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Racial Moderation of Infant Mortality Risk and Protective Factors in the United States

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Walden University
2025

Abstract

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Temitope Akinsola

MPH, Benedictine University, 2009

BS, University of Maryland, Eastern Shore, 2003

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Public Health

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Abstract

The rate of infant mortality is a pressing health issue in the United States, as ethnic minorities are disproportionately affected. This study addressed how race controls the predictive power of demographic, socioeconomic, and geographic factors on infant mortality. Using a quantitative correlational design, secondary data from 181 individuals listed in the CDC-National Vital Statistics System database were used, which contains nationally aggregated data related to infant mortality rates. Bronfenbrenner's social ecological model guided the study, and multiple regression and moderation models were used to examine socioeconomic status and access to healthcare on infant mortality outcomes. Results indicated that race significantly moderated the effects of maternal prepregnancy, BMI, and state residency (R^2 = .908, F (4, 35) = 20.234, p < .001), and BMI had a more substantial impact on infant mortality for African American mothers (B = 4.130, p < .001). Race and ethnicity also significantly moderated the effects of WIC participation on infant mortality (R^2 = .603, F (4, 172) = 32.705, p < .001); however, race and ethnicity did not significantly moderate the impact of geographic factors such as state or urban/rural status on infant mortality, except for within the State of Florida (B = 2.298, p = .021). Results from this study can help guide public health professionals and relevant stakeholders on how to understand the underlying factors affecting infant mortality. Results emphasize the need for targeted interventions, including integration of culturally competent quality healthcare for underserved populations, expansion of community based prenatal education programs, and addressing geographic and socioeconomic barriers.

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Dedication

Special thanks to my kids, especially my special needs sons (Nathan and Noah), daughters (Nifemi, Nuola, and Oyinkan), and husband (Funso), for standing by me and showing their efforts throughout the whole program.

Thank you, Grandma Alice, O. Adeosun, and my late father, Dr. Prince Anthony Adeyefa, for your continuous prayers.

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Section 1: Foundation of the Study and Literature Review

Infant mortality is the death of a child before they turn 1 (Petersen et al., 2019). Approximately two-thirds of infant deaths in the United States occur before or during the first month of life and are caused by congenital abnormalities or problems involving preterm births (Petersen et al., 2019). Several other notable causes of infant mortality include congenital disabilities, premature birth, low birth weight, and malnutrition (Riddell et al., 2017). Death tolls are measured by experts as infant mortality rates (IMR). The rate of infant death is significantly higher in African American and Hispanic preterm and newborns than Caucasian parents (Brisendine et al., 2017; Siddiqi et al., 2016).

Environmental and social barriers preventing access to essential medical resources are significant contributors to U.S. MRs (Assari & Bazargan, 2019). There is a gap in extant literature regarding high IMRs in minorities being under researched. Additionally, there is little research regarding if race facilitates effects of demographic, socioeconomic, or geographic factors on IMRs. Contributing factors to environmental and social barriers include demographic factors such as age, father's race, and body mass index (BMI) of mothers and children (Zhao et al., 2018). Social barriers include socioeconomic factors such as the level of education of parents, food insecurity, and inadequate housing situations (Vilda et al., 2019). Environmental barriers include location, urban or rural status, and county poverty rates (Mohamoud et al., 2021).

Background

Racial, socioeconomic, and geographic disparities involving age and cause-specific infant mortality in the United States have been examined to determine at what

point for White and Black infants were there increases in rates based on factors with race, socioeconomic status, and geography. The Centers for Disease Control and Prevention (CDC, 2019a) found nearly 21,000 infants died from one of the following five causes: birth defects, low birth weight or preterm birth, injuries, sudden infant death syndrome (SIDS), and maternal pregnancy complications.

The IMR in the United States is higher at a consistent rate than other developed countries. Socioeconomic inequality significantly contributed to this higher IMR (Singh & Yu, 2019). Considerable inequalities continue involving infant mortality between racial and ethnic groups. However, the most prevalent disparities were among babies born to Black, White, and Asian women. Higher rates of infant mortality were observed among mothers younger than 25 or older than 40 compared with those between 25 and 40, as well as mothers living in high poverty counties compared with those in low and middle poverty counties, and those living in rural counties compared with those in urban counties (Mohamoud et al., 2021; Selemani et al., 2015).

Problem Statement

The highest IMR in the United States per 1,000 live births is among African Americans at 10.8% (Ely & Driscoll, 2019). The Hispanic IMR is 8.2% (CDC, 2019b). Hispanics saw increased numbers in terms of IMRs and socioeconomic status (SES; Brisendine et al., 2017; Rice et al., 2017). IMRs among African American populations were persistently high in the United States (Kandasamy et al., 2020; McKane et al., 2018). Kandasamy et al. (2020) found in counties located in New England, IMR rates were 8.78 to 13.77% higher than in Midwest states among African American infants.

Race was a crucial factor, but other critical demographic, socioeconomic, and geographic factors have also been identified, yet little research has focused on these factors.

This study involved addressing interactions between demographic, socioeconomic, and geographic factors which affect infant mortality. Although researchers have investigated this issue, there is very little or no literature about how race interacts with other key predictors of infant mortality. Predictors have all been individually established and sometimes studied together. However, more research is needed on how protective factors and risk factors differ in terms of their influence across specifically racial lines. More broadly, there is a need for further research regarding why infant mortality rates differ between different areas. Such studies should also consider interactions of socioeconomic and geographic predictors with individual-level factors.

Purpose of the Study

This quantitative correlational study involved examining the extent to which race moderated the predictive power of demographic, socioeconomic, and geographic factors on infant mortality in the United States. To address research questions in this quantitative study, I used a correlational research design with mediation examining data on infant mortality. This occurred using data collected through CDC archives, specifically the CDC-National Vital Statistics System (CDC-NVSS) database, which contains nationally aggregated data related to IMRs. This database has the most complete data on births and deaths in the United States. I used data only from states within the United States.

Research Questions and Hypotheses

The following quantitative research questions and related hypotheses were used for the study:

RQ1: To what extent, if any, does race/ethnicity moderate the effect of demographic factors (age, father's race, BMI, residency) on IMRs?

$H_0$1: Race/ethnicity does not significantly moderate the effect of any demographic factors (age, father's race, BMI, residency) on IMRs.

H_a1: Race/ethnicity significantly moderates the effect of one or more demographic factors (age, father's race, BMI, residency) on the infant mortality rate.

RQ2: To what extent, if any, does race/ethnicity moderate the effect of socioeconomic factors (education, WIC food status) on IMRs?

$H_0$2: Race/ethnicity does not significantly moderate the effect of any socioeconomic factors (education, WIC food status) on IMRs.

H_a2: Race/ethnicity significantly moderates the effect of one or more socioeconomic factors (education, WIC food status) on IMRs.

RQ3: To what extent, if any, does race/ethnicity moderate the effect of geographic factors (state, urban/rural, county poverty level) on IMRs?

$H_0$3: Race/ethnicity does not significantly moderate the effect of any geographic factors (state, urban/rural, county poverty level) on IMRs.

H_a3: Race/ethnicity significantly moderates the effect of one or more geographic factors (state, urban/rural, county poverty level) on infant mortality rate.

Conceptual Framework

The conceptual model that grounded this study was the social ecological model (SEM). It is a model of interlocking ways in which social ecological factors affect people. It was originally developed in developmental psychology but has been widely applied to many fields, including but not limited to public health. The SEM involves concentric contexts in which people are involved and how these contexts interact with one another.

The SEM has four distinct but interrelated levels: individual, relationship, community, and societal. Further, the SEM involves how intricate interactions between individual, relationship, community, and societal factors impact human development and behavior (Stokols, 1996). According to Brofenbrenner (1979), all four levels also interoperate to influence individual decision-making. This can include health-related issues. Interactions between race and poverty or race and education might have different impacts than the sum of risks related to race and income or education separately.

Nature of the Study

I used a quantitative correlational study to collect and analyze data from the CDC-NVSS. Data was used to address research questions using this design with mediation. Correlational research involves examining the effects of critical predictors on outcomes (Johnson, 2001). I addressed complex relationships involving moderation. This required hierarchical multiple linear regression analyses using the Baron and Kenny moderation approach. Via this approach, the potential for moderation was tested by examining more complex modeling of interactions between critical variables.

Review of Literature

U.S. IMRs remain problematic for public health leaders. In the United States alone, the IMR rate has grown 40% since 1990 (World Health Organization [WHO], 2023b). This quantitative correlational study involved examining how race moderates the predictive power of other demographic, socioeconomic, and geographic factors on infant mortality in the United States. I addressed how significantly interactions between demographic, socioeconomic, and geographic factors affected infant mortality. Existing literature has addressed race, demographic, socioeconomic, and geographic predictive factors as well as their impacts on infant mortality separately. However, there is an absence of literature suggesting these key predictors, when combined, may impact the potential for increased IMRs.

Organization of the Literature Review

In Section 1, I address the search strategy to select literature related to the topic. This is followed by an explanation of the SEM and how it applied to this study. I then address the following topics: global IMRs as a public health concern, IMRs in the United States, and ecological and environmental risk factors. Additionally, maternal contributors to IMR, which include healthcare and funding, maternal demographics, maternal health, maternal lifestyle and life history, maternal education, maternal attitudes toward healthcare, maternal social support, and maternal mental health are discussed. Finally, I discuss socioeconomic determinants of IMRs and ethnicity and socioeconomic status.

Literature Search Strategy

Finding the necessary research began with searches of the following scholarly databases: Europe PMC, CHBD, CINAHL, Cochrane Library, EMBASE, Google Scholar, MEDLINE, MyScienceWork, PsychINFO, PubMed, PubPsych, Science Open, Scilit, and Scopus. Keywords and phrases were: *prenatal education*, *infant mortality rate*, *global issues with infant mortality rate*, *antenatal care*, *public health concern for infant mortality rate*, *women's autonomy and infant mortality rates*, *birth interval and infant mortality rates*, *healthcare predictors of infant mortality rate*, *healthcare accessibility and infant mortality rates*, *women's health impact on infant mortality rates*, *adverse birth and maternal outcomes associated with infant mortality rates*, *lack of prenatal education and infant mortality rates*, *socioeconomic determinants and infant mortality rates*, *the impact of financial means and infant mortality rates*, *financial means and prenatal education*, *race and prenatal education*, *biodemographic risk factors and infant mortality rates*, *living condition impact on infant mortality rates*, and *ecological and environmental impacts on infant mortality rates*.

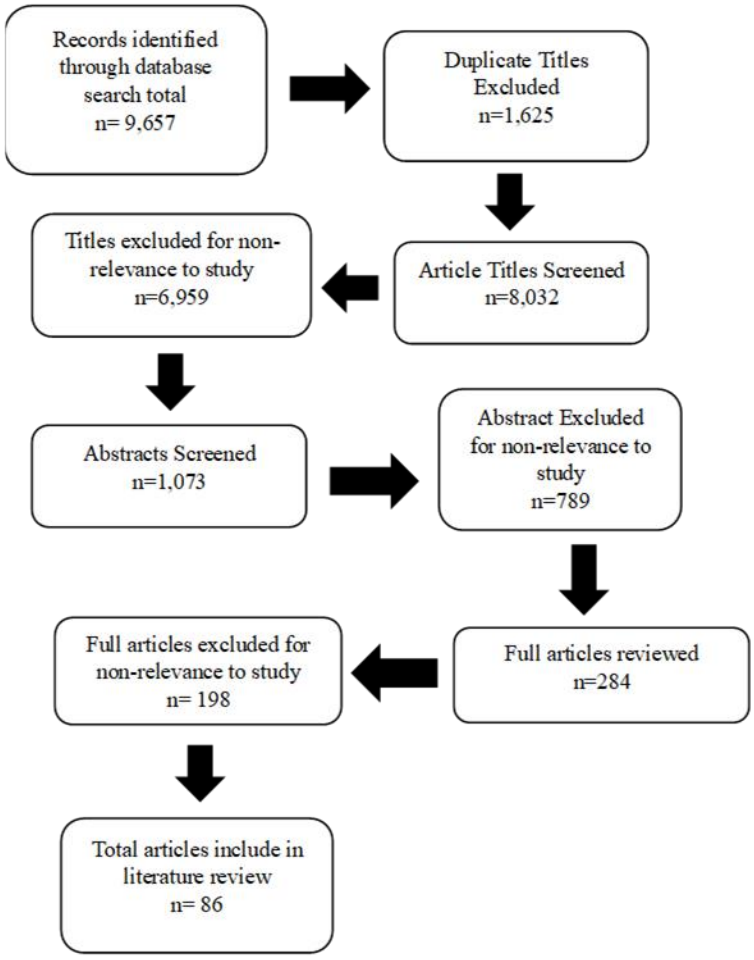
All sources were published in peer-reviewed journals or government reports, and all works were published or translated into English. Additionally, 75% of sources were published between 2018 and 2023. However, seminal sources were also included where appropriate.

Thousands of scholarly sources were found during the first search. I first removed duplications. Then, after reviewing titles and abstracts, more sources not related to this study were removed. Using inclusion criteria, I was able to narrow search parameters

further. In addition, seminal sources were used primarily during a historical and global review of existing literature and the conceptual framework (see Figure 1).

Figure 1

Flow Chart of Literature Review Selection



Conceptual Framework

Bronfenbrenner established the (SEM, which was the conceptual framework. I examined how race moderated the predictive power of other demographics and socioeconomic factors on infant mortality in the United States.

In this section, I explain the SEM's origins, including its foundation within the ecological systems theory. Then, information is provided regarding how the ecological systems theory developed into the SEM. Finally, I address the SEM in public health research and its applicability to this current study.

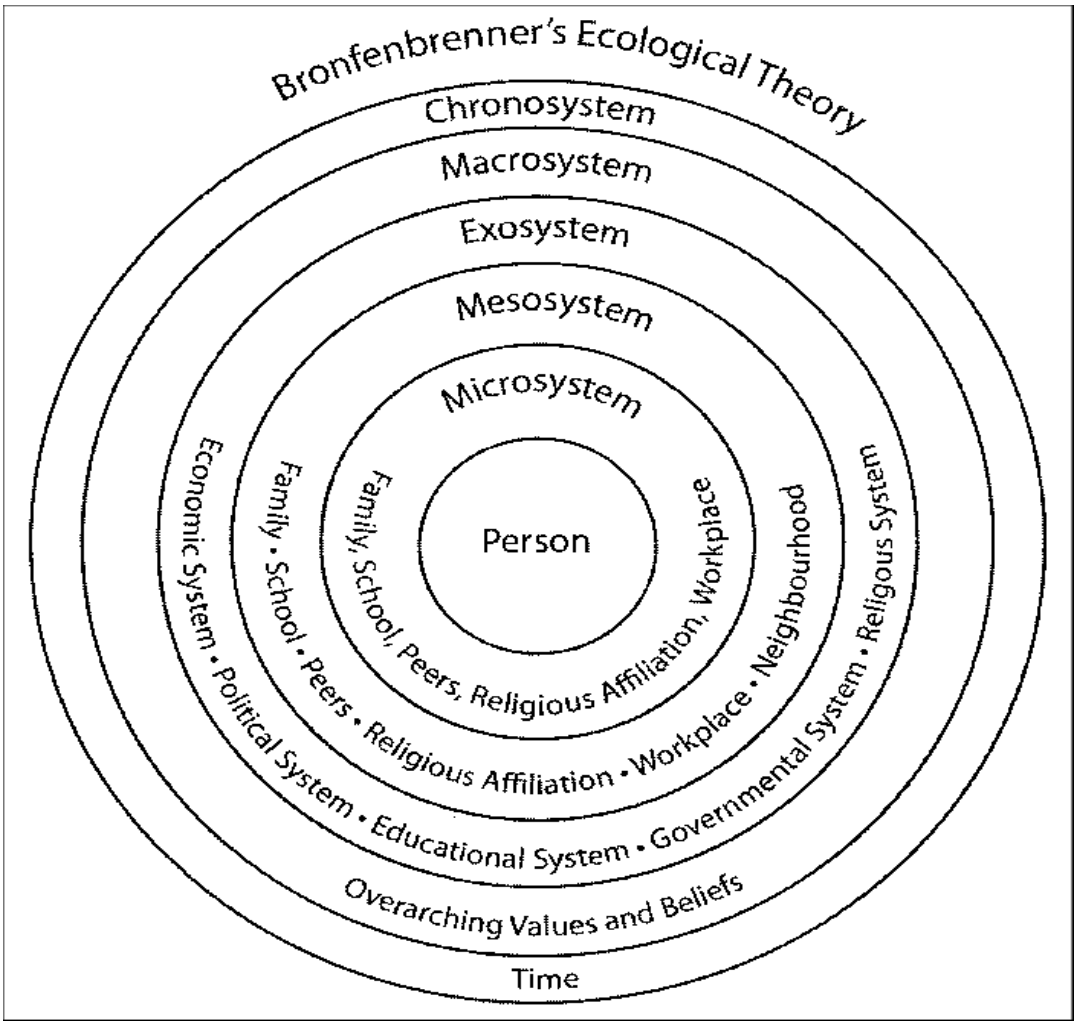
Ecological Systems Theory

The ecological systems theory is a framework by which individual relationships can be examined within different environments. Such environments comprise determinants that impact development, behavior, and psychological functions (Crawford, 2020). Individuals interact within environments, and based on environmental parameters, they are influenced by interactions within social environments (Crawford, 2020).

According to Bronfenbrenner (1979), the five systems of the SEM are the individual or center, microsystem, mesosystem, exosystem, and macrosystem. Eriksson et al. (2018) noted the addition of the chronosystem, which consists of changes within individual environments as they age and impact development. Added social structures illustrate major life transitions, such as leaving home and attending college, getting married, and facing death (Eriksson et al., 2018). These changes occur over the life course and impact adult development just as the microsystem, mesosystem, exosystem, and macrosystem impact childhood development. However, I did not address the chronosystem since the course of life is short with victims of infant mortality (see Figure 2).

Figure 2

Bronfenbrenner's Ecological Systems Theory



Note. From Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design.* Harvard University Press.

