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An Examination of the Father's Name on the Birth Certificate and SUID in Georgia Infants

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Bachelor of Arts
The University of Michigan
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A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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Abstract

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Objective: Sudden unexpected infant deaths (SUID) are defined as deaths in infants less than 1 year of age that occur suddenly and unexpectedly, and whose cause of death are not immediately obvious prior to investigation. Maternal, prenatal care, and infant risk factors have been identified for SUID; however, paternal involvement has not been sufficiently studied in past literature. As guided by the Precede-Proceed framework, this study examines if the absence of a father's name on the birth certificate is associated with an increased odds ratio of SUID among Georgia infants.

Methods: Linked birth-infant death files from 1998-2008 were used to obtain a final analysis population of 1,188 SUID cases and 12,246 controls. The primary independent variable of interest was coded as father absent on birth certificate or father present on birth certificate. Odds ratios were examined across three logistic regressions: 1) all cases and controls; 2) infants born to white mothers; and, 3) infants born to black or African-American mothers.

Results: Eighty one percent of infants in the final analysis population listed a father's name on the birth certificate. The absence of a father's name on the birth certificate was associated with a significantly greater odds ratio of SUID among both unmarried and married women, notably married mothers aged 20-34. The absence of a father on the birth certificate was protective among married mothers aged 35 or older. When stratified by race, the absence of a father's birth certificate was only associated with an increase in the risk of SUID among white mothers who were married, 20-34 years of age, and did not list a father on the birth certificate.

Discussion: The results of this study suggest that the absence of a father's name on the birth certificate is a risk factor for SUID. The findings from this study encourage continued support for state- and community-based programs and policies to improve paternal involvement during pregnancy and after birth. Future research should explore the predisposing, reinforcing, and enabling factors that influence the absence of a father's name on a birth certificate, in an attempt to identify potential causes.

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Lastly, I would like to dedicate this thesis to my beloved grandfather, Frank C. Jones, for his never-ending love and support.

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Introduction

Sudden unexpected infant deaths (SUID) are defined as “deaths in infants less than 1 year of age that occur suddenly and unexpectedly, and whose cause of death are not immediately obvious prior to investigation” ("Sudden Unexpected Infant Death," 2013). The three most common forms of SUID as classified on death certificates are: sudden infant death syndrome (SIDS), cause unknown, and accidental suffocation or strangulation in bed (ASSB). SIDS is the third cause of death among infants aged 1-12 months in the United States. Unintentional suffocation is the most commonly reported cause of death from unintentional injury among infants less than 1 year of age in the United States (Borse et al., 2008).

States in the southern region of the United States have historically experienced higher rates of SUID, including SIDS, ASSB and cause unknown, as compared to other regions. In 2010, Georgia had the ninth highest rate of SUID and the rates of SIDS, ASSB and cause unknown were 93.9, 18.0, and 15.8 per 100,000, respectively (CDC WONDER, 2014; Singh & van Dyck, 2010).

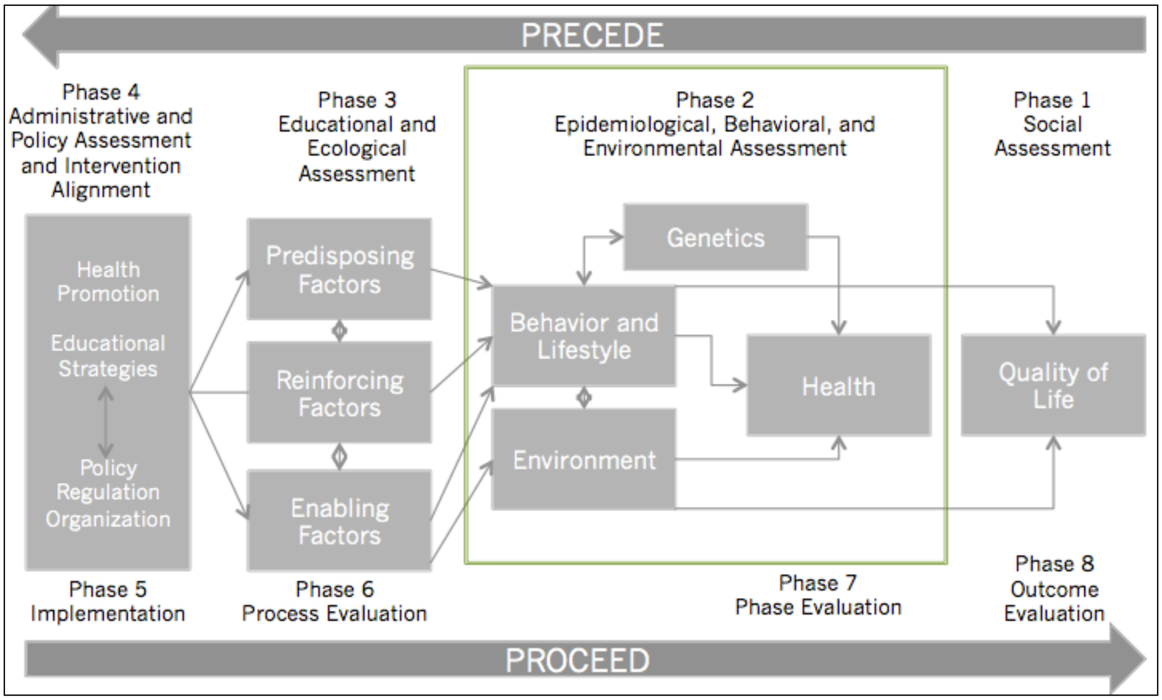
In 2009, the Georgia Child Fatality Review posited that the majority of child deaths in Georgia were largely preventable. The state identified several opportunities for prevention of SIDS, ASSB, and cause unknown death, including a recommendation to, “support communities and providers by incorporating culturally and linguistically competent values, policies, structures, and practices in SIDS/Infant Death-related programs” (Office of the Child Advocate for the Protection of Children, 2010, p. 23).

Thus, research should be guided by theories developed to aid the strategic planning of health promotion and prevention programs.

The Precede-Proceed model guided the current study (figure 1). The Precede-Proceed model is a planning model for health promotion and provides a road map for health professionals to apply theories and constructs systematically when planning and evaluating health behavior interventions (Glanz, Rimer, & Viswanath, 2008). The Precede framework stands for **p**redisposing, **r**einforcing, and **e**nabling **c**onstructs in **e**ducation/environmental **d**iagnosis and **e**valuation. This framework focuses on ensuring the health promotion programs are strategically planned to address demonstrated needs. The Proceed framework stands for **p**olicy, **r**egulatory, and **o**rganizational **c**onstructs in **e**ducation and **e**nvironmental **d**evelopment. This framework focuses on the environmental influences upon health and human behavior, including all influences external to the individual.

