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Risk Factors of Infant Mortality Among Sub-Saharan Immigrants in the United States

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Walden University
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Abstract

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Roland G. Lankah

MPH, Walden University, 2018

BA, Southern Illinois University, 2010

Dissertation Submitted in Partial Fulfillment

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Abstract

While prepregnancy body mass index (BMI), gestational weight gain (GWG), and birthplace have been suggested to play a key role in predicting infant mortality outcomes, they have not been thoroughly investigated across all races/ethnicities. The purpose of this study was to examine the associations between prepregnancy BMI, GWG, birthplace as independent variables, and infant mortality as the outcome variable within the United States Sub-Saharan African Immigrants (SSAI). A quantitative cross-sectional study design grounded in the biopsychosocial model was used. Data were extracted from the 2017-2018 natality-linked birth/infant death file from the Centers for Disease Control and Prevention Wonder Database. It included 1,877 child-bearing mothers between ages 15 and 49. Simple and stepwise multiple logistic regressions were conducted using SPSS Version 25. The key findings revealed that BMI (underweight and obese with normal-weight as a reference) were significant with the following odds ratio respectively (OR = 22.628; 95% CI = 2.868, 178.555; p = .000), and (OR = 1.903; 95% CI = 1.416, 2.558; p =.000). Only BMI (normal and obese) stratified by inadequate and excessive GWGs, respectively showed significant associations (OR =1.469; 95% CI = 1.151, 1.875; p = .002), (OR =1.362; 95% CI = 1.061, 1.748; p = .015). Infant mortality varied largely by birthplace with Cameroon (OR=10.535; p = .000); Kenya (OR= 8.195; p =.000); Liberia (OR = 5.945; p =.000); Sudan (OR = 5.054; p =.000); Congo (OR = 4.538; p =.000); and Ghana (OR = 2.268; p=.00) showing strong predictors, respectively. The study provided clinical and public health knowledge to help improve infant mortality outcomes within the U.S. SSAI population therefore creating a positive social change.

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Chapter 1: Foundation of the Study

The death of a child during the first year of life is known as infant mortality. Infant mortality outcome is divided into two categories: neonatal death (death within first 28 days of life) and post neonatal death (death between 28 and 365 days of life). It has been considered a key indicator of overall population health and wellbeing (Murphy et al., 2018). Thus, it is critical in health promotion and social development. The infant mortality rate (IMR) is measured as infants' death per 1,000 live births in the first year of life (United Nations Children's Fund [UNICEF], 2019). Global infant mortality reached 8.7 million in 1990, with an IMR of 65 deaths per 1,000 live births (World Health Organization [WHO], 2021). The worldwide infant mortality outcome has declined significantly within the last few decades. For example, neonatal deaths globally fell from 5.0 million in 1990 to 2.5 million in 2018, with approximately 7,000 deaths per day in 2018 compared to 14,000 deaths in 1990 (UNICEF, 2019). Although the risk of a child dying remains relatively high within their first 28 days of life, the rate declines with age. In 2018, for example, while the average death rate within the first 28 days of life was 18 deaths per 1,000 live births, the death rate after the first 28 days of life and prior to reaching 365 days was 11 deaths per 1,000 live births worldwide (UNICEF, 2019).

There have been global commitments to curb infant mortality through ongoing partnerships, policies, increased welfare, and government assistance to promote economic development and improve healthcare services. For example, $59.29 billion was spent between 2000 and 2014 in efforts to strengthen global infant health, including healthcare services, education, water, sanitation, food, and humanitarian assistance provided for 134 countries; the sub-Saharan Africa regions carried the largest proportion of the disbursement (Bhatia et al., 2019). Additionally, Objective 3 of the Sustainable Development Goals (SDG) aimed to end the preventable death of infants, with all countries targeted to reduce IMR to as low as 12 deaths per 1,000 live births (United Nations, 2020). The SDG redressed the 2000 Millennium Development Goal (MDG), which most countries failed to achieve; this objective aimed to reduce growing global IMR (Bhatia et al., 2019).

Despite these commitments, variations in infant mortality outcomes persist across populations due to prepregnancy and pregnancy risk indicators and socioenvironmental determinants. For example, globally, an estimated 2.4 million infants died in their first month of life in 2019, with approximately 6,700 deaths per day (UNICEF, 2020). Within these, the disparity in the level of infant mortality outcomes increased across regions. Over half of the world's infant deaths occurred in the sub-Saharan African population (Baraki et al., 2020). In 2019, the sub-Sahara African regions experienced the highest infant mortality, with an estimated 27 deaths per 1,000 live births (UNICEF, 2020). A child born in sub-Saharan Africa was ten times more likely to die in their first year of life than one in high-income countries (UNICEF, 2020).

Background

Several studies have furthermore suggested that the contextual health disparities faced by the sub-Saharan African immigrant (SSAI) population exist also in developed countries; however, studies focusing on perinatal health and infant outcome have vastly used a mixed population sample to predict infant mortality outcome. In the United States, for example, the four main causes of infant deaths in 2017 were congenital disabilities, preterm births, low birth weight, maternal complications, and sudden infant death syndrome (Murphy et al., 2018). The overall U.S. IMR in 2016 and 2018 were 5.8 and 5.7 deaths per 1,000 live births, respectively (Centers for Disease Control and Prevention [CDC], 2018a, 2020a).

Despite experiencing some decline in IMR, U.S. race/ethnicity disparities remain vastly disproportional. The CDC (2020b) presented the 2016 comprehensive statistic of infant mortality, and the IMR by race/ethnicity indicated rates ranging from 3.6 in the Asian population, 9.4 in American Indian/Alaskan natives, and 11.4 for non-Hispanic Black populations. Black infants were 2.5 to 2.8 times more likely to die from perinatal health conditions (i.e., health conditions seven days after birth), such as sudden infant death syndrome, influenza, or pneumonia, and 1.3 times more for congenital disabilities, as compared to White infants (Singh & Yu, 2019).

Approximately 3.79 million infants were born in the United States in 2018 (Hamilton et al., 2019). Of these, preterm births increased by 10.02% (379,777 preterm births). Non-Hispanic Black women suffered a statistically significant rise in preterm birth rates. For example, in 2017 and 2018, non-Hispanic Black mothers experienced an increased rate (13.93% to 14.13%) of preterm births compared to all racial groups surveyed (Hamilton, et al., 2019). While the statistic is staggering and shows an overview of the health disadvantages experienced by U.S. Black people as a homogeneous population, there is a lack of a population-based differentiation in IMR that focuses on race/ethnicity or ethnicity subgroups, such as the U.S. SSAI population.

Research has identified a considerable variation in health experiences across populations (Omenka et al., 2020; Singh & Yu, 2019). SSAI populations, among other racial groups, have unique health experiences and healthcare needs. A recent study conducted in Utah identified an elevated IMR among the U.S. SSAI population (Dyer & Baksh, 2016), thus, suggesting the need to assess risk factors influencing IMR. A population-based research assessing SSAI population health is essential as it provides insights relating to risk factors, including social and environmental, prepregnancy, and gestational health that are associated with the increased in IMR.

Problem Statement

Over 2 million SSAIs reside in the United States; some emigrated as refugees from crisis-affected nations due to prolonged violent civil wars that engulfed their homelands and caused their diasporas, and others emigrated to attain better educations and to improve their livelihoods (Echeverria-Estrad & Batalova, 2019). The vast majority of SSAI individuals came from countries in the middle, eastern, and western sub-Saharan African regions, and although they accounted for just 4.5% of the 44.7 million immigrants in the United States in 2010, the SSAI population has increased by more than 50% between 2010 and 2018 (Echeverria-Estrad & Batalova, 2019).

In comparison to other U.S. immigrants, SSAI individuals are mostly recent arrivals. According to a new survey, about 38% settled in the United States after 2010, with 30% arriving before 2000 and 32% migrating between 2000 and 2009 (Nwankwo & Wallace, 2020). Between 2010 and 2016, about 17% of all Africans who entered the United States were refugees (Nwankwo & Wallace, 2020). Variation in the migration flow and the immigrant selection processes from the countries of origin may influence disparities in health experiences upon arrival in the United States.

Multiple risk factors have been determined to influence infant mortality outcome. Among them, factors related to maternal preconception health (e.g., prepregnancy body mass index, [BMI]); gestational weight gain (GWG, e.g., excessive and inadequate gestational weight gain), as well as maternal birthplace have been suggested to play a key role in predicting infant mortality outcome; however, these factors have not been thoroughly investigated in SSAI individuals in the United States (Akgun et al., 2017; DeSisto & McDonald, 2018; Murphy et al., 2018; Siega-Riz et al., 2020).

Increased prepregnancy BMI, maternal GWG, and the mother's birthplace have been identified as potential perinatal health risks that may affect infant mortality outcome in previous research. In 2009, a guideline was established—by both the Institute of Medicine (IOM) and the National Research Council (NRC)—that addressed maternal GWG. The guideline suggested that women whose GWG exceeds or falls below the recommended baselines are more likely to experience an increased risk of adverse infant health conditions (Siega-Riz et al., 2020). Álvarez-Bueno et al. (2017) also concluded that infants of mothers with excessive GWG experienced preterm delivery, fetus death, heart disease, diabetes, and poor neurological development. Ukah et al. (2019) indicated that inadequate GWG (lower GWG) was also associated with infant death and morbidity, and Wartko et al. (2017) argued that low birthweight varied by maternal birthplace.

Maternal BMI, GWG, and birthplace were also positively associated with social, environmental, and maternal prepregnancy and pregnancy risk indicators such as lifestyles, lack of physical activities, culture, diet, disadvantaged community, and other socioeconomic related phenomena (Akgun et al., 2017; Ngoubene-Atioky & Williamson-Taylor, 2017). These studies accounted for contextual health inequalities/disparities, and the impact of health issues such as elevated maternal BMI and GWG on infant mortality outcome, but they have exclusively focused on ethnicities such as Hispanic and Asian immigrant populations (Rice et al., 2017; Thompson & Suter, 2020). Black population-based studies have most often evaluated mixed samples, (i.e., from different Black racial groups, including African Americans, Africans, and Caribbeans; Álvarez-Bueno et al., 2019; Bodnar et al., 2017; Voerman et al., 2019).

Most other published studies have explored the impact of environmental and social constructive factors on SSAI infant mortality (Dyer & Baksh, 2016), as well as a wide range of health issues related to HIV and cancer-screening (Adekeye et al., 2017; De La Cruz et al., 2020; Medhanie et al., 2017); however, the underlying effects of prepregnancy BMI, GWG, and maternal birthplace on SSAI infant mortality remain largely understudied.

Purpose of the Study

The purpose of this study was to examine the association between maternal prepregnancy BMI, GWG, and birthplace and infant mortality outcomes within the U.S. SSAI population while adjusting for covariates such as educational attainment and age. The study also determined the moderating effects of the covariates on the associations between the predictors and infant mortality outcomes, as well as assessed the association between the covariates and infant mortality outcomes. A quantitative cross-sectional study design was carried out using the sub-Sahara African regions, including eastern, middle, and western regions, that contain the countries that send the most SSAIs to the United States (see Echeverria-Estrada & Batalova, 2020; Pew Research Center, 2020).

Figure 1

Regions with Top Sending Countries

Eastern Africa Region
Ethiopia
Kenya
Somalia
Sudan
Middle Africa Region
Cameroon
Congo
Western Africa Region
Liberia
Nigeria
Ghana

Note: Figure 1was adapted from the Migration Policy Institute and the Pew Research Center, and it depicts the three sub-Sahara African regions with the top sending countries (Echeverria-Estrada & Batalova, 2020; Pew Research Center, 2020); it also represents the birthplaces of the U.S. SSAI population

The three *a priori* main independent variables investigated were (a) prepregnancy BMI, (b) maternal GWG, and (c) maternal birthplace. Three underlying research questions were designed to predict the association between these main independent variables and infant mortality outcomes.

Research Questions and Hypotheses

RQ1: Is there an association between maternal prepregnancy BMI and infant mortality outcome while controlling for maternal age and educational attainment?

$H_1$1: There is no association between maternal prepregnancy BMI and infant mortality outcome while controlling for maternal age and educational attainment.

$H_0$1: There is an association between maternal prepregnancy BMI and infant mortality outcome while controlling for maternal age and educational attainment.

RQ2: Is there an association between maternal GWG (measured by the difference between the maternal end-of-pregnancy weight and prepregnancy weight) and infant mortality outcome varied by maternal prepregnancy BMI while controlling for maternal age and educational attainment?

$H_1$2: There is no association between maternal GWG (measured by the difference between the maternal end-of-pregnancy weight and prepregnancy weight) and infant mortality outcome varied by maternal prepregnancy BMI while controlling for maternal age and educational attainment.

$H_0$2: There is an association between maternal GWG (measured by the difference between the maternal end-of-pregnancy weight and prepregnancy weight) and infant mortality outcome varied by maternal prepregnancy BMI while controlling for maternal age and educational attainment.

RQ3: Is there an association between maternal birthplace and infant mortality outcome while controlling for maternal age and educational attainment?

$H_1$3: There is no association between maternal birthplace and infant mortality outcome while controlling for maternal age and educational attainment.

$H_0$3: There is an association between maternal birthplace and infant mortality outcome while controlling for maternal age and educational attainment.

Theoretical Framework

The biopsychosocial theoretical framework guided the association between prepregnancy BMI, GWG, maternal birthplace, and infant mortality outcome. The biopsychosocial framework was initially devised by Engel in 1977 to explore health in multifaceted ways (Rosen, 2020). The biopsychosocial approach addressed the traditional framework of biomedicine, which primarily focused on the pathophysiology and biological aspects of illness (Rosen, 2020). The biomedicine model lacked the comprehensive inclusion of social and psychological approaches to address health and disease. Biopsychosocial theory, however, acknowledged the interplay between population and biomedical, psychological, and social influences (Rosen, 2020).

The model offered a wider basis for investigating the multi-dimensional determinants of infant mortality outcome, such as prepregnancy BMI and GWG, as well as socioenvironmental factors. Infant mortality outcome is multifactorial, thus meriting the biopsychosocial model approach and its focus on the natural biological system. It also accounts for the environmental, behavioral, psychological, sociological, and other cultural influences that contribute to poor birth outcomes.

Infant mortality outcome is determined by a series of events that occur prior to conception and during pregnancy, childbirth, the postpartum period, and childhood. Thus, the biopsychosocial approach guides the concept of a pregnancy continuum, which was used to develop three critical constructs. These constructs include prepregnancy risk indicators, pregnancy risk indicators, and social and environmental risk indicators.

The prepregnancy risk indicators and pregnancy risk indicators are intermediate conditions, which exhibited risk factors such as increased prepregnancy BMI and GWG that influence infant mortality outcome in the host country (Álvarez-Bueno et al., 2019; Bodnar et al., 2017; Voerman et al., 2019). These conditions were more likely influenced by acculturation, cultural assumptions, nutrition/diet, health behaviors, lifestyle, and socioeconomic factors in the host country.

Socioenvironmental risk indicators were pre-existing conditions related to the maternal birthplace prior to emigration. The social and environmental risk indicators were existing maternal conditions that affected infant mortality outcome in the host country. The constructs primarily focused on the concept, which determined how each of the variables included was associated with infant mortality outcome. Figure 2 below depicts the constructs, and each construct was linked to a specific study variable that was used to predict infant mortality outcome within the study population.

Figure 2

Study Constructs

CONSTRUCTS	**PREDICTOR VARIABLES**	**OUTCOME VARIABLE**
Prepregnancy Risk Indicators	Maternal Prepregnancy-BMI	Infant Mortality
Pregnancy Risk Indicators	Maternal GWG	
Social and Environmental Risk Indicators	Maternal birthplace	

Nature of the Study

The study was quantitative, and it employed a cross-sectional study design. In a cross-sectional study design, researchers determine the outcomes and the participants' disease exposure at the same period (Setia, 2016). This study design was suitable for the current study because it measured infant mortality outcomes within the selected population as a snapshot. The participants were selected based on the study's inclusion and exclusion criteria. The study inclusion criteria involved infants born between 2017 and 2018 to United States. SSAI mothers from the top nine sending countries within the three selected sub-Saharan African regions. Any missing variable-dependent categories, such as BMI, infant death, maternal birth country, and maternal GWG, were excluded.

I used SPSS version 25 to carry out the statistical analysis, and it incorporated (a) descriptive statistics, (b) simple logistic regressions, and (c) a stepwise multiple logistic regression. The logistic regression models estimated that an observed value was likely to fall into one of the two categories (yes or no) of the dichotomized outcomes variable based on one or more of the predictor variables (Laerd Statistics, 2018). The simple logistic regressions determined whether to reject or fail to reject the null hypothesis, and the stepwise multiple regression determined the most parsimonious/improved model for predicting infant mortality outcome. Both logistic regression models assessed the likelihood of infant mortality outcome associated with each main independent variable.

The CDC Wonder database was used for extracting the study data. The database used the linked birth/infant death records file from 2017–2018 U.S. vital statistics (CDC, 2020c). The information in the database is publicly accessible, and it included records reported on birth and death certificates.

Definitions

Excessive GWG: GWG that exceeds the maximum IOM/NRC pregnancy weight gain recommendation.

Gestational weight gain (GWG): The difference between the end-of-pregnancy weight and prepregnancy weight.

Inadequate GWG: GWG that falls below the minimum IOM/NRC pregnancy weight gain recommendation.

Infant mortality: Death of an infant within the first year of life. This was the outcome variable of the study.

Maternal birthplace: The top sending SSAI countries from which the mother was born and in which she lived prior to migrating to the United States. The countries were selected due to their common boundaries, histories, dietary habits, civil war backgrounds, and related migration and postmigration experiences. Maternal birthplace and maternal source country are used interchangeably in this study.

Maternal prepregnancy BMI: The mother's weight in kilograms/height in meter^2 before pregnancy.

Perinatal health: Health issues that affected the mother before, during, and after birth and that subsequently affected infant mortality.

Perinatal health condition: Infant health conditions within 22 weeks of gestation and 7 days after birth.

Sub-Saharan African immigrant or SSAI: An immigrant born and raised in one of the nine sub-Saharan African countries represented prior to emigrating to the United States.

Assumptions

I made three critical assumptions relative to the representation of the studied population. Researchers have suggested that recent immigrants show superior health as compared to immigrants with prolonged residency in the host country (Ichou & Wallace, 2019; Markides & Rote, 2019); however, the current study has no method to account for the length of time the immigrant mothers have resided in the United States. Thus, I assumed a uniform population and general level of health.

Although misclassification of ethnicity on death certificates was evidenced for Native American and Hispanic individuals (Markides & Rote, 2019), it was also a concern among African American and African immigrants in the current study. Thus, I assumed that the evidence suggested in this study was exclusively based on the selected population of interest, and the impact of misclassification on the study results was not statistically significant.

Like misclassification of ethnicity, incomplete information on the birth certificate could result in missing links in matching birth certificates to corresponding death certificates. I assumed that any data with missing information did not meet the inclusion criteria and deleted it.

Scope and Delimitations

The study's scope involved all infant birth/death records between 2017 and 2018 to mothers from the three sub-Saharan African regions with the nine top immigrants sending countries. The data collection method was configured to produce data with only variables of interest; therefore, birth certificates with missing data, such as maternal birth country, mother's weight gain, and prepregnancy BMI, were excluded from the collected data. Excluding potential participants with the exposure-to outcome of interest can increase the risk of statistical errors (Szklo & Nieto, 2019), thus, a larger sample size was collected to accommodate the excluded data. Increasing the sample also helped in maintaining adequate statistical power (Szklo & Nieto, 2019). In addition to the primary study variables, covariates, such as the mother's education and age, may affect infant mortality outcome. Several studies have exclusively associated maternal age with infant mortality outcome. For example, Ely and Driscol (2020) predicted that a maternal age above 40 was associated with increased infant mortality. Thus, I adjusted the current study for maternal age to account for confounding effects.

Limitations

The study was limited by systemic biases, which included misclassification and survey issues with data completeness. According to Szklo and Nieto (2019), misclassification rises when recollection biases occur, and exposed subjects are misclassified as unexposed or vice versa. For example, the study participants' ethnicity experiencing the exposure-outcome association of interest was more likely to be misclassified or queried in the CDC-Wonder database.

