(0,56)
Year of Death	120,777		
2009		26,076	21.6%
2010		24,292	20.1%
2011		23,723	19.4%
2012		23,444	19.2%
2013		23,242	19%
Multiple Births	120,777		
Single		103,100	85.4%
Twin		15,970	13.2%
Triplet		1,496	1.2%
Quadruplet		180	.1%
Quintuplet		51	.02%
Birth Place	120,777		
Hospital		118,909	98.5%
Free Standing Birth Center		145	.1%
Clinic/Doctors Office		20	0%
Residence		1,475	1.2%
Other		206	.2%
Unknown		22	
Five Minute Apgar Score	120,777		
Score of 0-3		49,313	40.8%
Score of 4-6		15,458	12.8%
Score of 7-8		20,052	16.6%
Score of 9-10		31,955	26.5%
Unknown		3,999	3.3%

[a] Median (Q1,Q3) reported for non-normally distributed variables.

Table 4: Clinical and Demographic Characteristics for Infant Mortality Cases in the U.S.-Mexico Border Statesa from 2009 to 2013.

		Infant Deaths	
	N	Mean	SD
	N	Frequency	%
	N	Median	(Q1, Q3)
Maternal Sociodemographic Characteristics			
Age	25, 955	27.37	6.27
Race	25,955		
White		19,409	74.8%
Black		4,236	16.3%
American Indian/ Alaskan Native		486	1.9%
Asian/ Pacific Islander		1,824	7.0%
Hispanic Origin	25, 955		
Hispanic		11,923	45.9%
Non-Hispanic White		7,413	28.6%
Non-Hispanic Black		3,953	15.2%
Non-Hispanic Other Race		2,074	8.0%
Missing		592	2.3%
Education Level	25, 955		
Less than 9 years education		1,487	5.7%
9-13 years of education		11,416	44.0%
13+ years of education		9,347	36.0%
Missing		3,705	14.3%
Residing on Border County	25, 955		
Border County		2,475	9.5%
Non-Border County		23,480	90.5%
Residing Border State	25,955		
California		11,742	45.2%
Arizona		2,503	9.6%
New Mexico		752	2.9%
Texas		10,958	42.2%
Marital Status	25,955		
Married		12,971	50%
Not Married		12,984	50%
Maternal Health During Pregnancy			
Number of Prenatal Visits	25,955	8	(5,12)
Gestational Diabetes	25,955		
Yes		820	3.2%
No		22,612	87.1%
Unknown		2	0%
Previous Preterm Birth	25,955		
Yes		745	2.9%
No		22,687	87.4%
Unknown		2	0%

Tobacco Use	25,955		
Yes		97	0.4%
No		974	3.8%
Unknown		24,880	95.9%
Diabetes	25,955		
Yes		296	9.7%
No		23,136	89.1%
Unknown		2	0%
Pre-Pregnancy Hypertension	25,955		
Yes		371	1.4%
No		23,061	88.8%
Unknown		2	0%
Gestational Hypertension	25,955		
Yes		1,228	4.7%
No		22,204	85.5%
Unknown		2	0%
Eclampsia	25,955		
Yes		51	0.2%
No		23,381	90.1%
Unknown		2	0%
Chronic Hypertension	25,955		
Yes		413	1.6%
No		25,540	98.4%
Unknown		2	0%
Labor Characteristics			
Premature Rupture of Membrane	25,955		
Yes		2,499	9.6%
No		20,914	80.6%
Unknown		21	0.1%
Abruption of Placenta	25,955		
Yes		710	2.7%
No		22,703	87.5%
Unknown		21	0.1%
Prolonged Labor	25,955		
Yes		186	0.7%
No		23,227	89.5%
Unknown		21	0.1%
Steroids	25,955		
Yes		1,248	4.8%
No		22,174	85.4%
Unknown		12	0%
Antibiotics	25,955		
Yes		4,503	17.3%
No		18,919	72.9%
Unknown		12	0%
Anesthesia	25,955		