The Precede-Procede model has eight distinct phases. The second phase is titled epidemiological, behavioral, and environmental assessments. This three-pronged phase assesses the health priorities and the behavioral and environmental determinants of a population. According to Glanz, Rimer, and Viswanath (2008), the epidemiological assessment, "(1) identifies the health problems, issues, or aspirations on which the program will focus, (2) uncovers the behavioral and environmental factors most likely to influence the identified priority health issues, and (3) translates these priorities into measureable objectives for the program being developed" (Glanz et al., 2008).

Figure 1. Precede-Proceed Planning Framework



The current study was designed to provide an epidemiological assessment of SUID in Georgia. Specifically, the current study examined whether the presence or absence of a father's name on a birth certificate was associated with an increased risk of SUID, including SIDS, ASSB, and cause unknown death. Furthermore, the study explored the maternal and infant risk factors that are prevalent among the SUID population and how these risk factors relate to the presence or absence of a father's name listed on the birth certificate. Findings from this study expand upon previous research regarding risk factors and at-risk populations for SUID in Georgia. This knowledge can be translated to state- and community-level prevention efforts to reduce risk factors and ultimately prevent SUID in Georgia.

Literature Review

Sudden Unexpected Infant Death

As previously noted, the three most common forms of SUID as classified on death certificates are: sudden infant death syndrome (SIDS), cause unknown, and accidental suffocation or strangulation in bed (ASSB). SIDS is defined as "the sudden death of an infant under one year of age which remains unexplained after a, thorough case investigation, including performance of a complete autopsy, examination of the death scene, and review of the clinical history" (Willinger, James, & Catz, 1991, p. 677). ASSB occurs when there is evidence of suffocation, wedging, or overlay during sleep (Centers for Disease Control and Prevention (CDC), 2013). The International Cause of Death (ICD) codes are the primary mechanism for classifying the underlying cause of SUID deaths in the United States. SUID deaths are assigned an International Cause of Death code as determined by information included in the death certificate. The Tenth Revision of the International Cause of Death (ICD-10) assigns the following classifications to the three primary causes of SUID death: SIDS (R95), deaths owing to unknown causes (R99), and ASSB (W75) (World Health Organization, 2010).

In 2010, 3,610 deaths among infants less than one year of age in the United States were reported as SIDS, cause unknown, and ASSB. The rates of SIDS, cause unknown, and ASSB were 52.3 (n=2,063), 23.3 (n=918), and 15.9 (n=629) per 100,000, respectively (CDC, 2013). SIDS rates have steadily declined over the past three decades, including a 20 percent decline from 2005 to 2010 (MacDorman, Hoyert, & Matthews, 2013). Researchers have partially attributed the decrease in SIDS to increasing rates in other manners of SUID, including ASSB and cause unknown, as well as changes in SUID classification. This hypothesis is supported by past research showing mortality trends can be impacted by ICD revisions, changes in the definitions of causes of deaths, and changes in adherence to and interpretation of cause-of-death definitions by the death certifier (Malloy & MacDorman, 2005). Population studies have shown that the decline in SIDS rates may be attributed to a changing classification of SUID. In 1996 to 2004, researchers found a 14 percent annual increase in the occurrence of ASSB while the rates of SUID remained stagnant, SIDS decreased, and cause unknown increased. The same study found that infant mortality rates attributable to ASSB have quadrupled since 1984 (Shapiro-Mendoza, Kimball, Tomashek, Anderson, & Blanding, 2009). A 2005 study found approximately 90 percent of the decrease in SIDS deaths from 1992 to 2001 could be attributed to an increase in non-SIDS causes of SUID, including ASSB and unknown cause of death (Malloy et al., 2005). A similar article published in 2006 found that, in 1999-2001, the decline in SIDS rates occurred alongside increasing rates of ASSB and cause unknown deaths (Shapiro-Mendoza, Tomashek, Anderson, & Wingo, 2006). These findings suggest that the downward trend in SIDS rates are likely due to an increase in the reporting and classification of other SUID deaths including ASSB and cause unknown.

Risk Factors

Past research has identified a variety of maternal and infant risk factors for SUID deaths. Specifically young maternal age, low maternal education, and low family income are strongly associated with an increased likelihood of SIDS and ASSB (Carlberg, Shapiro-Mendoza, & Goodman, 2012; Hoffman, Damus, Hillman, & Krongrad, 1988; Kraus, Greenland, & Bulterys, 1989). Much like for other causes of infant mortality, racial and ethnic disparities have been consistently noted as a significant risk factor in SIDS and ASSB cases. In 2005, SIDS rates in non-Hispanic black and American Indian/Alaska Native infants were double that of non-Hispanic white infants. SIDS rates for Asian/Pacific Islander and Hispanic infants were half that of non-Hispanic white infants (Hauck et al., 2002; Task Force on Sudden Infant Death Syndrome, 2011). Similarly, infants born to non-Hispanic black and American Indian/Alaskan Native women were more likely to experience ASSB mortality (Carlberg et al., 2012).

Past research has also shown infant characteristics including low birth weight, young gestational age, and preterm births are also associated with an increased risk of SIDS and ASSB. Low birth weight has been shown to be a risk factor for SIDS, with the rate of SIDS among very low birth weight and low birth weight infants being significantly higher than among infants of a normal birth weight (Kraus et al., 1989; Sowter, Doyle, Morley, Altmann, & Halliday, 1999). Age has also been shown to be a strong predictor of SIDS. Ninety percent of SIDS cases occur among infants below the age of six months, with rates peaking between two to four months of age (Shapiro-Mendoza et al., 2006). A similar age distribution has been seen among ASSB cases (Carlberg et al., 2012). Additionally, infants who are born preterm are at a higher risk of

SIDS and ASSB (Carlberg et al., 2012; Malloy & Hoffman, 1995; Shapiro-Mendoza et al., 2006).

In addition to maternal and infant characteristics, researchers have examined the relationship between gestational factors including prenatal care and maternal smoking and the outcome of SUID. Adequate prenatal care has been shown to be a protective factor against SIDS and ASSB. Several studies have seen a decreased risk of SIDS among infants of women who seek prenatal care and higher rates of ASSB mortality among infants of women who do not seek prenatal care (Carlberg et al., 2012; Kraus et al., 1989; Shapiro-Mendoza et al., 2006; Stewart et al., 1995). Maternal smoking during and after pregnancy has also proved to be a strong predictor of SIDS and ASSB mortality (Carlberg et al., 2012; Hoffman et al., 1988; Malloy, Kleinman, Land, & Schramm, 1988; Schoendorf & Kiely, 1992).