Moreover, the CDC-Wonder database participants were liable to provide inaccurate records of health status, including prepregnancy weight and end-of-pregnancy weight, which may have resulted in erroneous measurements of maternal GWG. Previous studies have suggested that obese individuals, especially women, under report their weight (Ju et al., 2018); however, whether underreported data or misclassification significantly impact the CDC-Wonder database is still unclear. The study's cross-sectional nature, which merely measured the exposure and outcome variable in the studied participants, did not determine causal and effect relationships between the study variables.

Covariates such as maternal educational level, earnings, marital status, age, and health risk factors, for example, hypertension and other perinatal complications, can all also have effects on the outcome of infant mortality. Some of these covariates were not categorically accounted for in this study. Future studies will benefit if these covariates are assessed using a logistic regression model to examine their influences on SSAI infant mortality outcome. For instance, although a lack of educational attainment might not be a clear predictor of infant mortality, it may still be deemed a risk factor since education may increase health literacy. Education also plays a critical role in predicting wages and access to healthcare services. The association between educational attainment and SSAI infant mortality is still unclear. Identifying these covariates and their direct relationships to birth outcomes will enable a more refined prediction of infant mortality outcome in future research studies.

Significance

The study provided clinical and public health knowledge to help improve infant mortality outcome within the U.S. SSAI population. In 2018, the United States experienced an increased population of approximately 203,000 foreign-born people (Batalova et al., 2020). While this number represented a decrease in the annual growth rate by 0.5%, an elevated overall growth rate was projected due to the influx of refugees seeking asylum from wars and due to global instabilities (Batalova et al., 2020). Furthermore, a disproportionately high number of asylum-seeking countries in sub-Saharan Africa lack proper healthcare and educational infrastructures. Thus, more SSAI individuals migrated to the United States with minimum education/health literacy.

For these reasons, the current study is critical, and it contributed to favorable improvements in infant health outcomes and healthcare services. For example, the study served as an essential tool/resource for prepregnancy counseling services. Healthcare providers will now provide health literacy to women of child-bearing age about health behaviors related to prepregnancy weight and offer adequate gestational weight gain recommendations. In addition, I presented literature to encourage healthy eating and physical activity. Prepregnancy counseling services may recommend incorporating dietary and physical activity as essential approaches for public health intervention and thereby improve health outcomes for both mothers and infants.

The study further provided insight into promoting culturally appropriate public health interventions that focus on reconciliation to improve SSAI infant mortality outcomes. Lopez-Cepero et al. (2018), for example, agreed that women who followed their healthcare providers' guidelines for an optimal BMI and GWG had better health outcomes. The absence of appropriate public health interventions and health literature tailored to SSAI exacerbates the current health vulnerabilities (Omenka et al., 2020). Prepregnancy BMI, GWG, and birthplace-related factors are important risks of infant mortality outcomes; thus, assessing these risk factors is essential to ascertaining appropriate public health intervention, healthcare services, and policies to reduce the rate of infant mortality within the U.S. SSAI population.

Summary

While several studies have suggested the disparities in birth outcomes due to variation in maternal periconceptional weight, gestational weight, and maternal birthplace, it is still unclear whether these variables are associated with infant mortality outcome within U.S. SSAI. To increase public and healthcare knowledge and to also affect culturally appropriate intervention, there is a need to identify the underlying factors that suggestively contribute to infant mortality outcomes in the U.S. immigrant population from sub-Saharan African origins. Previous studies, which have considered assessing the variation in infant mortality outcome based on maternal prepregnancy BMI, GWG, and birthplace, failed to focus on U.S. SSAIs' health needs. Therefore, I purposely aimed to investigate whether these variables predict infant mortality outcomes within the U.S. SSAI population.

I used biopsychosocial theory to guide these associations. The biopsychosocial theory was appropriate due to its multifactorial approach to addressing infant mortality outcomes from various perspectives. It presented a broad approach that accounted for factors related to prepregnancy and pregnancy risk indicators, social and environmental determinants, as well as how all these factors influenced infant mortality outcomes. The U.S. 2017 to 2018 linked birth/infant death records from the CDC-Wonder database were used for data collection. The expanded version of the database provided data on the primary variables of interest, including prepregnancy BMI, GWG, maternal birthplace, and infant mortality outcomes.

In Chapter 2, I present a comprehensive literature review of theoretical foundations, literature search strategies, and study constructs and the key variables. I also discussed how each variable and its construct are linked to infant mortality outcomes.

Chapter 2: Literature Review

The literature review presented suggestive evidence that assesses the influence of maternal prepregnancy BMI, GWG, and maternal birthplace on SSAI infant mortality outcome. It outlined the interplaying roles of key constructs, including prepregnancy risk indicators, pregnancy risk indicators, and social and environmental risk indicators. It also delineated the theoretical framework, which guided the concept that determined the variation in the constructs, the primary variables, and how they influenced infant mortality outcome. The literature review is structured according to two themes: the theoretical foundation and its various components and the literature review related to key variables.

The components of the theoretical foundation consist of the three constructs (prepregnancy risk indicators; pregnancy risk indicators; and social and environmental risk indicators); the intermediate determinants; the unknown factors; and the outcome components. The literature review related to key variables encompassed four primary variables: maternal prepregnancy BMI, maternal GWG, maternal birthplace, and infant mortality outcome. The final section of the chapter described covariate-related factors and their moderating effects on the association between the predictors and infant mortality outcome.

Literature Search Strategy

A systematic literature review was conducted online using Walden University's Library, Google Scholar, and government and organization websites, including WHO and CDC. Primary and secondary research articles reporting on maternal GWG, BMI, birthplace, perinatal health, and infant mortality outcomes published between 2016 to present in the English language were eligible for inclusion. The keywords used in the search categories included *gestation weight gain, sub-Saharan African health status, prepregnancy obesity*, *gestation weight gain and infant mortality*, *U.S. vita statistics, U.S. leading causes of infant mortality, U.S. infant mortality rate, sub-Saharan African immigrant and infant mortality, maternal birthplace,* and *infant mortality*.

Theoretical Foundation

The biopsychosocial model of health expanded the traditional biomedical aspects of health (Mali, 2017). The biopsychosocial framework was devised in 1977 Engel to facilitate the multifaceted concept of health (Rosen, 2020). The biopsychosocial also depicted the socioecological context to health. While the social or ecological models of health emphasized the holistic context—which guided health as an inextricable role that links mental, economic, societal, and environmental indicators—the biopsychosocial model was an embodiment of both the social and ecological aspects of health (Mali, 2017), and it integrated the psychological influence on the human health (Rosen, 2020). The biopsychosocial approach reflected the inclusion of all facets of human experience, which results from the interplay roles of social structure, the impact of the individual, communities, families, economic, cultural, and physical environmental conditions (Mali, 2017). Thus, the biopsychosocial model highlights that human health can be promoted or inhibited by social and environmental contexts. For example, in resource-poor countries, poor health was attributed to compelling health-seeking behaviors/choices (Mali, 2017). Differences in social status or demographics, including class, gender, ethnicity, and regions, can vary these social contexts and influence human health. The biopsychosocial model also depicted the cultural role as a health determinant by which the population perceived, expressed, and followed health, illness, and treatments (Mali, 2017).

The ambit of the biopsychosocial model expands to consist of factors affecting the three main constructs, intermediate health determinants, and unknown factors with modifying effects on infant mortality outcome. Figure 3 below depicted the schematic description of the biopsychosocial conceptual framework, related constructs, intermediate determinants, outcome, and other effect modifiers.

Figure 3

Schematic: Biopsychosocial Model Framework

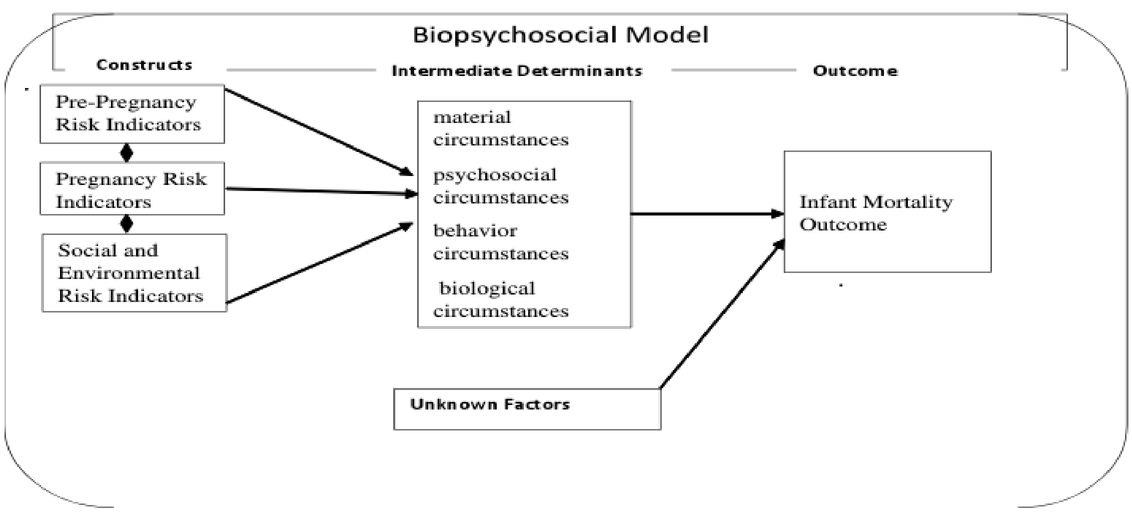


Figure 3. Adapted from “A framework for analyzing the determinants of maternal mortality” by J. McCarthy & D. Maine, 1992, *Studies in Family Planning 23*(1), p. 25, and “A conceptual framework for action on the social determinants of health” by the World Health Organization, 2010.

The diagram portrayed a relatively simple framework describing the biopsychosocial model for analyzing infant mortality outcomes. It showed the biopsychosocial model stages, which presented the basic constructs, including prepregnancy risk indicators, pregnancy risk indicators, social and environmental risk indicators, intermediate determinants, unknown factors, and infant mortality outcomes. The infant mortality outcome is the final component of the schematic, which was discussed in detail under the section, Literature Review Related to Key Variables.

Constructs

Prepregnancy Risk Indicators

The prepregnancy risk indicators involve risk factors existing prior to pregnancy, including maternal health behaviors or conditions, such as increased prepregnancy BMI, that adversely affect the infant's health. The prepregnancy risk indicators aspects of the biopsychosocial model seek to identify existing unfavorable health behavior, conditions acquired from the maternal birthplace, and those adopted in the host country prior to pregnancy. These behaviors can affect perinatal health and facilitate infant mortality outcomes. Factors placing infants at an increased risk of morbidity or mortality can be associated with prepregnancy situations. Identifying such risk situations during preconception can allow healthcare providers and child-bearing mothers to plan before pregnancy progresses and prevent further complications or perinatal conditions. The prepregnancy risk indicator is faceted, and while it would benefit from capturing every aspect of the risk situation, selecting systemic-based risk factors can suggest an order to identify groups, race/ethnicity with high risk. Therefore, it can promote public health strategies to target disadvantaged populations and deprived communities. Prepregnancy risk indicators that have been identified to impact infant mortality outcome include maternal overweight and health behaviors, including diets, culture, etc. For example, Garay et al. (2021) investigated the risk factors of excessive weight gain during pregnancy, and they found that maternal overweight and obese prepregnancy BMI were associated with excessive GWG. They further observed that health behaviors such as excessive alcohol consumption while pregnant were associated with inadequate GWG. Garay et al. recognized the biopsychosocial aspects of health, including psychological, social, and environmental factors, and addressed the broader concepts of infant mortality outcomes.

Pregnancy Risk Indicators

The biopsychosocial approach can further account for pregnancy risk indicators, which define health characteristics during pregnancy, including excessive weight gain or weight loss resulting in adverse infant health outcomes (Duberstein et al, 2021). Pregnancy risk indicators may also consist of conditions that existed prior to pregnancy (Duberstein et al, 2021).. Thus, both constructs (pregnancy and prepregnancy risk indicators) have an interplaying impact on infant mortality outcome. For example, Nwankwo and Wallace (2020) suggested a decline in health, including prepregnancy overweight/obesity within women with a high level of acculturation, and Ceballos et al. (2018) observed an increase in infant macrosomia due to maternal overweight for women with prolonged residency. These studies suggested that excessive prepregnancy weight gain and the risk of acculturation during pregnancy contribute to an unfavorable infant health outcome. Moreover, postmigration health behavior and environment are critical in promoting weight gain prior to and during pregnancy. For example, changes in immigrants' dietary and physical activity behaviors were primarily related to the availability, accessibility, and affordability of diet and physical activity products (Addo et al., 2019). Time management was also a key determinant in the changes observed in dietary and physical activity behaviors (Addo et al., 2019).

The pregnancy risk indicator is associated chiefly with maternal GWG. Ceballos et al. (2018) indicated that excessive GWG can increase pregnancy health risks for both mother and infant. Other studies have also demonstrated a strong association between inadequate GWG and infant mortality outcome. For example, Chen et al. (2020) indicated that inadequate GWG was positively associated with low birth weight, preterm birth, and perinatal mortality. Both studies provided strong evidence that promotes the amelioration of adverse birth outcomes through achieving balance GWG.

It has also been established that the psychosocial stressors caused by power intersections influence maternal GWG. Jörgensdotter Wegnelius and Peterson (2018) described intersectionality as a framework that facilitates discrimination and privilege based on the individual's social and political identities such as race, gender, and class. Immigrant women are likely to experience poor physical health due to power intersectionality. Intersectionality may result in discriminatory practices and can render immigrants invisible and marginalized, resulting in the neglect of immigrants' health risks, including access to healthy food, a built environment to improve physical activities, and access to adequate healthcare services. Jörgensdotter Wegnelius and Peterson provided a firm suggestion that pregnancy risk indicators are influenced by a range of biopsychosocial factors, with an inextricable role of social and psychological risk factors.

Social and Environmental Risk Indicators

The biopsychosocial model also considers all relevant social and environmental determinants of health and disease. The social and environmental risk indicators consist of the combined effects of perinatal health-related factors (e.g., social factors: healthcare, policy, economic, culture, family, living conditions, and community, etc.) both in the immigrants' source country and the host country that affect infant mortality outcome. The influence of social and environmental risk indicators on infant mortality outcomes varies widely among and within individual countries. For example, in middle and low-income countries, environmental determinants such as household air pollution, water, sanitation, and hygiene play a key role in infant mortality outcomes. Globally, approximately 4.3 million deaths were attributed to household air pollution, with infants experiencing excessive acute respiratory infection (Naz et al., 2017). Eighteen of the top 20 countries with elevated household air pollution were in Sub-Saharan Africa (Owili et al., 2017). These countries experienced an increased burden of acute respiratory infection due to reliance on solid biomass for cooking (Owili et al., 2017). Furthermore, the lack of adequate water supply, toilet facilities, and electricity were strongly associated with infant mortality outcomes within these regions (Adjiwanou & Engdaw, 2017).

Additionally, access to adequate healthcare services and healthcare expenditure, nutrition, and socioeconomic factors affect infant mortality outcomes in low-income countries. For example, in the past 15 years, there have been healthcare budgetary improvements in some Sub-Saharan African countries; however, a vast majority of the healthcare services were provided by privately owned entities, thus, requiring out-of-pocket expenditure (Kiross et al., 2020). Approximately 10% of the sub-Saharan African region's population suffered financial disparities per year due to out-of-pocket medical payments, and approximately 4% of the population lived below the regional poverty level (Kiross et al., 2020). Healthcare expenditure is fundamental to an overall healthcare system. It helps to maintain and improve the wellbeing of the population. The lack of adequate financing of a healthcare system may result in the inability to provide appropriate medical equipment, healthcare services, and disease prevention. Thus, healthcare expenditure reflects healthcare utilization across countries. Government expenditure on healthcare services also impacts healthcare use; however, health expenditure varies across countries. For instance, while few low-income countries such as Ethiopia, Gambia, and Malawi spent over 15% of government revenues on healthcare sectors, high-income countries in the regions failed to prioritize healthcare spending; thus, many countries across the sub-Sahara Africa regions suffered significant socioeconomic and healthcare infrastructure disparities (Kiross et al., 2020). Moreover, previous studies linked infant mortality outcome in sub-Saharan Africa regions to lack of access to skilled healthcare workers, increased prevalence of human immunodeficiency virus (HIV), unaffordability of and long traveling distances to healthcare facilities, and delays in seeking healthcare services (Kisenge et al., 2020). For pregnant women who live in faraway rural settings, such challenges are heightened. For example, in Liberia, long traveling distance to healthcare facilities was directly associated with negative maternal health-seeking behavior; thus, increasing infant mortality outcome (Laurenzi et al., 2020). This evidence shows the social and environmental barriers to healthcare services and their influence in predicting infant mortality outcome. In resource-poor countries, both poverty and the lack of adequate healthcare services contextually impacted infant mortality outcome, regardless of sociodemographic (Mohamoud et al., 2019).

Despite migrating to high-income countries from more impoverished socioeconomic contexts and environmental disadvantages, immigrants from low-income regions continue to experience infant health disparities postmigration. For example, Belihu et al. (2016) compared perinatal outcomes between East African immigrants and Australian-born mothers. They identified a disproportionally high rate of infant mortality, small for gestational age, low birth weight, and preterm birth among east African immigrants as opposed to their Australian-born counterparts. They also observed that a significant variation in infant morbidity existed among individual maternal source countries. The poor performances in high-income countries were mainly attributed to structural conditions, including social factors in nature rather than healthcare services (Fiori et al., 2020; Nong et al., 2020). Infant mortality outcome is amenable to a certain extent through effective healthcare services, and high-income countries such as the United States provide superior healthcare services compared to other peer nations. In the United States, most child-bearing mothers were recipients of Medicaid with access to state-of-the-art academic medical facilities; however, healthcare costs were problematic for women who were not qualified for Medicaid and were also uninsured (Fiori et al., 2020). This is even exacerbating conditions for immigrant mothers residing in a deprived community and rural areas with no coverage and limited access to medical facilities, which can contextually impact infant mortality outcomes in healthcare delivery. The U.S. IMR ranking was evident in states with weaker healthcare delivery systems, such as Mississippi, which had an IMR of 8.3 deaths per 1,000 in 2018 (CDC, 2020d). The opposite is true for states with a much stronger healthcare delivery system, such as California, with an IMR of 4.2 deaths per 1,000 live births in the same year (CDC, 2020d). These results suggested the integration of social and environmental contexts. It also explores variation in factors affecting infant mortality across countries and regions.

Intermediate Determinants

The biopsychosocial model was organized around the intermediate determinant component. The intermediate determinant included material, psychosocial, behavior, and biological circumstances (WHO, 2010). The material circumstances involved the community, housing, access to quality healthcare services, food, income, health, socioeconomic, and physical environment. The psychosocial circumstances, include stressors, social support, and coping styles while the behavior and biological circumstances included factors influencing diets, culture, physical activity, alcohol, tobacco consumption, and genetic factors (WHO, 2010). The intermediate determinants capture sequences of situations or outcomes that can either improve or exacerbate infant health outcomes.

Unknown Factors

Infant mortality outcomes can arise from factors other than the intermediate components, such as diet, access to healthcare services, or adverse health conditions during pregnancy. Infants born to women from an affluent community with access to quality healthcare services and healthy prepregnancy conditions may also experience poor infant outcomes for reasons that are unknown or cannot be predicted. The unknown factors are risk factors/covariates, which may play a confounding role in affecting infant mortality outcomes but are not considered the primary risk indicators in my study.

Literature Review Related to Key Variables

Prepregnancy BMI

Nearly two-thirds of the U.S. adult population was overweight or obese (CDC, 2021a). The prevalence of overweight/obesity increased from 22.8% in 1976 to 53.5% in 2014 (Singh & DiBari, 2019). Annually, approximately 4 million women give birth in the United States (CDC, 2021b). Of these, the rates of prepregnancy obesity among mothers increased to 20% (Singh & DiBari, 2019). Maternal prepregnancy overweight, and obesity are well documented as health risks for a wide array of poor infant heath and maternal health conditions. For example, prepregnancy overweight/obesity caused congenital disabilities, preterm, low birth weight, preeclampsia, delivery complications, and childhood metabolic syndrome (Álvarez-Bueno et al., 2017; Ju et al., 2018). Zhou et al. (2019) also found that maternal obesity was associated with fetal loss, spontaneous abortion, and large for gestational age compared with normal-weight. Furthermore, Singh & DiBari (2019) suggested that prepregnancy obesity was highly associated with infant mortality.