Yes		12,121	46.7%
No		11,301	43.5%
Unknown		12	0%
Attendant	25,955		
Doctor of Medicine (MD)		23,754	91.5%
Doctor of Osteopathy (DO)		1,085	4.2%
Certified Nurse Midwife (CNM)		574	2.2%
Other Midwife		49	0.2%
Other		404	1.6%
Unknown		89	.3%
Delivery Method	25,955		
Vaginal		15,110	58.2%
C-Section		10,829	41.7%
Infant Sociodemographic Characteristics			
Sex	25,955		
Female		11,531	44.4%
Male		14,424	55.6%
Weight at Birth (Grams)	25,955	1,731.12	1,286.596
Gestational Age (Weeks)	25,955	31	(23, 38)
Age of Death (Days)	25,955	4	(0, 57)
Year of Death	25,955		
2009		5,525	21.3%
2010		5,315	20.5%
2011		5,024	19.4%
2012		5,037	19.4%
2013		5,054	19.5%
Multiple Births	25, 955		
Single		22,490	86.6%
Twin		3,073	11.8%
Triplet		326	1.3%
Quadruplet		49	0.2%
Quintuplet		17	0.1%
Birth Place	25,955		
Hospital		25,718	99.1%
Free Standing Birth Center		30	0.1%
Clinic/Doctors Office		2	0%
Residence		174	0.7%
Other		23	0.1%
Unknown		8	0%
Five Minute Apgar Score	25,955		
Score of 0-3		9,540	36.8%
Score of 4-6		3,229	12.4%
Score of 7-8		4,314	16.6%
Score of 9-10		7,754	29.9%
Unknown		1,118	4.3%

[a] Characteristics were not calculated for border counties due to very low cell sizes.

Maternal Sociodemographic Characteristics

Among the mothers of deceased infants (120,777) the mean age was 27.03 (SD= 6.446) years old. The majority of the sample population was White (64.5%); Black (29.5%), American Indian/Alaskan Native (1.6%), and Asian/Pacific Islander (4.5%) were also represented in the sample. The rates of infant death varied for whites (5.5 infant deaths per 1,000), Hispanics (5.2 infant deaths per 1,000), and blacks (5.0 infant deaths per 1,000) in the non-border U.S. states. The rates in the border region were also different from the non-border states with 5.6 infant deaths per 1,000 among Hispanics 5.3 infant deaths per 1,000 among whites, and 4.9 infant deaths per 1,000 among blacks.

The sample included 21.25% Hispanic mothers (78.75% were non-Hispanic) and 21.5% of mothers resided in the U.S.-Mexico border region at the time of their infant's death (78.5% did not reside in the border region). Approximately half of the mothers reported being married at the time of infant death (45.5%). The level of education was split almost evenly with 49.8% of mothers acquiring at least a high school education and 45.4% of mothers attending at least one year of post-secondary education.

Maternal Health During Pregnancy

Maternal health data reflect only mother's health during pregnancy as reported on infant birth or death certificates and did not include history of health or disease. Variables related to mother's health during pregnancy included the use of tobacco during pregnancy (15.5%), the diagnosis of diabetes (1.2%), hypertension (2.7%), and the number of prenatal visits (median=8). The majority of health concerns listed above were minimal. During pregnancy, a relatively small percentage of mothers developed gestational diabetes (2.8%), gestational hypertension (5.12%) and eclampsia (.45%). In addition, only 4.7% of mothers reported a previous preterm birth.

Labor Characteristics

The majority of mothers did not experience complication such as premature rupture of membrane (15.35%), abruption of placenta (5.17%), and prolonged labor (1.22%). Some mothers were prescribed steroids (8.45%), antibiotics (24.11%), or anesthesia (5.6%) during labor. The numbers of deaths occurring during deliveries performed by medical doctors (MDs) as compared to certified Midwives (CMW) reflected the differences in the total numbers of deliveries performed by each of these professionals. Thus, the majority of deaths in the data set (89.5%) occurred during MD performed deliveries as compared to deliveries performed by a CMW (3.1%).

Infant Characteristics

There was a total of 9,722,515 live births from 2009-2013 in the Unites States. Thus, of the 9,722,515 live births, 1.24% (120,777/9,722,515) resulted in infant deaths, including 44.2% female and 55.8% male. Most infant deaths occurred at 4 days of age. The majority of infants who died within the first year were born in a hospital (98.5%), received a five-minute APGAR (appearance, pulse, grimace, activity, respiration) score of 0-3 (40.8%) and were not pleural (85.4%).

6.2 Infant Mortality Differences

Infant mortality rate (IMR) for the typically defined and newly defined reference groups for each PPOR category were calculated and are shown in Table 5. Differences in calculated infant mortality rates for the typically and newly defined reference groups were compared with chi-square for national, external, and internal reference groups. Criteria for statistical significance was $p < 0.01$ are shown in Table 5.

National Category Comparison

There were significant infant death differences for the national typically defined (non-Hispanic, 20+ years of age, 13+ years of education, non-border state) group and the national newly defined 1 group (Hispanic, 20+ years of age, 13+ years of education, non-border state) for each PPOR category ($p<0.001$). The national newly defined group 1 experienced a significantly higher infant mortality rate (IMR=3.23) compared to the national typically defined group (IMR=3.15). The mothers in the national newly defined 1 group was more likely to experience more infant deaths than those mothers in the national typically defined group (OR=1.03, 95% CI = .98, 1.08).