Each system has environmental factors that impact an individual's development and behavior. Within the ecological systems theory, the innermost circle consists of the individual whose main influences are subject to gender, age, and socioeconomic status within their immediate environment (Kilanowski, 2017). The next ring just outside of the individual is the microsystem. The environment within the microsystem includes areas such as the family and their home, school, peers, church, extended family, and friends

(Kilanowski, 2017). Next, the mesosystem is outside the microsystem and comprises such environmental factors as parents and peers, impacted by interactions between the microsystem relationships (Kilanowski, 2017). The exosystem includes extended environmental factors, including neighbors, mass media, and social services, prompted by interactions between an individual's environment, which exerts influence on the individual. Following the exosystem is the macrosystem, which consists of larger cultural and social contexts such as personal values, culture, and social attitudes (Kilanowski, 2017).

SEM

Bronfenbrenner (1979) recognized that human development was shaped based on the interactions between an individual and their immediate environment. Establishing this idea through observing children proved sound, as Bronfenbrenner (1979) found that the influence of adults within a child's environment was pertinent to the child's developing abilities. As a child ages, the developmental patterns are impacted by the environment in which the child spends time. For example, Bronfenbrenner (1979) watched as a child's behavior changed from being obedient in their home setting to being unruly around peers in their school environment.

According to Bronfenbrenner (1979), a child's behavior is due to the desire to fit in with their environment. Thus, a child around their parents may be well-behaved, yet the same child may behave poorly around disruptive friends. Using the prefix bio- justifies the importance of human development's biological processes in the social structure within different societies and environments. Even so, Bronfenbrenner (1994)

later suggested that the biological aspect of this model was based on producing an individual's potential for development and behavior based on environmental and social factors. However, later research suggested that this model is distinctive to each individual and not applicable to a generalization for child development (Giordano et al., 2020).

Adaptation of the Ecological Systems Theory to the SEM

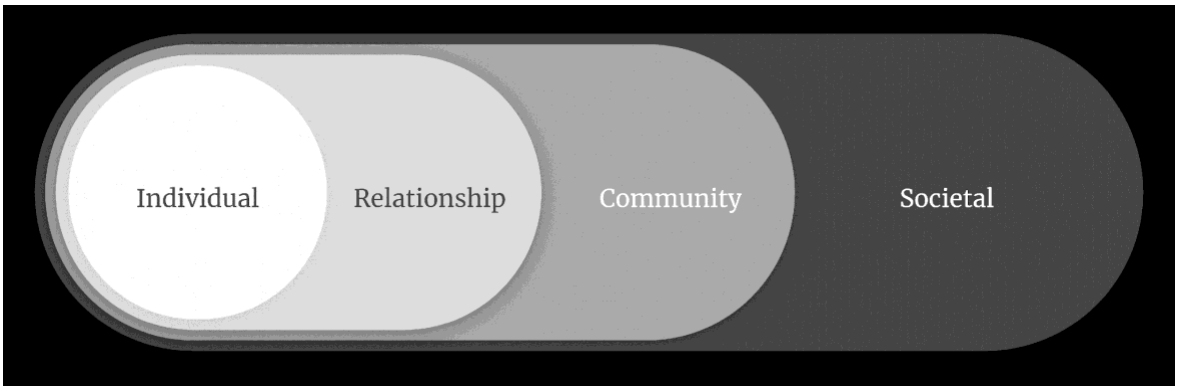
The adaptation of the SEM based on Bronfenbrenner's ecological systems theory was developed by bridging the gaps between human behavior and human development (Bukatko & Daehler, 1998). Fundamentally, Bronfenbrenner (1979) recognized that environmental factors must be recognized to understand the facets of continual human development. With this recognition, the entire ecological system must incorporate biological and social factors and environmental aspects. Therefore, the development of the SEM conceptual model was established to understand human development beyond the systems theory by using systems thinking, which emphasizes how events within the environment impact each element of an individual's growth and the social and developmental factors of an individual. Generally, a system is a community situated within an environment. Examples of these systems are health systems, education systems, food systems, and economic systems (Centers for Disease Control and Prevention, 2022). The impacts of such systems upon an individual are found in how things influence one another within a whole and are central to ecological models (Centers for Disease Control and Prevention, 2022).

The SEM conceptualizes how four specific factors are interconnected. This model was built from the ecological systems theory to establish how each element of an

individual's life impacts the next element. The four levels, individual, relationship, community, and societal, all interconnect with the systems established in Bronfenbrenner's (1979) theory; however, the SEM contemplates how the intricate interaction between individual, relationship, community, and societal factors impacts human development and human behavior (Stokols, 1996). Using the SEM establishes an understanding of how the broad range of factors interact, are interrelated, and are found interdependent as elements central to an individual (Stokols, 1996). The overlapping rings in Figure 3 illustrate how factors at one level influence factors at another level.

Figure 3

SEM



Note. From the Centers for Disease Control and Prevention. (2022). The social-ecological model. Author. https://www.cdc.gov/violenceprevention/about/social-ecologicalmodel.

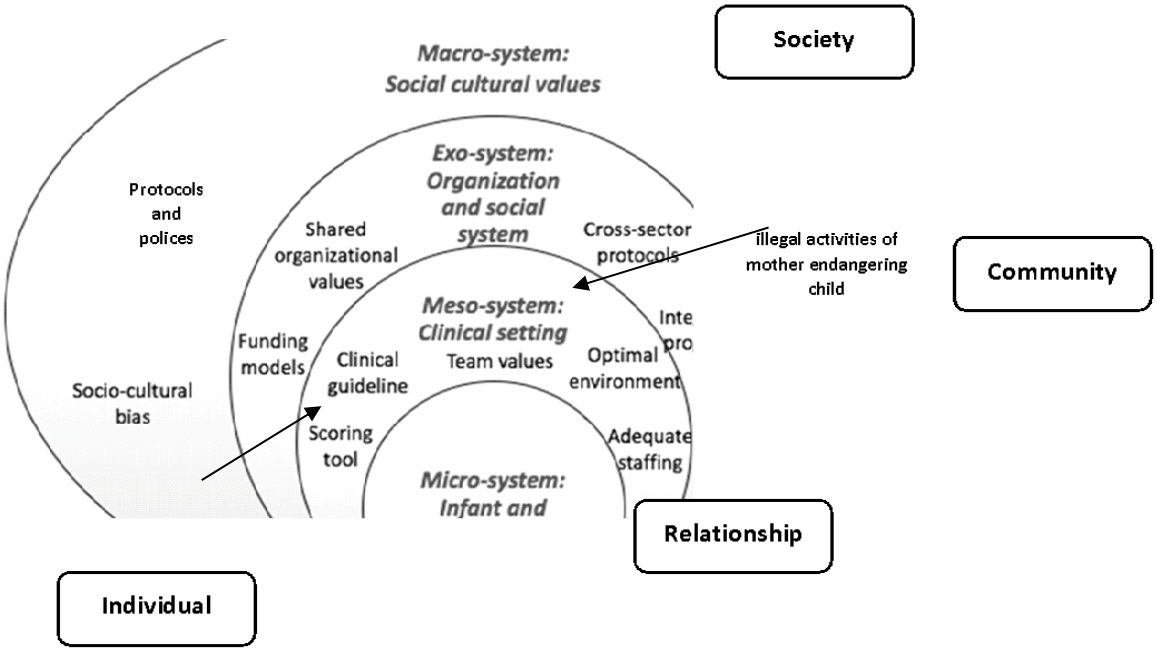
IMRs

To connect Bronfenbrenner's (1979, 2005) model to the current study's phenomenon of how race moderate demographics, socioeconomic factors, and geographic factors on IMR in the U.S., an adaptation to the model can be used (see Figure 4). Figure 4 below combines the ecological systems theory and the SEM within

the context of various maternal and societal variables. Therefore, Figure 4 below was used to illustrate the SEM concerning neonatal health and well-being.

Figure 4

Infant Wellbeing Within the SEM



Note. Adapted and developed for this study from Marcellus, L. (2018). Social-ecological examination of factors that influence the treatment of newborns with neonatal abstinence syndrome. *Journal of Obstetric, Gynecologic, & Neonatal Nursing, 47*(4), 509-519. https://doi.org/10.1016/j.jogn.2018.04.135

Figure 4 illustrates how each system, with its environmental factors, impacts IMR based on functions used at birth, the predictive values of medical staff and guidelines, organizational values, cultural norms, and policies that may affect the life or death of an infant. The innermost circle of the microsystem with the infant and their family consists of an environment in which findings suggest that the external factors associated with the

mother's prenatal care impact the infant's health (Appiah et al., 2021). This is the system in which the individual is involved, whereby the mother's self-care while pregnant impacts the infant and the propensity for its mortality.

The mesosystem's environmental factors that are significant in predictive behaviors of the child and the child's health include the healthcare setting in which the child is born, which can include knowledgeable and skilled staff caring for the newborn, the values pertinent to the care team, and what scoring tools the team utilizes with the newborn (Appiah et al., 2021). This is where the relationship is involved as the mother's behaviors interact with the healthcare environment for such help as antenatal education and care while the mother is pregnant.

The exosystem functions within an organizational and social system and includes factors such as access to mass media, place of delivery, and ANC visits (Appiah et al., 2021; Bronfenbrenner, 1977). These factors can impact the infant's life within the hospital setting, where hospital funding may be an issue. Some hospitals, particularly in underdeveloped countries, have limited funds, which could impact both the mother's and child's health and well-being (Dahab & Sakellariou, 2020). It is within the exosystem that the community impacts the mother and the mother's decisions regarding getting such assistance that will help with delivering a healthy infant.

The exosystem consists of the connecting facets between those social settings that do not specifically involve the individual. The elements within the exosystem, such as mass media or local politics, are not directly involved in the individual but have an impact on the individual nonetheless (Crawford, 2020). For example, a pregnant woman

may read the information on birthing classes on a social media site, influencing her decision to participate in such a class. In addition, the exosystem can include an individual's extended family, neighbors, school officials, or government agencies, each offering influential ideas that may impact an individual's choices and behaviors. A primary example of the exosystem's impact on an individual's development would be a parent's specific negative incidents occurring at work and causing the parent to be in a bad mood (Crawford, 2020). The parent projects the anger from the incident on the child, and the child is impacted by this negative effect.

The microsystem encompasses the socio-cultural values of the infant's family. The macrosystem's components can include beliefs and perceptions formed based on an individual's current environment. The macrosystem links the context of the facets impacting an individual's life. The items influential within a macrosystem might include the individual's socioeconomic status, geographic location, ethnicity, and ideologies of a culture. It can include a sociocultural bias on healthcare services, stigmas, and judgments from the mother's immediate community because she gave birth to a less-than-healthy infant (Crawford, 2020). Within the macrosystem, a mother finds societal assistance from public health education facilities providing antenatal information to assist with healthcare needs while pregnant and infant health care after birth.

Connection to Study

The use of the adapted SEM to explore IMR in the existing literature provides the necessary foundation to determine at what point race moderates the relationships between demographics, socioeconomic factors, and geographic factors related to IMR in the U.S.

Infant mortality can be related to certain facets applicable to social determinants. For example, the social determinants correlated to infant mortality include race, perceptions of prenatal care, and social acceptance of individual behaviors. This conceptual framework underpins this current study, which examined the impact of each environmental factor on IMR, such as the mother's prenatal care, the healthcare system's assistance in birthing, geographical location (e.g., urban versus rural), and environmental quality.

The application of SEM to IMR in the existing literature is limited. Dagher and Linares (2022) noted that socioeconomic factors, environmental factors, maternal factors, health service factors, and child factors implied by the SEM model impact infant mortality. In addition, Dagher and Linares (2022) suggested that the complex interplay between social determinants of health (SDoH) and IMR was impacted by social issues more than by social factors (e.g., race, SES). The researchers further noted that reviewing and addressing the research gaps among individual, interpersonal, community, and societal factors was necessary, as their impact on IMR consists of numerous interrelated disparities. These disparities found through SEM and associated with SDoH at multiple levels impact infant health, perpetuating disparities within an individual's lifespan and consequently influencing infant mortality disparities (Dagher & Linares, 2022; Singh, 2021).

Understanding that this SEM has been used extensively to conceptualize demographic, SES, and geographical factors of other variables (Bronfenbrenner, 1979; Kilanowski, 2017), the use of an adapted model allowed for the measurement and

correlations between race and demographic, socioeconomic, or geographic predictive factors, and impacts regarding infant mortality. An examination of these predictors combined based on Bronfenbrenner's (1975) SEM model showed the meaningful interaction of these factors as increasing the propensity for IMR.

Literature Review Related to Key Concepts

The literature concerned with IMR includes such contextual information as the global rates of IMR, how such rates are a public health concern, and how there has been a significant decrease in IMR within the U.S. over the past 50 years. However, much of the current research focuses on topics associated with IMR as maternal contributors to IMR, such as lifestyle, education, health behaviors, demographics, mental health, and attitudes toward antenatal care. In addition, as the proposed study examined how race moderates the predictive power of other demographics, socioeconomic factors, and geographic factors on infant mortality, the literature shows a gap in studies related to this topic directly but offers discussions on those closely associated subjects.

Global IMR as a Public Health Concern

The WHO (2023a) reported a global IMR of 26.052 deaths per 1000 live births. Africa has the highest rate of IMR, with Nigeria and the Central African Republic having over 70 infant deaths per 1,000 live births (United Nations, 2022). Conversely, Estonia, San Marino, and Iceland have the lowest IMR at less than 1.7 infant deaths per 1,000 live births (United Nations, 2022). In 1990, infant deaths were listed as more than 8 million worldwide, and in 2018, they were measured as less than 4 million (World Health

Organization, 2023b). While this number has decreased over the past five decades, infant death risk remains a significant concern for many countries.

The World Health Organization (2023a) and the Organization for Economic Co-operation and Development (2023) define infant mortality as the death of a child before they meet their first birthday. A rate measures infant mortality compared to 1,000 live births (World Health Organization, 2023a). Studies show that many of these high death rates are found within populations where families live in poverty, have little to no healthcare services, and are not educated on antenatal care (Ekholuenetale et al., 2020; Simmons et al., 2021; Thomas, 2020).

Globally, factors associated with these high IMRs within Africa and Asia included socioeconomic factors of maternal and paternal education, place of residence, maternal literacy, household wealth index, and maternal working status (Bilal et al., 2021; Kim & Saada, 2013). The socioeconomic factors of high IMRs were further broken down into environmental, maternal health services, and child factors. When measured in terms of availability for access and education, and when public health departments were more apt to provide awareness and education, these factors showed a decrease in the number of infant deaths (Esmaeilzadeh et al., 2021; Hug et al., 2019). Experts and public health agencies worldwide agree that the causation of high IMRs should be addressed with funding of healthcare services for greater accessibility and provisions of education on maternal care during pregnancy made available (Akinlo & Sulola, 2019; Doucouliagos et al., 2021; Hug et al., 2019).

Africa, particularly the Sub-Saharan and southern Asian countries, found birth asphyxia, infections, and preterm birth as reasons for over 85% of all infant deaths (Tesema et al., 2020). Rahman et al. (2022), Hill et al. (2022), and Simmons et al. (2021) further offered reasons for high IMRs in Africa based on such factors as little to no access to healthcare services or maternal education, the high cost of such care, racial disparities and inequities within the accessibility to quality care for antenatal care, and not enough attention being paid to the necessary health care of pregnant women and their unborn babies. Also, researchers found that poor nursing competencies impact IMR (Ike & Oluwatosin, 2022; Maree et al., 2020). Additionally, Africans often have limited access to prenatal care, with over 25% of women laboring and delivering their children at home in unsanitary conditions (Doctor et al., 2018).

IMRs in the United States

In the U.S., IMR trends have been recorded since the early 20th century, with researchers using markers such as infant death as a reportable indicator of the health and well-being of the country (Singh & Yu, 2019). While used as a social progress and human development marker, experts compare decade-gathered data on IMRs based on advancing healthcare, education, and technology (Islam et al., 2020; Khelfaoui et al., 2022). Much of the existing literature compares the U.S. IMRs to those of other countries. The attention to infant death is typically focused on Africa, which has the highest rate globally for IMRs (World Health Organization, 2023c). However, comparatively, the rates for IMR in the U.S. differ between biological differences in women's ages, geographic regions, race, and socioeconomic status.

Since 2017, historical research on IMR has shown a slow decline in the death rate of infants in the U.S. (Ely & Driscoll, 2019). Additionally, in 2019, the March of Dimes (2020) reported an IMR of 5.6% per 1,000 live births, inclusive of over 20,000 deaths of babies occurring before their first birthday. Data show that between 2009 to 2019, IMR decreased with the overall infant mortality rate, dropping to 12%. The March of Dimes (2020) claimed that "neonatal mortality is typically associated with the events surrounding the prenatal period and the delivery, whereas post-neonatal deaths are more likely to be associated with conditions or events that arise after the delivery and may reflect environmental factors" (p. 1). However, experts suggest that one of the leading causes of IMR is premature birth and low birth weight, associated with the prenatal care a mother participates in (Brown et al., 2019; Ely & Driscoll, 2019).

Predominant factors examined in the existing research suggested that in the U.S., the IMR is caused by preterm birth, low birth weight, pregnancy complications, congenital disabilities, and injury [e.g., accidental suffocation] (Ely & Driscoll, 2019). In addition, experts explained that the incidence of low birth weight due to the age variable is consistent with biological, lifestyle, and sociocultural factors (Anil et al., 2020; Genowska et al., 2018). The Centers for Disease Control and Prevention (2023b) present similar statistics as the March of Dimes related to IMR and agree that preterm birth and birth weight are among the causes of IMR in the U.S. However, statistics in the U.S also show that low birth weight was due to maternal age, with teenage mothers and women over 40 years old having a higher percentage of infant deaths versus mothers between the ages of 20 to 39 years (DeMarco et al., 2021; Singh & Yu, 2019). Biologically, female

teenagers have not developed a fully mature reproductive system. This can create such poor developmental attributes as providing the proper blood flow to the placenta to feed the fetus (Thornburg et al., 2021).

Other biological factors associated with preterm birth and low birth weight have been examined for their impact on such IMR in the U.S. Maheshwari et al. (2022) examined determinants of IMR, such as premature birth and preterm premature rupture of the birth membrane or issues with the mother's health. Teen mothers are more likely to have health issues like poor nutrition, hypertension, anemia, and high risks of eclampsia, all of which can cause adverse outcomes such as infant death (Akter, 2019; Maheshwari et al., 2022). With adolescent pregnancy, Maheshwari et al. (2022) and Marvin-Dowle et al. (2018) noted that teenage mothers were susceptible to the increased risk of delivering preterm or low birth weight babies yet were less likely to receive antenatal education.