In 2009, the IOM/NRC established guidelines for maternal GWG (Siega-Riz et al., 2020). Power et al. (2018) indicated that the maternal, infant, and child health of the Healthy People 2020 report established objectives that aimed to increase the number of child-bearing women who gain the recommended GWG. It also focused on increasing the number of live births for women who maintain healthy preconception weight. As a result, the IOM/NRC guideline was re-assessed, with the recommended GWG dependent on variation in maternal prepregnancy BMI. A high maternal prepregnancy BMI can indicate overweight and obesity, and it was measured as a mother's weight in kilograms divided by the square root of the height in meters (CDC, 2021b & Deputy et al., 2018). BMI was divided into four categories: underweight (BMI 18.5 kg/m^2), normal-weight (BMI 18.5–25 kg/m^2), overweight (BMI 25–30 kg/m^2), and obese (BMI 30 kg/m^2) (Power et al., 2018). BMI can be defined in the context of cultural and biological perspectives. The concept of BMI in Western culture is mostly applied to measure health outcomes. For instance, in Western culture, increased BMI was an indicator of many health problems such as diabetes, heart disease, and risk of certain cancers (CDC, 2020e). Whereas there are implications of beauty preferences and health behavior in other cultures, such as sub-Saharan African culture. Kim and Lee (2018) described human behavior as a habit-forming phenomenon that results from exhibiting a response to stimuli that shape health behavior, perceptions, and preferences for attraction. The human habit-forming phenomenon is expressed through sensory modalities. According to Mo et al. (2016), the related stimuli were demonstrated by perceptual and cognitive mechanisms that constitute one's need for attractiveness and perceivable body image. Beauty is multifaceted, and previous studies have shown that biological, psychological, cultural, and societal factors influence how one perceives beauty and attraction.

The perception of beauty varies with culture and time. Maymone et al. (2019) asserted that Western culture's evolution of what constitutes a "beautiful" female body—i.e., waist-to-hip ratio—had persisted relatively consistently throughout the 20th century; however, there was a vast variation in BMI across cultures and time periods. Ngoubene-Atioky and Williamson-Taylor (2017), for example, studied SSAI culture to determine if curvier and broader scale body types for women were preserved postmigration to the United States. They suggested that women with overweight BMI scores reported healthy status immediately upon migration to the United States. Approximately 4 to 6 years postmigration, women with overweight BMI scores reported improved health status. Previous studies have linked SSAI women to a rounder/thicker body figure. Overweight and obesity were, therefore, the primary measures of good fitness, appearance, and nourishment, while smaller body shape was viewed as ill-health, suffering, and deprivation (Ngoubene-Atioky & Williamson-Taylor, 2017).

Another prediction of the increase in SSAI maternal prepregnancy BMI involved prolonged duration in the United States. Longer duration in the United States resulted in overweight and obesity after controlling for behavior characteristics attributable to being overweight (Ceballos et al., 2018). The primary hypothesis that posits such a phenomenon is known as the acculturation paradox. Traditionally, the concept of acculturation was described as the process of a cultural and psychological phenomenon that occurs when the minority group adopted the majority culture (Agbemenu, 2016; Ceballos et al., 2018). Acculturation is multifaceted; thus, it involves adaptation and changes during premigration and postmigration. In the United States, SSAIs represent a large population with diverse groups of individuals geographically dispersed with various nativities or source countries; thus, they have different acculturation levels. These factors are essential and contribute differently to the risk and rates of maternal prepregnancy BMI. The prevalence of maternal prepregnancy BMI varies among races/ethnicities; therefore, there are distinctions in infant mortality outcomes.

Evidence showed that immigrants from different cultures may have different protective health behaviors, such as a healthy diet, lower alcohol and tobacco consumption, and access to family and social networks (Racape et al., 2016). Variation in immigrant protective heath behaviors accounted for the different experiences in the health effects. Moreover, studies have suggested that foreign-born individuals exhibited health advantages over residents of the host country. This concept is referred to as the healthy immigrant effect (Addo et al., 2019; King et al., 2019); however, the health advantage declines with time. A comprehensive study that assessed the National Health Interview Survey suggested that the odds of being overweight for prolonged residents (≥ 15 years) in the United States were 1.3 times higher than for newly arrived immigrants (< 4 years) (Da Costa et al., 2017). Postmigration overweight and obesity are indicators of health disadvantage in which the protective cultural effects offered by an individual immigrant's status diminish with an increased level of acculturation.

Postmigration weight gain can be associated with unhealthy dietary practices in the host country, especially for immigrants from low-income countries. Addo et al. (2019) revealed that postmigration changes in SSAI dietary behavior were positively associated with differentiation in assimilation, limited availability, accessibility, and affordability of African food products. Due to these essential factors, SSAI tends to rely on fast foods and other host country food products for dietary needs. Moreover, the lack of physical activity postmigration promoted maternal overweight and obesity (Addo et al., 2019). Time management was an important determinant that contributed to changes that affect dietary behaviors and physical activity (Da Costa et al., 2017). Exposure to the obesogenic environment in the United States, including easy access to palatable foods with high caloric contents and a “couch-potato” lifestyle are more likely to promote weight gain experience in SSAI with a high level of acculturation (Addo et al., 2019, & Addo et al., 2019). Thus, it can be assessed that acculturation and cultural phenomenon are indicators of prepregnancy overweight/obesity experience by SSAI postmigration. While these studies outlined the factors contributing to overweight/obesity, the exposure measures are primarily focused on the overall health outcomes of the population. There are some limitations, which require accessing how the resulting maternal health concern affects infant mortality outcome, which allows me to examine the association between SSAI maternal prepregnancy BMI and infant mortality outcome.

Gestational Weight Gain

Most factors, including acculturation concepts and cultural assumptions affecting SSAI maternal prepregnancy BMI, are more likely to influence maternal GWG. Increased maternal obesity and GWG are linked with maternal health behavior. While contemporary health determinant factors designed for health promotion account for perceived barriers and self-efficacy, the health needs for SSAI were vastly guided by the family, community, and cultural assumptions (Ngoubene-Atioky & Williamson-Taylor, 2016). For instance, in SSAI culture, overweight and obesity demonstrated healthy body image, nourishment, and status, while a thinner body indicated health conditions and poverty (Ngoubene-Atioky & Williamson-Taylor, 2016). It showed that perceived health behavior emerging from cultural assumptions is more salient for SSAI. Other studies have shown that the lack of health literacy and healthcare use are contributing factors despite the increased concerns of overweight and obesity postmigration (Addo et al., 2019, & Addo et al., 2019). Maintaining such cultural perceptions may result in unhealthy dietary behaviors postmigration; thus, fostering excessive GWG.

Dietary acculturation is another factor that accounts for increased maternal GWG in immigrant women. The healthy immigrant effect posits immigrants' health amelioration immediately postmigration to the United States; however, this health advantage experience continued to deteriorate with prolonged duration (Addo et al., 2019). The paradox depicts that immigrants adopt deleterious lifestyles and health behaviors, including unhealthy dietary practices and sedentary lifestyles in the United States. For example, the concept of dietary acculturation associated with a high BMI score and elevated risk of obesity in the Latina immigrant population (Ceballos et al., 2018) can also be implicated in SSAIs' health and wellbeing due to prolonged residency in the United States (Ngoubene-Atioky & Williamson-Taylor, 2016). In essence, variation in maternal GWG, including excessive and inadequate GWG (i.e., high or low GWG), can be explained by a high acculturation level, which may involve maternal lifestyle changes, food consumption, and socioenvironmental factors.

The 2009 IOM/NRC report demonstrated that pregnant women with prepregnancy BMIs of underweight, normal-weight, overweight, and obese must maintain a GWG, as depicted in Figure 4.

Figure 4

IOM/NRC GWG Recommendations Based on Maternal Prepregnancy BMI

Prepregnancy BMI Category	**Total maternal GWG in pounds**
Underweight: (BMI < 18.5 kg/m^2)	28-40
Normal-weight: (BMI 18.5 kg/m^2 - 25 kg/m^2)	25-35
Overweight: (25 kg/m^2 - 30 kg/m^2)	15-25
Obesity: (BMI ≥ 30 kg/m^2)	11-20

The IOM/NRC recommended that GWG progressively decline with elevated maternal prepregnancy BMI. For example, the recommended GWG for women with overweight prepregnancy BMI is 15–25 pounds, whereas the recommended GWG for women with obese prepregnancy BMI is reduced to (11–20 lbs.).

Despite the IOM/NRC recommendation, obese women tend to gain higher weight during pregnancy than recommended. For example, the average GWG for obesity classes I, II, and III were 27.1–28.0 lbs., 22.04–23.81 lbs., and 16.53–20.94 lbs., respectively (Siega-Riz et al., 2020). Only one in four obese women gained adequate GWG compared to one in three women with normal-weight (Dolin et al., 2020). Essentially, obese women are more likely to gain in excess of the IOM/NRC GWG recommendations. While this is true in many cases, excessive weight loss during pregnancy is also common with increased obesity severity. For example, women with class I, II, and III obesities were more likely to lose 2–5%, 4–9%, and 9–16% of their preconception weight during pregnancy, respectively (Siega-Riz et al., 2020), thus, suggesting that despite the IOM/NRC recommendations, excessive and inadequate GWG are experienced mainly by obese women in the United States.

A growing literature has depicted the relationship’s strength and direction between GWG and infant mortality outcome, but their outcomes have been vastly heterogeneous. For example, Siega-Riz et al. (2020) indicated that overweight/obese women who exhibited inadequate GWG experienced favorable infant health outcomes. They also argued that women who demonstrated normal prepregnancy BMI but experienced inadequate GWG observed less optimal infant health outcomes. Conversely, Ukah et al. (2019) argued that inadequate GWG is associated with infant death and severe neonatal morbidity irrespective of maternal prepregnancy BMI. They also reported that excessive GWG is associated with severe neonatal morbidity only for women with underweight and normal prepregnancy BMI.

Despite the conflicting evidence, several studies have emphasized that the association between GWG and infant mortality outcomes is consistent for women with severe obesity. A recent systematic review posited a clear positive association between elevated maternal GWG and risk of large for gestational age (LGA) and cesarean deliveries among women with increased prepregnancy BMI, including class II and class III obesities (Álvarez-Bueno et al., 2017; Ju et al., 2018). Zhou et al. (2019) also reported that excessive GWG for obese women in early pregnancy was associated with total infant mortality and fetal loss. For example, women with class II obesity who gained 5.5 kg or less GWG experienced one to two additional infant deaths per 1000 live births, and class II obesity mothers with GWG of 35–42 kg experienced two additional infant deaths per 1000 live births. These studies portrayed clear evidence that both inadequate and excessive GWG are determinants of infant mortality outcome; however, they are without limitations. Most of the studies focused on infant morbidity outcomes, and only a few addressed infant mortality outcomes. Secondly, most of the previous literature addressing perinatal health outcomes is heavily concentrated on White, Asian, and Hispanic populations, and only a few have focused on the U.S. SSAI population. The risk profiles may differ for White, Asian, Hispanic, and SSAI populations since race/ethnicity determinants are associated with both maternal GWG and infant mortality outcomes (see Ceballos et al., 2018). Thus, I provided insight into the normative of maternal GWG and how GWG influences infant mortality within the U.S. SSAI population.

Maternal Birthplace

The prognosis of infant mortality outcomes varies among maternal birthplace and races/ethnicities. The variation in infant mortality outcome by maternal birthplace was perceived to account for the healthcare system of the maternal birthplace, the socioenvironmental, and lifestyle (Kusuda et al., 2021). For example, Kusuda et al. suggested that infants born in Japan to Japanese mothers had optimal health outcomes than infants born to American-born Japanese and White mothers in California for severe intraventricular hemorrhage (IVH)—a condition that frequently involves death or developmental disability and neonatal mortality. Wartko et al. (2017) reported various associations between low birth weight (LBW) and maternal birthplace within foreign-born Hispanics, Asians, and non-Hispanic Black populations. They reviewed the lower risk of LBW in foreign-born mothers compared to their U.S.-born counterparts with similar socioeconomic status (SES). Most of the studies used data from the 1990s and early part of the 2000s; therefore, Wartko et al. (2017) suggested that updated research would be necessary to determine whether the observed disparities persist, given that there has been an elevated rate of immigration to the United States from the year 2000 and up. These studies showed variation in infant mortality attributed to socioenvironmental exposure and the implication of different health protective factors offered by maternal birthplace. Adverse birth outcomes, such as preterm, LBW, and birth defects, do not occur equally across populations and maternal birthplace.

Despite variation in infant mortality across maternal birthplace, other factors, including race/ethnicity disparities, can amplify infant mortality outcomes within different immigrant populations in the host country. For example, Marks et al. (2018) revealed the integrative model of minority development, suggesting systemic factors such as discrimination and national attitudes toward immigrants are more likely to affect immigrants' perceived health and wellbeing. Anti-immigrant policies can evoke concerns associated with unfavorable birth outcomes and the potential of poignant public health impacts due to anti-rhetoric and enforcement of migrant health. Furthermore, Singh and DiBari (2019) found that 33 to 47% of risk factors related to sociodemographic, including low maternal education, unemployment, and poor living conditions, can be attributed to race/ethnic disparities. While these studies do not explicitly determine factors contributing to the differences in infant mortality outcomes varied by birthplace, they describe conditions within the host country that affect infant mortality outcomes within a defined population.

Furthermore, African immigrants attained higher education than their U.S. counterparts (Nwankwo & Wallace, 2020). Despite their educational attainment, most African immigrants found it difficult to use their training and skills acquired from their source countries to secure employment, resulting in elevated unemployment (Nwankwo & Wallace, 2020). While many African immigrants participate in the U.S. labor force, their earnings do not yield sufficient income. Consequently, African immigrants are more likely to experience increased poverty, reside in disadvantaged communities, and come from households with yearly incomes below the national poverty level (Nwankwo & Wallace, 2020). While this is true in the host country, poor socioeconomic factors also affect infant mortality outcomes in the maternal birthplace. For example, immigrants from crisis-affected nations (e.g., Liberia and Somalia) were less likely to acquire adequate education, thus, affecting health literacy and health-seeking behaviors (Dhalimi et al., 2018). Therefore, factors related to the maternal birthplace and host countries can modify overall health and contribute to infant mortality outcomes. Previous studies have suggested evidence for the variability in infant mortality and contributing factors based on maternal birthplace (Belihu et al., 2016; Urquia, 2019); however, what is not well known is differences in infant mortality outcomes within the U.S. SSAI group varied by maternal birthplace. Studies that assessed immigrant birth outcomes have treated SSAI women as a single group, thus, potentially masking the infant mortality outcome variations across SSAI maternal birthplace. Therefore, my study is essential as it fills the gap and highlights public health intervention to address individual birthplace infant health disparities in the United States.

Infant Mortality Outcome

It has been discussed extensively that in the United States, infant mortality is primarily associated with race/ethnic disparities. For example, Holmes Jr. et al. (2020) found that infant mortality was highest among Black or African American ethnic groups compared to their White and Asian/Pacific Islanders counterparts. While several factors are essential in promoting infant mortality, birth defects and preterm accounted for the largest proportion of infant death in the United States (CDC, 2020b). For example, congenital disabilities were responsible for nearly 20.6% of all infant deaths in 2017, rendering them the leading cause of infant mortality (Almli et al., 2020). The race/ethnicity disparities in infant mortality attributable to birth defects are well established. Between 2003 and 2017, the infant mortality rate associated with birth defects declined by 4% for infants born to Hispanic mothers, 11% for non-Hispanic Black mothers, and 12% for non-Hispanic White mothers (Almli et al., 2020). In 2017, infant death attributed to birth defect decline was highest among Black mothers (13.3 per 10,000 live births) and lowest among infants born to White mothers (9.9 per 10,000 live birth) (Almli et al., 2020); all-cause infant mortality rates were highest among Black mothers (CDC, 2020b). While infant mortality is a concern within the U.S. Black population, previous studies have examined Black populations homogenously; thus, presenting limitations in literature for a population-based study that focused on infant mortality outcome within the U.S. SSAI population. Therefore, performing a comprehensive cross-sectional analysis to assess infant mortality within the U.S. SSAI will reveal disparities and affect public health interventions.

Confounding Variable

While prepregnancy BMI, GWG, and maternal birthplace are strongly associated with infant mortality outcome, other essential maternal characteristics, including maternal socioeconomic status (SES), and maternal age, serve as covariates. SES was defined by the person's education, income, and occupation (Obiang-Obounou & Fuh, 2020). Physiological distress has been suggested to guide the mediating effects of poor SES exposure and adverse birth outcomes (Mitchell & Christian, 2017). For example, maternal financial stressors had a direct physiological influence, including altering the physiological function of serval hormones (e.g., stress hormones or other biomarkers) that affected fetuses and resulted in infant mortality outcomes (Zilidis & Chadjichristodoulou, 2020). Mitchell and Christian (2017) reported a significant association between maternal SES (e.g., education and employment) and low birth weight, preterm, and small for gestational age. Poor SES conditions can be linked to the lack of access to quality healthcare services, thus, accounting for adverse infant health outcomes. In most sub-Saharan African countries, the primary driver of infant mortality outcome is poor SES. For example, in 2015, Obiang-Obounou and Fuh observed that Chad's government healthcare expenditure was only 6.2%, leading to over 56% of out-of-pocket spending. Due to the country's escalating poverty level, only 20% of child-bearing women were able to deliver in a hospital, which resulted in a significant increase in infant mortality outcomes. Improve SES can increase an infant's life expectancy if perinatal health needs, such as healthcare services utilization, diet, health literacy, and income, are met.

Another important covariate affecting infant mortality outcome involve maternal age. For instance, Ely and Driscol (2020) suggested that infants born to mothers under the age of 20 and age 40 or above experienced the highest infant mortality rates. Infants born to mothers between ages 30 and 34 suffered the lowest infant mortality rates, followed by mothers between ages 35 and 39 years old. Preterm births and low birthweight were strongly associated with mothers under age 20 or 40 and above (Ely & Driscol, 2020).

Summary

Given the large number of studies presenting evidence of infant mortality outcomes, it is clear that the inextricable roles of prepregnancy, pregnancy, and social and environmental risk indicators pose a significant risk to infant mortality outcomes. The chapter presented the broader concept of the biopsychosocial approach, which integrated social, environmental, and psychological contexts and embraced the relationship between the individual, cultural, physical environmental conditions, and human health. The constructs developed in this study (prepregnancy risk indicators, pregnancy risk indicators, and social and environmental risk indicators) address factors influencing maternal BMI, GWG, and maternal birthplace. While the chapter emphasized the interplaying role of the constructs and linked prepregnancy BMI, GWG, and maternal birthplace to infant mortality outcomes in several studies, the results have been heterogenous. They have primarily focused on other immigrants, including Hispanic, Asian, as well as mixed U.S. Black and White populations. Thus, population-based suggestive literature is necessary to explain the implication of these risk factors on SSAI infant mortality outcomes and to invoke public health intervention and policies.

In conclusion, the literature review revealed that only a few studies have focused on assessing infant mortality outcomes associated with maternal preconception weight, GWG, and birthplace within the U.S. SSAI population. Thus, the goal of this study was to expand public health knowledge and research to address the overall birth outcomes of U.S. SSAI women using effective public interventions that incorporate broader social concepts such as prepregnancy risk indicators, pregnancy risk indicators, and social and environmental risk indicators.

In Chapter 3, I focused on the research design and rationale and identified the methodology that defined the study population, procedures, and data collection process.