Family Stability and SUID

Past research has used marital status as a measure to understand the relationship between family stability and SUID. A 2011 retrospective case study using data from the Birth Cohort Linked Birth-Infant Data and Fetal Death data files from the National Center for Health Statistics examined the relationship between maternal marital status and risk of infant death (Balaya, Azoulay, & Abenhaim, 2011). Researchers found unmarried women experienced higher rates of infant mortality, including stillbirth, early neonatal deaths, late neonatal deaths, total infant deaths, and SIDS. This relationship between increased SIDS and unmarried women had been noted in an earlier study (Hoffman et al., 1988). Balaya et al. (2011) also found unmarried women also experienced higher rates of prematurity among their infants as compared to married women. When examining sociodemographic variables, unmarried women tended to be younger, African American, Native American, have lower education levels, and have inadequate prenatal care. Among unmarried women, infant mortality rates were highest among women who were African American, Native American, older than 40 years, and under 15 years of age. Among unmarried women, being Hispanic, having received prenatal care, and advanced maternal education were protective against infant mortality. Researchers have posited several reasons behind higher rates of infant mortality and morbidity among unmarried women. Marital status may act as an indicator of environmental and economic support and, in turn, affect positive maternal behaviors (Bennett, Braveman, Egerter, & Kiely, 1994). Another explanation for this relationship hypothesizes that the social stigma around illegitimate birth may discourage women from seeking prenatal care or gathering information on healthy maternal behavior (Kirchengast, Mayer, & Voigt, 2007).

Paternal Involvement

While past studies have examined maternal marital status as a potential risk factor for SUID, a small body of literature is dedicated to examining other indicators of paternal involvement as a SUID risk factor. In 1999, a team of researchers evaluated the absence of a father's name on the birth certificate in Georgia as a paternity measure (Gaudino, Jenkins, & Rochat, 1999). The authors stated:

> "…unmarried status may be less relevant today as a measure of paternity status and its influences or as a risk marker for adverse outcomes among highly unmarried populations who, nonetheless, continue to form families" (Gaudino et al., 1999, p. 254).

The same study found significant differences in the morbidity and mortality of infants in Georgia without a father's name reported on the birth certificate as compared to infants with a father's name reported on the birth certificate.

Similar findings have been noted in other literature examining the relationship between absence of a father's name on the birth certificate and infant mortality and morbidity in a national population. Infants whose father's name was missing from the birth certificate are more likely to experience adverse birth outcomes as compared to infants whose father's name was reported, including preterm birth, fetal growth restriction, low birth weight, Apgar score <7, fetal mortality, neonatal mortality, and post-neonatal mortality (Tan, Wen, Walker, & Demissie, 2004). A recent study estimated 65–75 percent of excess infant mortality could be prevented with increased paternal involvement (Alio, Mbah, Kornosky, et al., 2011).

A large portion of research exploring the relationship between paternal involvement and infant morbidity and mortality has focused on the adolescent and teenage population. Adolescent mothers have low rates of paternity establishment as compared to the general population, especially adolescent mothers who are non-Hispanic black, non-US born, and 12-15 years of age (Murray, Rosengard, Weitzen, Raker, & Phipps, 2012). Recent studies have found that infants who are born to teenager and adolescent mothers and have no father listed on the birth certificate face higher risks of adverse birth outcomes, including low birth weight, preterm birth, and small-for-gestation age (Alio, Mbah, & Salihu, 2011).

Across all racial and ethnic groups, the absence of a father's name on birth certificates is associated with increased likelihood of adverse birth outcomes (Ngui, Cortright, & Blair, 2009). A recent study found that paternal absence widens the black-white infant mortality gap by almost four fold and there is an elevated risk for Hispanic and non-Hispanic black infants with absent fathers as compared to non-Hispanic white infants (Alio, Mbah, Kornosky, et al., 2011). Non-Hispanic black infants without a father's name listed on the birth certificate have consistently shown the highest risk of infant morbidity compared to infants of other races with and without a father's name listed on the birth certificate (Alio, Kornosky, Mbah, Marty, & Salihu, 2010; Alio, Mbah, Kornosky, et al., 2011; Ngui et al., 2009). An elevated risk of infant morbidity among non-Hispanic black infants without father's names on the birth certificate has been shown among the teenage mother population as well (Alio, Mbah, & Salihu, 2011; Murray et al., 2012). In addition to being a teenager and non-Hispanic black, women with missing partner information on the birth certificate are more likely to be unmarried and have lower levels of education, smoked cigarettes during pregnancy, and recieved inadequate prenatal care (Murray et al., 2012; Tan et al., 2004).

SUID in Georgia

Southeastern states have historically experienced higher rates of infant mortality as compared to other regions in the United States. From 1970 to 2007, the rate of infant mortality declined by at least 48 percent across all states, but still remained highest in the southeast (Singh et al., 2010). In 2010, states in the South and the Midwest had the highest rates of infant mortality (MacDorman et al., 2013). SUID rates reflect the geographic disparities present in overall U.S. infant mortality. In 2010, the South had a SUID rate of 120.2 per 100,000 as compared to 90.8 in the Midwest, 65.8 in the Northeast, and 64.6 in the West. The South also had the highest rates of SIDS, ASSB, and unknown cause as identified by ICD-10 code. In 2010, the rate of SIDS was 66.2 per 100,000 as compared to 51.7 in the Midwest, 41.8 in the West, and 36.3 in the Northeast. The rate of ASSB in the South was 19.0 per 100,000 as compared to 24.8 in the Midwest, 7.4 in the West, and 10.0 in the Northeast. The rate of unknown death in the South was 35.1 per 100,000 as compared to 14.3 in the Midwest, 15.3 in the West, and 19.5 in the Northeast (CDC WONDER, 2014).

The state of Georgia experiences high rates of SIDS, ASSB, and cause unknown when compared to national trends. With a rate of 127.6 per 100,000, Georgia had the ninth highest rate of SUID among all states in the United States in 2010. In 2010, Georgia had a total of 170 deaths attributed to SIDS, ASSB, or cause unknown. As previously noted, the rates of SIDS, ASSB and cause unknown in 2010 was 93.9, 18.0, and 15.8 per 100,000, respectively (CDC WONDER, 2014).

Georgia Child Fatality Review Program

The agency responsible for reviewing all SUID cases in Georgia is the Georgia Child Fatality Review (GCFR) Program, an independent program administered out of the Georgia Office of the Child Advocate. The GCFR Program reviews all SIDS, ASSB, and unknown causes of death to children who are less than 18 years old. According to the

National MCH Center for Child Death Review (2014), the mission of the program is to prevent child death in Georgia by, "promoting more accurate identification and reporting of child fatalities, evaluating the prevalence and circumstances of both child abuse cases and child fatality investigations, and monitoring the implementation and impact of the statewide child injury prevention plan in order to prevent and reduce incidents of child abuse and fatalities in the state" ("State Spotlight – Georgia", 2014).

The GCFR Program is comprised of both a state team, titled the GCFR Panel, and 159 local teams. The local teams meet within 30 days of a child's death to review the case. The GCRF Panel is responsible for overseeing the GCFR Program process and creating annual reports on the incidence of child deaths and suggested prevention measures. The GCFR also includes a staff with responsibility for training of local teams, management of the reporting process, preparation of the draft annual report, and support for the Panel.