The national typically defined group also experienced significantly less infant deaths in the maternal health/prematurity (IMR=11.62), newborn (IMR=10.2), and infant (IMR=9.68) care categories compared to the national newly defined 2 group (Hispanic, 20+ years of age, 9-13 years of education, non-border state) at the maternal health/prematurity (IMR=23.56), newborn (IMR=13.34), and infant (IMR=2.98) care levels ($p<.001$). The chi-square distribution shows that more infant deaths result in the newly defined 2 group compared to the national typically defined group. The mothers in the national newly defined 2 group were more likely to experience more infant deaths than those mothers in the national typically defined group (OR=1.27, 95% CI = 1.23, 1.33).

There was also significant differences between infant deaths in the national typically defined group and the national newly defined 3 group (Hispanic, 20+ years of age, less than 9 years education, non-border state) in each perinatal period of risk category ($p<.001$). Mothers in the national newly defined group experienced more infant death (IMR=4.18) compared to the national typically defined group (IMR= 3.15). The mothers in the national newly defined 3 group was more likely to experience more infant deaths than those mothers in the national typically defined group (OR=1.33, 95% CI = 1.23, 1.42).

Overall, women who were white, at least 20 years old, had 13 or more years of education, and resided in a non-border state had significantly lower infant mortality rates compared to Hispanic women at three various education levels residing in non-border states.

External Category Comparison

There were significant infant death differences for the external typically defined group (non-Hispanic, 20+ years of age, 13+ years of education, border state) and the external newly defined 1 group (Hispanic, 20+ years of age, 13+ years of education, border state) for each perinatal periods of risk category (p-value<0.001). The external newly defined group 1 experienced significantly higher infant deaths in the maternal health/prematurity (IMR=17.49), newborn (IMR=10.05), and infant (IMR=2.54) care categories compared to the external typically defined maternal health/ prematurity (IMR=18.82), newborn (IMR=9.49), and infant (IMR=1.63) care categories. The test statistic shows that significantly more deaths resulted among the external newly defined group compared to the external typically defined group. The mothers in the external newly defined 1 group was more likely to experience more infant deaths than those mothers in the external typically defined group (OR=1.004, 95% CI = 0.95, 1.06).

The number of infant deaths in the maternal health/prematurity, infant, and newborn categories is not different for the external typically defined group and the external newly defined 2 group (Hispanic, 20+ years of age, 9-13 years education, border state) (p=.447). The external typically defined group experienced 3,056 infant deaths compared to the external typically defined group who experienced 4,066 infant deaths.

The number of infant deaths in all three perinatal periods of risk categories was not different for the external typically defined group and the external newly defined 3 (Hispanic, 20+ years of age, less than 9 years education, border state) group (p=.255). The infant mortality rate for the external typically defined group was 3 deaths per 1,000 compared to 4.14 deaths per 1,000 in the external newly defined 3 group.

Internal Category Comparison

The number of infant deaths in maternal health/prematurity, infant, and newborn categories is not different for the internal typically defined (non-Hispanic, 20+ years of age, 13+ years of education, border county) group and the internal newly defined 1 (non-Hispanic, 20+ years of age, 13+ years of education, border county) group (p=.068). The infant mortality rate for the internal typically defined group and the internal newly defined 1 group was 2.44 infant deaths per 1,000.

The number of infant deaths in the maternal health/prematurity, infant, and newborn levels is different for the internal typically defined group and the internal newly defined 2 (Hispanic, 20+ years of age, 9-13 years of education, border county) group. The number of infant deaths in the internal typically defined group (infant deaths= 178) was significantly lower than the internal newly defined 2 group (infant deaths =465). The mothers in the internal newly defined 2 group was more likely to experience more infant deaths than those mothers in the internal typically defined group (OR=1.29, 95% CI =1.08, 1.53).

The number of infant deaths in all three perinatal periods of risk categories is not different for the internal typically defined group and the internal newly defined 3 (Hispanic, 20+ years of age, less than 9 years education, border county) group (p=.052). The group infant mortality rate for the external typically defined group was 2.44 infant deaths per 1,000 live births compared to the 3.49 infant deaths per 1,000 live births experienced by the internal newly defined group. The comparison for the internal typically defined group and the internal newly defined 3 group cannot be used in PPOR analysis because the infant deaths in each perinatal periods of risk category did not meet the minimum value of sixty infant deaths.