Within the boundaries of the U.S., there are differences in IMRs by state. For example, the southern states of Georgia, Alabama, Mississippi, Louisiana, and Arkansas have the highest percentages of infant deaths compared to other states (Centers for Disease Control and Prevention, 2023b). Further, according to the Centers for Disease Control and Prevention (2023b), Louisiana and Mississippi have the highest infant mortality rates in the U.S.

Mississippi has the highest percentage for IMR in the country, with 8.3 deaths per 1,000 births, and is first for having the highest number of births to unwed mothers 54.5%, preterm births 12.9%, low birth weight 10.9% and highest teen birth rate (2.57 per 1,000 in ages 15-19). Louisiana has the second-highest IMR, the second-highest

percentage of teen births at 27.9%, and the highest percentage for low birth weight at 11.8%. New Hampshire was noted as the healthiest state regarding IMR, with 3.4 deaths per 1,000 live births.

Demography and IMR in the United States

Mothers younger than 25 or over 40 years old have a higher propensity for impacting the mortality rate of infants (Centers for Disease Control and Prevention, 2023b). Living in high-poverty counties was also deemed influential with increased IMRs throughout the U.S. (Goodman et al., 2022; Mohamoud et al., 2021). Women who give birth in rural areas across the U.S. also affect the IMR over those who give birth in urban area hospitals.

Experts contend that Mississippi's high IMR occurs due to many factors that impact the population within the state (Murphy et al., 2021; Udine et al., 2021). For example, poor birth outcomes in Mississippi have been attributed to poor health status in mothers before pregnancy, high rates of early deliveries, increased use of tobacco during pregnancy, and poor antenatal care and education about such care (Udine et al., 2021). Murphy et al. (2021) investigated the reasons for IMR in the U.S. They found myriad medical reasons impacting IMRs, such as low birth weight, congenital malformations, unintentional injuries, sudden infant death syndrome, cord and placental complications, bacterial sepsis of newborn, maternal complications, neonatal hemorrhage, respiratory hemorrhage, respiratory sepsis distress of newborn, and diseases of the circulatory system. However, these studies failed to account for such factors as race, environment,

the lifestyle of the mother, or maternal contributing aspects associated with the impact on infant death.

Other studies showed reasons for high IMR in the southern states as political determinants of achieving health equity (Jones, 2019; Owens & Fett, 2019). Jones (2019) examined the context of public health and the political dynamics that were supposed to impact positive healthcare changes in public health. Understanding such political determinants as connecting political power, political participation, and increased access to health care was noted as necessary, with legislatures vested in making positive changes to help decrease IMR. The findings showed that more than political neglect caused higher IMRs, with Jones (2019) claiming systemic barriers to power that included structural racism as a causation for increased infant death. Policies to advance health equity were considered the solution to decreasing Mississippi's high IMR. However, findings further noted insufficient support from white residents within the state (Jones, 2019). A distinct gap exists when comparing the IMRs between the southern and other states. For example, states such as California, New York, and Nevada all show low mortality percentages with an average of 3.9 infant deaths per 1,000 live births (Centers for Disease Control and Prevention, 2023b).

There is a distinct difference in how maternal health is addressed. Singh and Yu (2019) and Hirai et al. (2015) found that when comparing the pre-term and low birthweight rates between northern and western states versus those of southern states such as Louisiana, Georgia, and Mississippi, the northern states had lower percentages for both. Past research showed that over 70% of the high southern state IMRs in 1980 were

due to more Black births within these states (Hirai et al., 2015). While this difference reflected a persistent racial disparity between southern states and other areas, also socioeconomic inequality, a greater percentage of rural births, a lower percentage of available education for antenatal care, and a higher percentage of teen births (Kamal et al., 2019; Singh & Yu, 2019).

Despite the various contributors of IMR in the U.S., progress with decreasing IMRs has occurred over the past five years with agencies such as the American Academy of Pediatrics (2023), the Centers for Disease Control and Prevention (2023b, 2023c), and Healthy People 2030 (2023) working on strategies to help reduce infant mortality. For example, Healthy People 2030 (2023) developed a plan to reduce infant mortality using related objectives that impacted preterm births through education on antenatal care with women. Such education included relating the need for women to have a healthy weight before pregnancy and receive constant antenatal care throughout their pregnancy. Other pre- and postnatal strategies found in existing research that have been implemented for reducing IMR included education on the reduction of poor lifestyle behaviors such as drinking alcohol and maternal smoking, improvements with access and availability to antenatal care for all women, and improving preconception health for all women (Bhatia et al., 2019; Centers for Disease Control and Prevention, 2023bc).

Ecological and Environmental Risk Factors

Possible sources of exposure to a toxic substance are considered based on the category in which the toxin is established. Exposure agents, including bacteria, mold, pollen, protozoa, and viruses, are found in many natural and artificial environments

(Maheshwari et al., 2022). From activated gases caused by carbon and charcoal filters to areas exposed to moisture, creating the perfect environment for the growth of dangerous bacteria, biological environments are virtually a known breeding ground for hazardous toxic substances. Other such sources are inclusive of hazardous air pollutants from chemical factors unnaturally introduced to the air quality, congeners of configurations that create a change in the atomic and chemical level of substances changing the molecular balance and making the substance dangerous for human inhalation, such as physical compounds such as light, noise, and asbestos, nuclear power loss from waste fuel rods, radon gas, and ionizing radiation from x-rays (World Health Organization, 2022).

Multiple researchers have examined environmental risk factors associated with IMR and noted that health is related to the eco-environment (Burris et al., 2019). The alteration of certain disease patterns based on exposure to dangerous environmental factors impacts the health, safety, and well-being of those populations living within a specific environment (Henson et al., 2020). Studies showed that the ecological determinants of health could include contaminated food, shared and communicable diseases, and toxins and contagions from manufactured products (Rojas-Rueda et al., 2021). These all have predictable effects on the mortality rates of populations and can be attributed to causation for some areas' high IMR.

Environmental factors combined with genetics also have enormous implications for a fetus's development. The environmental influences on prenatal development have positive and adverse effects as a fetus develops in utero (O'Sullivan & Monk, 2020). One

such genetic influence is known as a gene mutation. A gene mutation can contribute to several abnormalities, such as the inherited disorder of Phenylketonuria (PKU), which comes from the mutated PAH recessive gene carried in both the mother and father (Elhawary et al., 2022). Suppose a mother has this gene and combines an environmental influence, such as an unrestricted diet. In that case, the outcome can increase phenylalanine levels, becoming high enough to cross through the placenta and damage the baby, affecting overall normal growth and development in utero. This environmental influence of an unrestricted diet combined with the mother's recessive PAH gene can cause negative effects such as low birthweight or preterm labor and affect infant mortality (Elhawary et al., 2022; Klaassen et al., 2021).

A second genetic influence that, combined with an environmental influence, can cause negative effects on a fetus is elevated prenatal cortisol, which can cause several conditions of adversity from mother to child (Bush et al., 2018; Takegata et al., 2021). Conditions such as low birth weight, delayed growth and development, excessive fetal activity, and chronic childhood illness were noted as outcomes of this gene-environmental interaction. This condition, an environmental factor caused by undue stress in the mother, will increase cortisol levels and can cross over into the placenta (Takegata et al., 2021). Cortisol is highly affected by physical activity, certain foods, smoking, alcohol, caffeine, and especially stress (Jia et al., 2022). The environmental stressors that can increase a mother's cortisol levels will cross through the placenta and can be adversely attributed to genetic factors. Often measurements from the Brazelton Neonatal Behavior Assessment Scale are utilized, and the correlation between the

mother's high cortisol levels and such low measurements account for an infant's rise in cortisol levels, which exposure of such can cause poor fetal and organ development and growth and impact IMRs (Bush et al., 2018).

Within research, experts noted how toxic substances significantly impact human health with a wide range of harmful effects. Depending on the type of toxic substance, the human body may or may not be able to fight off such adverse effects. However, more often, such toxification within an environment was considered notably significant in infant death (Genowska et al., 2018; Sial et al., 2022). Genowska et al. (2018) examined how the health status of infants was prone to poor health outcomes when the mother lived and worked within such occupational environments, including industrial pollution. Observation included environmental pollutants, urbanization within the service sector, and industrial pollutants common within the society's overall environment, which accounted for over 75% of the exposure issues to infant illness and death (Genowska et al., 2018). The collective impact of the population attributes was first indicative of such factors as poor working environment and industrial pollution. These factors were then associated with the area's higher infant mortality. Finally, such increased deaths among infants were considered contributors by the researcher as reasons for observing geographical variation in mortality within a given environment.

Compared to Genowska et al. (2018), Sial et al. (2022) also found that pollutants within a local environment were prevalent factors associated with infant health issues and IMRs. The researchers noted that pollution issues concerning fossil fuel energy consumption were considered factors of deterioration within a population's living

standards. The observation of 15 Asian economies and the IMR of such areas showed that living standards were more likely to be impacted when fossil fuel consumption was prevalent in energy provisions (Sial et al., 2022). Sial et al. (2022) claimed that due to the over-consumption of fossil fuel energy, the living standards in many Asian areas were deteriorating, and the air quality levels were causing health issues for pregnant women and newborns.

Heft-Neal et al. (2018) claimed that poor air quality had been considered a valid mortality risk factor in infants and globally showed prevalence in the increased IMRs within third-world countries. However, studies following Heft-Neal et al.'s (2018) findings claimed that air quality is just as prevalent a factor in the U.S. (Colmer et al., 2020; DiCicca & Malak, 2020). Such research enumerates how particulate air pollution, according to government officials, has decreased over the past several decades. However, this data showed throughout the past 30 + years that the spatial distribution of particulate pollutants has not decreased but has spread into a larger area. This spread preemptively presents a decrease in the particulate content of the air quality, but, according to experts, has expanded the environmental area to include such pollution variants (Colmer et al., 2020; DiCicca & Malak, 2020).

Beyond air pollution, other harmful toxic substances and agents have also been examined for their impact on society and overtly on mortality rates. Four categories of harmful toxic substances and agents determined by experts to be classified are biological, chemical, physical, and radiological (Prüss-Üstün et al., 2011). The impact of exposure to each type of toxic substance varies based on its chemical structure and classification.

Certain substances are more harmful than others, yet specific impacts and effects are based on the particular toxic substance's chemical and biological compounds. Substances prone to be the most harmful may be those that exposure does not immediately create effects but make an appearance in later years. For example, health effects such as cancer may present themselves after years of first exposure, and this often can make determining the causation of the disease difficult (Hauptman & Woolf, 2017). Another issue with human exposure to toxic substances is the dosage or exposure time related to the health issue in humans. When a substance known to impact human health negatively is discovered, the amount of exposure (or exact dose) is often unknown, which may be difficult to determine. The toxicity of a substance is based on its potency and causation and includes its route of exposure, exposure medium, and length of exposure (Hauptman & Woolf, 2017).

The past twenty years have brought to the attention of environmentalists the need to recognize the potential dangers associated with physical environment toxins and hazards, particularly in creating preventative methods to mitigate death rates (Henson et al., 2020; Ortigoza Braverman et al., 2020). Such attention has incorporated necessary physical environment interventions to prevent high mortality rates (Henson et al., 2020; Ortigoza Braverman et al., 2020).In addition, the focus on maternal and infant mortality rates being impacted by environmental factors has prompted experts first to provide the necessary data proving such correlations exist and then offer improvement of living conditions such as service provisions, utilities, and public transportation impact IMR (Lee & Miller, 2018; Ortigoza Granados, et al., 2020; Shobande, 2020).

Studies on common causes of low birth weight presented such reasons as restriction of fetal growth from environmental choices the mother makes, fetal growth restriction from the mother's environmental choices, such as drinking alcohol or smoking tobacco (Ratnasiri et al., 2020; Rice et al., 2017). Further, notable data present the basis of environmental health issues within rural versus urban areas, which are part of the environmental issues but are more commonly associated with funding and economic status issues. As previously discussed, several southern states showed higher IMRs than northern states, with Mississippi and Georgia taking first and second place for the highest death rates. However, the United States Census Bureau (2023) reported that from 2020 to 2021, infant deaths were double the number of births. While some experts consider the onset of COVID-19 and the subsequent vaccinations that followed were the culprit of poor fertility rates, thus causing a lack of pregnancy during this period, patterns at the state level masked trends in lower levels of socioeconomic factors rather than those of health risks (Shapira et al., 2021; Xavier et al., 2022). Lower socioeconomic factors were suggested as reasons for a change in pregnancy decreases and infant deaths due to COVID-19 (Shapira et al., 2021).

Maternal Contributors to IMR

The factors associated with IMR have been examined based on the maternal contributors to determine what and how these factors affect infant mortality rates. Such factors have included the inability to afford or access healthcare services, women's physical demographics, and their health behaviors, including their lifestyle choices. Additionally, a pregnant woman’s willingness to be provided with antenatal education,

along with their subsequent attitude towards antenatal care, was seen to factor into the IMR. A final topic examined by experts regarding how factors impact IMR included a pregnant woman's mental health.

Healthcare Funding

While a large percentage of underdeveloped countries have higher IMRs due to many mothers being unable to afford and lacking access to healthcare and prenatal care (Kiross et al., 2019; Masaba & Mmusi-Phetoe, 2020), this element is prevalent in some areas within the U.S. as well. Significant disparities are found between pregnant women living in rural areas versus those living in urban areas, as previously discussed. However, the primary and most recognized reason for higher IMRs for those living in rural areas was consistent with a lack of healthcare that may have included maternal physical and mental health history, geographic and environmental factors, and antenatal services (Ehrenthal et al., 2020; Mohamoud et al., 2021). While multiple federally and state-funded government programs assist in expanding healthcare availability in rural areas, specialty areas such as antenatal care are often ignored or considered irrelevant, as most healthcare providers have some form of antenatal care training (Goodman et al., 2022).

Funding for antenatal care significantly impacts IMR, which is affected by an area's economically sustainable and valued wealth. The funds provided by government agencies related to healthcare services are consistent with an area's healthcare needs which can include such aspects of healthcare as antenatal education and maternal care, vaccination coverage for newborns, and education on community health resources, all of which help to improve IMRs (Arunda et al., 2017; Guerra et al., 2019; Parihar, 2021).

While antenatal care is incorporated in this funding, it is not necessary. Therefore, there is separate funding due to the cost of providing antenatal, labor, and delivery services. However, reimbursement is often slow and problematic for rural hospitals, as most patients receive healthcare insurance support through Medicaid (Bhatt & Beck-Sagué, 2018; Cross-Barnet et al., 2022). Consequently, many rural hospitals cannot survive while waiting on the slow reimbursement process and often will cut their obstetrics healthcare services altogether, electing to send pregnant patients to larger hospitals farther away.

Studies showed solutions that could assist in providing a means to negate poor antenatal and birthing solutions, which impact high rates of IMR in rural areas, including policy changes that would assure financial viability for obstetric care in rural hospitals (Gamberini et al., 2022; Kozhimannil et al., 2022). Researchers noted that many rural hospital administrators consider obstetric care a specialty service and offer the means to cut costs by incorporating this care, including antenatal care, within a general practitioner's clinic (Kozhimannil et al., 2022). Kozhimannil et al. (2022), in a survey of US rural hospitals, noted that administrators concerned about financial viability recommended the need for at least 200 babies per year to avoid losing money. As most towns considered rural have populations with less than 2,500 people, and most counties hold a population of fewer than 20,000 people, the percentage of births tends to be lower than that in an urban area, creating justification for eliminating specialty care in obstetrics and gynecology (United States Department of Agriculture, 2021).

However, other experts disagree with these conclusions, claiming that rural areas, particularly in southern U.S. states, have a higher propensity for teen pregnancy (Bhatt & Beck-Sagué, 2018; Hirai et al., 2015). Further, these studies showed that women living in rural areas were comparatively more likely to experience two or more births than the one birth recorded for urban women (Bhatt & Beck-Sagué, 2018; Hirai et al., 2015). Consequently, these statistics illustrated that women in urban areas were more likely to have no births, or one birth compared to the two or more births commonly found in women in rural areas (Bhatia et al., 2019; Gamberini et al., 2022). Over the past ten years, trends in rural and urban populations have broadened notable differences in relative population size. Rural areas declined overall, while urban areas grew by nearly 10% (Hirai et al., 2015). The U.S. population grew at a slower pace during the 2020s compared with previous decades due in part to declining birth rates and decreased immigration into the U.S. According to the Centers for Disease Control and Prevention (2023a), population growth during 1990–2000 was over 13%, and during 2000–10, growth nearly 10% and from 2011-2020, growth was over 6%.

Maternal Health Behaviors and Lifestyle

A large amount of existing literature focuses on IMR and such maternal predictors as maternal age, marital status, unwanted pregnancy, and physical indicators of a mother’s unhealthy risk factors, such as obesity, increased potential for health conditions such as diabetes or hypertension (Ratnasiri et al., 2019, 2020). Researchers focusing on the mother’s maternal health risks and their impact on IMR suggested several bio-demographic factors were important for infant death, including the mother's poor

education, poverty, sex of the child, mother's age, and location (Ratnasiri et al., 2019, 2021). Findings from research on bio-demographic, socioeconomic, environmental, and health-related determinants of IMR suggested that a mother's pre-pregnancy health showed indicators and predictors associated with a higher potential for infant mortality (Kim & Saada, 2013). The predictive factors of a mother's health behaviors have been examined, with experts finding that pregnant and birthing women dying more than doubled from 1987 to 2018 (Centers for Disease Control and Prevention, 2022).

Ratnasiri et al. (2019) examined the common predictors associated with IMR, such as perinatal smoking and obesity, pulling published data from the Birth Statistical Master Files of California from 2007 to 2016. This cohort included recorded infant deaths, which the researchers established categorically based on maternal health behaviors. The researcher's data suggested that maternal factors of pre-pregnancy obesity and smoking during pregnancy considerably impacted IMR. However, the predictors are not typically addressed by direct medical care. Infant factors with a significant effect on IMR were birthweight and gestational age, which were affected by maternal smoking and obesity (Ratnasiri et al., 2019).