SUID Demographics in Georgia

The GCFR Panel has noted several demographic trends among Georgia SUID cases. Among sleep-related infant deaths from 2004-2008, 46 percent were of African American infants, 40 percent were of White infants, 8 percent were of Hispanic infants, and 6 percent were of infants of another race. Infants less than 6 months of age constituted 93 percent of all sleep-related deaths, and 56 percent of all infant deaths occurred when an infant was between 2-4 months of age (Office of the Child Advocate for the Protection of Children, 2011). The Georgia Child Fatality Review 2009 Annual Report showed that 66.4 percent of infants who died had caregivers 20-29 years of age, 15.1 percent had caregivers less than 20 years of age, and 18.5 percent had caregivers greater than 30 years of age (Office of the Child Advocate for the Protection of Children, 2010).

In the previously cited study in Georgia in 1999, the research team found that the reporting of a father's name on birth certificates in Georgia is a unique measure of legal paternity that is related to, but distinct from, marital status (Gaudino et al., 1999). Researchers also found the reporting of a father's name on the birth certificate was a previously un-described risk factor for infant mortality that is independent of previously reported risk factors, including marital status.

Among births in Georgia, 17.9 percent had no father's names listed on the birth certificate. The infants without fathers' names listed were 2.3 times more likely to die in the first year of life than infants with a reported father's name. The risk of infant mortality among infants without a reported father's name was significantly increased for death due to prematurity, low birth weight, sudden infant death syndrome, and external causes. The maternal risk factors for infant mortality among Georgia infants without father's names on the birth certificate were being less than 24 years old, having less than 12 years of education, being African American, having received late or less than adequate prenatal care, having smoked during pregnancy, and being pregnant for the first time. Infant risk factors were low birth weight, prematurity, and small-for-gestational age (Gaudino et al., 1999). In the discussion, authors encouraged future studies to examine the reporting of fathers' names on a birth certificate as a paternity measure.

The Current Study

While the body of research examining infant morbidity and paternal involvement is growing, a very limited amount of research has been dedicated to examining the relationship between paternal involvement and infant mortality (Alio, Mbah, Kornosky, et al., 2011; Gaudino et al., 1999; Tan et al., 2004). Furthermore, it has been 15 years since this issue was explored in Georgia. Additionally, the existing literature has not examined the absence of a father's name on the birth certificate as a unique paternity measure for SUID, including SIDS, ASSB, and cause unknown.

The current study aims to fill the gaps in literature regarding the relationship between the absence of a father's name on a birth certificate and SUID mortality, including SIDS, ASSB, and cause unknown deaths. The study also aims to describe the maternal and infant characteristics that are unique to the population of Georgia infants who died of SUID and have no father's name listed on their birth certificate.

Specific Aim #1: To understand the relationship between a father's name on the birth certificate and an infant's likelihood of experiencing SUID mortality.

Hypothesis #1: Infants in Georgia who do not have a father's name listed on the birth certificate will have higher odds ratios of SUID as compared to infants in Georgia who do have a father's name listed on the birth certificate.

Specific Aim #2: To understand the relationship between previously cited maternal, prenatal care, and infant characteristics and an infant's likelihood of experiencing SUID mortality.

Hypothesis #2: Infants in Georgia with previously cited maternal, prenatal care, and infant risk factors will have higher odds ratios of SUID as compared to infants that do not have such risk factors.

Methodology

Study Design and Participants

The current study will entail a quantitative secondary data analysis using an observational, retrospective case-control study design. The study sample is comprised is all infants under one year of age in Georgia.

The study subjects are infants under one year of age in Georgia who died of SUID, including the official cause of death as SIDS, ASSB, or unknown cause and a systematic sample of live births. Cases include all SUID deaths among infants born from 1998 through 2007 to Georgia residents. Cases were identified from the Georgia death certificate, which was later linked with the birth certificate for the purpose of the current study. A total of 9,516 infants were screened for eligibility, with initial eligibility requirements including being less than 12 months old at time of death and having the underlying cause of death coded as SIDS (International Classification of Diseases [ICD]-10 code R95), unknown cause (ICD-10 code R99), or ASSB (ICD-10 code W75). Cases coded as SIDS (ICD-10 code R95) as cause B or cause C were excluded from the current study, as well as that were missing any selected variables.

All SUID cases were compared with the systematic random sample of live births that occurred in Georgia over the same period. A total of 14,743 live births were systematically sampled from 1,362,401 overall live births to provide the comparison group. Live births that were missing any variables were excluded from the final analysis population.

Data Collection Procedures

The current study linked birth certificate and death certificate data for infants delivered to Georgia resident women during 1998-2007. The data set links infant births that occurred from 1998 through 2007 to infant deaths that occurred from 1998 through 2008.

There are 159 counties in Georgia and each county has a vital records registrar. Birth certificate records are completed in the county where the event occurred by hospital staff (Georgia Department of Public Health, 2013). Out-of-hospital births are recorded with the county vital records registrar in the county where the event occurred. Death certificate records are completed by a funeral director or a certifying physician, or, in the case of a coroner investigation, by a coroner who certifies the manner of death. The State Office of Vital Records within the Georgia Department of Public Health maintains birth and death certificate records.

Measures

Sudden Unexpected Infant Death. The primary dependent measure for this study was SUID, defined as an underlying cause of death coded as SIDS (ICD-10 code R95), unknown cause (ICD-10 code R99), or ASSB (ICD-10 code W75). The outcome measure was coded as a dichotomous variable with answer options including yes and no.

Paternal Involvement. The primary independent variable of interest in this study was the presence or absence of a father's name on the birth certificate. A name was considered absent on the birth certificate if the fields provided for the father's name was blank. In Georgia, a married woman is only permitted to report her husband's name on the birth certificate if she so chooses. If unmarried, a father must sign a Voluntary Paternity Acknowledgement Form at the hospital when the child is born or later at either the State Office of Vital Records or the Vital Records Office in the county where the child was born (Georgia Department of Public Health). The primary variable of interest was coded as a dichotomous variable with answer options including yes and no.

Maternal Characteristics. All maternal characteristics were obtained from birth records. Maternal age was reported as a ratio measure of age in years at the time of birth. Maternal age was recoded to a categorical variable with answer items including, "20 years of age or less", "21-24 years of age", "25-29 years of age", "30-34 years of age", or "older than or equal to 35 years of age". Maternal education was reported as a nominal measure indicating the last grade formal education completed. This item was recoded to a categorical variable with items including, "Less than high school", "High School", "College or Associates", and "More than college". Maternal race was reported as a nominal measure with answer options including white, black or African American, Asian, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, and Multiracial. This variable was recoded to a four-item categorical variable with answer options including, "White", "Black or African American", "Asian", and "Other". Maternal ethnicity was assessed by a dichotomous measure of whether or not the mother identifies as Hispanic or Latina. Maternal marital status was assessed with a nominal measure of the legally recognized marital status at delivery, conception, or anytime in between with answer options including married, unmarried, married but separated, widowed, divorced, never married, and unknown. This variable was recoded to a dichotomous variable with answer options including “married” and “not married” with all answer options besides “married” being considered “not married”.