Table 5: Number and rate of infant deaths by perinatal period of risk (PPOR) and reference group

	Typically Defined (Non-Hisp white, age 20+, >13yr edu)	**Newly Defined 1** (Hispanic white, age 20+, >13yr edu)	**Newly Defined 2** (Hispanic white, age 20+, 9-13yr edu)	**Newly Defined 3** (Hispanic white, age 20+,<9yr edu)
National				
Infant Death Rate Maternal Health Period	11.62	17.70	23.56	27.08
Infant Death Rate Newborn Care Period	10.20	12.13	13.34	12.04
Infant Death Rate Infant Care Period	9.68	2.51	2.98	2.69
Group IMR	3.15	3.23	3.99	4.18
Infant Deaths (No.)	15267	1778	2968	1087
Fetal Deaths and Live Births	4846721	549772	744461	259954
Chi square* (p) Odds ratio		439.68 (< 0.001) 1.03 (.98, 1.08)	801.38 (< 0.001) 1.27 (1.23,1.33)	412.99 (< 0.001) 1.33 (1.25,1.42)
External				
Infant Death Rate Maternal Health Period	18.82	17.49	24.78	25.51
Infant Death Rate Newborn Care Period	9.49	10.05	12.19	13.10
Infant Death Rate Infant Care Period	2.54	2.41	2.84	7.54
Group IMR	3.0	3.0	3.94	4.14
Infant Deaths (No.)	3056	2050	4066	1022
Fetal Deaths and Live Births	1020122	681517	1032454	246529
Chi square (p) Odds Ratio		21.815 (< 0.001) 1.004 (0.95, 1.06)	1.61 (< 0.447)	2.73 (< 0.255)
Internal				
Infant Death Rate Maternal Health Period	7.67	9.95	12.91	14.34
Infant Death Rate Newborn Care Period	9.18	7.02	8.25	8.14
Infant Death Rate Infant Care Period	7.54	7.42	10.27	12.41
Group IMR	2.44	2.44	3.14	3.49
Infant Deaths (No.)	178	309	465	90
Fetal Deaths and Live Births	72983	126621	147933	25784
Chi square, (p) Odds ratio (C.I.)		5.39 (< 0.068)	8.921 (< 0.012) 1.29 (1.08,1.53)	5.73 (< 0.052)

* Chi square tests and odds ratios test the differences between rates from each newly defined group and the reference group by PPOR category.

6.3 Excess Infant Deaths

Excess infant death was calculated by using the typically defined groups for the national, external, and internal categories as reference populations for the newly defined groups in each category. The excess infant deaths can be found in table 6.

In order to compare the national reference group, a reference population of 0.0032 was used. The population mortality rate for the national newly defined 1 (0.0032), national newly defined 2 (0.0040), and the national newly defined 3 (0.0042) was subtracted from the reference population to obtain the population excess mortality rate. The population excess mortality rate for each group was 0, 8, and 10 per 10,000 live births, respectively.

In order to obtain the number of excess deaths, the population excess mortality rate was multiplied with the total number of infant deaths and live births for each category. Compared to the national typically defined group (White, 20+ years of age, 13+ years of education, non-border state) the national newly defined 1 group (Hispanic, 20+ years of age, 13+ years of education, non-border state) experienced no excess deaths. Therefore, showing that although the infant mortality rate is higher, the group is not experiencing an abnormal number of deaths. On the other hand, the national newly defined 2 group (Hispanic, 20+ years of age, 9-13 years of education, non-border state) and the national newly defined 3 group (White, 20+ years of age, less than 9 years education, non-border state) had 595.57 and 259.95 excess deaths respectively.

A reference population value of 0.0023 was used to compare the external category. Compared to the external typically defined group (White, 20+ years of age, 13+ years of education, border state) the external newly defined group 1 (Hispanic, 20+ years of age, 13+ years of education, non-border state), external newly defined group 2 (Hispanic, 20+ years of age, 9-13 years of education, border state), and external newly defined group 3 (Hispanic, 20+

years of age, less than 9 years education, border state) had 477.06, 1,651.93, and 468.50 excess infant deaths respectively.

Excess infant deaths among the internal group was calculated using a reference population value of 0.0024. When the internal newly defined 1 group (Hispanic, 20+ years of age, 13+ years of education, border county) was compared to the internal typically defined group (White, 20+ years of age, 13+ years of education, border county) there were no excess infant deaths. However, when the internal typically defined group was compared to the internal newly defined 2 group (Hispanic, 20+ years of age, 9-13 years education, border county) and internal newly defined 3 group (Hispanic, 20+ years of age, less than 9 years education, border county) the excess death rate was 103.55 and 28.36 respectively.

In the national and internal reference groups with 13+ years of education had no excess deaths. In addition, it seems as if the groups with the highest excess death rates were those Hispanic women who had lower levels of education.