Further, Ratnasiri et al. (2019) suggested that intrauterine growth was directly related to infant mortality, which was impacted by the crossing of carcinogens into the placenta found in cigarette smoke. Finally, the researchers claimed that based on maternal behavior patterns, including obesity and smoking, the method of infant delivery was impacted and was the cause for increased IMR. Reported data showed that IMRs were

higher in cesarean deliveries and cesarean deliveries with higher in women who were obese or who smoked during pregnancy (Ratnasiri et al., 2019).

Following the publication of their first study on infant mortality predictors from maternal health behaviors, Ratnasiri et al. (2020) reviewed the trends in maternal pre-pregnancy obesity in women and IMR outcomes. Reviewing data over ten years, the researchers explained that the prevalence of obesity in women before pregnancy with a recorded infant death was consistent. In addition, noted statistics supporting evidence that overweight or obese women had a higher potential for infant death showed that such adverse outcomes included low birth weight, preterm birth, small-for-gestational-age birth, large-for-gestational-age birth, and cesarean delivery. Obesity in women was thus considered a rising trend with increased incidences of adverse neonatal outcomes and IMRs (Ratnasiri et al., 2020).

The amount of research discussing alcohol use while pregnant is excessive. Researchers agree that abuse or overindulgence in alcohol during pregnancy leads to long-term harm to a fetus and contributes to issues after the infant is born (Jana et al., 2023; Jia et al., 2022; Vilanova et al., 2019). The expert opinions on drinking alcohol while pregnant consistently explain that alcohol passes from a mother's bloodstream through the placenta and into the fetus. A fetus has a limited ability to process alcohol and, as such, can cause multiple physical and mental issues after birth, including low birth weight, which increases the potential for infant mortality (Jana et al., 2023; Vilanova et al., 2019).

All contributing factors, such as substance use, obesity, smoking, and drinking alcohol during pregnancy, are considered lifestyle choices that have been clinically shown to impact infant birth adversely. Such factors are considered choices, and many healthcare and maternity advocates claim that these risk factors can be eliminated only through the education of families (Kino et al., 2018). Experts also claimed that the macro-level contexts in which education impacts health are integral to improving national health administration and policy (Kino et al., 2018; Raghupathi & Raghupathi, 2020).

Maternal Education

Another major factor researched on IMR was the lack of prenatal education for pregnant women. Studies showed that a lack of prenatal education negatively impacted the infant mortality rate (Andriano & Monden, 2019). Findings from Ratnasiri et al. (2019) suggested that prenatal care and support from health education programs may address maintaining appropriate pre-pregnancy weight to combat infant deaths arising from pre-pregnancy underweight, overweight, and obesity. Prenatal health education would provide the opportunity to address poor birth outcomes, including low birth weight and cesarean delivery, and poor health associated with obesity. In addition, diet, lifestyle, and weight have profound and enduring effects on the long-term health of the offspring and disease risk into adulthood (Ratnasiri et al., 2019). Therefore, health education for women before and during pregnancy, focused specifically on weight maintenance, could improve IMRs in the U.S.

A primary factor researched on IMR was the lack of prenatal education for pregnant women (Green & Hamilton, 2019; Maru et al., 2021). Green and Hamilton

(2019) examined the predictive factors associated with IMRs in the U.S., comparing foreign-born mothers to U.S.-born mothers' attitudes related to education and antenatal care. While several studies identify racial and ethnic variations in the education-to-health relation among U.S. and foreign-born women, Green and Hamilton (2019) found that foreign-born mothers were more likely to participate in public education on antenatal health. In addition, education is more strongly related to infant mortality among US-born mothers than foreign-born mothers because education is likely more closely connected to income. This connection may account for the ability to access resources and behaviors that directly and indirectly influence child health, such as smoking and drinking, for US-born mothers compared to foreign-born mothers (Green & Hamilton, 2019; Ratnasiri et al., 2020).

The overall levels of infant mortality were lower among foreign-born mothers, and the maternal education–infant mortality gradient is steeper among US-born mothers. The gradient within the latter group is steepest for US-born whites and flattest for blacks. Second, there is considerable variation in the maternal education–infant mortality gradient among foreign-born mothers (Andrasfay & Goldman, 2020; Vilda et al., 2021). While foreign-born white and Hispanic mothers have relatively steep gradients, the gradients for foreign-born Asian and black mothers are essentially flat. Third, the relationship between maternal education and infant mortality varies by the timing of infant death for some groups, particularly for US-born mothers (Green & Hamilton, 2019). Specifically, maternal education has a stronger association with post-neonatal mortality than neonatal mortality. Finally, for most racial groups, absolute differences in

infant mortality between US- and foreign-born mothers are most prominent at the lowest levels of education and tend to converge at the highest levels. The study results are consistent with the prior literature on nativity, education, and infant health (Green & Hamilton, 2019).

Researchers recognized that understanding the need for maternal educational attainment was distinctly associated with better infant health and less likely to impact IMRs (Kiross et al., 2019; Yu et al., 2019). However, there were considered factors that other experts that were opposite to Green and Hamilton's study, including an epidemiological paradox that countered how some foreign-born mothers were not adequately educated and often had not acclimated to the English language. As a result, these women usually lacked antenatal care and had adverse birth outcomes such as low birth weight and infant mortality (Mensch et al., 2019; Yu et al., 2019).

Other researchers suggested that the more educated a pregnant mother was, the more likely they would accept and understand the need for antenatal education and care (Maru et al., 2021; Mensch et al., 2019). Studies illustrated that women with education and understanding of antenatal care were less likely to have problems during their pregnancy and showed a lower impact on the IMRs than women who failed to understand the importance of antenatal education and care and who often had labor and delivery difficulties (Maru et al., 2021). Maru et al.'s (2021) research found that among the population of pregnant immigrant women in the U.S., less than 44% visited a healthcare provider before becoming pregnant, and less than 35% visited a provider after becoming pregnant up until their third trimester. While lack of insurance or funding to pay for

healthcare is cited as a primary reason for immigrant women not receiving the necessary antenatal care, other factors contribute to lower healthcare utilization and a higher propensity for infant mortality (Maru et al., 2021). Other factors, outside of financial ones, were noted as social and religious restrictions that impact healthcare beliefs, socioeconomic factors such as housing and food insecurity, demographic factors like being employed during pregnancy and not recognizing the right to time off, immigration status, assimilation issues, and understanding the need for antenatal care (Mensch et al., 2019).

Maternal Attitudes Towards Healthcare

The U.S. promotes antenatal care, yet studies still show that women and men do not recognize the need for this healthcare and healthcare education (Krishnaswami et al., 2019; Ratnasiri et al., 2020). Ratnasiri et al. (2020) explained that when identifying maternal attitudes toward their health issues (e.g., perinatal smoking, obesity, and prenatal education), many women ignore the lessons shared with them for a healthy delivery. Maternal attitudes toward healthcare, particularly antenatal education, have been challenging to determine. Many women claim the need for such education is obsolete since they have regular provider visits, and the providers supposedly offer the necessary information and education. However, researchers found that these women lacked knowledge and understanding of multiple risk factors associated with complicated labor and delivery and increased rates of infant mortality (Heaman et al., 2019; Peahl et al., 2020).

Studies further investigated how, even though Medicaid pays for more than half of the births in the U.S., the women receiving Medicaid have little understanding of the importance constituting the need for antenatal care (Cross-Barnet et al., 2022; Hill et al., 2019). Women in Hill et al.'s (2019) study examined women enrolled in a Strong Start state program. They questioned their ideas of needing maternity care, psychosocial risk factors, and comprehensive education, and positively responded to such increased offerings in maternity education. The participating women also noted that the education their Strong Start program provided included increased support on matters such as breastfeeding, community referrals, involving partners in infant care, and nutrition. Hill et al. (2019) suggested that with such programs providing education and maternity care approaches, women's risk factors were effectively addressed, and pregnant women would have overall positive care experiences. Cross-Barnet agreed with Hill et al. (2019), noting that Strong Start participants were found to have significantly lower rates of low-birth-weight infants, preterm birth, and cesarean section deliveries.

Maternal Mental Health

Pregnant women are often traumatized by constant emotional upheavals as hormones create new emotional instabilities. Depression and anxiety are common among pregnant women who find themselves in new and uncomfortable pregnancy-related situations (Dekel et al., 2019; Sawyer et al., 2019). Studies showed that common mental disorders such as depression and anxiety were more likely to occur during pregnancy.

Up to 15% of women who give birth suffer from a diagnosable mental health condition, with these conditions typically being depression or anxiety (Dekel et al.,

2019). Stability in mental health during pregnancy assists in alleviating many risk factors and can reduce stress, which may factor into health issues with an infant. Experts also shared data on the connection between maternal mental health disorders, stillbirth, and infant mortality (Adane et al., 2021; Van Niel et al., 2020). Adane et al. (2021) countered that over 60% of recent publications (2018-2020) considered stillbirth and neonatal or infant mortality associated with maternal depression and anxiety. Maternal mental health disorders were deemed related to increases in stillbirth and infant mortality.

Ethnicity and IMRs

In the U.S., African American infants are three times more likely to die at birth than White newborns (Greenwood et al., 2020). The racial disparity noted with IMRs was considered, as studies revealed how socioeconomic determinants were based on ethnicity, which drives poverty and education for women of specific ethnicity (Greenwood et al., 2020; Jang & Lee, 2022). Burris et al. (2019) noted that race is a social construct involving environmental exposures that differ by race due to ongoing residential, educational, and economic status, racial segregation, and discrimination. Characterizing and mitigating environmental factors contributing to differential preterm risk could identify at-risk women, prevent preterm births, and reduce perinatal health disparities.

Despite the overall decline in IMRs within the U.S., racial disparities in infant mortality have persisted. As these rates within the nation are 5.58 per 1000 live births, population masks significant disparities by race and ethnicity, which include the non-Hispanic Black population experiencing an IMR of 10.8, followed by people from Native Hawaiian or Other Pacific Islander populations at 9.4 and American Indians at 8.2. The

non-Hispanic White and Asian populations in the United States have the lowest IMR at 4.6 and 3.6, respectively, as of 2018 (Hill et al., 2022).

Other research found that Black, Hispanic, American Indian, and Alaska Native women have higher rates of pregnancy-related death compared to White women (Hill et al., 2022; Rice et al., 2017). Pregnancy-related mortality rates among Black, Hispanic, and American Indian and Alaska Native women are over three times higher than for White women, with such minorities having a higher incidence of preterm births, low birthweight births, or births for which they received late or no prenatal care when compared to White women. In addition, infants born to Black, American Indian, Alaska Native, and other minorities have markedly higher mortality rates than those born to White women (Hill et al., 2022). In contrast, the risk of infant mortality varies among Hispanic infants by race, with poorer outcomes experienced by Hispanic black infants (Rice et al., 2017).

Compared to non-Hispanic infants of the same race, Hispanic black infants experience a minor health disadvantage, and Hispanic white infants have better or similar infant health outcomes, which suggests implications of racial heterogeneity on infant health outcomes and provides insight into the role of race as a social construct (Rice et al., 2017). In addition, IMR declined in minority populations, yet the disparities in infant mortality have increased over the past 20 years (Rice et al., 2017; Singh & Yu, 2019).

Many elements characterize minority populations, including poor residential environments, experiences of racial discrimination, lack of medical insurance, treatment at low-quality hospitals, and low income and education levels, all demonstrating strong

correlations with high infant mortality rates (Tagoe et al., 2020). Identifying, acknowledging, and addressing these disparities must be performed before engaging in strategies to mitigate them. Social determinants of health play a significant role in health disparities, including infant mortality. Even with the positive decreases in IMR throughout the U.S., other researchers found an increase in the black-and-white disparities associated with these deaths (Connor et al., 2019; Smith et al., 2018). Studies showed that from 1986 through 2016, Black infants were nearly 3% more likely to be at risk for mortality from sudden death syndrome, lack of antenatal care and education, and premature birth or low birth weight.

Further, Black and Hispanic rates of IMR were found due to a larger population of teen pregnancies than White IMR rates. Health inequities continue to be a product of structural racism, with such inequity for IMR being considered a disparate impact of social and structural racism (Vilda et al., 2021). However, researchers must continue expanding the literature on IMR to help mitigate such issues as health, social, and racial disparities.

Conclusion

In the U.S., the IMRs persist, with considerable research noting various reasons for such increased rates. The current study examined potential reasons for IMR and the impact of related factors such as women's demographics, environmental risk factors, and geographic locale. In addition, experts noted a primary source of information as maternal contributors to IMR, including healthcare and funding issues, maternal health behaviors and lifestyle, maternal education, maternal attitudes toward healthcare, and maternal

mental health. All of these factors were examined and considered factors that were suggested impacting IMRs.

Additionally, data from existing research suggested that such considerations, including maternal physical and mental health history and geographic and environmental factors, impact IMRs (Ehrenthal et al., 2020; Mohamoud et al., 2021). Further, the factors associated with impacting IMR based on healthcare funding linked to rural populations and environments also included the type of household, safety risks in the home, and dangers or hazards within the environment inclusive to poor life choices such as drinking alcohol or smoking while pregnant (Ratnasiri et al., 2020; Rice et al., 2017). The existing research listed a predominant determinant of IMR based on socioeconomic factors. Still, it was limited to maternal incidentals and risk factors, and much of the researcher's findings show a significance in predictors of poverty in underdeveloped countries, as the socioeconomic determinants show high poverty levels within the populations (Goodman et al., 2022; Mohamoud et al., 2021). Limited resources were found regarding IMRs and the correlations of demographics and socioeconomic factors in the United States. Overall, the findings within the existing literature suggested that the predictors and characteristics associated with IMR need to be further examined regarding these associative considerations since there is a lack of literature discussing the combined impacts of demographic, socioeconomic, and geographic factors on IMR, particularly within the U.S.A (Crawford, 2020; Dagher & Linares, 2022).

Definitions

Age: Age is a demographic variable used in RQ1 and was retrieved directly from the dataset (Coley & Nichols, 2016).

Body Mass Index (BMI): BMI is a demographic variable used in RQ1 and was retrieved directly from the dataset (Zhao et al., 2018).

County Poverty Level: The county-level poverty status will be calculated by cross-referencing the county where the birth occurred with county-level median income data (Mohamoud et al., 2021).

Education: The highest educational program completed by the mother was retrieved directly from the dataset (Assari & Bazargan, 2019).

Infant Mortality: The Centers for Disease Control and Prevention (2019b) defines infant mortality as the death of an infant before their first birthday.

Race/Ethnicity: Race or ethnicity is the key moderating variable in all research questions and was created as a categorical variable using combinations of race and ethnicity information (McKane et al., 2018).

Urban/Rural: The urban or rural status was calculated by cross-referencing the county where the birth occurred with county-level population density (Mohamoud et al., 2021).

Assumptions

Assumptions are the objective items observed that a researcher must identify that they might take for granted (Wolgemuth et al., 2017). Directly noting such assumptions regarding the instrument, the methods, the analysis, and the participants provides

supporting evidence associated with the formed hypotheses. The research of the current study has identified three assumptions:

I assumed the CDC-NVSS provided enough information for analysis regarding hypotheses.

I assumed the instrument was valid and reliable.

I assumed the amount of data was sufficient to generalize to the population within the dataset.

Scope and Delimitations

Merriam and Tisdell (2015) defined the scope and delimitations of research as those boundaries placed upon a given study. The researcher delimits these boundaries and sets the scope of the study based on facets solely associated with the purpose, problem, and research questions. For example, the current study is delimited to using archived data regarding IMR based on CDC-NVSS reported data. Another delimitation is the objective of the research, set by the researcher to determine the extent to which race moderates the predictive power of other demographics, socioeconomic factors, and geographic factors on infant mortality in the United States. Other delimitations include the research variables, the targeted population, and the statistical analysis method. All are selected by the researcher based on the researcher's preference and desire.

Limitations

Limitations are defined as flaws or shortcomings that potentially impact data analysis findings (Almeida et al., 2017). These can result from having a small sample size, a flawed methodology, or the unavailability of resources (Theofanidis & Fountouki,

2018). Overall, minimal ethical and practical limitations are anticipated. The study relies primarily on publicly available data, and the variables have been chosen in careful alignment with the available data (Almeida et al., 2017). One limitation is that the dataset does not include a better proxy for income than the use or nonuse of food stamps during pregnancy. One way of helping to alleviate this limitation was to include county-level data on poverty. However, it required locating accurate county-level median income data for the same period as the dataset and cross-referencing the two. Otherwise, the study should be feasible and practical, with little concern for bias, because of the results of the quantitative analyses.

Significance

The potential contributions of the current study that will advance the knowledge in women's and infant healthcare are relevant to the study's significance. This significance, which is an explanation of why the research on this topic is necessary, will justify the importance of awareness with such factors as race moderating the predictive power of other demographics, socioeconomic factors, and geographic factors on infant mortality (Kiross et al., 2019; Pabayo et al., 2019). It is significant to understand these factors that impact infant mortality so that prevention plans can be set in place by healthcare providers, public health professionals, and others who work with those populations in which demographics, socioeconomic factors, and geographic factors highly influence infant mortality. As the interaction between race and demographic, socioeconomic, and geographic factors are potential key predictors of infant mortality, the contributions of this study will be expressly applicable in both research and practice.

The current study's results can also potentially contribute to advancements in practice and policy; whereby socioeconomic and geographic location policies can be changed. For example, policies implemented to assist those women who identify with lower SES populations and live in rural areas that lack the necessary education and access to prenatal care may significantly change the infant mortality rate of this specific population. Such potential implications for positive social change will be bounded by the scope of the current study and possibly will create positive influences to assist with modifications to decrease infant mortality rate. By studying race as a moderator of critical demographic, seriocomic, and geographic predictors of infant mortality, the present study addresses all three calls for research. Moreover, it may offer insight into why such significant disparities in infant mortality exist across racial lines.

Summary and Conclusions

Section 1 included information about the foundations of the current study to determine if race and ethnicity moderated the effects of demographic, socioeconomic, and geographic factors on IMRs. Data were collected and analyzed using the Baron and Kenny moderation approach and hierarchical multiple linear regression analyses. In Section 2, I discuss the methodology, research design, and data collection process.

Section 2: Research Design and Data Collection

The purpose of this quantitative study was to examine the extent to which race moderated the predictive power of other demographics, socioeconomic, and geographic factors on IMRs in the United States. This research was addressed through three research questions:

RQ1: To what extent, if any, does race/ethnicity moderate the effect of demographic factors (age, father's race, BMI, residency) on IMRs?