Chapter 3: Research Method

Research assessing social and environmental contexts and perinatal health conditions in the U.S. immigrant populations present a literature gap by primarily focusing on Hispanic and Asian immigrants (Driscoll & Ely, 2020; Ely et al., 2020). In the present population-based study, I addressed this gap by investigating the association between maternal prepregnancy BMI, GWG, maternal birthplace, and infant mortality outcome within the U.S. SSAI population while adjusting for maternal educational attainment and age. I also demonstrated the association between the covariates (educational attainment and age) and infant mortality. The theory guiding the association between the variables is the biopsychosocial theory. The biopsychosocial theory is a broad concept; thus, it allowed the study to explore infant mortality outcomes through a multifaceted context. The chapter began with describing the research design and rationale, followed by the methodology, threats to validity, and the study's ethical procedures.

Research Design and Rationale

The three *a priori* main independent variables were prepregnancy BMI, GWG, and maternal birthplace; the dependent variable was infant mortality outcome. Using a secondary dataset, a quantitative cross-sectional study design was used to determine the association between the *a priori* main independent variables and infant mortality outcome. One of the benefits of the cross-sectional study design was that it allowed me to determine the outcomes and exposure of interest within the same time frame (see Setia, 2016). As a result, it was appropriate for the current study because it was conducted relatively quickly and inexpensively—mainly because the secondary dataset was publicly available for assessment. The cross-sectional study design did not account for determining causal effect relationships between the variables of interest; however, it enabled simple and stepwise multiple logistic regressions to assess the association between the study variables (Statistics Solutions, 2019). The cross-sectional study design was also suitable because it has consistently been used to address infant mortality outcomes in immigrant populations in previous research studies, measuring trends, association/relationships, and differences between studied variables (Driscoll & Ely 2020; Setia, 2016).

Methodology

Population

The study's population included U.S. SSAI mothers from the three sub-Sahara Africa regions (eastern, middle, and western) with the top sending countries. These regions are seen in Figure 1, with their respective sending countries.

The countries were selected based on similarities within shared regions such as culture, diet, religions, and the likelihood of experiencing similar socioeconomic and environmental disparities ; thus, they were more likely to share similar experiences postmigration. The population involved women of child-bearing ages between ages 15 and 49 who gave birth in the United States between 2017 and 2018.

Sampling and Sampling Procedures

The secondary dataset for the current study was obtained from the CDC-Wonder database using the linked birth/infant death records file from 2017-2018. The linked birth/infant death records file was provided by the 57 vital statistics jurisdictions, which compiled infant birth and death information through a vital statistics cooperative program (Ely & Driscol, 2020). The CDC Wonder data is a population-based surveillance database that uses natality information consisting of infant death rates within the first year of life in the United States and to U.S. residents (CDC, 2020c). The database also uses infant death certificates for linking corresponding birth certificates and contains essential variables related to maternal risk characteristics, including prepregnancy BMI, maternal country of birth, education, maternal weight gain, age, maternal prepregnancy, and delivery weights. While a disclaimer provided a guideline for the usage and purpose of the data, CDC Wonder requires no user agreement to acquire the data, making it publicly accessible for download. The inclusion criteria involved birth between 2017–2018 by SSAI women of reproductive age (15–49 years old). Women under the age of 15 and above the age of 49 were excluded.

Power Analysis

A power analysis was not necessary since the data was secondary and has already been collected; however, I calculated the sample size using the G*power software with a two-tail *t* test, 0.15 effect size, a power of 0.80, and an alpha level of 0.05. Figure 5 indicates a sample size of 55 was necessary to detect a true effect.

Figure 5

*Sample Size Calculation Using G*Power*

Tail(s)	=	Two
Effect size f²	=	0.15
? err prob	=	0.05
Power (1-? err prob)	=	0.80
# of predictors	=	3.0
Critical t	=	2.8722813
Df	=	51
Total sample size	=	55
Actual power	=	0.8045119
	=	

Instrumentation and Operationalization of Constructs Operationalization

I used data from the period between 2017–2018 linking birth/death records files, which contain data from the U.S. standard birth/death certificates. The U.S. birth and death certificate data are collected in national vital statistics by the Vital Statistics Cooperative Program. The data used in this study were maintained in the CDC-Wonder database (CDC, 2020c). The U.S. birth certificate was previously revised in 2003 to expand demographic and maternal medical information (Elo et al., 2014). All data in the linked birth/infant death records file are based on the 2003 revised U.S. birth certificate. While there were some initial variations in adapting the 2003 revision, in 2016, all 50 states and the District of Columbia began to use the 2003 birth certificate, thus making 2017 the first year in which the linked birth/infant death records file embodied data exclusively based on the 2003 birth certificate standard (Martin et al., 2018). Both birth and death certificate data from 2017 and 2018 were combined to account for more robust and reliable rates for subgroups, including immigrants (Ely et al., 2020).

The linked birth/infant death records file was appropriate for the current study due to the expanded version, which compiled data according to the mother's birth countries and racial/ethnicity groups. It enabled the streamlining of variables that link infant births to corresponding death records while allowing controlling for specific covariates, including maternal age and socioeconomic factors such as maternal education. The data is in a public domain that provided public access with no additional permission requirement from the CDC; however, I reviewed the CDC freedom of information act and privacy policies thoroughly for better insights on the uses and distribution of the data and related documents.

Several studies focusing on maternal and infant health outcomes have identified the reliability and validity of the CDC-Wonder linked birth/death records file. For example, Driscoll and Ely (2020) investigated how variations in maternal age distribution and age-specific infant mortality rates affected infant mortality trends between 2000 and 2017 using the 2000–2017 version of the linked birth and infant death data. The study specifically sought to compare age-adjusted infant mortality rates based on maternal age distribution with crude rates of infant births and race/ethnicity differentiation. They found that variation in the maternal age distribution accounted for a one-third reduction in infant mortality rate between 200 and 2017. Two-thirds of the decline was attributed to maternal age-specific infant mortality rate but varied by maternal race and Hispanic origin. The linked birth/infant death file was also used to investigate infant mortality based on maternal prepregnancy BMI and maternal race, and Hispanic origin. Ely et al.(2020) suggested that the total infant neonatal and postneonatal mortality rates declined for mothers with normal-weight prepregnancy BMI and increased with increasing maternal prepregnancy BMI. They also indicated that the infant mortality rate was, although not exclusively, lower for underweight mothers compared to obese mothers, and that infant mortality rates varied by maternal prepregnancy BMI. Ely and Driscol (2020) used the linked birth/infant death file to determine the 2018 infant mortality rate by infant age at death, maternal racial/ethnicity, Hispanic origin, maternal age, gestational age, leading causes of infant death, and state of maternal residence. Martin et al. (2013) evaluated the revised 2003 birth certificate to determine the reliability and validity of the medical and health data included on the certificate between 2010 and 2011. Martin et al. extracted hospital medical records from the 2003 revised birth certificates in two states to assess missing data levels, exact agreement, kappa scores, sensitivity, and false discovery rates. Their result depicted levels of variations in data quality, and those missing items weaken data reliability. However, their study was limited by a small sample size, and generalization could not be determined as data from a selected hospital is not representative of all State's hospitals. Secondly, several contracts have been entered after this study with the 57 vital records reporting systems with a central goal to provide a substantial improvement to data quality through standardization, performance activities, and support (Martin et al., 2013).

The 2017–2018 linked birth/death records file includes maternal self-reported data such as demographics reported on the infant birth/death certificates. During delivery, self-reported maternal prepregnancy weight and height were recorded, and the maternal prepregnancy BMI was calculated as 703*maternal weight(lbs.)/maternal height(inches)^2 (Ely et al., 2020). The prepregnancy BMI was classified according to the IOM/NRC maternal BMI categories: underweight (BMI < 18.5); normal-weight (BMI: 18.5 -25.0); overweight (BMI 25.0 - 30.0); and obesity (BMI of 30.0 or more).

Between 2017 and 2018, 43,838 weighed infant death records were reported (Ely et al., 2020). Of these, 3,106 or 7.1% were missing maternal prepregnancy BMI data. There were also 7,647,212 infant birth records reported, and of these, 182,963 or 2.4% were missing maternal prepregnancy BMI data (Ely et al., 2020). Ely et al. (2020) suggested that the data from the 2017 report was based on 99.6% of the 22,341 infant deaths in the United States and 99.3% infant death reported in 2018. Like the maternal prepregnancy BMI, data report from the linked birth/death records file was also weighted to account for the 0.4% (2017) and 0.7% (2018) infant death records, which could not be linked to birth certificates.

Overall, these studies provided evidence of the most recent reliability and validation established for the CDC-Wonder linked birth/death records file that measures infant mortality based on maternal prepregnancy BMI, race/ethnicity, and maternal age distribution. The U.S. standard birth and death certificates are provided in Appendix A.

Operationalization of Variables

The following are the *a priori* main independent variables and outcome variable along with their definitions:

Maternal prepregnancy BMI was referred to as maternal body mass index before becoming pregnant, which was measured as weight in kilograms divided by the square of height in meters. Maternal prepregnancy BMI was categorized according to the IOM/NRC recommendations as underweight (BMI < 18.5 kg/m^2); normal-weight (BMI 18.5–24.9 kg/m^2); overweight (BMI 25.0–29.9 kg/m^2); and obese (BMI > 30 kg/m^2).

The maternal GWG was referred to as the mother's weight gain during pregnancy, and it was measured by the difference between the maternal end of pregnancy weight and prepregnancy weight. Maternal GWG was categorized based to the four categories of maternal prepregnancy BMI and labeled as,

- Underweight GWG
- Normal-weight GWG
- Overweight GWG
- Obese GWG

Each category was further classified into "inadequate," "adequate," and "excessive," based on the IOM/NRC definitions:

Underweight GWG

- Adequate GWG = (28–40 lbs.)
- Inadequate GWG = (< 28 lbs.)
- Excessive GWG = (> 40 lbs.)

Normal-weight GWG

- Adequate GWG = (25–35 lbs.)
- Inadequate GWG = (< 25 lbs.)

- Excessive GWG = (> 35 lbs.)

Overweight GWG

- Adequate GWG = (15–25 lbs.)
- Inadequate GWG = (< 15 lbs.)
- Excessive GWG = (> 25 lbs.)

Obese GWG

- Adequate GWG = (11–20 lbs.)
- Inadequate GWG = (< 11 lbs.)
- Excessive GWG = (> 20 lbs.)

The maternal birthplace was the sub-Saharan African countries, in which the mother was born and lived prior to migrating to the U.S. These regions were chosen for their common boundaries, histories, dietary habits, civil war backgrounds, and related migration and postmigration experiences.

Maternal age was the mother's age during the time of delivery and divided into three categories: < 20; 20–39; and > 39. Educational attainment was the mother's level of education during delivery and classified into four categories: < high school; high school; college; and graduate or professional educations.

Infant mortality outcome was referred to as the death of an infant within the first year of life. Infant mortality outcome was dichotomous as "yes" or "no," where "yes" indicated infant death occurred within the first year of life, and "no" indicated no death occurred within the first year of life.

In Figure 6, I depicted the variable categories and the coding schematic for all study variables.

Figure 6

Variable Categories and the Coding Schematic

Prepregnancy-BM	Birthplace	Gestational weight gain	Educational attainment	Maternal age	Infant mortality outcome
1=Underweight BMI	1= CAMEROON	Underweight-GWG 1=Inadequate 2=adequate (ref.) 3=Excessive	1= (< high school)	1= (<20)	1=yes (death occurred)
2= Normal-weight BMI (Ref)	2= CONGO	Normal-weight GWG 1=Inadequate 2=adequate (ref.) 3=Excessive	2= high school	2= (20-39) (ref)	0=no (no death occurred)
3=Overweight BMI	3= ETHIOPIA	Overweight GWG 1=Inadequate 2=adequate (ref.) 3=Excessive	3=College (ref)	3= (>39)	
4=Obese BMI	4=KENYA	Obese GWG 1=Inadequate 2=adequate (ref.) 3=Excessive	4= Graduate/prof.		
	5 =SOMALIA				
	6 = SUDAN				
	7= LIBERIA				
	8 = GHANA				
	9 = NIGERIA (ref.)				

Data Analysis Plan

I used the IBM SPSS Statistics program, version 25 to conduct the study's data analysis. The 2017–2018 linked birth/death records file was downloaded in a "text" format. The initial dataset was transferred from the text format into an excel spreadsheet. The dataset has been pre-coded into a numeric, alphabetic, and blank schematic format in the CDC-Wonder database (CDC, 2020b). The CDC-Wonder does conduct an automatic check for data completeness, code validity, and inconsistencies; however, the data must be cleaned and reformatted to be SPSS compatible. Therefore, while in the excel spreadsheet, I deleted missing data, and I converted maternal weight measured in kilograms (kg), such as maternal GWG into pounds. The conversion allowed uniformed measurement units with data in other categories. All infant deaths were dichotomized into "yes" or "no." I saved the dataset in excel format and uploaded the completed dataset into SPSS. I conducted a codebook assessment to determine potential inconsistencies, and unwanted data was further deleted. Below, I have reiterated the research questions and hypotheses:

RQ1: Is there an association between maternal prepregnancy BMI and infant mortality outcome while controlling for maternal age and educational attainment?

$H_1$1: There is no association between maternal prepregnancy BMI and infant mortality outcome while controlling for maternal age and educational attainment.

$H_0$1: There is an association between maternal prepregnancy BMI and infant mortality outcome while controlling for maternal age and educational attainment.

RQ2: Is there an association between maternal GWG (measured by the difference between the maternal end-of-pregnancy weight and prepregnancy weight) and infant mortality outcome varied by maternal prepregnancy BMI while controlling for maternal age and educational attainment?

> $H_1$2: There is no association between maternal GWG (measured by the difference between the maternal end-of-pregnancy weight and prepregnancy weight) and infant mortality outcome varied by maternal prepregnancy BMI while controlling for maternal age and educational attainment.
>
> $H_0$2: There is an association between maternal GWG (measured by the difference between the maternal end-of-pregnancy weight and prepregnancy weight) and infant mortality outcome varied by maternal prepregnancy BMI while controlling for maternal age and educational attainment.

RQ3: Is there an association between maternal birthplace and infant mortality outcome while controlling for maternal age and educational attainment?

> $H_1$3: There is no association between maternal birthplace and infant mortality outcome while controlling for maternal age and educational attainment.

$H_0$3: There is an association between maternal birthplace and infant mortality outcome while controlling for maternal age and educational attainment

In SPSS, the data analysis followed the following elements. A descriptive statistic that quantitatively provided the summary of all variables included in the study. An initial simple logistic regression analysis with each *a priori* main independent variable to determine statistically significant variables *without* adjusting for age and educational attainment. (I also conducted a simple logistic regression analysis to assess the likelihood of infant mortality outcome associated with maternal educational attainment and age). I rejected or failed to reject the null hypothesis depending on whether or not the main independent variable contributed significantly to infant mortality outcome. A second simple logistic regression analysis was conducted while adjusting for age and educational attainment. In this analysis, I confirmed the previous hypotheses after controlling for the covariates, and I assessed the R^2 values to demonstrate the correlation between each main independent variable and infant mortality outcome. A high correlation indicates a high likelihood of infant mortality associated with the main independent variable. I further conducted a stepwise multiple logistic regression with only the statistically significant main independent variables from the previous simple logistic regression analysis to determine the most parsimonious model that effectively predicted infant mortality outcome. In this analysis, each significant main independent variable and covariates (age and educational attainment) was entered into the model using a stepwise process. The process was terminated after all the variables that contributed significantly to the model had been added. The final model in this analysis demonstrated the parsimonious model because it contained all significant main variables and covariates that effectively predicted infant mortality outcome.

The *a priori* main independent variables included maternal prepregnancy BMI, maternal GWG, and maternal birthplace. The outcome variable was infant mortality outcome. The initial data analysis began with a complete descriptive statistic of participants and was proceeded by analyses to assess RQ1, RQ2, and RQ3, respectively. I used a 95% confidence interval, and a *p*-value (< .05) determined a statistically significant association.

In RQ1, I examined the association between prepregnancy BMI and infant mortality outcome. I used normal maternal prepregnancy BMI as a reference category because normal prepregnancy BMI has been associated with a reduced risk of infant mortality outcomes (Ely et al., 2020; Siega-Riz et al., 2020). In RQ2, I initially analyzed the association between GWG and infant mortality outcome by classifying GWG as GWG (inadequate, adequate, and excessive). I used adequate GWG as the reference category since adequate GWG was also associated with less risk of infant mortality outcome (Siega-Riz et al., 2020). Furthermore, I classified GWG based on the four categories of prepregnancy BMI, and I demonstrated the association between GWG and infant mortality outcome in each category. The categories included underweight GWG, normal-weight GWG, overweight GWG, and obese GWG. Each category was subclassified as inadequate, adequate, and excessive. Adequate GWG in each category was also used as a reference. In RQ3, I examined the association between birthplace and infant mortality outcome. A reference category for birthplace was determined by selecting the country with the least infant mortality outcome.

The odds ratios generated by the regression models determined the likelihood of infant mortality outcome associated with each main independent variable, and the R^2 values determined the level of corrections. The simple logistic regression analyses identified all non-statistically significant *a priori* main independent variables to be eliminated from the step for determining the most parsimonious model.

The stepwise multiple logistic regression was the final analysis conducted in which all statistically significant independent variables identified from the previous simple logistic regression analysis along with the covariates were included in the stepwise multiple logistic regression model to determine the most parsimonious model for predicting infant mortality outcome.

Threat to Validity

The validity of the study was subjected to at least three primary threats. Data from the linked birth/death records file is self-reported, thus, allowing the probability of bias or purposely omitting important information. For example, in 2017, an estimated .04% of linked birth/death records file data was missing mothers' responses to questions (CDC, 2017). Missing data due to non-linkage corresponding birth and death certificates. For example, in 2017, approximately 7.8% of deaths and 1.4% of live birth records were missing (Almli et al., 2020). And the study also experienced misclassification in which data of mothers of different races or ethnicities may be misclassified with participants of interest. While data in the linked birth/death records file has been weighted to account for non-linked death and birth certificates, I also excluded any missing data to address any inconsistencies.

Ethical Procedures

The Walden University Institutional Review Board (IRB) reviewed and approved my study for the ethical requirements. The data used in the study was secondary data and publicly accessible from the CDC-Wonder database; thus, the CDC did not require additional IRB approval (CDC, 2020c). The CDC also did not require a user agreement;

however, the disclaimer that provided a guideline for usage and purpose of the data was considered and followed as planned. The data included in the linked birth/death records file was birth and death certificate information collected during the time of birth and linked to corresponding infant death (CDC, 2020b). Birth certificate worksheets during the time of birth were electronically submitted to the U.S. Vital Statistics corporation program (CDC, 2020c). All personal information, including names, addresses, and birth facilities, was excluded from the dataset before incorporating into the CDC-Wonder database. The data was downloaded on my laptop for analysis. The laptop was password-protected, with no other person having access to the data. The data on the laptop had no personally identifiable information.

Summary

In conclusion, I described the research design and rationale in this chapter. One of the benefits of the study's cross-sectional nature was the ability to determine the outcome of the study and the exposure within the same timeframe, thus allowing the study to be conducted as quickly as possible and cheaper using a public secondary dataset. I also delineated the study's methodology, sample and sampling procedures, instrumentation and operationalization of constructs, and data analysis plan. Data were extracted using the 2017–2018 Natality linked birth/infant death file, and it included women of child-bearing ages between ages 15 and 49 with births. The natality-linked birth/infant death file contains birth certificates and links to corresponding death records. Lastly, I presented threats to the study's validity and ethical procedures. While the data used in the study were a secondary dataset, the analysis was without threat. I determined that recall bias resulting from the self-report nature of the dataset and misclassification are critical threats to the study's validity. The Walden University IRB approved the overall ethical procedure of the study. In the following chapter (Chapter 4), I described the data collection process, the study's data, analysis, and I presented the study results.

Chapter 4: Results

As mentioned previously, the purpose of this study was to investigate the association between maternal prepregnancy BMI, GWG, maternal birthplace, and infant mortality outcome within the U.S. SSAI population. This chapter presented the data collection process, analysis, results, and summarized the study's findings.

Below, the research questions and hypotheses are reiterated:

RQ1: Is there an association between maternal prepregnancy BMI and infant mortality outcome while controlling for maternal age and educational attainment?