Table 6: Comparison of Excess Infant Deaths by Reference Group

	Typically Defined (Non-Hisp white, age 20+, >13yr edu)	**Newly Defined 1** (Hispanic white, age 20+,>13yr edu)	**Newly Defined 2** (Hispanic white, age 20+, 9-13yr edu)	**Newly Defined 3** (Hispanic white, age 20+, <9 yr edu)
National				
Reference Population Mortality Rate	0.0032	(0.0032)	(0.0032)	(0.0032)
Reference Group Mortality Rate		0.0032	0.0040	0.0042
Reference Group Excess Mortality Rate[a]		0	8	10
Excess Deaths (No.)		0	595.57	259.95
External				
Reference Population Mortality Rate	0.0023	(0.0023)	(0.0023)	(0.0023)
Reference Group Mortality Rate		0.0030	0.0039	0.0042
Reference Group Excess Mortality Rate		7	16	19
Excess Deaths (No.)		477.06	1651.93	468.40
Internal				
Reference Population Mortality Rate	0.0024	(0.0024)	(0.0024)	(0.0024)
Reference Group Mortality Rate		0.0024	0.0031	0.0035
Reference Group Excess Mortality Rate		0	7	11
Excess Deaths (No.)		0	103.55	28.36

[a] per 10,000 live births

Chapter 7: Discussion

7.1 Study Overview

Infant mortality is a primary indicator of a nation's health and estimating infant mortality and excess infant deaths is a central task of public health agencies. The estimation of excess infant deaths is accomplished by defining a reference group (national, external, or internal, see page 14 above) with the lowest infant mortality rate and comparing the reference group rate to other subgroups. Determining a reference group with the lowest possible excess infant death rates is critical for improving efforts to lower excess infant deaths. The typical reference group has been defined as white, non-Hispanic females, 20+ years of age, with 13+ years of education. Whether this reference group in fact captures the lowest possible infant death rates is rarely examined particularly with regard to estimating excess infant deaths in predominantly Hispanic communities and regions.

This study explored how changing the reference group education and ethnicity criteria might change the estimation of infant mortality rates and excess infant deaths for predominantly Hispanic communities. Effects at the national, external, and internal levels were examined.

Several significant differences were found when comparing the estimations of excess infant death calculations when using typically defined and newly defined reference group criteria. Contrary to the predictions, the newly defined reference groups at all levels, national, external, and internal, in fact experienced higher infant mortality rates (group IMR) than the typically defined groups. Interestingly however, the difference between the typically defined and newly defined groups was not as great as has been found in other studies (Cao et al., 2007). In addition, excess infant deaths were consistently observed in newly defined groups where education was less than 13 years, a finding that is in accordance with other studies that use education as a predictor of infant outcomes (Gage, Fang, O'Nell & DiRienzo, 2012).

7.2. Maternal sociodemographic and health characteristics

The sociodemographic characteristics of the sample (United States and border states) closely resembled the national statistics for age (27 years), education (55% high school diploma), and Hispanic ethnicity (Mathews, MacDorman, & Thoma, 2015). However, the sample did not represent race-specific rates accurately. In the United States, the majority of infant deaths occur among African Americans (Mathews, MacDorman, & Thoma, 2015), however the sample data showed a larger percentage of deaths among White mothers. In national data, African American mothers also experienced the highest rates of infant deaths in the United States border states, followed by American Indians/ Alaskan Natives. However, this sample showed Whites and Hispanics experiencing a higher rate of infant mortality as compared to African Americans and American Indians/Alaskan natives.

The descriptive data of health characteristics for women who experienced death of an infant are also interesting to consider in relation to national statistics for different health indicators. For example, the sample had lower percentages of previous preterm birth for both the United States and border states. In the United States, eclampsia is a leading cause of maternal mortality affecting 3.4% of mothers who experienced infant death (Welch, 2017). However, the sample showed a large difference. In the sample, eclampsia affected less than 0.5% of mothers. In addition to lower rates of eclampsia, the national sample also experienced less gestational diabetes compared to the national percentage (3% of mothers who experience infant death) (Samadi, Mayberry, & Reed, 2012). When examining the border states, mothers had similar prenatal visits, eclampsia, and chronic hypertension (Hamilton, Martin, Michelle, Osterman,

2016) as compared to national data. The border sample population experienced higher rates of diabetes (9.7%) compared to the national percentage (6.7%), which is expected. However, the border states experienced almost 2% lower rates of gestational diabetes as compared to the national percentage of 5% (Schlosberg, 2018).