$H_0$1: Race/ethnicity does not significantly moderate the effect of any demographic factors (age, father's race, BMI, residency) on IMRs.

H_a1: Race/ethnicity significantly moderates the effect of one or more demographic factors (age, father's race, BMI, residency) on the infant mortality rate.

RQ2: To what extent, if any, does race/ethnicity moderate the effect of socioeconomic factors (education, WIC food status) on IMRs?

$H_0$2: Race/ethnicity does not significantly moderate the effect of any socioeconomic factors (education, WIC food status) on IMRs.

H_a2: Race/ethnicity significantly moderates the effect of one or more socioeconomic factors (education, WIC food status) on IMRs.

RQ3: To what extent, if any, does race/ethnicity moderate the effect of geographic factors (state, urban/rural, county poverty level) on IMRs?

$H_0$3: Race/ethnicity does not significantly moderate the effect of any geographic factors (state, urban/rural, county poverty level) on IMRs.

H_a3: Race/ethnicity significantly moderates the effect of one or more geographic factors (state, urban/rural, county poverty level) on infant mortality rate.

Section 2 includes information about the research methodology. First, the research methodology and design choice are addressed in greater detail. Second, the population of interest is addressed, along with how that population was sampled in the secondary dataset. Next, instrumentation along with how key variables were operationalized was addressed. The data analysis process was discussed. The section concludes with a discussion of threats to validity, research ethics, and summary of key points.

Research Design and Rationale

The key variables for this study included independent variables, a dependent variable, and a moderator. Independent variables were factors that were linked to maternal mortality in literature, including age, fathers' race, BMI, residency, education, WIC food status, state, urban/rural status, and county poverty level. The dependent variable was IMRs at the county level. The moderator variable was mothers' race and ethnicity.

The methodology for the study is quantitative. Quantitative research is empirical and relational (Apuke, 2017). Quantitative researchers focus on understanding key relationships between specific and narrowly defined variables which can be hypothesized based on existing theories (Bacon-Shone, 2013). Quantitative research involves drawing conclusions and achieving results that are empirically supported by statistical power (Apuke, 2017). To enable such empirical support, quantitative research involves using close-ended and short-form data from large sample sizes (Bacon-Shone, 2013).

A quantitative methodology was appropriate for this study. My purpose was to examine the extent to which race moderated the predictive power of other demographics, socioeconomic, and geographic factors on infant mortality in the United States, which was an inherently relational purpose. In addition, I was focused on specific and narrowly defined variables, all of which can be reliably quantified without reliance on complex scales and instrumentation. The quantitative methodology was also suitable due to large volumes of secondary data. Hence, this methodology is ideal.

Quantitative research can be experimental or nonexperimental. Experiments can demonstrate causal links between variables (Baker, 2017). However, experimental research requires researchers to be able to feasibly and ethically manipulate key variables (Baker, 2017). In this study, this would be neither feasible nor ethical. Independent variables that would need to be manipulated were intrinsic factors beyond my control. Moreover, manipulating them when they affect infant mortality would be highly unethical. Hence, a nonexperimental design was adopted. Nonexperimental studies can still show meaningful relationships.

With the nonexperimental approach, there are three main designs. These designs are descriptive, correlational, and ex post facto (Johnson, 2001). For this study, a correlational design was used. Correlational research is used to examine the effects of key predictors on outcomes (Johnson, 2001). In this study, all relationships were predictive, which required a more in-depth analysis. Correlational research can be used to demonstrate the strength and nature of such relationships (Johnson, 2001). By contrast, descriptive research serves only to describe populations (Bacon-Shone, 2013). Such

research cannot answer inferential research questions such as those guiding this study and hence was not suitable. Finally, ex-post facto research involves examining differences between two or more divergent populations (Johnson, 2001). I addressed a continuous outcome, making this design inappropriate.

Methodology

The methodology for the study involved addressing the population, sampling, instrumentation, operationalization, and data analysis. Proposed research was conducted using the CDC-NVSS dataset.

Population

The population of interest for the proposed study were infants born in the United States at the county level. Within this broad population, the target population was infants who were born in the United States between 2018 and 2020. All participants were born between 2018 and 2020, recorded by the CDC-NVSS, from the United States, and from a state for which data reporting was deemed reliable per the CDC. This was necessary for a wide range of recent data, while also not including COVID-19.

Sampling Procedures

The dataset used for the study was from the Centers for Disease Control and Prevention's National Vital Statistics System (CDC-NVSS). The CDC-NVSS is a national-level database of vital statistics in the US, tracking factors such as births, deaths, divorces, etc., across the country. Per the CDC website, "These data are provided through contracts between [National Center for Health Statistics] and vital registration systems operated in the various jurisdictions legally responsible for the registration of vital events

– births, deaths, marriages, divorces, and fetal deaths" (CDC, 2023, n.p). Therefore, rather than sampling a subset of the larger population, the CDC-NVSS collects data regarding all relevant instances of the events it intended to keep track of. The complete nature of the NVSS's data collection makes the resulting set of data the most complete possible regarding key vital factors. This completeness makes the CDC-NVSS the ideal set of data for the proposed study.

Instrumentation

The CDC-NVSS's data represents the sole instrument for the proposed study. The NVSS tracks all instances of births, deaths, marriages, divorces, and fetal deaths in the United States (CDC, 2023). In addition to recording the event itself, the NVSS collects various other data about each event from the local authorities. For infant birth/death statistics, the categories of data included are mother's residence, maternal characteristics, paternal characteristics, pregnancy history and prenatal care characteristics, maternal risk factors, pregnancy risk factors, maternal infections present and/or treated during pregnancy, labor characteristics, delivery characteristics, maternal morbidity, infant characteristics, abnormal conditions of newborn, congenital anomalies of newborn, and cause of infant's death. The set of data collected was federally mandated, with the categories of data and specific variables having been developed for the CDC-NVSS through an iterative process since the first version of the NVSS was published in 1890 (CDC, 2023). Therefore, the CDC-NVSS data are considered highly reliable because of the extensive efforts to develop and determine the appropriate measures, and also have a high validity given their intrinsic nature.

Operationalization of Variables

Race/Ethnicity

Race/ethnicity was the key moderating variable in all research questions and was created as a categorical variable using combinations of race and ethnicity information. The specific data points used will be “Maternal Race” and “Maternal Hispanic Origin.” The variable will then be aggregated at the county level as percentages for each category.

Age

Age was a demographic variable used in RQ1 and will be retrieved directly from the dataset. Age will be defined using the factor of “Age of Mother,” a categorical variable with categories ranging from 15 years through over 50 years, at 5-year intervals. The variable was then aggregated at the county level as percentages for each category.

Fathers’ Race/Ethnicity

The father’s race/ethnicity was a demographic variable used in RQ1 and was registered as none, the same as the mothers, or different from the mothers. The father’s race/ethnicity was determined using the variables of “Paternal Race” and “Father's Hispanic Origin” if available. The variable will then be aggregated at the county level as percentages for each category.

BMI

BMI was a demographic variable used in RQ1 and was retrieved directly from the dataset. BMI was measured using the item “Mother's height and weight” from the CDC-NVSS and measured as a continuous calculated value. The variable was aggregated at the county level as an average.

Education

The highest educational program completed by the mother was retrieved directly from the dataset. Education was measured as a categorical variable using the item "Mother's Education" with values ranging from 8th grade or less to doctoral or professional degree. The variable was aggregated at the county level as percentages for each category.

WIC Food Status

WIC food status was a measure of whether the mother was on the food stamp program during pregnancy and is the only proxy available for income. WIC was measured as a categorical variable using the item "WIC Status" with the categories of yes, no, and unknown or not stated. The variable was aggregated at the county level as percentages for each category.

State

The state in which the birth occurred was retrieved directly from the dataset. State was measured as a categorical variable using data from the item "maternal residence."

Urban/Rural

The urban or rural status was calculated by cross-referencing the county in which the birth occurred with county-level population density, and hence a dichotomous variable derived from "maternal residence."

County Poverty Level

The county-level poverty status was calculated by cross-referencing the county in which the birth occurred with county-level median income data, and hence a categorical variable derived from "maternal residence."

Data Analysis Plan

As the first step of data analysis, descriptive statistics were applied to the data for the study. Descriptive statistics were used to characterize the overall sample study. Descriptive statistics were also used to assess and tabulate the statistical properties (mean, median, mode, or frequency as appropriate for variable type) of each variable. All analyses, descriptive and inferential, were carried out using the latest version of SPSS statistical analysis software.

Each of these research questions was answered through a hierarchical multiple linear regression analysis. Per the Baron and Kenny (1986) moderation approach, the potential for moderation is tested by examining whether a more complex model containing terms modeling the interaction of critical variables creates a more accurate predictive correlational model than one without the interaction terms. Hence, the basic strategy was to conduct a base model of regression for each RQ using only the original factors (age, father's race, BMI, residency for RQ1, education, WIC food status for RQ2). This model was assessed for its key characteristics, most importantly, the multiple R-squared value. Then, a second model containing the original factors, race/ethnicity, and the interaction terms for race/ethnicity with each of the original factors. The null hypothesis for the associated research question can be rejected if (a) the second model's

multiple R-squared is significantly higher than that of the first, and (b) the coefficient of regression for one or more of the interaction terms is statistically significant in the hierarchical model relating to that RQ (Baron & Kenny, 1986). The size and sign of the coefficient of regression denote the strength and direction of the moderation effect.

For all the multiple linear regression models, several key assumptions must be tested. First, the dependent variable must be continuous (Laerd Statistics, 2023). For the proposed study, the dependent variable will be the rate of infant mortality for the specific geographic location, percentage, and hence continuous. Second, the independent variables must be continuous or nominal (Laerd Statistics, 2023). This assumption is satisfied by the definition of the variables above. Third, observations must be independent (Laerd Statistics, 2023). Independence was assumed based on the methodology used in collecting the original data. Fourth, the relationship of the variables needs to be roughly linear (Laerd Statistics, 2023). This assumption was tested by creating scatterplots and partial regression plots of the variables to assess linearity.

Fifth, the condition of homoscedasticity, or the same error variance, must be met (Laerd Statistics, 2023). This condition was assessed using a plot of the studentized residuals against the unstandardized predicted values. Sixth, there must not be excessive multicollinearity (Laerd Statistics, 2023). Multicollinearity was assessed using variance inflation factors/tolerance. If multicollinearity is identified, one of each set of highly correlated predictors will be eliminated from the model. Seventh, the data must have no significant outliers, high leverage points, or highly influential points (Laerd Statistics, 2023). Such points were identified through a combination of visual inspection,

studentized deleted residuals, and Cook's distance. If any such points are identified, they will be deleted. Finally, the residuals must be roughly normally distributed (Laerd Statistics, 2023). This was tested via a normal Q-Q plot in SPSS. If any of the assumptions above are violated, appropriate data transforms to correct them are undertaken. If such transformations, such as the natural logarithm, fail, then a multiple logistic regression, which has less stringent assumptions, may be substituted.

Threats to Validity

Validity consists of internal and external validity. Internal validity represents the internal cohesion of the study (Merriam & Tisdell, 2015). Internal validity was ensured in two ways. First, the various components of the study have been carefully aligned, from the problem to the purpose to the research questions to the data collection and analysis. Second, the study's internal validity rests upon the CDC-NVSS dataset. The NVSS dataset was constructed using entirely direct measures of the underlying variables rather than Likert-scale items or other more ambiguous and indirect instruments. Hence, the validity was intrinsic to the measures. One limitation was that the dataset did not include a better proxy for income than the use or nonuse of food stamps during pregnancy. One way of helping to alleviate this limitation was the inclusion of county-level data on poverty, although this will require locating accurate county-level median income data for the same period as the dataset and cross-referencing the two.

External validity, by contrast, relates to generality. A study achieves external validity if it has a large enough sample size to achieve statistical significance and is also representative of the population (Merriam & Tisdell, 2015). Regarding the statistical

significance of the study, a G*Power analysis for a multiple regression model with 6 predictors requires a minimum sample size of 98 participants to achieve 80% statistical power, 95% significance, and a medium effect size, which will be well exceeded by the number of counties available. Regarding representativeness, the CDC-NVSS dataset was not merely representative, but exhaustive, containing data on all recorded events within the target population. Hence, representativeness is assured.

Ethical Procedures

Ethical research practices were followed at every step of the research. IRB approval was obtained before collecting any data. Such approval was expected to be expedited because of the use of a secondary dataset. Per the CDC (2023), because the CDC-NVSS dataset was a public use publication from a national agency, no permission was needed to retrieve the data or use them in research, provided the data used are not drawn from the "Restricted-use Vital Statistics Data" category. This study's data does not fall under that category, and hence, no site authorization will be required to access and use the dataset. The CDC-NVSS data are anonymized before posting online. In addition, to avoid de-anonymization through excessive specificity, the dataset suppresses the results of any query that would yield nine or fewer data points. The CDC also reports only on counties with at least 250,000 residents to further protect the anonymity of the data, with other data falling under the aggregate label "Unidentified Counties." Hence, the anonymity of the data upon which the study was based has been assured on multiple levels and will not pose any potential risk of harm to the individuals whose data were used to assemble the dataset.

Summary

This study involved addressing interactions between race and key predictors and their effects on infant mortality. The study was guided by three research questions.

The research methodology was qualitative with a historical correlational design. The population of interest was infants who were born between 2018 and 2020 in the United States. The dataset for the study was CDC-NVSS. The NVSS tracks all instances of births, deaths, marriages, divorces, and fetal deaths in the United States and was the sole instrument for data collection. Data were analyzed through descriptive statistics, and research questions were answered via a hierarchical multiple linear regression analysis. Ethical practices were followed during the research.

Section 3: Presentation of the Results and Findings

This quantitative study involved examining the extent to which race moderated the predictive power of other demographics, socioeconomic, and geographic factors on infant mortality in the southern United States. The following research questions were used:

RQ1: To what extent, if any, does race/ethnicity moderate the effect of demographic factors (age, father's race, BMI, residency) on IMRs?

$H_0$1: Race/ethnicity does not significantly moderate the effect of any demographic factors (age, father's race, BMI, residency) on IMRs.

H_a1: Race/ethnicity significantly moderates the effect of one or more demographic factors (age, father's race, BMI, residency) on the infant mortality rate.

RQ2: To what extent, if any, does race/ethnicity moderate the effect of socioeconomic factors (education, WIC food status) on IMRs?

$H_0$2: Race/ethnicity does not significantly moderate the effect of any socioeconomic factors (education, WIC food status) on IMRs.

H_a2: Race/ethnicity significantly moderates the effect of one or more socioeconomic factors (education, WIC food status) on IMRs.

RQ3: To what extent, if any, does race/ethnicity moderate the effect of geographic factors (state, urban/rural, county poverty level) on IMRs?

$H_0$3: Race/ethnicity does not significantly moderate the effect of any geographic factors (state, urban/rural, county poverty level) on IMRs.

H_a3: Race/ethnicity significantly moderates the effect of one or more geographic factors (state, urban/rural, county poverty level) on infant mortality rate.

In Section 3, the results and findings of the study are presented. First, I explain how the data set was accessed for secondary analysis. This is followed by a presentation of results, including descriptive statistics of the sample, evaluation of relevant statistical assumptions, and statistical analysis. The section concludes with a summary of the findings.

Accessing the Data Set for Secondary Analysis

Secondary data were accessed from the CDC-NVSS for infants who were born between 2018 and 2020, in the CDC-NVSS dataset, from the southern United States, and from a state where data reporting was considered reliable per the CDC. However, to include deaths occurring in 2018, births from 2017 were included, and similarly, to include deaths of people who were born in 2020, deaths in 2021 were also included. The southern United States was defined using U.S. Census regions comprising the states of Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, and Texas.

All data for these variables were selected from the CDC-NVSS dataset at the county level. Thus, all study variables were aggregated at the county level as percentages for each category. However, county-level data are only presented for counties with populations of 250,000 or more persons. For counties with fewer than 250,000 persons

within a county, data were grouped and labeled as unidentified counties. Many counties had fewer than 250,000 persons.

Three samples were drawn that included all relevant instances at the county level for specific study variables. Cases at the county level that had missing values for variables were excluded. Cases that had data coded as unknown or not stated were recorded as missing values. For RQ1, fathers' race was recorded as none, the same as the mother, or different from the mother. Race/ethnicity was determined by combining the variables for mother's race with ethnic origin.

Results

Among 54 counties, 90.7% (n = 49) reported most mothers were White, while 9.3% (n = 5) had a majority of mothers who were Black or African American. Similarly, for fathers, 90% (n = 45) of counties reported a majority of White fathers, and 10% (n = 5) of counties reported a majority of Black or African American fathers based on data from 50 counties.

In 38.9% (n = 21) of counties, most mothers were 20 to 24. In 35.2% (n = 19) of counties, the largest age group of mothers was 25 to 29. 22.2% of counties had a majority of mothers between 30 and 34 (n = 12), while only 3.7% (n = 2) of counties had a majority of mothers between 35 and 39.

Nearly half or 49.1% (n = 26) of counties reported most mothers had a pre-pregnancy BMI in the normal range (18.5-24.9). In 28.3% (n = 15) of counties, most mothers were classified as overweight (25-29.9). A smaller percentage of 11.3% (n = 6) of counties reported most mothers in obesity class 1 (30-34.9) or 2 (35-39.9).

The majority of counties were from Texas with 31.5% (*n* = 17), followed by North Carolina at 13.0% (*n* = 7), Georgia at 11.1% (*n* = 6), and Tennessee at 11.1% (*n* = 6). Other states include Mississippi at 9.3% (*n* = 5), Kentucky at 7.4% (*n* = 4), Alabama at 5.6% (*n* = 3), Virginia at 3.7% (*n* = 2), Louisiana at 3.7% (*n* = 2), Florida at 1.9% (*n* = 1), and Oklahoma at 1.9% (*n* = 1).