Prenatal Care Characteristics. Prenatal care was assessed with a nominal measure of the Kotelchuck index which is defined as an index of adequacy of prenatal care based upon three items including, (1) month of entry, (2) number of prenatal visits, and (3) gestational age of infant at birth. Answer options included: inadequate, intermediate, adequate, and adequate plus. Additionally, the number of prenatal care visits was assessed with a ratio measure of total number of prenatal care visits the mother received during the current pregnancy. This variable was recoded to a six-item categorical variable with answer options including, “0 visits”, “1-4 visits”, “5-6 visits”, “7-10 visits”, “11 or more” visits. The month the mother began prenatal care was assessed with a nominal measure of the month during which prenatal care began with answer options including none through ninth. This variable was recoded to a three-item categorical variable with answer options including, “care began in first trimester (1-3 months)”, “care began in second trimester (4-6 months)”, and “care began in third trimester (7-9 months) or no prenatal care”. A nominal measurement with answer options including yes and no assessed if this is the first pregnancy for the mother.

Infant Characteristics. Infant sex was determined by a nominal measure of the infant’s biological sex with answer options including male and female. The infant’s gestational age was determined by a ratio measure of weeks of gestation. This variable was recoded to a four-item categorical variable with answer options including "very preterm (20-33 weeks)", "preterm (34-36 weeks)", "full-term (37-41 weeks)" and "post-term (greater than 42 weeks)". The infant's weight was measured by a ratio measure of the infant's birth weight immediately after delivery in grams. This variable was recoded to a three-item categorical variable with answer options including, "low birth weight (0-2499 grams)", "normal birth weight (2500-4000 grams)", and "high birth weight (>4000 grams)". A nominal measure of the number of fetuses for the pregnancy assessed plurality with answer options including single, twin, triplet, quadruplet, quintuplet, sextuplet, septuplet, eight or more, and unknown. This variable was recoded a dichotomous variable with answer options including, "single" and "multiple birth".

Analyses

SPSS v. 20 was used to conduct analysis of the research questions. The frequency distribution of the selected maternal and infant factors among all SUID deaths was compared to survivors. The differences in nominal maternal and infant variables were analyzed using Pearson chi-square tests of independence.

A bivariate correlation was conducted to assess for collinearity among all variables. Analyses of all independent variables and the outcome of SUID stratified by the father's name on the birth certificate were used to determine potential confounding and effect modification.

A multivariate logistic regression was used to model the association between paternal involvement, significant maternal, prenatal care, and infant variables, and the outcome of SUID. Additionally, two logistic regressions stratified by maternal race were used to model the association between paternal involvement, significant maternal, prenatal care, and infant variables, and the outcome of SUID among white and black or African American mothers. An alpha of .05 was used to determine significance of association in the bivariate and multivariate analyses.

The current study was determined to be research involving minimal contact with human subjects and received expedited human subjects review from the Institutional Review Board at Emory University.

Results

Description of Analysis Population

Characteristics of the analysis population are shown in Table 1. Overall, the majority of the mothers in the analysis population had a father listed on the birth certificate (81.0%), were younger than 30 years of age (70.5%), white (64.2%), non-Hispanic/Latina (88.4%), had at least a high school education (73.9%), were married (57.3%), had received adequate or more prenatal care (73.9%), and were not delivering their first pregnancy (67.4%). The majority of infants were male (52.1%), full-term (82.2%), and of normal birth weight (81.9%).

Variable Categories

The number of prenatal care visits and the trimester care began were originally included as covariates, but removed due to their inclusion in calculations for the Kotelchuck index. Due to a lack of significance in the initial bivariate analysis and small numbers in racial groups other than white and black or African American, the sample was limited to include white and black or African American mothers. All other racial groups were removed from the final analyses. Twins were removed from the analyses due to small numbers and significant variance between the singleton and twin-plus strata in the stratified analysis. Originally, the gestational age variable included the four items categories of very preterm, preterm, full-term, and post-term; however, due to similarities in bivariate and multivariate analyses, the categories were combined into a three-category variable: preterm, full-term, and post-term.

The categories of maternal age of 25-29, being non-Hispanic Latina, and not being the first pregnancy for the mother were used as the reference categories for their respective variables due to the largest percentage of SUID cases being within these strata. For all other variables, the reference category represents the category that has been shown in previous studies not to increase risk of SUID including: mothers having more years of education, being unmarried, having an adequate Kotelchuck score, and infants being female, full-term, and of normal birth weight.

Results of the bivariate analyses

Results of the chi-square tests of independence are shown in Table 2. Results of the chi-square tests of independence indicated significant differences in all variables between the SUID and survivor analysis population. Odds ratios were calculated to understand common characteristics of the SUID analysis population.

The odds ratio of not having a father's name on the birth certificate was 2.44, indicating that the odds of not having a father's name on the birth certificate in the SUID group were 2.44 times those of the Living group. This result was statistically significant ($X^2 = 193.22$, $p = 0.000$)

Mothers of infants who experienced SUID had significantly higher odds of being younger, black or African American, non-Hispanic/Latina, having lower levels of education, and not being married compared to mothers of surviving infants. Mothers of infants who experienced SUID also had higher odds ratios of receiving inadequate prenatal care and of this not being their first pregnancy. Infants in the SUID analysis population had significantly higher odds of being male, preterm, and low birth weight as compared to survivors.

Across all bivariate analyses, the strongest odds ratios among the SUID analysis population were for the variables representing the father's name being absent on the birth certificate, low maternal age, low maternal education, and infants being of low birth weight. Several significant dose-response relationships were observed in the bivariate analyses of ordinal variables. The odds ratios decreased in order across categories of maternal age, maternal level of education, the Kotelchuck Index scores up to "adequate", the infant's gestational age, and the infant's birth weight.

Bivariate collinearity diagnostics were conducted and are shown in Table 3. From these diagnostics, it was determined that there were no collinearity issues among any of the variables. Therefore, the final models included all remaining variables.

Interaction and Confounding Assessment

Stratified cross tabulations were used to assess effect modification and confounding; these cross tabulations examined the relationship between father's name on the birth certificate and the outcome of SUID stratified by all covariates. Odds ratios and exposure odds assessed stratum-specific differences. Results of the stratified analyses are shown in Table 4.

Results of the stratified analyses indicated that maternal age modified the effect of absence of a father's name on the birth certificate upon SUID. Stratum-specific results also indicated that marital status modified the effect of absence of a father's name on the birth certificate and SUID. Interaction terms were created for mother's age younger than 20 and father's name on the birth certificate, mother's age greater than 35 and father's name on the birth certificate, and married and father's name on the birth certificate. The stratified analysis also indicated stratum-specific differences between maternal race and father's name on the birth certificate. It was determined that there was significant effect modification by the race variable, so separate logistic regressions were run by race (white and black or African American) to assess the association between all other variables and SUID.