7.3 Clinical and labor characteristics of infant deaths

The infant characteristics of the sample data were relatively comparable to national data for attendant performing the delivery (medical doctor 92.1%), birth place (1.36% outside of hospital) (Macdorman, Mathews, & Declercq, 2014), and five minute APGAR score (45.3% score 0-3) (Li, Wu, Lei, Zhang, Mao, & Zhang, 2013). The infant data for multiple births that resulted in infant deaths were exceptionally different in the sample as compared to the national data. National data suggested that in the United States more multiple births result in deaths than singleton births, however of the infant deaths in the sample, a majority were single births (CDC, 2017). In addition, in the United States the percentage of infant deaths by sex is 21% higher in males than females, however the sample data showed death among males and females being relatively even (CDC, 2017).

As compared to national statistics, the sample data with regard to labor was tremendously different. The sample data had relatively higher rates as compared to national statistics for premature rupture of membrane (2-4%) and abruption of placenta (1%) (Ananth & Wilcox, 2011) and lower rates for prolonged labor (8-11%), anesthesia (69%), and cesarean section (32%) (Osterman & Martin, 2011). When looking at the border states, medical providers performed a cesarean section 10% more than the national average (CDC, 2017). These alarming rates need to be further studied to determine if cesarean sections are being performed more often than necessary.

7.4. Number and rate of infant deaths by PPOR category for typical and newly defined reference groups

The Perinatal Periods of Risk (PPOR) model method allows for communities to investigate infant mortality using four distinct perinatal categories defined by infant birthweight and gestational age. The four categories are maternal health/ prematurity, maternal care, newborn care, and infant health. The categories in which infant death are the highest represent an area of disparity and suggest that preventative measures need to be directed to the area. This study calculated infant mortality rates for national, external, and internal reference groups at three different educational levels. To determine whether reference groups defined according to their educational level would produce significantly different estimates of infant deaths in all of the PPOR categories, chi square analyses were conducted to determine in which PPOR categories significantly higher rates of infant deaths occurred.

In the study, reference group infant mortality was compared at the national, external, and internal levels. In general, the maternal health/prematurity category always had a higher number of infant deaths regardless of the reference group criteria. The national and external reference groups experienced higher rates of infant mortality in the newborn care category compared to the infant care category, while the internal reference group had relatively the same rate of infant deaths in both the infant and newborn categories.

More specifically, the national typically defined group experienced noticeably less deaths in the maternal health/prematurity category compared to the newly defined national reference groups but experienced almost a three times higher rate in the infant category. The external typically defined group and the external newly defined groups experience roughly similar rates for maternal health/prematurity, infant, and newborn categories. The internal reference groups were different in that there was some variability between each of the reference group criteria. In the maternal health/prematurity and infant care categories, infant mortality rates increased as education decreased in the internal groups. The newborn category for the internal typically defined and newly defined groups was similar.

Newly defined groups at the internal level had higher infant mortality rates compared to the typically defined group, a finding that is inconsistent with the literature (March of Dimes, 2011). Previous findings showed lower infant mortality rates among Hispanics residing on the border. In contrast, this study showed that infant mortality rates were 1.28 times higher in the internal newly defined group compared to the typically defined group.

The reference groups that were compromised of non-Hispanic white women at least twenty years of age and with 13 years of education had better infant health outcomes, regardless of residence, a finding that is consistent with the literature (Gonzales & Gilleskie, 2017).

According to the sample, infant death rates in the United States have been decreasing. The infant deaths were 26,076 infant deaths in 2009 compared to 23,242 in 2013. However, among border states in the sample infant death rates have remained static between 2011 and 2013.

In the United States, for the years 2009-2013 the infant death rate was 1.5 times higher among Hispanic women living in the non-border states as compared to the non-Hispanic White women. These women shared the same educational levels and age criteria.

While infant deaths occurred in all perinatal periods of risk categories, more deaths occurred in the maternal health/prematurity category. Therefore, efforts to reduce or eliminate differences between Hispanic and White infant mortality rates need to focus predominantly in the maternal health/ prematurity category.

7.5. Comparison of excess infant deaths using infant death rates from typical and newly defined reference groups

Using infant death rate data calculated for the comparisons described above, excess infant deaths were calculated for each reference group. The reference groups were compared within the national, external, and internal categories, therefore the typically defined reference group infant mortality rate for each category was used as the reference population. In the study, excess death rate and education were inversely related, as education decreased, excess death rate increased. In the national category, the excess deaths increased dramatically as education decreased. The newly defined 3 group (Hispanic women with less than 9 years education) experienced an excess mortality rate of more than twelve times the excess infant death rate than the newly defined 1 group (Hispanic women with 13+ years education). In the external category, excess death rate in the newly defined 2 category was the highest with 1,651 infant deaths. The internally defined group showed no difference between the typically defined and newly defined 1 group. The data showed that women who had the same educational level residing on the border, regardless of ethnicity had similar excess death. However, as education decreased, Hispanic women experienced increased excess death rates.