Table 1

Demographic Characteristics Aggregated at the County Level for RQ1

Demographic characteristics at the county level		N	%
Mother's Single Race			
	Black or African American	5	9.30%
	White	49	90.70%
Father's Single Race			
	Black or African American	5	10.00%
	White	45	90.00%
Age of Mother			
	20-24 years	21	38.90%
	25-29 years	19	35.20%
	30-34 years	12	22.20%
	35-39 years	2	3.70%
Mother's Pre-pregnancy BMI			
	Normal 18.5 - 24.9	26	49.10%
	Overweight 25 - 29.9	15	28.30%
	Obesity 1 30 - 34.9	6	11.30%

Demographic characteristics at the county level		N	%
Mother's Single Race			
	Black or African American	5	9.30%
	White	49	90.70%
	Obesity 2 35 - 39.9	6	11.30%
State			
	Alabama	3	5.60%
	Florida	1	1.90%
	Georgia	6	11.10%
	Kentucky	4	7.40%
	Louisiana	2	3.70%
	Mississippi	5	9.30%
	North Carolina	7	13.00%
	Oklahoma	1	1.90%
	Tennessee	6	11.10%
	Texas	17	31.50%
	Virginia	2	3.70%

In 43.6% (n= 79) of counties, the majority of mothers were high school graduates or GED completers. This was followed by 24.9%(n=45) of counties where respondents mostly reported some college credit, but not a degree.

In 39.2% (n= 71) of counties, most mothers reported being on the food stamp program during pregnancy.

In 13.3%(n=24) of the counties, most mothers were of White Hispanic descent. In 47%(n=85) of the counties, there were mostly White mothers, while in 40%(n=72) of the counties, the mothers were predominantly Black or African American.

Table 2

Socioeconomic Factors Aggregated at the County Level for RQ2

Socioeconomic factors at the county level		N=181	%
Mother's Education			
	9th through 12th grade with no diploma	31	17.1
	High school graduate or GED completed	79	43.6
	Some college credit, but not a degree	45	24.9
	Associate degree (AA, AS)	7	3.9
	Bachelor's degree (BA, AB, BS)	16	8.8
	Master's degree (MA, MS, MEng, MEd, MSW, MBA)	3	1.7
WIC			
	No	110	60.8
	Yes	71	39.2
Mother's Combined Race & Ethnicity			
	White	85	47
	Black	72	39.8
	White Hispanic	24	13.3

Table 3 summarizes the data at the county level for Research Question 3:

Most counties were in Florida, 19.2%(n=41) and Texas,19.2%(n=41). Almost a tenth of the counties were from North Carolina, 9.4%(n=20), followed by Georgia, 7%(n=15), and Maryland, 6.1%(n=13).

The overwhelming majority of counties were in urban or metro areas, 86.4% (n= 184).

Mothers in most counties were either White, 39.4% (n= 84), Black or African American,36.6%(n=78), or of Hispanic descent,19.7% (n=42).

Table 3

Geographic Factors at County Level for RQ3

Geographic factors at the county level	N=213	%
State		
Alabama	10	4.70%
Arkansas	7	3.30%
Delaware	2	0.90%
Florida	41	19.20%
Georgia	15	7.00%
Kentucky	5	2.30%
Louisiana	8	3.80%
Maryland	13	6.10%
Mississippi	4	1.90%
North Carolina	20	9.40%
Oklahoma	10	4.70%
South Carolina	12	5.60%
Tennessee	11	5.20%
Texas	41	19.20%
Virginia	12	5.60%
West Virginia	2	0.90%

Geographic factors at the county level	N=213	%
Metro	184	86.40%
Nonmetro	29	13.60%
Mother's Combined Race & Ethnicity		
Black Hispanic	1	0.50%
White	84	39.40%
Black	78	36.60%
White Hispanic	42	19.70%
Asian	5	2.30%
American Indian / Native Alaskan	1	0.50%
More than one race	2	0.90%

Table 4 gives a summary of the descriptive statistics for the dependent variable, infant mortality rate, and the continuous independent variables, aggregated at the county level for the three research questions.

For research question 1, the average infant mortality rate across demographic groups was 7.32 (n=53), with the age category of mothers being 1.89 (n=53), and the mother's pre-pregnancy BMI category was 2.85 (n=53). This is an indication that the majority of the mothers fell into the normal to overweight range.

For research question 2, for socioeconomic predictors, the mean infant mortality rate was 9.76 (n= 181), with the average education category of the mothers being 3.49 (n= 181). This indicated that most of the mothers had at least finished high school. Race plays a critical role, considering all groups with equal education, but African American mothers experience a significantly higher IMR.

For research question 3, the average infant mortality rate was 7.56 (n=213). This reiterates the need to consider place-based disparities and their interaction with race.

Table 4

Descriptive Statistics for Continuous Study Variables

Descriptive statistics	*M*	*SD*	*n*
RQ1			
Infant Mortality Rate	7.32	5.06	53
Age Category of Mother	1.89	0.87	53
Mother's Pre-pregnancy BMI Category	2.85	1.03	53
RQ2			
Infant Mortality Rate	9.76	5.34	181
Education Category	3.49	1.19	181
RQ3			
Infant Mortality Rate	7.56	3.49	213

Tests of Assumptions

The following section presents the tests of assumptions associated with hierarchical multiple linear regression. The first two assumptions were met through the study design. Firstly, there must be a continuous dependent variable. For this study, the infant mortality rate of a county was used as the dependent variable. Secondly, the independent variables should either be continuous or nominal, which was also met by the study design. The third assumption requires that observations should be independent. This was also met through the methodology used in collecting original data.

The fourth assumption requires that the variables should be roughly linear. This was tested with scatterplots and partial regression plots of the continuous variables in Figures 1 to 4.

A scatterplot was specified to establish if a linear relationship exists between the dependent and independent variables collectively. Figure 1 shows a scatterplot of the

studentized residuals against the unstandardized predicted values for RQ1. The residuals were relatively randomly scattered around the horizontal axis (y = 0). However, some of the points seem to form a subtle curved pattern, which may indicate a slight deviation from linearity.

A second scatterplot was specified to test for a linear relationship between the dependent and independent variables collectively in RQ2. The scatter plot in Figure 2 showed no strong curved patterns, with the points mostly randomly scattered along the horizontal axis. Although a slight funnel-shaped pattern was visible where the spread of residuals increased higher predicted values, this did not directly violate the assumption of linearity.

A third scatterplot was specified to test for a linear relationship between the dependent and independent variables collectively in RQ3. Figure 3 shows a slight grouping or clustering of points, with residuals on the left side being more densely packed and those on the right side being more spread out. However, there doesn't seem to be a strong curved or U-shaped pattern, which suggests that nonlinearity might not be a significant issue.

Figure 5

Assumption 4: Scatterplot Between Studentized Residuals vs Unstandardized Predicted Values for RQ1

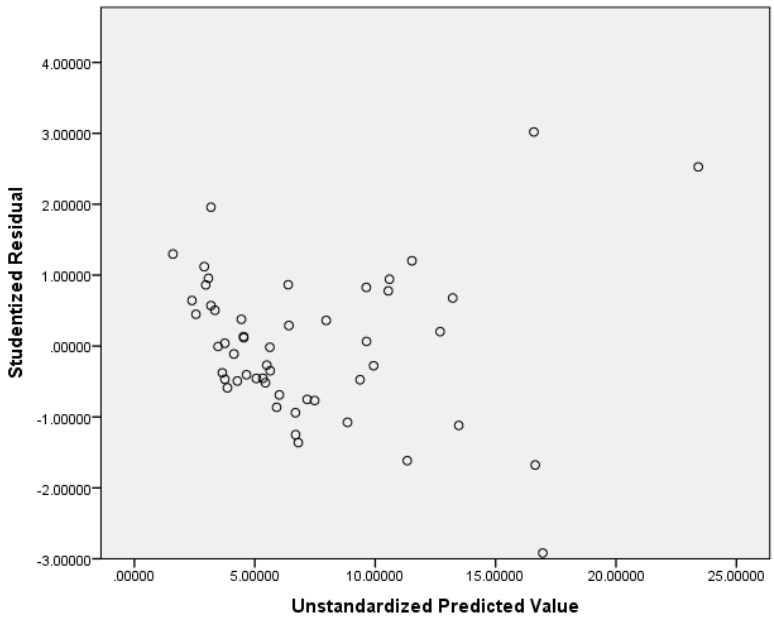


Figure 6

Assumption 4: Scatterplot Between Studentized Residuals vs Unstandardized Predicted Values for RQ2

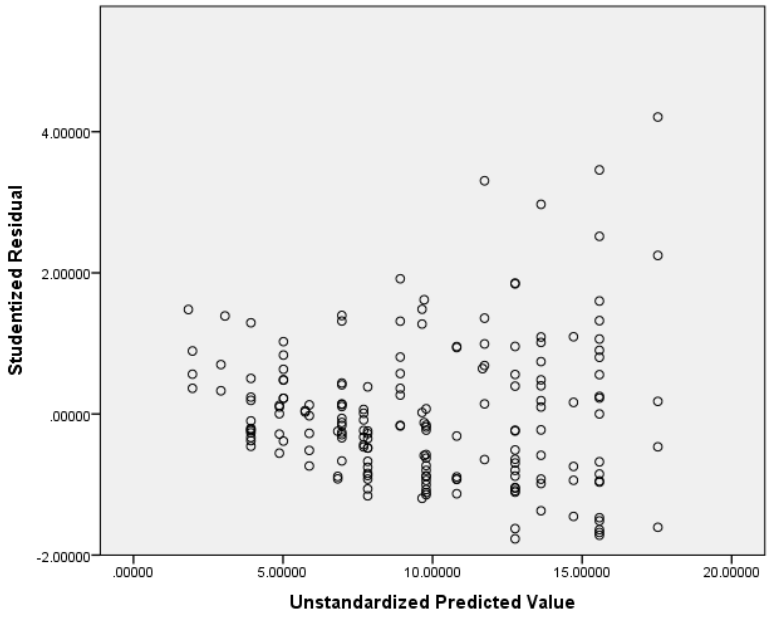
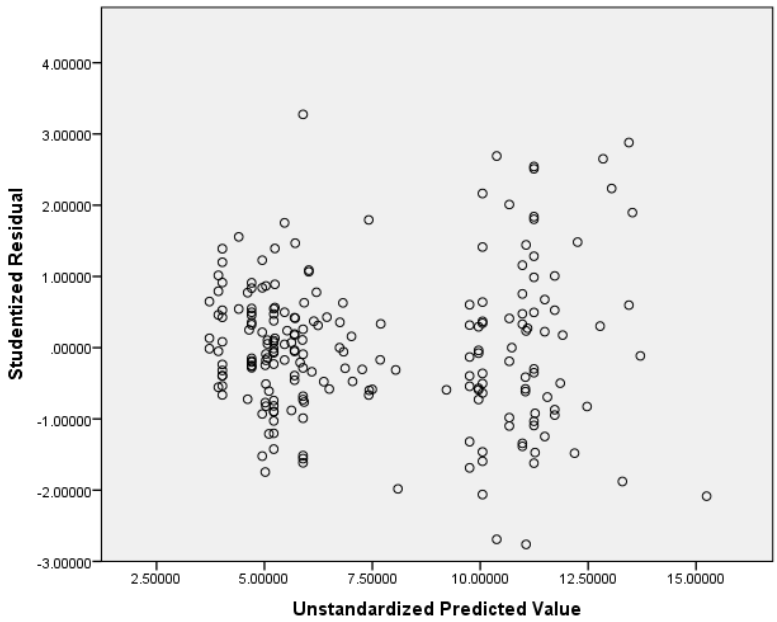


Figure 7

Assumption 4: Scatterplot Between Studentized Residuals vs Unstandardized Predicted Values for RQ3



Partial regression plots between each continuous independent variable and the dependent variable were examined. Figures 4 to 6 show a relatively random scatter of points indicating linear relationships.

Figure 8

Assumption 4: Partial Regression Plot between Infant Mortality Rate and Mother's Age

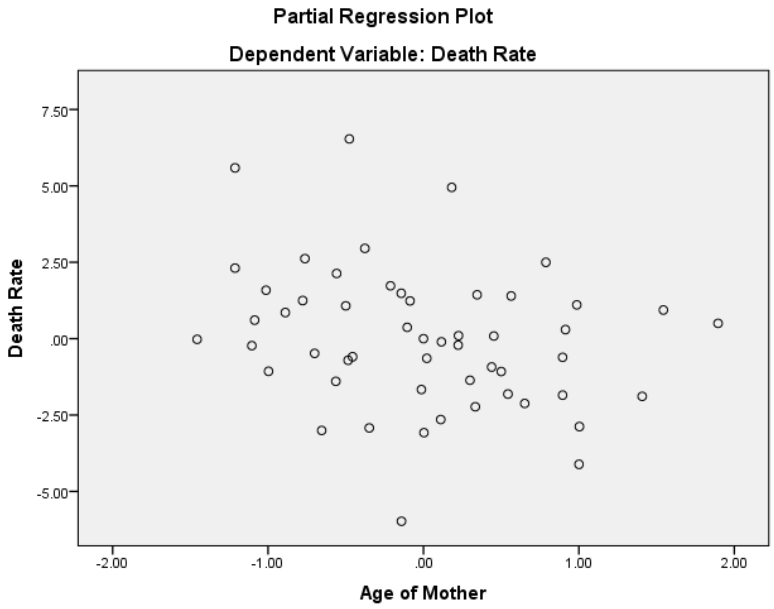


Figure 9

Assumption 4: Partial Regression Plot between Infant Mortality Rate and Mother's Pre-pregnancy BMI

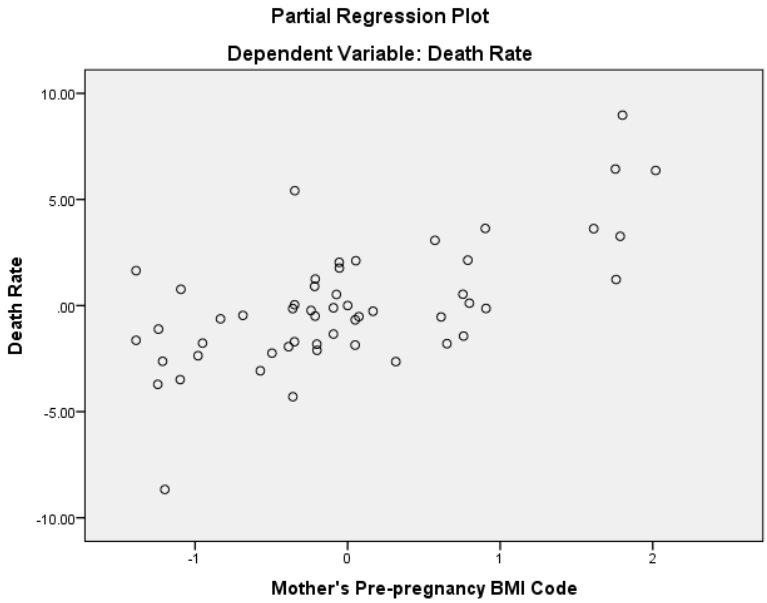
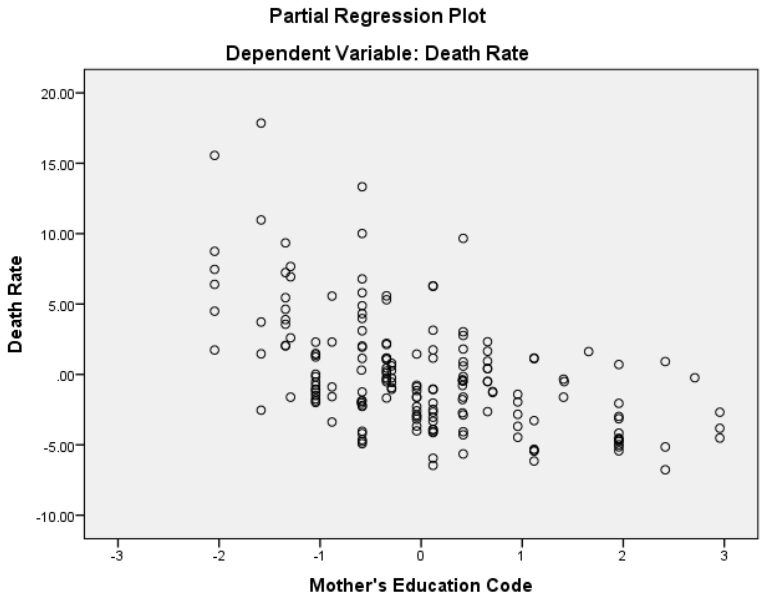


Figure 10

Assumption 4: Partial Regression Plot between Infant Mortality Rate and Mother's Education Code



Homoscedasticity assumes that the variance is equal for all values of the predicted dependent variable. Figures 1 and 2 show an approximately even spread of residuals, although there were a few points that differed in height. However, the slight clustering in Figure 3 might suggest a non-constant variance of residuals for RQ3, indicating heteroscedasticity.

The assumption of no multicollinearity was checked first by examining whether there were two or more independent variables that were highly correlated with each other. Secondly, the Tolerance/VIF values were inspected, and excessively high correlations were found between two or more independent variables. Furthermore, no tolerance values less than 0.1 were found for the three research questions, indicating a lack of multicollinearity (see Table 5).

Table 5

Assumption 6: Collinearity Statistics

Independent variables	Collinearity statistics	
	Tolerance	VIF
RQ1		
Age of Mother	0.775	1.291
FatherRaceRecode	0.808	1.238
Mother's Pre-pregnancy BMI Code	0.758	1.319
State=Georgia	0.367	2.724
State=Kentucky	0.462	2.164
State=Louisiana	0.533	1.876
State=Mississippi	0.37	2.706
State=North Carolina	0.323	3.096
State=Oklahoma	0.756	1.322
State=Tennessee	0.369	2.709
State=Texas	0.212	4.724

Independent variables	Collinearity statistics	
	Tolerance	VIF
State=Virginia	0.594	1.683
MothersSingleRace	0.643	1.555
RQ2		
Mother's Education Code	0.853	1.173
WIC=Yes	0.908	1.101
RaceEthnic=Black	0.864	1.158
RaceEthnic=White Hispanic	0.856	1.168
RQ3		
RaceEthnic=Black Hispanic	0.941	1.062
RaceEthnic=Black	0.759	1.318
RaceEthnic=White Hispanic	0.776	1.288
RaceEthnic=Asian	0.898	1.113
RaceEthnic=American Indian/Alaskan	0.874	1.144
RaceEthnic = More than one race	0.92	1.088
State=Arkansas	0.607	1.647
State=Delaware	0.828	1.208
State=Florida	0.24	4.171
State=Georgia	0.427	2.341
State=Kentucky	0.678	1.474
State=Louisiana	0.57	1.755
State=Maryland	0.458	2.184
State=Mississippi	0.719	1.391
State=North Carolina	0.351	2.849
State=Oklahoma	0.494	2.024
State=South Carolina	0.482	2.077
State=Tennessee	0.5	2.002
State=Texas	0.237	4.225
State=Virginia	0.466	2.144
State=West Virginia	0.829	1.207
Metro	0.887	1.127

This assumption holds that there should be no significant outliers, high-leverage points, or highly influential points. A visual inspection and studentized deleted residuals were examined for outliers. A deleted studentized residual more important than 3 was set as evidence of an outlier. Two deleted studentized residuals just above 3 and just below -3 were found for RQ1. Cook's Distance was inspected to determine whether these cases posed a problem. Tabachnick and Fidell (2001) suggested that a value above 1 would

indicate a problem. However, a maximum Cook's Distance value of .381 was found, indicating that these cases did not pose a problem.