Results of multivariate analysis

Results of the logistic regression are shown in Table 5. Infants who did not have a father listed on their birth certificate and had a married mother aged 20-34 years of age had an odds ratio for SUID of 2.10 (95% CI: 1.31-3.36). Infants who did not have a fathers name on the birth certificate and had an unmarried mother had an odds ratio for SUID of 1.69 (95% CI: 1.03-2.77). Both of these indicate significantly increased odds of SUID. Additionally, infants who did not have a father listed on the birth certificate and had a mother 35 years of age or older had an odds ratio for SUID of 0.44 (95% CI: 0.24-0.81), indicating significantly lower odds of SUID. Among infants without a father on the birth certificate who were born to a mother younger than 20 years of age, the odds of SUID did not differ significantly from 1 (OR = 1.03; 95% CI: 0.77-1.38).

Dose-response relationships were apparent in the logistic regression for the variables maternal age, maternal education, and infant birth weight. Compared to women aged 25-29, women younger than 20 who listed a father on the birth certificate had an increased odds ratio of SUID by a factor of 2.01 and women aged 21-25 had an odds ratio for SUID of 1.644. For mothers ages 30-34, the odds ratio did not significantly differ from those ages 25-29 (OR=0.89; 95% CI: 0.72-1.34), and being age 35 or older and listing a father on the birth certificate was protective for SUID as was being age 35 or older and not listing a father (see above). Lower levels of education were associated with increasing odds ratios for SUID. Among infant characteristics, low birth weight increased the odds ratio for SUID and high birth weight was protective for SUID.

When adjusted for all variables and interaction terms, additional risk factors included inadequate prenatal care and being male. Protective maternal characteristics included being Hispanic/Latina, married, and the infant's being the mother's first pregnancy. Infants born post-term also had a significantly decreased odds ratio for SUID compared to infants born full-term.

Several variables were not significantly related to SUID in the final model. Women who did not list a father on the birth certificate and were younger than 20 years of age did not have a significant odds ratio for SUID. Maternal race, receiving intermediate or adequate-plus prenatal care, and preterm birth were not significantly associated with increased or decreased odds ratio for SUID.

Results of race-stratified multivariate analysis

Results of the race-specific logistic regressions are shown in Table 6. When stratified by race, the absence of a father on the birth certificate was only significantly associated with SUID in one group. White mothers who were married, between the ages of 20-34, and did not list a father listed on the birth certificate had a significantly elevated odds ratio for SUID of 2.55 (95% CI: 1.46-4.44). Among black mothers of the same characteristics, the odds ratio did not differ from 1 (OR = 1.23, 95% CI: 0.49-1.61). None of the interaction terms had odds ratios that significantly differed from 1.

The stratified regression showed increase odds ratios of SUID for both racial groups among mothers younger than 20 who listed a father on the birth certificate, and all mothers aged 20-25 years. White mothers who were older than 35 and listed a father on the birth certificate had a significantly decreased odds ratio of SUID, but the decrease did not achieve significance among black or African American mothers.

Among white women, being Hispanic or Latina was protective; no black or African American women designated Hispanic/Latina ethnicity. Between both racial groups, the odds of SUID decreased with increasing education, but the effects of high school or college education were non-significant for blacks/African Americans. The effects of being married were similarly protective between the races, but non-significant for blacks/African Americans. The effects of inadequate prenatal care were similarly risky between the races, but non-significant for whites. Among both white and black or African American mothers, having a first pregnancy was protective against SUID.

Regarding infant characteristics, being male was significantly risky for both racial groups. Among black or African American infants, post-term gestational age was associated with decreased odds of SUID, but the decreased odds among white women did not achieve significance. Among infants born to white mothers, low birth weight was a significant risk factor and hiving a high birth weight was protective.

Discussion

Summary of Findings

The primary research question of the current study examined if the absence of father's name listed on the birth certificate was associated with an increased risk of SUID. The absence of a father's name on the birth certificate was associated with a significantly greater odds of SUID among both unmarried and married women, notably married mothers aged 20-34. Conversely, the absence of a father on the birth certificate was protective among married mothers aged 35 or older. When stratified by race, the absence of a father's birth certificate was only associated with an increase in the risk of SUID among white mothers who were married, 20-34 years of age, and did not list a father on the birth certificate. Findings from this study suggest the absence of a father's name on the birth certificate is a risk factor that is unique and distinct from marital status and other risk factors and should be examined in relation to maternal race, maternal age, and marital status.

The secondary research question examined the maternal, prenatal care, and infant risk factors associated with SUID. Risk factors for SUID included young maternal age, low levels of maternal education, inadequate prenatal care, being a male infant, and low birth weight. Protective factors included older maternal age, higher levels of maternal education, being Hispanic/Latina, first pregnancy, post-term gestational age, and high birth weight. Findings from the current study are consistent with past literature regarding risk and protective factors for SUID. Younger maternal age and low education as a risk factor have been previously cited (Carlberg et al., 2012; Hoffman, et. al, 1988; Kraus et al., 1989). Similarly, a greater risk for infants born preterm (Carlberg et al., 2012; Malloy et al., 1995; Shapiro-Mendoza et al., 2006), those with low birth weight (Kraus et al., 1989; Sowter et al., 1999), and those with inadequate prenatal care (Carlberg et al., 2012; Kraus et al., 1989; Shapiro-Mendoza et al., 2006; Stewart et al., 1995) has also been described. The reduced risk for infants of Hispanic/Latino origin (Hauck et al., 2002; Task Force on Sudden Infant Death Syndrome, 2011) has been discussed as well.

Strengths

The current study utilized the Precede-Proceed model to provide an epidemiological assessment of SUID among Georgia infants. The application of proven theory is a strength in behavioral research as it utilizes proven constructs to explore and explain the relationship between factors. The use of Precede-Proceed in the current study will allow future public health researchers and practitioners to more effectively mobilize findings from this epidemiological assessment to identify potential means for alleviating the burden of SUID in Georgia.

This study marks the first time in 15 years that the relationship between a father's name on the birth certificate and infant mortality among Georgia infants has been explored. While findings from the 1999 study showed a significant relationship between the absence of a father's name on the birth certificate and infant mortality, very little research in the past several decades has been dedicated to exploring paternal involvement or, more broadly, family structure, in SUID in the Georgia population (Gaudino et al., 1999). As such, the current study is a novel and needed examination for understanding populations at risk for SUID in Georgia.

Lastly, the current study utilized a large sample size that was sufficient to run multivariate analyses with multiple covariates. Past literature has found complex relationships between epidemiological, behavioral, and environmental variables and SUID. As a result, it is necessary to utilize a large sample size and a study design that accounts for possible covariates when examining risk factors for SUID at the population level.