$H_1$1: There is no association between maternal prepregnancy BMI and infant mortality outcome while controlling for maternal age and educational attainment.

$H_0$1: There is an association between maternal prepregnancy BMI and infant mortality outcome while controlling for maternal age and educational attainment.

RQ2: Is there an association between maternal GWG (measured by the difference between the maternal end-of-pregnancy weight and prepregnancy weight) and infant mortality outcome varied by maternal prepregnancy BMI while controlling for maternal age and educational attainment?

$H_1$2: There is no association between maternal GWG (measured by the difference between the maternal end-of-pregnancy weight and prepregnancy weight) and infant mortality outcome varied by maternal prepregnancy BMI while controlling for maternal age and educational attainment.

$H_0$2: There is an association between maternal GWG (measured by the difference between the maternal end-of-pregnancy weight and prepregnancy weight) and infant mortality outcome varied by maternal prepregnancy BMI while controlling for maternal age and educational attainment.

RQ3: Is there an association between maternal birthplace and infant mortality outcome while controlling for maternal age and educational attainment?

$H_1$3: There is no association between maternal birthplace and infant mortality outcome while controlling for maternal age and educational attainment.

$H_0$3: There is an association between maternal birthplace and infant mortality outcome while controlling for maternal age and educational attainment.

Data Collection

The data used in this study was a secondary dataset extracted from the CDC-Wonder database using the 2017–2018 linked birth/infant death records file. Thus, there were no special recruitment procedures. The 2017–2018 linked birth/infant death records file is collected by the Vital Statistics Cooperative Program as a requirement to compile and maintain individual birth records from the 57 vital statistics jurisdictions (Ely & Driscol, 2020). The Vital Statistics Cooperative Program uses infant birth certificates for linking corresponding death records.

Test for Assumptions

The first logistic regression assumption assumes that the dependent variable must be measured at a dichotomous scale and required one or more independent variables, which may be continuous or categorical. This assumption was met as my dependent variable-infant mortality outcome was dichotomized as (yes/no), and my predictor included more than one main independent variables (prepregnancy BMI, GWG, and birthplace). All my independent variables were also categorical (i.e., ordinal and nominal). In the second assumption, all data points must be independent of each other. This assumption was also met as the variables (prepregnancy BMI, GWG, birthplace, and infant mortality outcome) required separate observations and data points. The logistic regression assumption also required no outliers, linearity, and collinearity. While linearity describes a linear relationship between the independent and dependent variables, Collinearity addresses linear relationships between the independent variables. For linearity, the Box-Tidwell (1962) procedure can be used to test for linearity between the independent and dependent variables (Laerd Statistics, 2018). On the other hand, collinearity is identified when the linear relationships between the independent variables are highly correlated. The variance of inflation factor (VIF) and the Tolerance are two values that determine the threshold of collinearity. A VIF greater than 10 (VIF >10) and tolerance less than 0.1 (tolerance <0.1) indicate high linear correlations between the independent variables (Laerd Statistics, 2018). Furthermore, the variables must have no outliers (data points containing unusually large or small observations). These three assumptions (linearity, collinearity, and outlier) required a continuous variable to test for linear relationships. However, due to the categorical nature of my variables (i.e., ordinal and nominal), testing for these assumptions was not feasible. These assumptions are only applicable when there is a continuous variable. Moreover, data normality was also not tested because it is not an assumption of logistic regression.

Study Results

Descriptive Statistics

The study sample included infants born between 2017 to 2018 to U.S. SSAI mothers ages 15 to 49. There were 1,877 participants (N = 1877) included in the study. Of these, Table 1 showed that 838 or approximately 45% experienced infant mortality outcomes, and 1,039 or 55.35% did not. 20 (1.07%) of the mothers had underweight BMI, 677 (36.07%) exhibited normal weight BMI, 827 (44.06%) were overweight, and 353 (18.81%) were obese. Of the 20 underweight mothers, nine (45%) experienced inadequate GWG; another nine (45%) maintained adequate GWG, and two (10%) gained excessive GWG. Of the 677 mothers with normal-weight BMI, 225 (33.23%) experienced inadequate GWG, 324 (47.86%) maintained adequate GWG, and 128 (18.91%) gained excessive GWG. Of the 827 mothers with overweight BMI, 193 (23.34%) experienced inadequate GWG, 378 (45.71%) exhibited adequate GWG, and 256 (30.96%) gained excessive GWG. Of the 353 mothers with obese BMI, 115 (32.58%) experienced inadequate GWG, 144 (40.79%) maintained adequate GWG, and 94 (26.63%) gained excessive GWG. Table 1 also showed that overall, the majority of the mothers had a college-level education or higher and less than 10% of the mothers had less than a high school education. 1,673 (89.3%) of the mothers were between ages 20 and 39, 190 (10.12%) were above 39 years old, and 14 (0.75%) were younger than 20.

Table 1 depicted the summary of the descriptive statistics related to all variables included in the study

Table 1

Descriptive Statistics of Key Variables

Variable	%(N)
Infant mortality outcome	
Yes	44.65 (838)
No	55.35 (1,039)
Maternal Prepregnancy-BIM	
Underweight	1.07 (20)
Normal	36.07 (677)
Overweight	44.06 (827)
Obesity	18.81 (353)
Underweight GWG	
Inadequate	45 (9)
Adequate	45 (9)
Excessive	10 (2)
Normal-weight GWG	
Inadequate	33.23 (225)
Adequate	47.86 (324)
Excessive	18.91 (128)
Overweight GWG	
Inadequate	23.34 (193)
Adequate	45.71 (378)
Excessive	30.96 (256)

Obese GWG	
Inadequate	32.58 (115)
Adequate	40.79 (144)
Excessive	26.63 (94)
Maternal Birthplace	
Cameroon	3.2 (60)
Congo	5.65(106)
Ethiopia	10.87 (204)
Kenya	4.32 (80)
Somalia	17.63 (331)
Sudan	3.3 (62)
Liberia	4 (75)
Nigeria	12.04 (226)
Ghana	39 (732)
Education Attainment	
< High school	9.96 (187)
High school	31.22 (586)
College	49.01(920)
Graduate/prof. degree	9.8 (184)
Maternal Age	
(20-39)	89.3 (1,673)
<20	0.75 (14)
>39	10.12 (190)
Total	**1877**

Simple and Stepwise Multiple Logistic Regressions

Initially, I conducted a simple logistic regression analysis to assess each research question and to determine whether each main independent variable is a statistically significant predictor of infant mortality outcome without controlling for the covariates (educational attainment and age). I also conducted similar analysis using each covariate to determine the likelihood of infant mortality outcome predicted by educational attainment and maternal age. I rejected or failed to reject the null hypotheses depending on whether the main independent variable contributed significantly to infant mortality outcome.

Following the initial simple logistic regression, I conducted a second simple logistic regression analysis with each significant main independent variable from the previous analysis while controlling for the covariates (educational attainment and maternal age). The R^2 value generated from the analysis determined the total variation in infant mortality outcome that can be explained by each of the significant main independent variable. A higher R^2 value showed a high correlation/likelihood of infant mortality outcome associated with the main independent variable. I also determined whether the hypotheses from the initial analysis was sustained after controlling for maternal educational attainment and age.

Following the second simple logistic regression analysis, a stepwise multiple logistic regression analysis with the statistically significant main independent variables was conducted to demonstrate the most parsimonious prediction of infant mortality outcome. The parsimonious logistic regression model determined the likelihood of infant mortality outcome associated with each significant main independent variable and covariate. Each of the significant main independent variables, which was derived from the simple logistic regression analyses, along with the covariates (age and educational attainment), were added to the multiple logistic regression model through a stepwise process. The statistical criterion established for the stepwise process involved the reduction of the -2 log-likelihood error. The process of adding the significant main independent variables and covariates was terminated after all the variables, which can significantly reduce the -2 log-likelihood error have been entered into the model. The final model was the most parsimonious model because it contained only variables that most effectively predicted infant mortality outcome.

Simple Logistic Regression

Research Question 1

In RQ1, a simple logistic regression analysis was conducted to investigate the association between maternal prepregnancy BMI and infant mortality outcome. Normal prepregnancy BMI was used as a reference category since previous findings have shown that normal prepregnancy BMI is less likely associated with infant mortality outcomes (Ely & Driscol, 2020; Ely et al., 2020; Siega-Riz et al., 2020). In the logistic regression analysis, prepregnancy BMI was found to be significant $\chi2$ (3) = 74.522, p =.000. In Table 2, underweight prepregnancy BMI showed significantly high odds (OR = 25.819; 95% CI = 3.437, 193.980; p = .002) of infant mortality outcome over normal-weight prepregnancy BMI, followed by obese prepregnancy BMI (OR = 2.092; 95% CI =

1.609, 2.720; *p* = .000). While overweight prepregnancy BMI showed reduced odds (OR = .849; 95% CI = .690, 1.044; *p* = .121), the association was not significant.

Table 2

Association Between Prepregnancy BMI and Infant Mortality outcome

			95% C.I.for EXP(B)	
	P-value	OR	Lower	Upper
Prepregnancy BMI	.000			
Underweight BMI	.002	25.819	3.437	193.980
Overweight BMI	.121	.849	.690	1.044
Obese BMI	.000	2.092	1.609	2.720
Normal BMI (ref.)				
Constant	.000	.736		

Overall, the analysis showed that underweight BMI and obese BMI predicted infant mortality outcome. Since the analysis also yielded an overall statistically significant association, I rejected the null hypothesis; thus, suggesting that there is an association between maternal prepregnancy BMI and infant mortality outcome.

Research Question 2

In RQ2, adequate GWG was used as the reference category. Adequate GWG has been associated with less risk of infant mortality in previous studies (Ceballos et al. ,2018 & Chen et al., 2020). In the regression analysis, I examined the association between maternal GWG and infant mortality outcome. GWG, in the logistic regression analysis, was found to be significant $\chi 2$ (2) = 24.326, *p* =.000. In Table 3, the analysis showed that (inadequate and excessive) GWG were significantly associated with infant mortality outcome (OR = 1.713; 95% CI = 1.378, 2.129; *p* = .000), and (OR = 1.349; 95% CI = 1.076, 1.691; *p* = .009) over adequate GWG, respectively.

Table 3

Association Between GWG and Infant mortality outcome.

			95% C.I.for EXP(B)	
	P-value	OR	Lower	Upper
GWG	.000			
Inadequate GWG	.000	1.713	1.378	2.129
Excessive GWG	.009	1.349	1.076	1.691
Adequate GWG (ref.)				
Constant	.000	.638		

Overall, the analysis showed that GWG (inadequate and excessive) predicted infant mortality. The analysis also showed significant association; therefore, I rejected the null hypothesis; thus, suggesting that there is an association between GWG and infant mortality outcome.

Research Question 2: GWG Varied by Maternal Prepregnancy BMI:

To identify what categories of maternal prepregnancy BMI, GWG (inadequate and excessive) significantly contribute to infant mortality outcome, I classified GWG into four categories based on maternal prepregnancy BMI. Each category was also subclassified into inadequate, adequate, and excessive GWGs. Adequate GWG was used as the reference. The categories/sub-categories which did not contribute significantly to infant mortality outcome were not reported.

The categories/subcategories of GWG included:

Underweight GWG (GWG classified by underweight prepregnancy BMI).

- *Inadequate*
- *Adequate*
- *Excessive*

Normal-weight GWG (GWG classified by normal-weight prepregnancy BMI).

- *Inadequate*
- *Adequate*
- *Excessive*

Overweight GWG (GWG classified by overweight prepregnancy BMI).

- *Inadequate*
- *Adequate*
- *Excessive*

Obese GWG (GWG classified by obese prepregnancy BMI).

- *Inadequate*
- *Adequate*
- *Excessive*

Table 4

Omnibus Tests of Model Coefficients

Prepregnancy BMI			Chi-square	df	*P-value*
Underweight	Step 1	Step	1.662	2	.436
		Block	1.662	2	.436
		Model	1.662	2	.436
Normal-weight	Step 1	Step	21.676	2	.000
		Block	21.676	2	.000
		Model	21.676	2	.000
Overweight	Step 1	Step	5.048	2	.080
		Block	5.048	2	.080
		Model	5.048	2	.080
Obese	Step 1	Step	5.163	2	.076
		Block	5.163	2	.076
		Model	5.163	2	.076

After examining the association between GWG varied by maternal prepregnancy BMI, Table 4 identified that only GWG stratified by mothers with normal-weight prepregnancy BMI (Normal-weight GWG) significantly $\chi 2$ (2) = 21.676, $p = .000$ predicted infant mortality outcome. Underweight GWG, overweight GWG, and obese GWG were non-significant. The analysis showed that only inadequate, normal-weight GWG was significant with odds of (OR = 2.273; 95% CI = 1.604, 3.220; $p = .000$) as indicated in Table 5. Excessive, normal-weight GWG was not statistically significant.

Table 5

Association Between Normal-Weight GWG and Infant Mortality Outcome

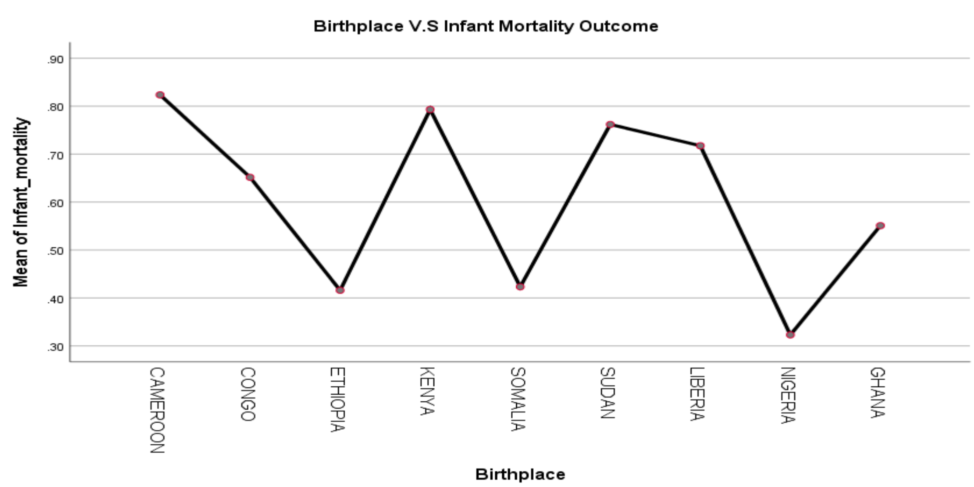
Prepregnancy BMI		*P-value*	OR	95% C.I.for EXP(B) Lower	Upper
Normal weight	GWG	.000			
	Inadequate	.000	2.273	1.604	3.220
	Excessive	.115	1.400	.921	2.129
	Constant	.000	.521		

Research Question 3

In RQ3, I investigated whether there was an association between maternal birthplace and infant mortality outcome. I used the birthplace, Nigeria, as a reference category since, on average, U.S. SSAI from Nigeria experienced the lowest risk of infant mortality outcome, as shown in Figure 7.

Figure 7

Birthplace Versus Infant Mortality Outcome



Maternal birthplace in the logistic regression yielded a statistically significant association ($\chi 2$ (8) = 209.847, *p* = .000 with infant mortality outcome. Table 6 indicated that SSAI from Cameroon showed the strongest predictor (OR = 11.267; 95% CI = 5.612, 22.617; *p* = .000) of infant mortality outcome over those from Nigeria, followed by Kenya (OR = 9.154; 95% CI = 5.182, 16.172; *p* = .000); Sudan (OR = 5.965; 95% CI = 3.341, 10.649; *p* = .000); Liberia (OR = 5.428; 95% CI = 3.223, 9.143; *p* = .000); Congo (OR = 4.571; 95% CI = 2.961, 7.056; *p* = .000); Ghana (OR = 2.137; 95% CI = 1.576, 2.897; *p* = .000); and Somalia (OR = 1.735; 95% CI = 1.327, 2.269; *p* = .000), respectively. Ethiopia also experienced increased odds (OR = 1.310; 95% CI = .947, 1.813; *p* = .103) of infant mortality, but not statistically significant.

Table 6

Association Between Maternal Birthplace and Infant mortality Outcome.

			95% C.I.for EXP(B)	
	P-value	OR	Lower	Upper
Birthplace	.000			
Cameroon	.000	11.267	5.612	22.617
Congo	.000	4.571	2.961	7.056
Ethiopia	.103	1.310	.947	1.813
Kenya	.000	9.154	5.182	16.172
Somalia	.000	1.735	1.327	2.269
Sudan	.000	5.965	3.341	10.649
Liberia	.000	5.428	3.223	9.143
Ghana	.000	2.137	1.576	2.897
Nigeria (ref.)				
Constant	.000	.444		

Infant mortality outcome varied vastly among maternal birthplace. The overall analysis also presented a statistically significant association. As a result, I rejected the null hypothesis; thus, suggesting that there is an association between maternal birthplace and infant mortality outcome.

Covariates

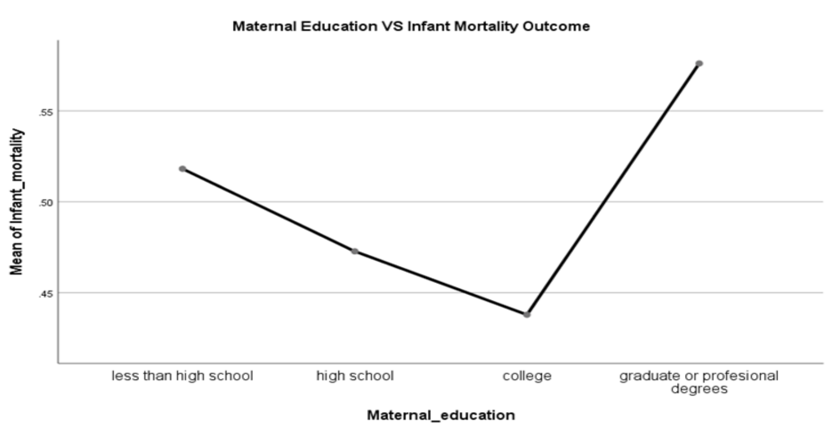
I also conducted simple logistic regression analysis to assess the likelihood of infant mortality outcome associated with the covariates (educational attainment and maternal age).

Educational Attainment

I investigated whether there is an association between maternal educational attainment and infant mortality outcome. I used college educated mothers as reference category since Figure 8 depicted that college-educated SSAI mothers experienced the least infant mortality outcome.

Figure 8

Educational attainment Versus Infant Mortality Outcome



Maternal educational attainment in the simple logistic regression analysis, was found to be significant $\chi2$ (3) = 12.864, *p* =.005. Table 7 showed that the odds ratio for mothers with less than high school education (<high school) was (OR= 1.243; 95% CI = .906, 1.705; p = .177) implying that <high school did not affect infant mortality outcome. The statement that mothers with less than high school education was nearly 24% more likely to experience infant mortality outcome than college educated mothers was not supported by the analysis. However, mothers with high school and graduate/prof. level educations showed high odds (OR= 1.364; 95% CI = 1.107, 1.680; p = .004), and (OR= 1.558; 95% CI = 1.134, 2.141; p = .006), which implied a nearly 36% and 56% increase in the odds ratio, respectively. Thus, indicating that mothers with high school and graduate/prof. level educations are 36% and 56% more likely to experience infant mortality outcome than college-educated mothers.

Table 7

Association Between Maternal Educational Attainment and Infant Mortality outcome

			95% C.I.for EXP(B)	
	P-value	OR	Lower	Upper
Education Attainment	.005			
<high school	.177	1.243	.906	1.705
High school	.004	1.364	1.107	1.680
Graduate/prof	.006	1.558	1.134	2.141
Constant	.000	.685		

Maternal Age

Moreover, I investigated the association between maternal age and infant mortality outcome. I used ages between (20–39) as reference categories since this category was found to be less likely associated with infant mortality outcomes (Ely & Driscol, 2020). Maternal age in the simple logistic regression analysis was found to be significant $\chi 2\ (2) = 49.727$, p =.000.