The data shows that excess death rates in the United States and the United Stated border region is more effected by mother's education level than a mothers ethnicity due to the fact that newly defined groups with more than 13 years of education in all categories, national, external, and internal, did not show meaningful differences in excess death rates.

7.6. Strengths

A strength of the study was that few studies have explored different reference groups used in conjunction with the PPOR model. This study compared different reference groups to determine which groups yield optimal outcomes. In addition, the study summarized maternal sociodemographic, infant, and labor characteristics in the United States and Mexico border region.

Another strength of the study was that it focused on a population, Hispanics living in the U.S.-Mexico border region, that has not been frequently studied. The information gained on infant mortality in the border region allows the finding from the study to fill in the gaps in literature for birth outcomes among mothers of various education levels and Hispanic ethnicity.

An additional strength of the study, was the large amount of infant deaths captured. The study included 120,777 infant deaths in the United States making the study representative of infant deaths in the country. In addition, the study captured over 25,000 infant deaths in the border states.

7.7. Limitations

A limitation of the study was that fetal-infant death (deaths before 0 days of life) could not be included as part of the group infant mortality rates for each reference group. Although the Perinatal Periods of Risk Model has an exclusive section for fetal deaths in the maternal health/prematurity and maternal care categories, fetal deaths were excluded due to the feto-infant death data set not having a recorded variable for education, the variable being manipulated in the study. If the death records with mother's education level were available, the death counts could have provided further information of infant mortality difference among the different reference groups.

The PPOR model is divided into two analytical phases. This study focused on only Phase one of PPOR analyses. The study determined which reference groups produced best infant outcomes but did not determine which risk and preventive factors were likely to have the largest effect on improving infant mortality rate among the different reference groups because phase 2 analysis of PPOR was not completed.

Another limitation of this study was that the number of infant deaths recorded in the border counties from the years 2009 to 2013 was minimal. There were several counties among the border counties that had no infant death data. Therefore, descriptive statistics could not be calculated for these subgroups due to small sample size. In addition, the significance in the internal reference groups could not be used for further PPOR analysis because there had less than sixty infant deaths per perinatal category.

7.8 Conclusions

For a majority of the infant and maternal social and behavioral characteristics related to infant health outcomes, the rates in this sample were very similar to those reported nationally. Key differences were that the distribution of deaths among specific races were different from national rates and the incidence of gestational diabetes and eclampsia reported in this sample were lower than national rates.

Typically, defined reference groups at the national, external, and internal levels experience lower levels of infant mortality as compared to reference groups that varied primarily by mother's level of education and ethnicity. Importantly, the highest counts of infant deaths were seen in the maternal health/prematurity perinatal periods of risk category for all reference groups regardless of education, ethnicity, age, or where the mother was residing. Suggesting that effective interventions could target this time period to reduce infant deaths.

Excess death rates are inversely related to a mother's education level; as mother's level of education decreased, infant deaths increased. The national and internal reference groups with

13+ years of education did not experience any excess death in comparison to the typically defined reference group. Thus, education is a crucial factor for infant health outcomes.

7.9 Suggestions for Future Research

Future research on this topic could lead to a more complete understanding of the variables that affect infant mortality in the border region. The completion of the phase 2 PPOR analysis would allow community members to target prevention planning by determining which risk and preventative factors would have the largest impact on improving infant mortality.

Chapter 8: Strategic Frameworks

The University of Texas at El Paso (UTEP) Masters in Public Health Program (MPH) emphasized the need to address three strategic frameworks. These frameworks include Healthy People 2020, Healthy Border 2020, and the Paso del Norte Regional Strategic Health Framework. Specific objectives from these frameworks were integrated into this thesis study to improve infant and maternal health in the United States and in the United States and Mexico border counties.

8.1 Healthy People 2020

Healthy People 2020 is a national framework set forth by the U.S. Department of Health and Human Services to promote health and disease prevention. The framework is focused on eliminating health disparities, reaching health equity, and improving the overall health of all groups (DHHS, 2017).

The Healthy People 2020 topic: maternal, infant, and child health addresses health at a variety of levels including objectives for morbidity and mortality, pregnancy health behaviors, and infant care. An objective that closely related to the thesis study is “MICH-1: Reduce the rate of fetal and infant deaths.” This objective targets reducing infant deaths by having a 10% improvement from the year 2010.. According to this thesis study, the border region has met the target set by Healthy People 2020 of 6.0 infant deaths per 1,000 live births.