Limitations

Several concerns pertaining to the population and sample limit the current study. Cases and controls who were missing any variables were excluded from the study, which may be a source of selection bias. Additionally, the current study utilized data collected from 1998 – 2007. Since these data were collected, there have been several advances in Georgia's SUID reporting and prevention efforts, due to Georgia's involvement in the SUID Case Registry Pilot Program ("Sudden Unexpected Infant Death", 2013). Consequently, these findings may not generalize to the current population. The current study also did not have a sufficient sample of mothers that identified as Asian, American Indian/Alaska Native, or multiracial to be able to investigate these groups. Past research has found that maternal race is strongly associated with both the absence of the father's name on the birth certificate and with SUID (Alio et al., 2010; Alio et al., 2011; Carlberg et al., 2012; Hauck et al., 2002; Murray et al., 2012; Ngui et al., 2009). Therefore, the inability to examine the relationship between the father's name on the birth certificate and SUID among these racial groups is a limitation of the current study.

Another limitation is that the current study utilized a retrospective, case-control design and, therefore, causality cannot be determined. Additionally, the case-control design limits the study to using exposure odds ratios as estimators of risk ratios. In using this methodology, this study relies on a rare disease assumption, meaning that the prevalence of SUID is assumed to be low enough in the Georgia population so that the odds ratio approaches the relative risk.

The current study is also limited by the absence of several behavioral and environmental characteristics that are commonly found to be associated with SIDS. Tobacco, health insurance status, and breastfeeding were excluded as covariates from the current study due to issues of incomplete data and underreporting. Additionally, vital birth records do not provide adequate information to explain the absence of a father or other measures of family support during the time of birth. For example, possible explanations for the father's absence during birth could be deployment, incarceration, or a estrangement from the mother. Furthermore, variables regarding the presence of other individuals at birth, such as grandmothers or siblings, could have greatly informed this study. The study also did not account for the presence of physiological measures that may be associated with an increased risk of SUID, including various birth defects.

Finally, the current study study did not assess collinearity at the multivariate level. While collinearity among variables at the bivariate level was not detected, results of the logistic regression modeling suggest that there may be collinearity between birth weight and gestational age. In the final model, there was no relationship between gestational age and SUID. However, when birth weight was removed from the model, increased gestational age was significantly associated with lower odds of SUID. These findings suggest collinearity between birth weight and gestational age as they relate to the outcome of SUID. Additionally, the findings suggest that birth weight is a stronger predictor of SUID than gestational age.

Future Directions

Despite the limitations, findings from the current study have various implications for the direction of future research and public health efforts. While the absence of a father's name on the birth certificate is associated with an increased odds ratio of SUID, it clearly serves as a marker of those at risk, rather than as a causal factor that increases the risk. As a result, as guided by the Precede-Proceed framework, future research should explore potential hypotheses regarding the predisposing, reinforcing, and enabling factors that influence the absence of a father's name on a birth certificate, in an attempt to identify potential causes. Future research efforts should examine common reasons related to the absence of a father's name on the birth certificate in Georgia, such as deployment, estrangement, or incarceration. Additionally, researchers should examine if the absence of a father's name on the birth certificate indicates decreased social support, financial support, marital support, or increased levels of stress or stigmatization during pregnancy and after birth. Such findings may expand on ways in which paternal involvement exists in the causal pathway of SUID and other causes of infant mortality. Findings from the current study also indicate a need for increased research examining maternal and child health in the larger context of family environments. Future research should examine the relationship between the presence of grandparents or extended family involvement and the risk of sudden, unexplained infant mortality.

As guided by the Precede-Proceed framework, the current study provides valuable findings that can be leveraged to more effectively target at-risk populations for SUID prevention efforts. Such targeted prevention efforts can be integrated into hospital, primary care provider, social worker, or child protection service practices. Additionally, an elevated risk of SUID has been noted among both married and unmarried women who do not list a father on the birth certificate, with the highest risk among married women. These findings suggest that public health practitioners must look at both father's presence on the birth certificate and marital status to assess SUID risk. The results of this study also suggest a need to improve vital statistics reporting. Additional variables to expand on the family environment and structure could inform future maternal and child health prevention efforts.

Most importantly, the findings from this study encourage continued support for national, state and community-based programs and policies to improve paternal involvement during pregnancy and after birth. Current programs in Georgia focus on parenting, healthy relationships, domestic violence, economic stability, and incarcerated fathers (National Responsible Fatherhood Clearinghouse, n.d.). Future public health efforts to improve maternal and child health outcomes should encourage programs focused on increasing paternal involvement in Georgia and elsewhere.

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Tables

Table 1. Descriptive Characteristics of Analysis Population

Characteristic	**N**	**%**
Sudden Unexpected Infant Death		
Yes	1181	8.8
No	12246	91.2
Father absent on birth certificate		
Yes	2548	19.0
No	10879	81.0
Maternal Characteristics		
Maternal age (years)		
<20	2718	20.2
21-24	3244	24.2
25-29	3509	26.1
30-34	2570	19.1
≥ 35	1386	10.3
Maternal Race		
White	8622	64.2
Black/African American	4805	35.8
Maternal Ethnicity		
Hispanic/Latina	1558	11.6
Not Hispanic/Latina	11869	88.4
Maternal Education		
<High school	3507	26.1
High school	4398	32.8
College/Associates	2708	20.2
>College	2814	21.0
Married		
Yes	7694	57.3
No	5733	42.7
Prenatal Care		
Kotelchuck Index		
Inadequate	1598	11.9
Intermediate	1912	14.2
Adequate	5425	40.4
Adequate plus	4492	33.5
First pregnancy		
Yes	4380	32.6
No	9047	67.4
Infant Characteristics		
Sex		
Female	6427	47.9
Male	7000	52.1

Gestational age		
Preterm	1958	14.6
Full-term	11037	82.2
Post-term	432	3.2
Birth weight		
Low birth weight	1432	10.7
Normal birth weight	11003	81.9
High birth weight	992	7.4

Table 2. Chi-Square Tests of Independence

Variable	SUID (*n* = 1248)	Living (*n* = 12892)	*OR*	95% CI	X^2	Sig.
Father absent on birth certificate						
Yes	403	2145	2.44	[2.14, 2.78]	193.22	.000
No	778	10101	1.0	-		-
Maternal Characteristics						
Maternal age (years)					285.96	.000
<20	403	2315	2.65	[2.23, 3.16]		*
21-24	386	2858	2.06	[1.73, 2.45]		*
25-29	216	3293	1.0	-		-
30-34	117	2453	0.73	[0.58, 0.92]		*
≥ 35	59	1327	0.68	[0.50, 0.91]		*
Maternal Race					74.03	.000
White	623	7999	1.0	-		-
Black/African American	558	4247	1.69	[1.50, 1.90]		*
Maternal Ethnicity					56.54	
Hispanic/Latina	58	1500	0.37	[0.28, 0.48]		.000
Not Hispanic/Latina	1123	10746	1.0	-		-
Maternal Education					283.05	.000
<High school	494	3013	6.43	[4.98, 8.30]		*
High school	435	3963	4.30	[3.33, 5.56]		*
College/Associates	182	2526	2.82	[2.13, 3.74]		*
>College	70	2744	1.0	-		-
Married					218.10	
Yes	437	7257	0.40	[0.36, 0.46]		.000
No	744	4989	1.0	-		-
Prenatal Care						
Kotelchuck Index					71.91	.000
Inadequate	230	1368	2.00	[1.68, 2.37]		*
Intermediate	155	1757	1.05	[0.87, 1.27]		
Adequate	421	5004	1.0	-		-
Adequate plus	375	4117	1.08	[0.94, 1.25]		
First pregnancy					29.98	
Yes	301	4079	1.0	-		-
No	8167	9047	1.46	[1.27, 1.67]		.000
Infant Characteristics						
Sex					21.66	
Male	692	6308	1.33	[1.18, 1.50]		.000
Female	489	5938	1.0	-		-
Gestational age					64.17	.000
Preterm	263	1695	1.76	[1.52, 2.04]		*
Full-term	893	11037	1.0	-		-
Post-term	25	407	0.70	[0.46, 1.05]		
Birth weight					118.15	.000