Table 8

Association Between Maternal Age and Infant Mortality Outcome

			95% C.I.for EXP(B)	
	P-value.	OR	Lower	Upper
Maternal Age	.000			
<20	.006	8.320	1.856	37.289
>39	.000	2.667	1.946	3.654
Constant	.000	.721		

Table 8 showed high odds (OR= 8.320; 95% CI = 1.856, 37.289; p = .006), and (OR= 2.667; 95% CI = 1.946, 3.654; p = .000) of infant mortality associated with maternal ages (<20) and (>39), respectively. This implied a nearly 732% and 167% increase in the odds ratio, respectively. Thus, indicating that mothers ages <20 and >39 are 732% and 167% more likely to experience infant mortality outcome than mothers ages between (20 & 39).

Summary

In summary, the simple logistic regression analysis identified that all the main independent variables were significantly associated with infant mortality outcome. Thus, I rejected all the null hypotheses associated with each research question. Furthermore, both maternal educational attainment and maternal age were also associated with infant mortality outcome.

Simple Logistic Regression While Controlling for Covariates

Research Question 1

In RQ1, I examined the association between maternal prepregnancy BMI and infant mortality outcome while controlling for maternal educational attainment and age. The analysis was found to be significant $\chi2$ (3) = 135.527, p =.000. In Table 9, prepregnancy BMI explained 9.3% (Nagelkerke R^2) of the variance in infant mortality outcome and correctly classified 62.3% of all cases.

Table 9

Model Summary

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
2444.982[a]	.070	.093

The estimated odds ratio (OR = 26.422; 95% CI = 3.499, 199.544; P = .002) in Table 10 predicted that mothers with underweight prepregnancy BMI remained highly associated with infant mortality outcome over mothers with normal-weight prepregnancy BMI. Infants of mothers with obese prepregnancy BMI also showed significantly high odds (OR = 2.169; 95% CI = 1.654, 2.843; P = .000) of infant mortality outcome over mothers with normal-weight prepregnancy BMI. Overweight prepregnancy BMI remained associated with non-significantly reduced odds (OR = .871; 95% CI = .702, 1.082; P = .212) of infant mortality outcome over mothers with normal-weight prepregnancy BMI.

Table 10

Association Between Maternal Prepregnancy BMI and Infant Mortality Outcome

			95% C.I.for EXP(B)	
	P-value	OR	Lower	Upper
Prepregnancy BMI	.000			
Underweight BMI	.002	26.422	3.499	199.544
Overweight BMI	.212	.871	.702	1.082
Obese BMI	.000	2.169	1.654	2.843
Normal BMI (ref.)				
Maternal Age	.000			
<20	.008	7.722	1.693	35.231
>39	.000	2.707	1.958	3.743
(20-39) (ref.)				
Edu. Attainment	.004			
<high school	.356	1.168	.840	1.624
High school	.012	1.330	1.065	1.660
Graduate/prof. degrees	.001	1.713	1.233	2.379
College (ref.)				
Constant	.000	.551		

After controlling for the covariates (age and educational attainment), prepregnancy BMI in the logistic regression analysis yielded an overall statistically significant association. Therefore, I rejected the null hypothesis; thus, suggesting that there is an association between maternal prepregnancy BMI and infant mortality outcome while controlling maternal educational attainment and age. The R-squared value also showed 9.3% correlation between prepregnancy BMI and infant mortality outcome.

Research Question 2

In RQ2, I examined the association between maternal GWG and infant mortality outcome while controlling for educational attainment and age. GWG, in the logistic regression analysis, was found to be significant χ2 (2) = 24.326, *p* =.000. Table 11 showed that the predictor variable (GWG) explained 6% (Nagelkerke R^2) of the variance in infant mortality outcome and correctly classified approximately 61% of all cases.

Table 11

Model Summary

-2 Log-likelihood	Cox & Snell R Square	Nagelkerke R Square
2494.247[a]	.045	.060

The analysis in Table 12 showed that GWG (inadequate and excessive) remained significantly associated with infant mortality outcome with strong odds of nearly 74.2% (OR = 1.742; 95% CI = 1.378, 2.129; *p* = .000), and 31.4% (OR = 1.314; 95% CI = 1.076, 1.691; *p* = .009) over adequate GWG, respectively.

Table 12

Association Between GWG and Infant Mortality Outcome

			95% C.I.for EXP(B)	
	P-value.	OR	Lower	Upper
GWG	.000			
Inadequate GWG	.000	1.742	1.392	2.179
Excessive GWG	.021	1.314	1.042	1.657
Edu. Attainment	.004			
<high school	.452	1.133	.818	1.571
High School	.006	1.348	1.088	1.669
Graduate/prof.	.002	1.654	1.194	2.292
Maternal Age	.000			
<20	.021	5.909	1.308	26.698
>39	.000	2.773	2.014	3.817
Constant	.000	.488		

After I controlled for the covariates, GWG in the logistic regression analysis predicted an overall statistically significant association. I rejected the null hypothesis; thus, suggesting that there is an association between maternal GWG and infant mortality outcome while controlling for maternal educational attainment and age. GWG in the logistic regression also predicted 6% correlation with infant mortality outcome.

Research Question 2: GWG Varied by Prepregnancy BMI While Controlling for Covariates:

In *research question 2*, I also identified the categories/sub-categories of GWG varied by maternal prepregnancy BMI that significantly contribute to infant mortality outcome while controlling for the covariates, educational attainment, and maternal age. As stated, GWG was classified into four categories based on maternal prepregnancy BMI. Each category was also subclassified into inadequate, adequate, and excessive GWGs. Adequate GWG was used as the reference. The categories/sub-categories which did not contribute significantly to infant mortality outcome after adjusting for the covariates were not reported in the parsimonious model.

Table 13

Omnibus Tests of Model Coefficients

Prepregnancy BMI		Chi-square	df	*P-Value.*
Underweight GWG	Step	1.275	4	.866
	Block	1.275	4	.866
	Model	2.937	6	.817
Normal weight GWG	Step	18.528	5	.002
	Block	18.528	5	.002
	Model	40.205	7	.000
Overweight GWG	Step	46.789	5	.000
	Block	46.789	5	.000
	Model	51.837	7	.000
Obese GWG	Step	17.204	5	.004
	Block	17.204	5	.004
	Model	22.366	7	.002

After I adjusted for the covariates, Table 13 depicted that underweight-GWG was found not to be significant ($\chi2$ (4) = 1.275, p = .866); thus, underweight GWG was not reported. Normal-weight GWG ($\chi2$ (5) = 18.528, p = .002) remained significantly associated with infant mortality outcome. Additionally, overweight GWG $\chi2$ (5) = 46.789, p = 0.000, and obese GWG ($\chi2$ (5) = 17.204, p = .004) were found to be significantly associated with infant mortality outcome than previously predicted in the initial simple logistic regression analysis.

Normal-weight GWG: In Table 14, mothers with inadequate, normal-weight GWG remained strongly associated (OR = 2.209; 95% CI = 1.539, 3.173; p = .000) with infant mortality outcome than those with adequate GWG. Excessive, normal-weight

GWG also remained non-statistically significant (OR = 1.401; 95% CI = .908, 2.163; p = .127).

Table 14

Association Between Normal-weight GWG, and Infant Mortality Outcome

			95% C.I.for EXP(B)	
Normal-Weight Prepregnancy BMI	*P*-value	OR	Lower	Upper
Maternal age	.004			
Ages <20	.076	4.265	.857	21.219
Ages >39	.004	2.599	1.356	4.979
Edu. Attainment	.064			
< High Sch.	.877	1.049	.575	1.913
High Sch.	.266	.817	.571	1.167
Graduate/Prof Degree	.060	1.667	.978	2.840
GWG	.000			
Inadequate GWG	.000	2.209	1.539	3.173
Excessive GWG	.127	1.401	.908	2.163
Adequate GWG (ref)				
Constant	.000	.496		

In summary, after controlling for educational attainment and age, the results showed that only mothers with normal-weight prepregnancy BMI who exhibited inadequate GWG experienced statistically significant infant mortality. In other words, inadequate, normal-weight GWG yielded a higher risk of infant mortality than adequate GWG. The overall analysis also showed a significant association between Normal-weight GWG and infant mortality outcome; thus, inadequate, normal-weight GWG was reported in the regression analysis for the parsimonious model.

Overweight GWG: In Table 13, after I have controlled for age and educational attainment, overweight GWG was found to be significantly associated with infant mortality than I previously predicted in the initial simple logistic regression. Table 15 showed that overweight GWG (inadequate and excessive) showed high odds (OR = 1.373; 95% CI = .944, 1.996; p = 0.097) and (OR = 1.165; 95% CI = .828, 1.641; p = .380) of infant mortality outcome over adequate GWG, respectively; however, it was not statistically significant.

Table 15

Association Between Overweight GWG, and Infant Mortality Outcome

Overweight prepregnancy BMI	*P*-value	OR	95% C.I.for EXP(B) Lower	Upper
Maternal age	.000			
Ages <20	.999	21953.	.000	.
Ages >39	.000	3.180	2.019	5.010
Edu. Attainment	.000			
< High Sch.	.126	1.476	.896	2.431
High Sch.	.000	2.311	1.596	3.346
Graduate/Prof Degree	.010	1.876	1.164	3.025
GWG	.242			
Inadequate GWG	.097	1.373	.944	1.996
Excessive GWG	.380	1.165	.828	1.641
Adequate GWG (ref)				
Constant	.000	.353		

In summary, although the overall analysis predicted a statistically significant association between overweight GWG and infant mortality outcome after I adjusted for the covariates, overweight GWG (inadequate and excessive) was not significantly associated with infant mortality. Thus, I did not report overweight GWG (inadequate and excessive) in the parsimonious model.

***Obese GWG*:** Like overweight GWG, obese GWG showed significant association with infant mortality outcome after controlling for the covariates than I previously predicted in the initial simple logistic regression analysis. Table 16 showed that mothers with inadequate, obese GWG experienced strong but non-statistically significant odds (OR = 1.212; 95% CI = 0714, 2.060; *p* = .476) of infant mortality outcome over mothers with adequate GWG. On the other hand, mothers with excessive, obese GWG exhibited significantly high odds, nearly 86% (OR = 1.862; 95% CI = 1.047, 3.311; *p* = .034) of infant mortality than adequate GWG.

Table 16

Association Between Obese GWG, and Infant Mortality Outcome

			95% C.I.for EXP(B)	
Obese Prepregnancy BMI	*P*-value	OR	Lower	Upper
Maternal age	.029			
Ages <20	1.000	102491.	.000	.
Ages >39	.008	2.947	1.328	6.539
Edu. Attainment	.147			
< High Sch.	.209	.634	.311	1.290
High Sch.	.374	1.266	.752	2.131
Graduate/Prof Degree	.175	2.502	.665	9.418
GWG	.105			
Inadequate GWG	.476	1.212	.714	2.060
Excessive GWG	.034	1.862	1.047	3.311
Adequate GWG (ref)				

The results showed that only mothers with obese prepregnancy BMI that gained excessive GWG experienced significant infant mortality. The overall analysis also found a statistically significant association between obese GWG and infant mortality outcome.

Thus, excessive, obese GWG was reported in the regression analysis for the parsimonious model.

In summary, after assessing all statistically significant GWG categories/sub-categories in research question 2, the analyses showed that only inadequate, normal-weight GWG, and excessive, obese GWG showed significant associations with infant mortality outcome after adjusting for educational attainment and age. Although the analysis showed that overweight GWG presented a statistically significant association with infant mortality outcome, overweight GWG (inadequate and excessive) were not statistically significant. Therefore, only inadequate, normal-weight GWG and excessive, obese GWG were reported in the analysis for the parsimonious model.

Research Question 3

In *research question 3,* I examined the association between maternal birthplace and infant mortality outcome while adjusting for maternal educational attainment and age. The analysis was found to be significant $\chi 2$ (3) = 57.655, p =.000. In Table 17, birthplace explained nearly 18% (Nagelkerke R^2) of the variance in infant mortality outcome and correctly classified approximately 68% of all cases.

Table 17

Model Summary

-2 Log-likelihood	Cox & Snell R Square	Nagelkerke R Square
2313.006[a]	.133	.178

Table 18 indicated that SSAI from Cameroon remained the strongest predictor (OR = 12.584; 95% CI = 6.229, 25.422; p = .000) of infant mortality outcome over those from Nigeria, followed by Kenya (OR = 8.885; 95% CI = 4.971, 15.879; *p* = .000); Liberia (OR = 5.946; 95% CI = 3.490, 10.132; *p* = .000); Sudan (OR = 5.726; 95% CI = 3.153, 10.400; *p* = .000); Congo (OR = 4.902; 95% CI = 3.101, 7.749; *p* = .000); Ghana (OR = 2.295; 95% CI = 1.677, 3.140; *p* = .000); and Somalia (OR = 1.951; 95% CI = 1.363, 2.791; *p* = .000), respectively. Ethiopia also experienced increased odds (OR = 1.278; 95% CI = .901, 1.814; *p* = .170) of infant mortality, but remained non-statistically significant.

After controlling for the covariates, maternal birthplace in the logistic regression analysis yielded an overall statistically significant association. Therefore, I rejected the null hypothesis; thus, suggesting that there is an association between maternal birthplace and infant mortality outcome while controlling maternal educational attainment and age. The R-squared value also predicted the highest, approximately 18% correlation between birthplace and infant mortality outcome over all other variables.

Table 18

Association Between Maternal Birthplace and Infant Mortality Outcome

			95% C.I.for EXP(B)	
	P-value	OR	Lower	Upper
Maternal age	.000			
Ages <20	.039	5.051	1.082	23.582
Ages >39	.000	2.979	2.126	4.173
Edu. Attainment	.012			
< High Sch.	.999	1.000	.655	1.527
High Sch.	.493	1.090	.852	1.395
Graduate/Prof. Degree	.001	1.790	1.267	2.529
Birthplace	.000			
Cameroon	.000	12.584	6.229	25.422
Congo	.000	4.902	3.101	7.749
Ethiopia	.170	1.278	.901	1.814
Kenya	.000	8.885	4.971	15.879
Somalia	.000	1.951	1.363	2.791
Sudan	.000	5.726	3.153	10.400
Liberia	.000	5.946	3.490	10.132
Ghana	.000	2.295	1.677	3.140
Nigeria (ref.)				
Constant	.000	.349		

Summary

To summarize, after I controlled for maternal educational attainment and age, all main independent variables remained significantly associated with infant mortality outcome. The R-squared value showed that birthplace explained the highest, nearly 18% of the variance in infant mortality outcome, followed by maternal prepregnancy BMI (9.3%), and GWG (6.0%). In addition, while GWG significantly contributed to infant mortality outcome, only GWG (inadequate and excessive) classified by normal weight and obese weight prepregnancy BMIs, respectively, were statistically significant.

Stepwise Multiple Logistic Regression: Parsimonious Model.

Upon identifying all the significant main independent variables using the simple logistic regression analyses, a stepwise multiple logistic regression analysis was conducted to investigate the association between the significant main independent variables, covariates, and infant mortality outcome. In this case, all of the main independent variables and covariates (age and educational attainment) were entered into the model. I used the stepwise multiple logistic regression process to find the most parsimonious set of predictors that effectively predicted infant mortality outcome. Each of the significant main independent variables (prepregnancy BMI, GWG, and birthplace) derived from the simple logistic regression analysis, along with the covariates (age and educational attainment), were added to the multiple logistic regression one at a time through a stepwise process, using a statistical criterion of reducing the -2 log-likelihood error. The entire process of adding the predictors stopped after all the predictors, which made a statistically significant reduction to the -2 log-likelihood error had been added. The model in the final step is the most parsimonious model because it contained only variables that most effectively predicted infant mortality outcome.

Table 19

Stepwise Multiple Logistic Regression: Variable Entered at Each Step.

	Variable	Model Log-Likelihood	Change in -2 Log-Likelihood	*P-value*
Step 1	Birthplace	-1290.254	209.847	.000
Step 2	Birthplace	-1265.391	206.808	.000
	Maternal Age	-1185.331	46.688	.000
Step 3	Birthplace	-1229.133	180.784	.000
	Maternal Age	-1160.870	44.258	.000
	Prepregnancy BMI	-1161.987	46.492	.000
Step 4	Birthplace	-1222.491	182.370	.000
	Maternal Age	-1153.882	45.153	.000
	Educational Attainment	-1138.741	14.870	.002
	Prepregnancy BMI	-1156.503	50.395	.000
Step 5	Birthplace	-1211.862	172.675	.000
	Maternal Age	-1147.562	44.075	.000
	Educational Attainment	-1133.908	16.768	.001
	Prepregnancy BMI	-1150.178	49.307	.000
	GWG	-1131.306	11.563	.003

As presented in Table 19, all main independent variables and covariates satisfied the statistical criteria; thus, all were entered into the model. The variable in Step 1, birthplace, had the single highest significant contribution to infant mortality outcome. The second variable, maternal age with the highest impact on infant mortality, entered the model at Step 2. This was followed by prepregnancy BMI entered in the model at Step 3, educational attainment was entered at Step 4, and GWG was entered at Step 5.

Given that the final Step (Step 5) contained all of the predictors that satisfied the criteria established for the stepwise multiple logistic regression, it was considered the parsimonious model that most effectively predicted infant mortality outcome.

Table 20

Hosmer and Lemeshow Test

Step	Chi-square	df	*P-value*
5	7.855	8	.448

The Hosmer-Lemeshow goodness-of-fit (p = .448) for step 5 where (p > 0.05) as indicated in Table 20, predicted a correctly specified model. Furthermore, the main independent variables and covariates (prepregnancy BMI, GWG, educational attainment, maternal age, and Birthplace) in Step 5 contributed significantly to the model- $\chi2$ (18) = 329.460, p =.000. In Table 19, together, they accounted for nearly 22% (Nagelkerke R^2) of the variance in infant mortality outcome and correctly classified 69.3% of all cases.

Table 21 presented the most parsimonious model; thus, it was the only model I interpreted. The rest of the models, along with the analyses, can be found in the Appendix

Table 21

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
5	2251.048[c]	.161	.215

Research Question 1

In Table 22, the probability of the Wald Statistic for the predictor variable, mothers with underweight prepregnancy BMI (X^2 (1, N = 1877) = 8.79, *p* = 0.003 was less than or equal to the level of statistically significance (0.05). The null hypothesis that the b coefficient for mothers with underweight prepregnancy BMI was zero was rejected. The odds ratio for underweight prepregnancy BMI was (OR= 22.628; 95% CI = 2.868, 178.555; *p* = 0.00), which implied a nearly 2,163% increase in the odds ratio. Thus, indicating that mothers with underweight prepregnancy BMI are approximately 2,163% more likely to experience infant mortality outcome than mothers with normal-weight prepregnancy BMI.

Moreover, the probability of the Wald Statistic for the predictor variable, mothers with overweight prepregnancy BMI (X^2 (1, N = 1877) = 1.374, *p* = .241 was greater than or equal to the level of statistically significance (0.05), as shown in Table 22. The null hypothesis that the b coefficient for mothers with overweight prepregnancy BMI was zero was not rejected. The odds ratio for overweight prepregnancy BMI was (OR= .869; 95% CI = .688, 1.099; *p* = .241) implying that overweight prepregnancy BMI did not affect infant mortality outcome. The statement that mothers with overweight prepregnancy BMI were nearly 13% less likely to experience infant mortality outcome than mothers with normal weight prepregnancy BMI was not supported by the analysis.

As depicted in Table 22, the probability of the Wald Statistic for the predictor variable, mothers with obese prepregnancy BMI (X^2 (1, N = 1877) = 18.229, *p* = .000 was less than or equal to the level of statistically significance (0.05). The null hypothesis that the b coefficient for mothers with obese prepregnancy BMI was zero was rejected. The odds ratio for obese prepregnancy BMI was (OR=1.903; 95% CI = 1.416, 2.558; *p* = 0.00) implying a nearly 90% increase in the odds. Thus, indicating that mothers with obese prepregnancy BMI are approximately 90% more likely to experience infant mortality outcome than mothers with normal-weight prepregnancy BMI.