For RQ2, case wise diagnostics identified three cases with studentized deleted residuals above 3. Cook's Distance with a maximum value of .108 was found, indicating that these cases did not pose a problem.

One case with a deleted studentized residual greater than 3 was identified for RQ3. However, Cook's Distance with a maximum value of .315 was found, indicating that this case was not problematic.

The last assumption was that the residuals must be roughly normally distributed. Normal P-P plots were specified to test this assumption. Figures 7 to 9 show roughly straight lines of the standardized residuals for RQ1, RQ2, and RQ3, validating this assumption.

Figure 11

Assumption 8: Normal P-P Plot of Regression Standardized Residual for RQ1

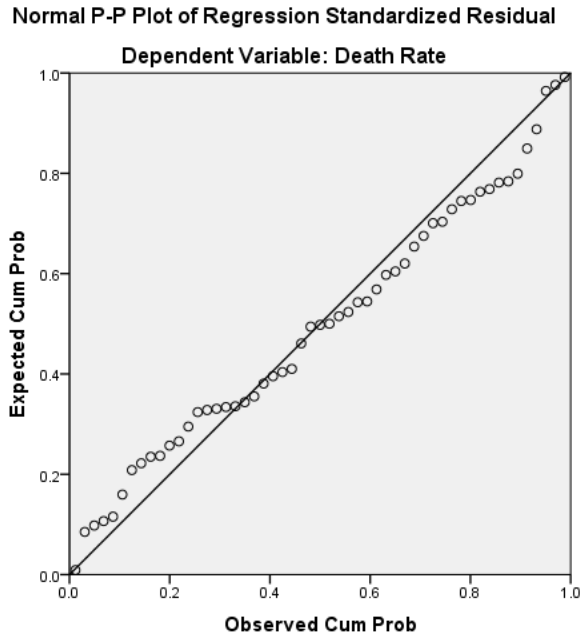


Figure 12

Assumption 8: Normal P-P Plot of Regression Standardized Residual for RQ2

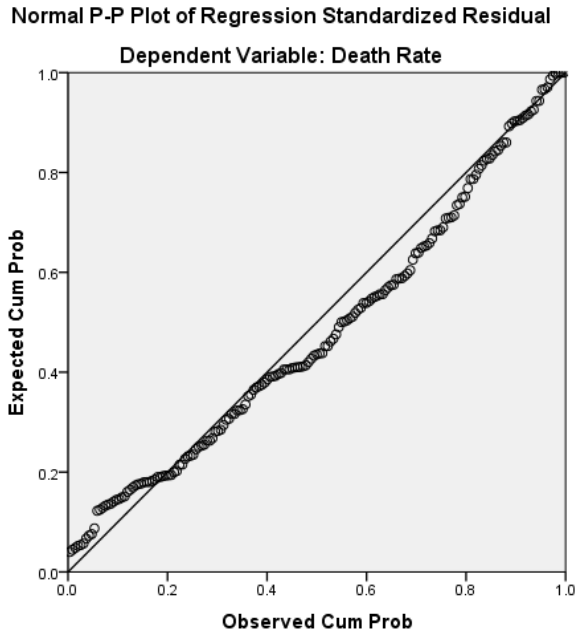
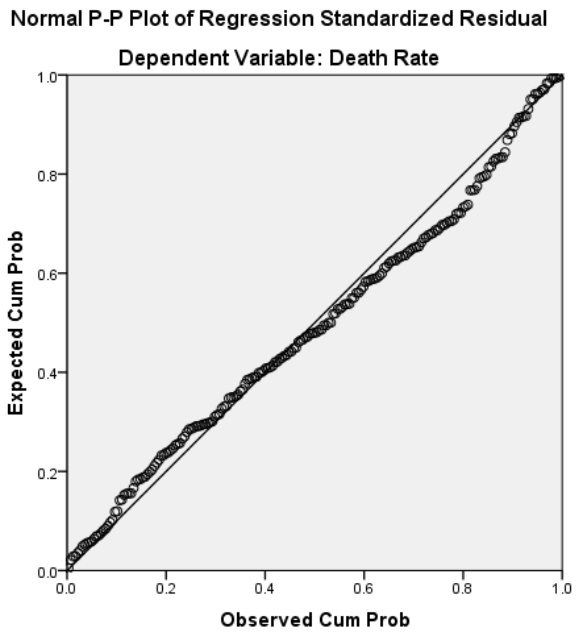


Figure 13

Assumption 8: Normal P-P Plot of Regression Standardized Residual for RQ3



RQ1

A hierarchical multiple regression was run to determine to what extent, if any, race/ethnicity moderated the effect of demographic factors (age, father's race, BMI, and residency) on the infant mortality rate. The first model only included the main effects, i.e., variables related to the state of residence, mother's race, whether the father's race was different or similar to the mother's race, pre-pregnancy BMI, and age of the mother. The second model added interaction terms between race and mother's BMI, age, father's race, and state of residence to test for moderation.

Tables 6 and 7 show that the first model was statistically significant and explained 80.7% of the variance in infant mortality rates, $R^2 = .807$, F (13, 39) = 12.515, $p < .001$; adjusted $R^2 = .742$. The addition of interaction terms between race and the demographic variables led to a statistically significant increase in R^2 of .101 and explained 90.8% of the variance, $R^2 = .908$, F (4, 35) = 20.234, $p < .001$. These results suggest that race does have a moderating effect on the relationship between demographic factors and the infant mortality rate.

Furthermore, the interaction terms in the second model provided evidence that race moderated the effects of certain demographic factors. Table 8 shows that the interaction between race and the mother's pre-pregnancy BMI was significant ($B = 4.130$, $p < .001$), indicating that the effect of BMI on infant mortality varies significantly across racial groups. Specifically, the positive coefficient suggests that BMI has a more substantial impact on infant mortality for mothers of African American descent.

The interaction between race and residency in North Carolina, ($B = 9.798$, $p = .001$) and Georgia, ($B = -5.470$, $p = .054$) was also significant or near-significant, suggesting that the relationship between state residency and infant mortality is different across racial groups. For instance, North Carolina shows a positive relationship, whereas Georgia shows a negative relationship. The positive interaction effect for North Carolina means that infants of Black or African American descent may be associated with a higher infant mortality rate compared to other races in the same state or the same race in different states. Conversely, the negative interaction effect for Georgia suggests that infants of Black or African American descent may be associated with a lower infant

mortality rate compared to other races in the same state or the same race in different states. This points to better outcomes for Black infants residing in Georgia.

However, no significant interaction was found between race and age of the mother ($p = .060$) or race and father's race same as the mother's ($p > .05$), suggesting that these demographic factors are not moderated by race in this context.

Regarding the main effects, the mother's pre-pregnancy BMI had a significant main effect in both models (B=2.153 in Model 1, B=1.750 in Model 2, $p < .001$ for both). This indicates that higher maternal BMI was associated with higher infant mortality rates, even when accounting for race interactions. Furthermore, the father's race had a significant negative main effect ($B = -7.814$, $p < .001$), meaning that when the father's race was the same as the mother's race, infant mortality was significantly lower than when the father's race was missing or unknown.

The results of the analysis indicate that race moderates the effect of certain demographic factors on infant mortality rates, particularly in the case of BMI and state of residency. As per the data analysis plan, the null hypothesis for this research question was rejected in light of the following (a) the second model's multiple R-squared was significantly higher than that of the first, and (b) the coefficient of regression for one or more of the interaction terms is statistically significant in the hierarchical model (Baron & Kenny, 1986). The results of the analysis indicate that race moderates the effect of certain demographic factors on infant mortality rates, particularly in the case of BMI and state of residency. The alternative hypothesis is accepted, finding that race/ethnicity

significantly moderates the effect of one or more demographic factors (BMI, residency) on infant mortality rate.

Table 6

RQ1: Model Summary

Model	*R*	R^2	Adjusted R^2	SE of Estimate	Change Statistics				
					R^2Change	F Change	df1	df2	Sig. F Change
1	.898a	0.807	0.742	2.56825	0.807	12.515	13	39	0.00
2	.953b	0.908	0.863	1.87356	0.101	9.571	4	35	0.00

Note. a Predictors: (Constant), State=Virginia, State=Oklahoma, State=Louisiana, State=Kentucky, FatherRaceRecode=Same as mother, State=Mississippi, State=Tennessee, State=Georgia, Age of Mother, Mother's Pre-pregnancy BMI Code, State=North Carolina, MothersSingleRace6=Black or African American, State=Texas
b Predictors: (Constant), State=Virginia, State=Oklahoma, State=Louisiana, State=Kentucky, FatherRaceRecode=Same as mother, State=Mississippi, State=Tennessee, State=Georgia, Age of Mother, Mother's Pre-pregnancy BMI Code, State=North Carolina, MothersSingleRace6=Black or African American, State=Texas, Race_NC_Interaction, Race_GA_Interaction, Race_LA_Interaction, Race_BMI_Interaction
c Dependent Variable: Death Rate

Table 7

RQ1: ANOVA

Model		Sum of Squares	*df*	Mean Square	*F*	*p*
1	Regression	1073.078	13	82.544	12.515	.000b
	Residual	257.24	39	6.596		
	Total	1330.318	52			
2	Regression	1207.461	17	71.027	20.234	.000c

Residual	122.857	35	3.51

Note: A Dependent Variable: Death Rate
b Predictors: (Constant), State=Virginia, State=Oklahoma, State=Louisiana, State=Kentucky, FatherRaceRecode=Same as mother, State=Mississippi, State=Tennessee, State=Georgia, Age of Mother, Mother's Pre-pregnancy BMI Code, State=North Carolina, MothersSingleRace6=Black or African American, State=Texas
c Predictors: (Constant), State=Virginia, State=Oklahoma, State=Louisiana, State=Kentucky, FatherRaceRecode=Same as mother, State=Mississippi, State=Tennessee, State=Georgia, Age of Mother, Mother's Pre-pregnancy BMI Code, State=North Carolina, MothersSingleRace6=Black or African American, State=Texas, Race_NC_Interaction, Race_GA_Interaction, Race_LA_Interaction, Race_BMI_Interaction

Table 8

RQ1: Coefficients

Model	Unstandardized Coefficients			Std. Coeff	*t*	Sig.	95% CI for *B*	
		B	*SE*	Beta			Lower Bound	Upper Bound
1	(Constant)	9.96	2.3		4.331	0	5.308	14.611
	Age of Mother	-0.789	0.465	-0.136	-1.696	0.098	-1.731	0.152
	Mother's Pre-pregnancy BMI Code	2.153	0.399	0.437	5.403	0	1.347	2.959
	MothersSingleRace6 or African American	8.994	1.505	0.525	5.976	0	5.95	12.037
	FatherRaceRecode=Same as mother	-8.154	1.486	-0.43	-5.487	0	-11.159	-5.148
	State=Georgia	-1.191	1.838	-0.075	-0.648	0.521	-4.908	2.527
	State=Kentucky	-1.06	1.965	-0.056	-0.54	0.593	-5.034	2.914
	State=Louisiana	-0.845	2.535	-0.032	-0.333	0.741	-5.974	4.283
	State=Mississippi	2.641	1.985	0.154	1.33	0.191	-1.374	6.657
	State=North Carolina	0.12	1.833	0.008	0.066	0.948	-3.588	3.828
	State=Oklahoma	5.914	2.982	0.161	1.983	0.054	-0.117	11.945

Model	Unstandardized Coefficients			Std. Coeff	*t*	Sig.	95% CI for *B*	
		B	*SE*	Beta			Lower Bound	Upper Bound
	State=Tennessee	-0.259	1.833	-0.016	-0.141	0.888	-3.966	3.448
	State=Texas	-2.144	1.643	-0.2	-1.305	0.199	-5.467	1.179
	State=Virginia	-0.094	2.401	-0.004	-0.039	0.969	-4.951	4.764
2	(Constant)	10.654	1.707		6.242	0	7.189	14.119
	Age of Mother	-0.684	0.353	-0.118	-1.941	0.06	-1.4	0.031
	Mother's Pre-pregnancy BMI Code	1.75	0.313	0.355	5.586	0	1.114	2.386
	MothersSingleRace6 or African American	-5.581	3.615	-0.326	-1.544	0.132	-12.92	1.759
	FatherRaceRecode=Same as mother	-7.814	1.093	-0.412	-7.149	0	-10.033	-5.595
	State=Georgia	-0.621	1.37	-0.039	-0.453	0.653	-3.402	2.161
	State=Kentucky	-0.968	1.434	-0.051	-0.675	0.504	-3.878	1.943
	State=Louisiana	0.452	2.225	0.017	0.203	0.84	-4.065	4.97
	State=Mississippi	2.535	1.562	0.148	1.623	0.114	-0.636	5.706
	State=North Carolina	-1.263	1.366	-0.085	-0.925	0.361	-4.035	1.509
	State=Oklahoma	5.984	2.176	0.163	2.75	0.009	1.566	10.402
	State=Tennessee	-0.185	1.337	-0.012	-0.138	0.891	-2.899	2.53
	State=Texas	-2.095	1.2	-0.195	-1.747	0.089	-4.531	0.34
	State=Virginia	-0.585	1.755	-0.022	-0.333	0.741	-4.147	2.978
	Race_BMI_Interaction	4.13	0.937	0.826	4.407	0	2.228	6.032
	Race_GA_Interaction	-5.47	2.746	-0.149	-1.992	0.054	-11.044	0.104
	Race_LA_Interaction	2.842	3.439	0.077	0.827	0.414	-4.139	9.823
	Race_NC_Interaction	9.798	2.695	0.266	3.635	0.001	4.327	15.269

Note: A Dependent Variable: Death Rate

RQ2

A hierarchical multiple regression was conducted to determine to what extent, if any, race/ethnicity moderated the effect of socioeconomic factors (education, WIC food status) on infant mortality rate. The first model only included the main effects, i.e., socioeconomic factors, education, WIC status, and race/ethnic group on infant mortality rate. In the second model, interaction terms were added between race and ethnic group and socioeconomic factors to test for moderation.

Tables 9 and 10 show that the first model was statistically significant, $R^2 = .566$, F (4, 176) = 57.430, $p < .001$; adjusted $R^2 = .556$. Maternal education, WIC status, and race/ethnic groups (Black and White Hispanic) explained approximately 56.6% of the variance in the infant mortality rate. The inclusion of the interaction terms between race/ethnic groups and maternal education and WIC status led to a slight increase in the R^2 of .037, suggesting that the inclusion of the interaction terms explained an additional 3.7% of the variance in the infant mortality rate, $R^2 = .603$, F (4, 172) = 32.705, $p < .001$; adjusted $R^2 = .585$. Thus, race/ethnic groups have a slightly moderating effect on the relationship between socioeconomic factors and infant mortality rates.

Table 11 shows that all the coefficients for the first model were statistically significant. Maternal education showed a significant negative effect ($B = -1.953$, $p < .001$), indicating that higher maternal education was associated with lower infant mortality. Similarly, WIC status also showed a significant negative effect ($B = -2.819$, $p < .001$), indicating that WIC participation is associated with lower infant mortality rates.

However, the Black race/ethnic group showed a significant positive effect (B = 5.793, p < .001), indicating that the Black or African American ethnic group is associated with higher infant mortality compared to other groups. Conversely, the White Hispanic ethnic group showed a significant negative effect (B = -2.090, p = .014), suggesting that White Hispanic ethnicity is associated with lower infant mortality.

The coefficients for the interaction terms in the second model showed that race/ethnic group had a moderating effect for WIC participation but not for maternal education. The interaction between the Black race/ethnic group and WIC participation showed a significant negative impact (B = -4.391, p < .001), suggesting that being Black and receiving WIC benefits significantly decreased the infant mortality rate compared to Black individuals without WIC benefits. A marginally significant effect in the interaction between White Hispanic individuals receiving WIC benefits was found (B = -3.088, p = .065), indicating a similar but weaker protective effect for these individuals. However, no significant interaction effect was found between maternal education and either Black or White Hispanic ethnic groups. Thus, the impact of education on the infant mortality rate did not vary significantly by race/ethnic group.

The results of the analysis found that maternal education and WIC participation reduced infant mortality, while Black ethnicity increased. About the moderating effect of race/ethnicity, no significant interaction was found between race/ethnicity and maternal education (p > .3). However, race/ethnicity, specifically Black ethnicity, had a significant moderating effect on WIC participation and infant mortality rate. Thus, being of Black ethnicity and receiving WIC benefits led to a more substantial reduction in the infant

mortality rate than what would be expected from each factor alone. The null hypothesis was rejected, and the alternative hypothesis was accepted, finding that race/ethnicity significantly moderates the effect of one or more socioeconomic factors (WIC food status) on the infant mortality rate.