8.2 Healthy Border 2020

Healthy Border 2020 is an initiative to improve the health and well-being of U.S. and Mexico border residents. Healthy Border 2020 is managed by a binational organization termed the U.S. Mexico Border Health Commission. The initiative addresses several public health objectives including access to health services, breast cancer, diabetes mellitus, injury prevention, and maternal, infant, and child health. (U.S. Mexico Border Health Commission, 2015).

The priority area that relates to this thesis study is the maternal, infant, and child health category. The priority area addresses reducing infant mortality, increasing rate of mothers receiving first trimester prenatal care, and reducing the pregnancy rate in adolescents in both the United States and Mexico. The Border Health Commission (BHC) plans to reduce infant mortality rates in the United States by 15% and in Mexico by 50% from the rate (6.1 deaths per 1,000) in the year 2010. The objective addresses infant mortality in relation to age and residential status, two components that are integrated in the reference groups establish in this study.

8.3 Paso del Norte Regional Strategic Health Framework

The Paso del Norte Regional Strategic Framework is a local initiative set forth by the Paso del Norte Health Foundation. The foundation promotes the health of the region and prevents disease through leadership in research, education, and advocacy (Paso Del Norte Health Foundation, 2016). The strategic framework addresses five priority areas including healthy eating, mental health, tobacco and alcohol use, sexual health, and health care.

Although there is not a specific priority area to address infant health, the framework does address adolescent pregnancy. The strategies suggested for this sub-topic can be applied to infant mortality and heath to improve the overall infant mortality rates in the border region among Hispanic mothers of adolescent age.

Chapter 9: MPH Core Competencies

The University of Texas at El Paso (UTEP) Masters in Public Health Program (MPH) is comprised of five specific core competencies. These competencies include social and behavioral sciences, epidemiology, biostatistics, environmental health, and health service administration and policy. In addition, the program also includes a Hispanic/border health concentration. This study integrates four of these disciplines: social and behavioral sciences, epidemiology, biostatistics, and Hispanic/ Border Health.

9.1 Social and Behavioral Sciences

Social and behavioral sciences addresses the behavioral, social, and cultural factors related to health at the individual and at the population level. This study compared the risk factors and social factors that result in infant death.

9.2 Epidemiology

Epidemiology is the study of disease patterns and injury in human populations. This study reported infant death rates and excess fetal infant death for the border region based on previously obtained data from the Centers for Disease Control and Prevention (CDC). Additionally, the study described the infant death population in terms of sociodemographic, maternal, and labor characteristics.

9.3 Biostatistics

In public health biostatistics is the study of statistical reasoning and methods to address, analyze, and solve problems. This study managed and cleaned six datasets (live births for years

2009-2013 and infant deaths in U.S.) before performing descriptive statistics, chi-square tests, and odds ratio comparisons.

9.4 Hispanic/ Border Health Concentration

The Hispanic and border health concentration looks at addressing the health challenges among communities on the United States and Mexico border. This study identified differences in infant mortality rates and excess deaths for groups living in the United States and Mexico border states and border counties.

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Vita

Alexis Ramos obtained her Bachelor of Science Degree in Biological Sciences with a Biomedical Concentration with an Honors Degree from the University of Texas at El Paso (UTEP). As an undergraduate student, Alexis received the UTEP Top Ten Senior Award, the Men and Women of Mines Award, and was a UTEP Miner Ambassador. Alexis worked as a research assistant in Dr. Dominguez's laboratory studying the prevalence of efflux pumps in Methicillin-Resistant Staphylococcus aureus (MRSA). During the summer of 2015, Alexis participated in the Border Latino and American Indian Summer Exposure to Research (BLAISER) program at the University of Arizona College of Medicine. During the BLAISER program, Ms. Ramos studied fecal bile acid levels in neonates that develop necrotizing enterocolitis and presented her research in an oral presentation at the UROC conference in Tucson, Arizona.

In the Fall of 2016, Alexis began the Masters of Public Health (MPH) program at UTEP. In July 2016, Alexis began working as a Graduate Intern for the City of El Paso Department of Public Health (DPH) in the ZIKA and later Emergency Preparedness Program. Ms. Ramos completed her MPH Practicum at the DPH where she completed a Tuberculosis (TB) Report for the City of El Paso for the years 2014 to 2018.

Alexis plans to receive her MPH at the UTEP 2018 Spring Commencement Ceremony where she will serve as the Graduate School Student Marshall of Students. Alexis has been accepted to and will attend Texas Tech University Health Sciences Center Physician Assistant Program in the summer of 2018 where she plans to continue studying infant health in rural communities like the U.S.- Mexico border region.

Contact Information: alexisramos01@yahoo.com