Research Question 2

In RQ2, Table 22 also showed that the probability of the Wald Statistic for the predictor variable, inadequate GWG (X^2 (1, N = 1877) = 9.573, *p* = .002 was less than or equal to the level of statistically significance (0.05). The null hypothesis that the b coefficient for inadequate GWG was zero was rejected. The odds ratio for inadequate GWG was (OR = 1.469; 95% CI = 1.151, 1.875; *p* = .002) presenting a nearly 47% increase in the odds ratio. This implied that mothers who gained inadequate GWG were approximately 47% more likely to experience infant mortality outcome than mothers with adequate GWG. However, this was only linked to mothers with normal weight prepregnancy BMI as indicated in the simple logistic regression analysis.

Research question 2 also presented that the probability of the Wald Statistic for the predictor variable, excessive GWG (X^2 (1, N = 1877) = 5.888, *p* = .015 was less than or equal to the level of statistically significance (0.05) as indicated in Table 22. The null hypothesis that the b coefficient for excessive GWG was zero was rejected. The odds ratio for excessive GWG was (OR = 1.362; 95% CI = 1.061, 1.748; *p* = .015), which presented a 36% increase in the odds ratio. This implied that mothers who gained excessive GWG are 36% more likely to experience infant mortality outcome than mothers with adequate GWG. However, this was only true for mothers with obese prepregnancy BMI, as indicated in the simple logistic regression analysis.

Research Question 3

In Table 19, birthplace sustained the strongest association with infant mortality. Table 22 showed that Cameroonian mothers remained the highest predictor of infant mortality. Nearly 954% (OR = 10.535; 95% CI = 5.177, 21.439; *p* = .000) of infant mortality outcome was attributed to Cameroonian mothers over mothers from Nigeria. Kenya (OR = 8.195; 95% CI = 4.531, 14.822; *p* = .000); Liberia (OR = 5.945; 95% CI = 3.465, 10.199; *p* = .000); Sudan (OR = 5.054; 95% CI = 2.759, 9.259; *p* = .000); Congo (OR = 4.538; 95% CI = 2.837, 7.260; *p* = .000); Ghana (OR = 2.268; 95% CI = 1.644, 3.130; *p* = .000); and Somalia (OR = 1.956; 95% CI = 1.356, 2.822; *p* = .001) also presented statistically significant infant mortality outcome, respectively. While Ethiopia also experienced increased odds, approximately 44% (OR = 1.436; 95% CI = .998, 2.065; *p* = .051) of infant mortality, the statement that mothers from Ethiopia are 44% more likely to experience infant mortality outcome than mothers from Nigeria was not supported by the analysis.

Covariates

Educational Attainment

Table 22 presented that the probability of the Wald Statistic for the covariate, mothers with less than high school educational attainment (<high school) (X^2 (1, N = 1877) = .181, *p* = .671 was greater than or equal to the level of statistically significance (0.05). The null hypothesis that the b coefficient for mothers with less than high school

educational attainment was zero was not rejected. The odds ratio for <high school educational attainment was (OR = .910; 95% CI = .588, 1.408; *p* = .671). This implied that <high school educational attainment did not affect infant mortality outcome. The conclusion that SSAI mothers with <high school educational attainment were 9% less likely to experience infant mortality outcome than college-educated mothers was not supported by the analysis.

Similarly, the probability of the Wald Statistic for the covariate, mothers with high school educational attainment (high school) (X^2 (1, N = 1877) = .067, *p* = .796 was greater than or equal to the level of statistically significance (0.05) as indicated in Table 22. The null hypothesis that the b coefficient for mothers with high school educational attainment was zero was not rejected. The odds ratio for high school educational attainment was (OR = 1.034; 95% CI = .802, 1.332; *p* = .796). Thus, indicating that high school educational attainment did not significantly affect infant mortality outcome. The conclusion that SSAI mothers with high school educational attainment were 3.4% more likely to experience infant mortality outcome than college-educated mothers was also not supported by the analysis.

However, in Table 22, the probability of the Wald Statistic for the covariate, graduate/professional level education (X^2 (1, N = 1877) = 16.150, *p* = .000 was less than or equal to the level of statistically significance (0.05). The null hypothesis that the b coefficient for graduate/professional level education was zero was rejected. The odds ratio for graduate/professional level education was (OR = 2.073; 95% CI = 1.4538, 2.957; *p* = .000), which presented over 100% increase in the odds. This implied that mothers with graduate/professional level education were over 100% more likely to experience infant mortality outcome than college-educated mothers.

Maternal Age

Maternal age showed the second highest impact on infant mortality outcome. Table 22 showed that the probability of the Wald Statistic for the covariate, maternal age (>39) (X^2 (1, N = 1877) = 38.319, p = .000 was less than or equal to the level of statistically significance (0.05). The null hypothesis that the b coefficient for maternal age (>39) was zero was rejected. The odds ratio for maternal age (>39) was (OR = 2.983; 95% CI = 2.110, 4.216; p = 0.000), which reported a nearly 200% increase in the odds ratio-also implying that mothers with age above 39 (>39) are nearly 200% more likely to experience infant mortality outcome than mothers with ages (20-39).

However, unlike maternal age (>39), the probability of the Wald Statistic for the covariate, maternal age (<20) (X^2 (1, N = 1877) = 3.442, p = .064 was greater than or equal to the level of statistically significance (0.05) as also indicated in Table 22. The null hypothesis that the b coefficient for maternal age (<20) was zero was not rejected. The odds ratio for maternal age (<20) was (OR = 4.375; 95% CI = .920, 20.804; p = 0.064). Thus, indicating that maternal age (<20) did not affect infant mortality outcome. The report that SSAI mothers with ages less than 20 (<20) are nearly 336% more likely to experience infant mortality outcome than mothers with ages (20-39) was not supported by the analysis.

Table 22

Parsimonious Model: Association Between Prepregnancy BMI, GWG, Birthplace, and infant mortality outcome while controlling for Age and Educational Attainment.

					95% C.I.for EXP(B)	
	B	Wald	*P-value*	OR	Lower	Upper
Birthplace			.000			
Cameroon	2.355	46.397	.000	10.535	5.177	21.439
Congo	1.513	47.065	.000	4.538	2.837	7.260
Ethiopia	.362	2.652	.051	1.436	.998	2.065
Kenya	2.103	58.157	.000	8.195	4.531	14.822
Somalia	.671	16.234	.000	1.956	1.356	2.822
Sudan	1.620	36.465	.000	5.054	2.759	9.259
Liberia	1.782	40.454	.000	5.945	3.465	10.199
Ghana	.819	23.895	.000	2.268	1.644	3.130
Nigeria (ref.)						
Maternal Age			.000			
<20	1.628	3.442	.064	4.375	.920	20.804
>39	1.088	38.319	.000	2.983	2.110	4.216
(20-39)(ref)						
Edu. Attainment			.001			
<high school	-.075	.181	.671	.910	.588	1.408
High school	.036	.067	.796	1.034	.802	1.332
Graduate/Prof. Edu.	.681	16.150	.000	2.073	1.453	2.957
College (ref)						
Prepregnancy BMI			.000			
Underweight BMI	3.119	8.759	.003	22.628	2.868	178.555
Overweight BMI	-.140	1.374	.241	.869	.688	1.099
Obese BMI	.644	18.229	.000	1.903	1.416	2.558
Normal-Wt. BMI (ref.)						
GWG			.003			
Inadequate GWG	.385	9.573	.002	1.469	1.151	1.875
Excessive GWG	.309	5.888	.015	1.362	1.061	1.748
Constant			.000	.271		

Summary

In summary, the three research questions I assessed in the current study determined whether there were associations between maternal 1) prepregnancy BMI and infant mortality outcome, 2) GWG and infant mortality outcome, and 3) birthplace and infant mortality outcome while controlling for age and educational attainment. In addition, I described the probability of the covariates (maternal age and education attainment) on the likelihood of infant mortality outcome. In the simple logistic regression analyses, I found that all main independent variables contributed significantly to infant mortality outcome. Thus, all null hypotheses were rejected. The R-squared values showed that the variable, maternal birthplace explained the highest variance in infant mortality outcome, followed by prepregnancy BMI and GWG, respectively. The stepwise multiple logistic regression entered all main independent variables and covariates. Maternal birthplace contributed the highest impact on infant mortality outcome-followed by maternal age. Maternal prepregnancy BMI presented the third highest impact on infant mortality outcome, followed by maternal educational attainment, and GWG showed the less contribution to infant mortality outcome.

The overall parsimonious analysis in Table 22 showed the model containing all main independent variables, and covariates effectively predicted infant mortality outcome. The model deduced that only underweight and obese prepregnancy BMIs contributed significantly to infant mortality outcome. GWG (inadequate and excessive) showed strong odds of infant mortality; however, this evidence was only linked to mothers with normal-weight prepregnancy BMI who gained inadequate GWG and mothers with obese prepregnancy BMI who gained excessive GWG.

Furthermore, the parsimonious model in Table 22 presented that infant mortality outcome differed vastly by maternal birthplace. Despite controlling for maternal age and educational attainment, the model showed that Cameroonian showed the strongest predictor of infant mortality outcome compared to Nigeria, followed by Kenya, Liberia; Sudan; Congo; Ghana; and Somalia, respectively. While Ethiopia also presented a high likelihood of infant mortality outcome, it was not statistically significant.

After adding all main independent variables to the model, it was reported in Table 22 that mothers over the age of 39 (>39) are more likely to experience infant mortality outcome than mothers between ages (20–39). Furthermore, mothers with graduate/professional level education also suffered elevated odds of infant mortality outcome compared to college-educated mothers. Mothers who attained less than high school education experienced a non-statistically significant infant mortality outcome. These three findings were also supported by the analysis previously conducted using simple logistic regression. However, mothers under 20 (<20) and mothers who attained high school education experienced a non-statistically significant infant mortality outcome after adding all main independent variables to the model.

In the next chapter (chapter 5), I provided a detailed summary of the study’s overall results, limitations, recommendations, and the implications for social change.

Chapter 5: Discussion, Recommendations, and Conclusions.

I examined the association between maternal prepregnancy BMI, GWG, birthplace, and infant mortality outcome utilizing the IOM/NRC guidelines and the linked birth/infant death records file from 2017–2018 while controlling for the covariates, age, and educational attainment. I also assessed whether the covariates (maternal age and educational attainment) predicted infant mortality outcome. In this chapter, I presented the overall summary of the study, including interpretation of the results, limitations, recommendations, and implications of the study to social change.

Interpretation of the Findings

The study showed that underweight and obese prepregnancy BMIs were significant predictors of infant mortality outcome. The increased infant mortality associated with underweight and obese prepregnancy BMIs were expected as these have been established by previous studies and the IOM/NRC recommendations, which suggested that underweight and obese prepregnancy BMIs contributed to increased infant mortality and fetus loss (Singh & DiBari, 2019; Zhou et al., 2019). However, what was not anticipated was that overweight prepregnancy BMI yielded a nonsignificant reduced risk of infant mortality. Several studies have shown that overweight prepregnancy BMI presented health conditions, including severe infant mobility and death (Ukah et al., 2019, Siega-Riz et al., 2020). Overweight women experience fat storage (citation). While further research is needed, it is evident in this study that overweight does not affect infant mortality outcome. Weight gain is widely variable among women from various backgrounds. The evidence in the study supported previous findings that fat due to overweight may support fetal development resulting in optimal health status for infants born to SSAI women. For example, results derived from previous self-reported surveys indicated that overweight BMI scores promoted healthy status among SSAI (Ngoubene-Atioky & Williamson-Taylor, 2017). The mechanism by which overweight prepregnancy BMI affects infant mortality among SSAI is still unclear; however, the evidence presented in this study reinforced the need to assess and establish a baseline for healthy prepregnancy BMI that supports and improves infant health within the U.S. SSAI population. It was also apparent that the opposite is true-the lack of fat storage can contribute to excessive infant mortality. For example, women with underweight prepregnancy BMI were more likely to experience nearly 2,163% times more infant mortality than women with normal weight prepregnancy BMI. While a direct investigation is required, sub-Saharan Africans culturally perceive a thinner body as unhealthy and a sign of poverty (Ngoubene-Atioky & Williamson-Taylor, 2017). My result disconfirmed previous findings demonstrating that maternal overweight prepregnancy BMI is linked to infant mortality (see Álvarez-Bueno et al., 2017; Ju et al., 2018).

I also found that GWG (inadequate and excessive) was highly associated with infant mortality. However, GWG related infant death was more likely linked to normal-weight or obese prepregnancy BMIs. For example, the study suggested that only mothers with normal-weight prepregnancy BMI that gained inadequate GWG experienced significant infant mortality outcome, and only mothers with obese prepregnancy BMI that gained excessive GWG experienced significant infant mortality outcome. My findings are similar to Siega-Riz et al. (2020)'s conclusion, which confirmed that mothers with normal-weight and obese prepregnancy BMIs who experienced inadequate and excessive GWGs, respectively, demonstrated less optimal infant health outcomes. However, the study vastly diminished the premises established by the IOM/NRC recommendations and previous studies that inadequate and excessive GWGs are risk factors of infant mortality across all maternal prepregnancy BMIs (Álvarez-Bueno et al., 2017; Ju et al., 2018; Siega-Riz et al., 2020; Zhou et al., 2019). In fact, categorically, the study found no significant evidence that underweight and overweight, prepregnancy BMIs coupled with inadequate or excessive GWGs predicted infant mortality outcome.

My findings further inferred that maternal birthplace contributed the highest to infant mortality outcome among SSAI, and infant mortality varies vastly among SSAI birthplace. For example, the study deduced that Cameroonian women showed the highest risk of infant mortality, and Ethiopia was not significantly associated with infant mortality. These results supported a similar premise in previous studies. Although conducted with different race/ethnicity, infant mortality outcome was associated with variation in maternal birthplace (Belihu et al., 2016; Urquia, 2019; Wartko et al., 2017). While participants in my study shared similar experiences such as country borders, histories, dietary habits, civil wars, and migration and postmigration experiences, it was clear that the SSAI population also exhibits differences in the levels of infant mortality based on maternal birthplace.

The covariates of maternal age and educational attainment—showed that mothers with ages greater than 39 conferred disproportionately high odds of infant mortality outcome. This finding is consistent with Ely and Driscol (2020)'s study, which suggested that infants born to mothers ages over 40 years old experienced high infant mortality rates.

Another unanticipated result involved maternal educational attainment. For example, graduate/professional level education predicted high infant mortality outcomes. This result showed inconsistency with previous studies, such as those by Mitchell and Christian (2017), Obiang-Obounou and Fuh (2020), and Zilidis and Chadjichristodoulou (2020), that assessed health and SES. These studies determined that SES such as higher educational attainment, and employment promoted optimal infant health. Contrary to this evidence, I found that as SSAI women's educational attainment increased, it subsequently increased the likelihood of infant mortality. While my finding was seemingly counterintuitive to previous studies, it is reasonable to assume that other variables may be important factors. For example, after using ages (20-39) as the reference category, 100% of women with a graduate/professional level education were >39 years of age. As previously suggested, infant born to mothers ages 40 or older experienced higher rate of infant mortality (Ely & Driscol , 2020).

Limitations of the Study

In this study, I used a high-quality population-based dataset. It is, however, not without limitations. Due to the retrospective data collection nature, the study was subject to misclassification and recall biases. Misclassification in the study data may present internal validity issues, in which data of mothers with different races/ethnicities may be misclassified with participants of interest. Another limitation involving the study's internal validity include the lack of quality control measures of the study data. While the CDC-Wonder database automatically verifies data for validation, including code validation, consistency, data completeness, and individual birth hospitals' validation, the state's validation processes are unclear (Almli et al., 2020).

Furthermore, the study data were extracted from the U.S. standard birth certificate. The data information on the birth certificate is required for all birth occurring in the United States regardless of the precise location. However, the data completeness on the birth certificate presented some concerns in the data collection process. For example, the birth certificate data is self-reported, and items such as the mother's race, birthplace, GWG, prepregnancy BMIs, age, education may be inaccurately reported or purposely omitted.

Despite adjusting for covariates such as age and educational attainment, other confounders, including behavioral, medical, birth plurality, and sociodemographic factors and confounding unknown variables, may have influenced infant mortality outcome. These confounders were not accounted for in this study. Future studies should ensure that these variables are accounted for. In addition, the study contained a small size of participants with underweight prepregnancy BMI. The perception that sub-Saharan African perceive overweight/obese as healthy was evidenced by the large population of overweight and obese participants in the study population. Thus, this may affect the study results relating to GWG stratified by underweight prepregnancy BMI.

Another limitation of the study involved the concept referred to as the "healthy immigrant effect." While the study's cross-sectional nature provided a snapshot between

2017–2018, it does not determine the years the mothers immigrated to the United States. Thus, I could not assess the health status of the participants as it relates to their healthy immigrant effects. Overall, while the findings in the current study supported conclusions derived from several previous studies, several factors may interfere with the study results, including the data collection process and the aforementioned confounders.

Recommendations

Generally, maternal preconception health and health during pregnancy are key determinants of infant mortality outcome. Despite this evidence, addressing population-based specific health risk factors is critical to improving infant health outcomes. I investigated the association between infant mortality outcome and three predictors—maternal prepregnancy BMI, GWG, and birthplace. As discussed earlier, infant mortality outcome differed vastly according to maternal race/ethnicity and racial subgroup. For example, contrary to the IOM/NRC recommendations, I found no evidence that inadequate and excessive maternal GWG coupled with underweight and overweight prepregnancy BMIs influence infant mortality outcome. Given such findings, it is recommended that future researchers assessing infant mortality outcome investigate how these results are comparable to those of other ethnicities or ethnic subgroups. I also presented that an increase in age and educational level promote adverse infant health outcome. The result is counterintuitive to popular evidence presented by previous studies, which inferred that the risk of infant mortality outcome declines with increases in maternal educational attainment (Mitchell & Christian, 2017; Obiang-Obounou & Fuh, 2020; Zilidis & Chadjichristodoulou, 2020). Thus, it is recommended that prospective researchers interested in the effects of educational attainment on infant mortality outcome account for age groups. In the same way, the findings disconfirmed other popular evidence that maternal overweight prepregnancy BMI and GWG contribute to infant mortality outcome. Given that my results found no supporting evidence, thus it questioned the implication of IOM/NRC BMI recommendations across a population of various races/ethnicities and ethnicity subgroups.

Positive Social Change

The overall objective of the current study was to provide clinical and public health knowledge to help improve infant mortality outcomes within the U.S. SSAI population. Studies focusing on infant mortality risk factors have primarily used a mixed population sample to predict infant mortality, thus preventing population-based public health measures. The SSAI population exhibits a unique health profile, which differs from other races/ethnicities. For example, studies investigating cultural assumptions and perceived health status have suggested that overweight promotes health status within the U.S. SSAI. I added to that knowledge by implying that maternal underweight and obese prepregnancy BMI contribute highly to infant mortality, and overweight BMI is not a significant risk factor for infant mortality. Using this knowledge, health care providers may guide SSAI childbearing mothers for optimal weight gain before pregnancy.

I also presented an alternative perspective relative to GWG. While previous evidence showed that inadequate or excessive GWG contributed to infant mortality outcome irrespective of the mother’s prepregnancy weight, the results in my study suggested that inadequate and excessive GWGs are risk factors only for mothers with normal-weight and obese prepregnancy BMIs when controlled for age and educational attainment, respectively. While these results supported the IOM/NRC recommendations in some respects, my study showed that when applying GWG as a pregnancy health measure for SSAI, BMI categories mostly affected must only be accounted for and screened. For example, the IOM/NRC recommendations may only be implicated during a pregnancy involving normal-weight or obese pregnancy BMIs for a SSAI woman. Moreover, given the confirmation that only underweight and obese prepregnancy BMIs affect infant mortality outcome, public health interventions and healthcare providers may consider incorporating BMI-specific ranges using overweight and normal-weight BMIs as standards in their interventional and counseling services. Such an approach may align with cultural perception and help achieve optimal pregnancy health outcomes for both SSAI mothers and their infants.

My results also supported previous evidence that variation in maternal birthplace influences infant mortality outcome. For example, differences in healthcare systems, health behaviors, nutrition, and dietary lifestyles may be essential drivers of infant mortality outcomes. Thus, it is crucial for healthcare providers and public health interventions to consider the prognosis of high-risk infants and promote a structure and quality of healthcare that favors infants of mothers from different birthplaces. While more studies are needed to assess the impact of maternal birthplace on infant mortality outcomes, the findings of this study provide a rationale for improving the prognosis of high-risk infants within the U.S. SSAI population.