Table 9

RQ2: Model Summary

Model	*R*	R^2	Adjusted R^2	*SE* of Estimate	Change Statistics				
					R^2 Change	*F* Change	df 1	df2	Sig. *F* Change
1	.752a	0.566	0.556	3.55948	0.566	57.43	4	176	0
2	.777b	0.603	0.585	3.44299	0.037	4.028	4	172	0.004

Note. a Predictors: (Constant), RaceEthnic=White Hispanic, WIC=Yes, RaceEthnic=Black, Mother's Education Code
b Predictors: (Constant), RaceEthnic=White Hispanic, WIC=Yes, RaceEthnic=Black, Mother's Education Code, HispRace_WIC_Interaction, BlackRace_WIC_Interaction, HispRace_Edu_Interaction, BlackRace_Edu_Interaction
c Dependent Variable: Death Rate

Table 10

RQ2: ANOVA

Model		Sum of Squares	*df*	Mean Square	*F*	*p*
1	Regression	2910.523	4	727.631	57.43	.000b
	Residual	2229.904	176	12.67		
	Total	5140.427	180			
2	Regression	3101.51	8	387.689	32.705	.000c
	Residual	2038.917	172	11.854		

a Dependent Variable: Death Rate
b Predictors: (Constant), RaceEthnic=White Hispanic, WIC=Yes, RaceEthnic=Black, Mother's Education Code

c Predictors: (Constant), RaceEthnic=White Hispanic, WIC=Yes, RaceEthnic=Black, Mother's Education Code, HispRace_WIC_Interaction, BlackRace_WIC_Interaction, HispRace_Edu_Interaction, BlackRace_Edu_Interaction

Table 11

RQ2: Coefficients

Model	Unstandardized Coefficients			Std. Coeff	*t*	*p*	95% CI for *B*	
		B	*SE*	Beta			Lower Bound	Upper Bound
1	(Constant)	15.645	1.071		14.601	0	13.53	17.759
	Mother's Education Code	-1.953	0.242	-0.434	-8.063	0	-2.431	-1.475
	WIC=Yes	-2.819	0.569	-0.258	-4.957	0	-3.941	-1.696
	RaceEthnic=Black	5.793	0.582	0.532	9.961	0	4.646	6.941
	RaceEthnic=White Hispanic	-2.09	0.843	-0.133	-2.478	0.014	-3.754	-0.426
2	(Constant)	14.255	1.324		10.768	0	11.642	16.869
	Mother's Education Code	-1.806	0.295	-0.401	-6.133	0	-2.388	-1.225
	WIC=Yes	-0.536	0.845	-0.049	-0.634	0.527	-2.204	1.133
	RaceEthnic=Black	8.508	2.177	0.781	3.909	0	4.212	12.805
	RaceEthnic=White Hispanic	-3.336	2.87	-0.212	-1.162	0.247	-9.001	2.33
	BlackRace_Edu_Interaction	-0.283	0.56	-0.09	-0.505	0.614	-1.388	0.822
	HispRace_Edu_Interaction	0.843	0.827	0.169	1.019	0.31	-0.79	2.476
	BlackRace_WIC_Interaction	-4.391	1.194	-0.306	-3.678	0	-6.748	-2.034
	HispRace_WIC_Interaction	-3.088	1.663	-0.132	-1.857	0.065	-6.369	0.194

a Dependent Variable: Death Rate

RQ3

A hierarchical multiple regression was conducted to investigate to what extent, if any, race/ethnicity moderated the effect of geographic factors (state, urban/rural) on

infant mortality rate. The county poverty level was not included as the data for this was not available. The main effects comprising race/ethnicity and geographic factors (state, urban/rural) were included in the first model. The interaction terms between race/ethnicity and geographic factors were added to the second model.

The first model was statistically significant and explained 72.7% of the variance in infant mortality rate, $R^2 = .727$, F (22, 190) = 23.008, $p < .001$; adjusted $R^2 = .695$ (Tables 12 and 13). The following coefficients for the main effects in the first model were statistically significant. Black Hispanic race/ethnicity ($B = 5.782$, $p = .004$), Black or African American ethnicity ($B = 6.028$, $p < .001$), and more than one race ($B = 7.237$, $p < .001$) showed significant positive effects indicating that Black Hispanic, Black or African American, and more than one race ethnicities are associated with higher infant mortality rates. Arkansas showed a significant positive effect, indicating that this state is associated with a higher infant mortality rate ($B = 1.950$, $p = .04$). However, Georgia ($B = -1.740$, $p = .029$) and Texas ($B = -1.441$, $p = .037$) showed significant negative effects, indicating that these states were associated with lower infant mortality rates. Similarly, a metro or urban area also showed a significant negative impact ($B = -.801$, $p < .001$), indicating that metro areas were associated with lower infant mortality rates.

The addition of the interaction terms in the second model slightly improved the explained variance ($R^2 = .774$), indicating a modest improvement of 4.7% in explained variance. Although the significance of the interaction effects as a whole was significant, $R^2 = .774$, F (46, 166) = 12.360, $p < .001$; adjusted $R^2 = .711$, the change in variance explained by the interaction terms was not statistically significant, $\Delta R^2 = .047$, $p = .097$

(Tables 12 and 13). This suggests that race/ethnicity only weakly moderates the geographic factors.

Most of the interaction terms between race/ethnicity and state in the second model were not statistically significant (see Table 14 for the significant coefficients; the complete table with all the coefficients is attached as an appendix). The only significant interaction term was found between race/ethnicity and Florida state ($B = 2.298$, $p = .021$), indicating that being Black or African American in Florida may indeed moderate the infant mortality rate. The positive coefficient suggests that infants of African American ethnicity in Florida may be associated with a higher infant mortality rate. In addition, the interaction term between race/ethnicity and being in an urban or rural area was not significant ($B = -.345$, $p = .696$), indicating that the impact of metro status did not vary much by race/ethnicity.

Therefore, while the second model was significant, the inclusion of interaction terms between race/ethnicity and geographic factors did not significantly improve the model's explanatory power compared to the first model. Except for Florida, no significant interaction was found between race/ethnicity and state or metro status. Since the addition of the interaction terms did not produce a significant change, the results do not provide enough evidence to suggest that race/ethnicity significantly moderates the effect of geographic factors on infant mortality rates. Therefore, the alternative hypothesis was rejected, and the null hypothesis was accepted, finding that race/ethnicity does not significantly moderate the effect of any geographic factors (state, urban/rural) on infant mortality rate.

Table 12

RQ3: Model Summary

Model	*R*	*R2*	Adjusted R^2	*SE* of Estimate	Change Statistics				
					R^2 Change	*F* Change	df1	df2	Sig. *F* Change
1	.853a	0.727	0.695	1.92379	0.727	23.008	22	190	0
2	.880b	0.774	0.711	1.87284	0.047	1.437	24	166	0.097

Note. a Predictors: (Constant), Metro, State=North Carolina, RaceEthnic=Black, State=Kentucky, State=Virginia, State=South Carolina, State=Arkansas, State=West Virginia, State=Delaware, State=Tennessee, State=Oklahoma, State=Mississippi, RaceEthnic=Black Hispanic, State=Maryland, RaceEthnic=Asian, State=Louisiana, RaceEthnic=More than one race, State=Georgia, RaceEthnic=American Indian / Alaska, RaceEthnic=White Hispanic, State=Florida, State=Texas.
b Predictors: (Constant), Metro, State=North Carolina, RaceEthnic=Black, State=Kentucky, State=Virginia, State=South Carolina, State=Arkansas, State=West Virginia, State=Delaware, State=Tennessee, State=Oklahoma, State=Mississippi, RaceEthnic=Black Hispanic, State=Maryland, RaceEthnic=Asian, State=Louisiana, RaceEthnic=More than one race, State=Georgia, RaceEthnic=American Indian / Alaska, RaceEthnic=White Hispanic, State=Florida, State=Texas, WhHispRace_AK_Interaction, WhHispRace_ML_Interaction, WhHispRace_VA_Interaction, WhHispRace_TN_Interaction, WhHispRace_NC_Interaction, BlackRace_OK_Interaction, AsianRace_VA_Interaction, WhHispRace_GA_Interaction, WhHispRace_OK_Interaction, BlackRace_TN_Interaction, BlackRace_TX_Interaction, BlackRace_VA_Interaction, BlackRace_MS_Interaction, BlackRace_AK_Interaction, BlackRace_FA_Interaction, AsianRace_TX_Interaction, MoreRace_NC_Interaction, BlackRace_ML_Interaction, BlackRace_NC_Interaction, WhHispRace_FA_Interaction, BlackRace_GA_Interaction, BlackRace_Metro_Interaction, WhHispRace_TX_Interaction, WhHispRace_Metro_Interaction
c Dependent Variable: Death Rate

Table 13

RQ3: ANOVA

Model		Sum of Squares	*df*	Mean Square	*F*	*p*
1	Regression	1873.358	22	85.153	23.008	0.00
	Residual	703.187	190	3.701		
	Total	2576.544	212			
2	Regression	1994.296	46	43.354	12.36	0.00

Residual	582.248	166	3.508	

Table 14

RQ3: Coefficients

Model	Unstandardized Coefficients			Std. Coeff	*t*	*p*	95% CI for *B*	
		B	*SE*	Beta			Lower Bound	Upper Bound
1	(Constant)	7.266	0.702		10.354	0.000	5.881	8.65
	RaceEthnic=Black Hispanic	5.782	1.987	0.114	2.909	0.004	1.862	9.702
	RaceEthnic=Black	6.028	0.314	0.835	19.193	0.000	5.408	6.647
	RaceEthnic = More than one race	7.237	1.425	0.201	5.077	0.000	4.426	10.049
	State=Arkansas	1.95	0.949	0.1	2.055	0.041	0.078	3.822
	State=Texas	-1.441	0.687	-0.163	-2.096	0.037	-2.796	-0.085
	Metro	-1.801	0.408	-0.178	-4.413	0.000	-2.606	-0.996
2	(Constant)	7.205	0.817		8.818	0.000	5.592	8.818
	RaceEthnic=Black Hispanic	5.685	2.025	0.112	2.807	0.006	1.687	9.684
	RaceEthnic=Black	6.029	0.982	0.835	6.141	0.000	4.091	7.967
	RaceEthnic = More than one race	10.1	2.099	0.28	4.812	0.000	5.956	14.244
	Metro	-1.561	0.578	-0.154	-2.701	0.008	-2.702	-0.42
	BlackRace_FA_Interaction	2.298	0.989	0.158	2.324	0.021	0.345	4.251

Note. Dependent Variable: Death Rate

Summary

This section included results of hierarchical multiple regression analyses which were conducted to determine whether race and ethnicity moderated effects of demographic, socioeconomic, and geographic factors on IMRs. Results showed race significantly moderated effects of certain demographic factors, particularly maternal

prepregnancy BMI and state residency. Results indicated BMI had a stronger impact on infant mortality for African American mothers. State residency also showed different effects based on race. However, no significant interactions were found for mothers' age or fathers' race.

Furthermore, race and ethnicity significantly moderated effects of certain socioeconomic factors such as WIC participation on infant mortality, with a stronger protective effect for Black individuals receiving WIC. However, no significant moderation was found for maternal education. Lastly, race/ethnicity did not significantly moderate the effect of geographic factors such as state or urban/rural status on infant mortality except for Florida. Although race/ethnicity significantly affected infant mortality in Florida for Black individuals, no broad moderating effect was found for geographic factors overall.

Race/ethnicity moderated effects of certain demographic and socioeconomic factors, particularly BMI and WIC status. These findings highlight that racial disparities involving infant mortality are more pronounced. Furthermore, findings emphasize the need for targeted interventions based on specific demographic and socioeconomic contexts, which are discussed in more depth in Section 4.

Section 4: Application to Professional Practice and Implications for Social Change

I aimed to investigate the extent to which race moderated predictive effects of demographic, socioeconomic, and geographic factors on infant mortality in the United States. The SEM was used as the conceptual framework for the study to address major gaps in literature by analyzing how these predictors interacted to contribute to IMR disparities. The study established significant disparities involving IMRs particularly among African American and Hispanic populations who have higher IMRs compared to their White counterparts. Previous findings indicated African American infants face significantly higher risks of preterm birth and low birth weight because of environmental and social stressors. Systemic inequalities are responsible for these disparities, which include limited access to healthcare, poor literacy levels, environmental toxins, and socioeconomic disadvantages. Inequities between these communities were addressed by leveraging the SEM to examine individual, community, and systemic factors. Use of community-based programs, policy changes, and culturally sensitive healthcare practices will lead to addressing inequities. I analyzed and evaluated research findings to acknowledge health inequities and offer sustainable solutions to impact health outcomes.

RQ1

The study revealed race and ethnicity moderated the relationship between demographic factors and infant mortality. Findings indicated African American and Hispanic populations who were younger (less than 25) and advanced (more than 40) experienced higher IMRs compared to White populations. Young African American mothers experienced IMRs of 11.2 per 1000 live births compared to 6.4 for White

mothers. This discrepancy shows effects of maternal age on infant outcomes are exaggerated in racial minority groups because of environmental and social stressors.

Disparities can also be explained by residency patterns. Jang and Lee (2022) established maternal age, together with residency factors, contributes significantly to disparities involving IMR. Systemic inequalities have led to African American IMRs of 13.5 per 1000 live births compared to 8.2 for urban White infants. Systemic inequalities have hindered minorities from accessing prenatal care and also exposed them to environmental toxins. Rural White populations have lower IMRs, an indication of better healthcare accessibility.

The U.S. IMR of 5.6 per 1000 live births is notably higher compared to other developed nations such as Iceland, with 1.7. This is a reflection of the healthcare system of the country, which has challenges which affect minority populations.

RQ2

The study revealed race and ethnicity substantially influence how socioeconomic factors affect infant mortality. Elder et al. (2016) established African American mothers with lower literacy levels experienced significantly higher IMRs compared to White mothers with the same education capacity. African American mothers with less than a high school diploma had IMRs of 15.8 per 1000 live births, compared to 8.7 for White mothers with the same education level. This disparity can be due to disadvantages involving accessing healthcare and gaining access to high-quality resources.

Hispanic and African American groups include people receiving low income, and programs like WIC are used to assist them. Hispanic participants in the WIC program

have been able to reduce IMR from 8.9 to 6.3 per 1,000 live births. This was an indication of programs to combat risk factors associated with IMRs can significantly reduce numbers. However, the African American community has not benefited considerably from some interventions, which was an indication of bottlenecks undermining program efficacy. Nations such as Norway, which has an IMR of 1.8 to 2.0 per 1,000 live births, have strong socioeconomic support and access to prenatal care. This shows proper social policies and programs have the capability of mitigating disparities.

RQ3

The study involved examining the moderating role of race and ethnicity on the relationship between geographical factors and IMRs. The study established African American infants in high-poverty counties had significantly higher IMRs compared to their White counterparts living in the same areas. IMR of African Americans in high poverty counties was 14.7 per 1,000 live births, while for Whites, it was 6.8 (Womack et al., 2020). Southern states have huge disparities which stem from systemic inequities and historical discrimination and have instigated health disparities.

In urban areas, African American populations live in unfriendly environments and poverty, which has predisposed them to higher IMRs. Rural Hispanic populations have benefited from stronger community ties and culturally sensitive healthcare initiatives, which negate economic disadvantages, with IMR decreasing from 9.1 to 6.5 per 1,000 live births. Lorenz et al. (2016) stated the United States compared to other developed nations lags in terms of addressing geographic health disparities. Nations with robust

universal healthcare systems record very low levels of inequality across the geographical spectrum.

Social Change

The study involved exploring why minority groups in America are suffering from high IMR rates compared to White populations. It is imperative this study leads to positive social change for these communities and addresses health issues. Culture has a significant impact on societal views regarding matters of health, and it is essential to bring solutions to these communities by embracing and understanding their ways (Crawford, 2020). Integration of culturally competent care models can lead to healthier maternal and infant outcomes (Crawford, 2020). Interventions ensure mothers have access to prenatal and postnatal care, even in marginalized communities (Appiah et al., 2021). A shift in mindset regarding matters of maternal health will lead to long-lasting solutions for these communities (Appiah et al., 2021).

Limitations of the Study

The study offered valuable information; however, several limitations were acknowledged. Data for the study was limited and received from the CDC-NVSS. Some information was unavailable from the source, and aggregated data may have obscured individual-level nuances. I used a cross-sectional design, which limited causal inferences about relationships between predictors and IMRs. There are some key variables that are unmeasurable, such as implicit biases in healthcare delivery, cultural attitudes, and access to healthcare. These key factors contribute to IMRs among minority groups. Information

from the study did not include underrepresented groups such as Native American or Asian populations.

Recommendations for Future Research

The disparities within the nation can be addressed in multiple ways, which ensures all citizens have access to quality and affordable healthcare to mitigate the high prevalence of IMR witnessed in minority groups. Effective and efficient delivery of healthcare will also significantly reduce across all groups, lowering the average in the country. The recommendations aim at improving the well-being of mothers and infants so that they can be healthy citizens who will aid the nation to grow to greater heights. The government has the mandate of ensuring citizens' access to healthcare, and this can be done by expanding Medicaid coverage and offering incentives to healthcare providers to offer prenatal and postnatal care in marginalized regions. Bhatt and Beck-Sague (2018) reiterated the need for Medicaid expansion to provide healthcare for many citizens, especially low-income earners who lack the finances to acquire insurance, locking them out of healthcare.

The communities where there is historical discrimination will require anti-racist programs for healthcare providers to eliminate bias and offer care. Community-based programs may aid by creating public health campaigns and educational initiatives aimed at promoting healthy behaviors and emphasizing prenatal care among mothers in racial minority groups. Community health workers need to be funded so that they can carry out their mandate and provide culturally sensitive support. Environmental interventions have to be carried out to reduce the risk factors brought about by toxins and other stressors.

The government needs to have pollution control and improve housing in urban areas where the risk is imminent. The resources available should be equitably shared to reduce geographic barriers when it comes to healthcare. Further research needs to be conducted to show the correlation linking race, socioeconomic factors, and IMR. This will generate information that aids in coming up with policies and programs aimed at improving the well-being of citizens.

Public Health Practice

The study aims to reduce health disparities being witnessed in American society (Dagher & Linares, 2022; Singh, 2021). This can be done by addressing race and socioeconomic factors that predispose minority groups to poor health (Esmaeilzadeh et al., 2021; Hug et al., 2019). The findings from the study may offer insights into designing health policies that will eradicate high IMR rates in given communities (Akinlo & Sulola, 2019; Doucouliagos et al., 2021; Hug et al., 2019). High-risk areas require more funding and programs that target communities that are greatly affected (Esmaeilzadeh et al., 2021; Hug et al., 2019). Health equity has to be promoted by focusing on social determinants of health, which will guarantee access to healthcare and eradicate marginalization (Bilal et al., 2021; Kim & Saada, 2013).

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