Furthermore, I also reported the increase in infant mortality associated with graduate/professional level education and age. Prospective mothers might consider incorporating childbirth timelines into their educational pursuits since the risk of infant mortality outcome increases with age and education.

Conclusion

Despite the overwhelming global efforts to reduce infant mortality rates, differences persist across race/ethnicity, and disadvantaged groups continue to experience an elevated risk of infant death. The findings in this study addressed the gaps in the literature relating to predictors of infant mortality outcome within U.S. SSAI. The study showed that maternal prepregnancy BMI, GWG, and birthplace were associated with infant mortality outcome.

Widening public health research that is population-based is vital in public health intervention. While several risk factors have been determined to contribute to infant mortality outcome, focusing on aspects related to preconception health (e.g., prepregnancy BMI); GWG (namely excessive and inadequate GWG); maternal birthplace; and the maternal life course is essential in addressing infant mortality outcomes and providing optimal healthcare for U.S. SSAI infants.

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Appendix A: U.S. Standard Certificate of Live Birth

U.S. STANDARD CERTIFICATE OF LIVE BIRTH

LOCAL FILE NO.

BIRTH NUMBER:

CHILD

1. CHILD'S NAME (First, Middle, Last, Suffix)
2. TIME OF BIRTH (24 hr)
3. SEX
4. DATE OF BIRTH (Mo/Day/Yr)
5. FACILITY NAME (If not institution, give street and number)
6. CITY, TOWN, OR LOCATION OF BIRTH
7. COUNTY OF BIRTH

MOTHER

8a. MOTHER'S CURRENT LEGAL NAME (First, Middle, Last, Suffix)
8b. DATE OF BIRTH (Mo/Day/Yr)
8c. MOTHER'S NAME PRIOR TO FIRST MARRIAGE (First, Middle, Last, Suffix)
8d. BIRTHPLACE (State, Territory, or Foreign Country)
9a. RESIDENCE OF MOTHER-STATE
9b. COUNTY
9c. CITY, TOWN, OR LOCATION
9d. STREET AND NUMBER
9e. APT. NO.
9f. ZIP CODE
9g. INSIDE CITY LIMITS? □ Yes □ No

FATHER

10a. FATHER'S CURRENT LEGAL NAME (First, Middle, Last, Suffix)
10b. DATE OF BIRTH (Mo/Day/Yr)
10c. BIRTHPLACE (State, Territory, or Foreign Country)

CERTIFIER

11. CERTIFIER'S NAME: ____________________

TITLE: □ MD □ DO □ HOSPITAL ADMIN. □ CNM/CM □ OTHER MIDWIFE

□ OTHER (Specify)____________________

12. DATE CERTIFIED ____/____/______ MM DD YYYY
13. DATE FILED BY REGISTRAR ____/____/______ MM DD YYYY

INFORMATION FOR ADMINISTRATIVE USE

MOTHER

14. MOTHER'S MAILING ADDRESS: 9 Same as residence, or: State: City, Town, or Location:

Street & Number: Apartment No.: Zip Code:

15. MOTHER MARRIED? (At birth, conception, or any time between) □ Yes □ No
IF NO, HAS PATERNITY ACKNOWLEDGEMENT BEEN SIGNED IN THE HOSPITAL? □ Yes □ No
16. SOCIAL SECURITY NUMBER REQUESTED FOR CHILD? □ Yes □ No
17. FACILITY ID. (NPI)
18. MOTHER'S SOCIAL SECURITY NUMBER:
19. FATHER'S SOCIAL SECURITY NUMBER:

INFORMATION FOR MEDICAL AND HEALTH PURPOSES ONLY

MOTHER

20. MOTHER'S EDUCATION (Check the box that best describes the highest degree or level of school completed at the time of delivery)
- □ 8th grade or less
- □ 9th - 12th grade, no diploma
- □ High school graduate or GED completed
- □ Some college credit but no degree
- □ Associate degree (e.g., AA, AS)
- □ Bachelor's degree (e.g., BA, AB, BS)
- □ Master's degree (e.g., MA, MS, MEng, MEd, MSW, MBA)
- □ Doctorate (e.g., PhD, EdD) or Professional degree (e.g., MD, DDS, DVM, LLB, JD)

21. MOTHER OF HISPANIC ORIGIN? (Check the box that best describes whether the mother is Spanish/Hispanic/Latina. Check the "No" box if mother is not Spanish/Hispanic/Latina)
- □ No, not Spanish/Hispanic/Latina
- □ Yes, Mexican, Mexican American, Chicana
- □ Yes, Puerto Rican
- □ Yes, Cuban
- □ Yes, other Spanish/Hispanic/Latina

(Specify)____________________

22. MOTHER'S RACE (Check one or more races to indicate what the mother considers herself to be)
- □ White
- □ Black or African American
- □ American Indian or Alaska Native (Name of the enrolled or principal tribe)__________
- □ Asian Indian
- □ Chinese
- □ Filipino
- □ Japanese
- □ Korean
- □ Vietnamese
- □ Other Asian (Specify)__________
- □ Native Hawaiian
- □ Guamanian or Chamorro
- □ Samoan
- □ Other Pacific Islander (Specify)__________
- □ Other (Specify)__________

FATHER

23. FATHER'S EDUCATION (Check the box that best describes the highest degree or level of school completed at the time of delivery)
- □ 8th grade or less
- □ 9th - 12th grade, no diploma
- □ High school graduate or GED completed
- □ Some college credit but no degree
- □ Associate degree (e.g., AA, AS)
- □ Bachelor's degree (e.g., BA, AB, BS)
- □ Master's degree (e.g., MA, MS, MEng, MEd, MSW, MBA)
- □ Doctorate (e.g., PhD, EdD) or Professional degree (e.g., MD, DDS, DVM, LLB, JD)

24. FATHER OF HISPANIC ORIGIN? (Check the box that best describes whether the father is Spanish/Hispanic/Latino. Check the "No" box if father is not Spanish/Hispanic/Latino)
- □ No, not Spanish/Hispanic/Latino
- □ Yes, Mexican, Mexican American, Chicano
- □ Yes, Puerto Rican
- □ Yes, Cuban
- □ Yes, other Spanish/Hispanic/Latino

(Specify)____________________

25. FATHER'S RACE (Check one or more races to indicate what the father considers himself to be)
- □ White
- □ Black or African American
- □ American Indian or Alaska Native (Name of the enrolled or principal tribe)__________
- □ Asian Indian
- □ Chinese
- □ Filipino
- □ Japanese
- □ Korean
- □ Vietnamese
- □ Other Asian (Specify)__________
- □ Native Hawaiian
- □ Guamanian or Chamorro
- □ Samoan
- □ Other Pacific Islander (Specify)__________
- □ Other (Specify)__________

Mother's Name __________

Mother's Medical Record No. __________

26. PLACE WHERE BIRTH OCCURRED (Check one)
- □ Hospital
- □ Freestanding birthing center
- □ Home Birth: Planned to deliver at home? 9 Yes 9 No

27. ATTENDANT'S NAME, TITLE, AND NPI

NAME: ____________________ NPI:______

28. MOTHER TRANSFERRED FOR MATERNAL MEDICAL OR FETAL INDICATIONS FOR DELIVERY? □ Yes □ No

IF YES, ENTER NAME OF FACILITY MOTHER

MOTHER

29a. DATE OF FIRST PRENATAL CARE VISIT
___/___/_____ ☐ No Prenatal Care
M M D D YYYY

29b. DATE OF LAST PRENATAL CARE VISIT
___/___/_____
M M D D YYYY

30. TOTAL NUMBER OF PRENATAL VISITS FOR THIS PREGNANCY
_____________ (If none, enter "0".)

31. MOTHER'S HEIGHT _______ (feet/inches)

32. MOTHER'S PREPREGNANCY WEIGHT _______ (pounds)

33. MOTHER'S WEIGHT AT DELIVERY _______ (pounds)

34. DID MOTHER GET WIC FOOD FOR HERSELF DURING THIS PREGNANCY? ☐ Yes ☐ No

35. NUMBER OF PREVIOUS LIVE BIRTHS (Do not include this child)

35a. Now Living
Number _____
☐ None

35b. Now Dead
Number _____
☐ None

36. NUMBER OF OTHER PREGNANCY OUTCOMES (spontaneous or induced losses or ectopic pregnancies)

36a. Other Outcomes
Number _____
☐ None

37. CIGARETTE SMOKING BEFORE AND DURING PREGNANCY
For each time period, enter either the number of cigarettes or the number of packs of cigarettes smoked. IF NONE, ENTER "0".

Average number of cigarettes or packs of cigarettes smoked per day.

	# of cigarettes		# of packs
Three Months Before Pregnancy	_______	OR	_______
First Three Months of Pregnancy	_______	OR	_______
Second Three Months of Pregnancy	_______	OR	_______
Third Trimester of Pregnancy	_______	OR	_______

38. PRINCIPAL SOURCE OF PAYMENT FOR THIS DELIVERY
☐ Private Insurance
☐ Medicaid
☐ Self-pay
☐ Other
(Specify) ____________

35c. DATE OF LAST LIVE BIRTH
___/_____
MM YYYY

36b. DATE OF LAST OTHER PREGNANCY OUTCOME
___/_____
MM YYYY

39. DATE LAST NORMAL MENSES BEGAN
___/___/_____
M M D D YYYY

40. MOTHER'S MEDICAL RECORD NUMBER

MEDICAL AND HEALTH INFORMATION

41. RISK FACTORS IN THIS PREGNANCY (Check all that apply)

Diabetes
- ☐ Prepregnancy (Diagnosis prior to this pregnancy)
- ☐ Gestational (Diagnosis in this pregnancy)

Hypertension
- ☐ Prepregnancy (Chronic)
- ☐ Gestational (PIH, preeclampsia)
- ☐ Eclampsia

☐ Previous preterm birth

☐ Other previous poor pregnancy outcome (Includes perinatal death, small-for-gestational age/intrauterine growth restricted birth)

☐ Pregnancy resulted from infertility treatment-If yes, check all that apply:
- ☐ Fertility-enhancing drugs, Artificial insemination or Intrauterine insemination
- ☐ Assisted reproductive technology (e.g., in vitro fertilization (IVF), gamete intrafallopian transfer (GIFT))

☐ Mother had a previous cesarean delivery
If yes, how many _________

☐ None of the above

42. INFECTIONS PRESENT AND/OR TREATED DURING THIS PREGNANCY (Check all that apply)
- ☐ Gonorrhea
- ☐ Syphilis
- ☐ Chlamydia
- ☐ Hepatitis B
- ☐ Hepatitis C
- ☐ None of the above

43. OBSTETRIC PROCEDURES (Check all that apply)
- ☐ Cervical cerclage
- ☐ Tocolysis

External cephalic version:
- ☐ Successful
- ☐ Failed

☐ None of the above

44. ONSET OF LABOR (Check all that apply)
- ☐ Premature Rupture of the Membranes (prolonged, ∃12 hrs.)
- ☐ Precipitous Labor (<3 hrs.)
- ☐ Prolonged Labor (∃ 20 hrs.)
- ☐ None of the above

45. CHARACTERISTICS OF LABOR AND DELIVERY (Check all that apply)
- ☐ Induction of labor
- ☐ Augmentation of labor
- ☐ Non-vertex presentation
- ☐ Steroids (glucocorticoids) for fetal lung maturation received by the mother prior to delivery
- ☐ Antibiotics received by the mother during labor
- ☐ Clinical chorioamnionitis diagnosed during labor or maternal temperature >38°C (100.4°F)
- ☐ Moderate/heavy meconium staining of the amniotic fluid
- ☐ Fetal intolerance of labor such that one or more of the following actions was taken: in-utero resuscitative measures, further fetal assessment, or operative delivery
- ☐ Epidural or spinal anesthesia during labor
- ☐ None of the above

46. METHOD OF DELIVERY

A. Was delivery with forceps attempted but unsuccessful?
☐ Yes ☐ No

B. Was delivery with vacuum extraction attempted but unsuccessful?
☐ Yes ☐ No

C. Fetal presentation at birth
- ☐ Cephalic
- ☐ Breech
- ☐ Other

D. Final route and method of delivery (Check one)
- ☐ Vaginal/Spontaneous
- ☐ Vaginal/Forceps
- ☐ Vaginal/Vacuum
- ☐ Cesarean
  If cesarean, was a trial of labor attempted?
  - ☐ Yes
  - ☐ No

47. MATERNAL MORBIDITY (Check all that apply) (Complications associated with labor and delivery)
- ☐ Maternal transfusion
- ☐ Third or fourth degree perineal laceration
- ☐ Ruptured uterus
- ☐ Unplanned hysterectomy
- ☐ Admission to intensive care unit
- ☐ Unplanned operating room procedure following delivery
- ☐ None of the above

NEWBORN INFORMATION

NEWBORN

48. NEWBORN MEDICAL RECORD NUMBER

49. BIRTHWEIGHT (grams preferred, specify unit)
____
9 grams 9 lb/oz

50. OBSTETRIC ESTIMATE OF GESTATION:
_____________ (completed weeks)

51. APGAR SCORE:
Score at 5 minutes: ______________
If 5 minute score is less than 6,
Score at 10 minutes: ______________

52. PLURALITY - Single, Twin, Triplet, etc.

54. ABNORMAL CONDITIONS OF THE NEWBORN (Check all that apply)
- ☐ Assisted ventilation required immediately following delivery
- ☐ Assisted ventilation required for more than six hours
- ☐ NICU admission
- ☐ Newborn given surfactant replacement therapy
- ☐ Antibiotics received by the newborn for suspected neonatal sepsis
- ☐ Seizure or serious neurologic dysfunction

55. CONGENITAL ANOMALIES OF THE NEWBORN (Check all that apply)
- ☐ Anencephaly
- ☐ Meningomyelocele/Spina bifida
- ☐ Cyanotic congenital heart disease
- ☐ Congenital diaphragmatic hernia
- ☐ Omphalocele
- ☐ Gastroschisis
- ☐ Limb reduction defect (excluding congenital amputation and dwarfing syndromes)
- ☐ Cleft Lip with or without Cleft Palate
- ☐ Cleft Palate alone
- ☐ Down Syndrome
  - ☐ Karyotype confirmed
  - ☐ Karyotype pending
- ☐ Suspected chromosomal disorder
  - ☐ Karyotype confirmed
  - ☐ Karyotype pending

Record

Appendix B: Stepwise Multiple Logistic Regression

						95% C.I.for EXP(B)	
		Wald	df	*P-value.*	OR	Lower	Upper
Step 1	**Birthplace**	179.168	8	.000			
	Cameroon	46.397	1	.000	11.267	5.612	22.617
	Congo	47.065	1	.000	4.571	2.961	7.056
	Ethiopia	2.652	1	.103	1.310	.947	1.813
	Kenya	58.157	1	.000	9.154	5.182	16.172
	Somalia	16.234	1	.000	1.735	1.327	2.269
	Sudan	36.465	1	.000	5.965	3.341	10.649
	Liberia	40.454	1	.000	5.428	3.223	9.143
	Ghana	23.895	1	.000	2.137	1.576	2.897
	Nigeria (ref.)						
Step 2	**Birthplace**	177.363	8	.000			
	Cameroon	48.394	1	.000	12.000	5.958	24.167
	Congo	48.432	1	.000	4.771	3.073	7.409
	Ethiopia	1.593	1	.207	1.238	.889	1.725
	Kenya	54.355	1	.000	8.710	4.899	15.486
	Somalia	17.901	1	.000	1.801	1.371	2.366
	Sudan	31.505	1	.000	5.404	2.998	9.741
	Liberia	41.589	1	.000	5.657	3.341	9.579
	Ghana	26.634	1	.000	2.253	1.655	3.068
	Nigeria (ref.)						
	Maternal Age	43.661	2	.000			
	<20	4.282	1	.039	5.079	1.090	23.672
	>39	39.752	1	.000	2.928	2.097	4.089
	(20-39)(ref)						
Step 3	**Birthplace**	158.085	8	.000			
	Cameroon	40.556	1	.000	9.962	4.910	20.211
	Congo	42.283	1	.000	4.462	2.843	7.003
	Ethiopia	2.369	1	.124	1.311	.929	1.851
	Kenya	51.029	1	.000	8.386	4.679	15.029
	Somalia	15.409	1	.000	1.742	1.320	2.297
	Sudan	27.339	1	.000	4.941	2.715	8.994
	Liberia	40.789	1	.000	5.630	3.313	9.568

	Ghana	22.985	1	.000	2.151	1.573	2.942
	Nigeria (ref.)						
	Maternal Age	41.550	2	.000			
	<20	4.062	1	.044	4.961	1.045	23.546
	>39	37.760	1	.000	2.901	2.066	4.075
	(20-39)(ref.)						
	Prepregnancy BMI	37.275	3	.000			
	Underweight BMI	8.062	1	.005	19.712	2.518	154.330
	Overweight BMI	1.751	1	.186	.858	.684	1.077
	Obese BMI	16.645	1	.000	1.825	1.367	2.436
	Normal Weight BMI (ref)						
Step 4	**Birthplace**	158.418	8	.000			
	Cameroon	41.809	1	.000	10.455	5.133	21.295
	Congo	42.694	1	.000	4.749	2.976	7.577
	Ethiopia	3.627	1	.057	1.421	.990	2.039
	Kenya	52.331	1	.000	8.825	4.892	15.921
	Somalia	14.101	1	.000	2.011	1.396	2.895
	Sudan	29.951	1	.000	5.441	2.966	9.980
	Liberia	43.502	1	.000	6.090	3.560	10.418
	Ghana	24.027	1	.000	2.221	1.614	3.055
	Nigeria (ref.)						
	Maternal Age	42.375	2	.000			
	<20	4.194	1	.041	5.092	1.073	24.178
	>39	38.428	1	.000	2.968	2.104	4.187
	(20-39) (ref.)						
	Edu. Attainment	14.953	3	.002			
	<High School	.114	1	.736	.928	.601	1.432
	High School	.078	1	.779	1.037	.806	1.334
	Graduate/Prof.	14.434	1	.000	1.976	1.391	2.809
	College (ref.)						
	Prepregnancy BMI	40.741	3	.000			
	Underweight BMI	8.550	1	.003	21.710	2.759	170.846
	Overweight BMI	1.268	1	.260	.876	.695	1.103
	Obese BMI	19.804	1	.000	1.947	1.452	2.610
	Normal Weight BMI (ref.)						
Step 5	**Birthplace**	150.700	8	.000			

Cameroon	42.195	1	.000	10.535	5.177	21.439
Congo	39.820	1	.000	4.538	2.837	7.260
Ethiopia	3.809	1	.051	1.436	.998	2.065
Kenya	48.394	1	.000	8.195	4.531	14.822
Somalia	12.896	1	.000	1.956	1.356	2.822
Sudan	27.510	1	.000	5.054	2.759	9.259
Liberia	41.892	1	.000	5.945	3.465	10.199
Ghana	24.853	1	.000	2.268	1.644	3.130
Nigeria (ref.)						
Maternal Age	41.582	2	.000			
<20	3.442	1	.064	4.375	.920	20.804
>39	38.319	1	.000	2.983	2.110	4.216
(20-39)(ref.)						
Edu. Attainment	16.821	3	.001			
<High School	.181	1	.671	.910	.588	1.408
High School	.067	1	.796	1.034	.802	1.332
Graduate/Prof.	16.150	1	.000	2.073	1.453	2.957
College (ref.)						
Prepregnancy BMI	39.320	3	.000			
Underweight BMI	8.759	1	.003	22.628	2.868	178.555
Overweight BMI	1.374	1	.241	.869	.688	1.099
Obese BMI	18.229	1	.000	1.903	1.416	2.558
Normal Weight BMI (ref.)						
GWG	11.521	2	.003			
Inadequate GWG	9.573	1	.002	1.469	1.151	1.875
Excessive GWG	5.888	1	.015	1.362	1.061	1.748
Adequate GWG (ref.)						
Constant	92.169	1	.000	.271		