Low birth weight	229	1432	2.12	[1.18, 2.48]	*
Normal birth weight	906	11003	1.0	-	-
High birth weight	46	946	0.54	[0.40, 0.73]	*

*Indicates that the 95% confidence interval for the Odds Ratio does not include 1 for this stratum

Table 3. Collinearity Assessment of Independent Variables

Birth Weight	Gest. Age	Sex	First Pregnancy	Kotelchuck Index	Marital Status	Maternal Education	Maternal Ethnicity	Maternal Race	Maternal Age	Father on BC	
.11**	.08**	-.01	.04**	.14**	-.51**	.26**	-.06**	-.28**	.25**	1.0	1
.08**	.02*	.00	.28**	.12**	-.41**	.52**	.04**	-.14**	1.0		2
-.17**	-.12**	.00	.04**	-.07**	.40**	-.09**	.25**	1.0			3
-.05**	-.05**	-.00	-.01	.01**	-.01	.27**	1.0				4
.10**	.04**	.00	-.01	.16**	-.41**	1.0					5
-.14	-.07**	.00	-.09**	-.15**	1.0						6
-.06**	-.18**	-.01	-.04**	1.0							7
.04**	-.02*	-.02	1.0								8
-.04**	.03**	1.0									9
.46**	1.0										10

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Table 4. Analysis of Covariates and SUID Stratified by Presence or Absence of a Fathers Name on the Birth Certificate

Variable	Father Absent						
	SUID		Living			Exposure Odds	
	Yes	No	Yes	No	*OR*	SUID	Living
Maternal Characteristics							
Maternal age					2.44		
<20	177	226	811	1504	1.45	0.78	0.54
21-24	130	256	635	2223	1.78	0.51	0.29
25-29	50	166	410	2883	2.12	0.30	0.14
30-34	25	92	174	2279	3.56	0.27	0.08
≥ 35	21	59	38	1212	5.84	0.55	0.10
Maternal Race							
White	147	476	722	7227	2.89	0.31	0.11
Black/African American	256	302	1373	2874	1.77	0.85	0.48
Maternal Ethnicity							
Hispanic/Latina	18	40	173	1327	3.45	0.45	0.13
Not Hispanic/Latina	385	738	1972	8774	2.32	0.52	0.23
Maternal Education							
<High school	206	288	895	2118	1.69	0.72	0.42
High school	148	287	849	3114	1.89	0.52	0.27
College/Associates	44	138	322	2204	2.18	0.32	0.15
>College	5	65	79	2665	2.59	0.08	0.03
Married							
No	378	366	2037	2952	1.50	1.03	0.69
Yes	25	412	108	7149	4.02	0.06	0.02
Prenatal Care							
Kotelchuck Index							
Inadequate	107	123	501	867	1.51	0.87	0.59
Intermediate	53	102	300	1457	2.52	0.52	0.21
Adequate	128	293	717	4287	2.61	0.44	0.17
Adequate plus	115	260	627	3490	2.46	0.44	0.18
First pregnancy							
Yes	109	192	811	3268	2.29	0.57	0.25
No	294	586	1334	6833	2.60	0.50	0.20
Infant Characteristics							
Sex							
Male	230	462	1073	5235	2.43	0.50	0.21
Female	173	316	1072	4866	2.54	0.55	0.22
Gestational age							
Preterm	104	159	444	1251	1.84	0.65	0.35
Full-term	288	605	1620	8524	2.51	0.48	0.19
Post-term	11	14	81	326	3.16	0.79	0.25
Birth weight							
Low birth weight	89	140	341	862	1.61	0.64	0.40
Normal birth weight [a]	300	606	1712	8385	2.43	0.50	0.20
High birth weight	14	32	92	854	4.06	0.44	0.11

Table 5. Logistic Regression Analysis Predicting SUID

Variable	*OR*	95% CI	*p*
Father absent on birth certificate			
Yes	2.10	[1.31, 3.36]	.002
No[a]	1.0	-	-
Interaction Terms			
Father Absent on BC * Not Married	1.69	[1.03, 2.77]	.038
Father Absent on BC * < 20 years of age	1.03	[0.77, 1.38]	.837
Father Absent on BC * ≥ 35 years of age	0.44	[0.24, 0.81]	.008
Maternal Characteristics			
Maternal age			
<20	2.01	[1.60, 2.53]	.000
21-24	1.64	[1.37, 1.97]	.000
25-29[a]	1.0	-	
30-34	0.89	[0.72, 1.34]	.320
≥ 35	0.62	[0.43, 0.88]	.008
Maternal Race			
White[a]	1.0	-	-
Black/African American	1.11	[0.96, 1.27]	.158
Maternal Ethnicity			
Hispanic/Latina	0.28	[0.21, 0.38]	.000
Not Hispanic/Latina [a]	1.0	-	
Maternal Education			
<High school	3.28	[2.44, 4.41]	.000
High school	2.29	[1.73, 3.03]	.000
College/Associates	1.90	[1.42, 2.54]	.000
>College [a]	1.0	-	
Married			
No	1.0	-	-
Yes	0.77	[0.65, 0.91]	.002
Prenatal Care			
Kotelchuck Index			
Inadequate	1.33	[1.11, 1.60]	.002
Intermediate	0.99	[0.81, 1.21]	.905
Adequate[a]	1.0	-	-
Adequate plus	0.95	[0.82, 1.12]	.555
First pregnancy			
Yes	0.52	[0.44, 0.60]	.000
No [a]	1.0	-	
Infant Characteristics			
Sex			
Male	1.35	[1.19, 1.52]	.000
Female	1.0	-	-

Gestational age			
Preterm	1.10	[0.90, 1.34]	.348
Full-term	1.0	-	-
Post-term	0.64	[0.42, 0.98]	.040
Birth weight			
Low birth weight	1.64	[0.42, 0.98]	.000
Normal birth weight	1.0	-	-
High birth weight	0.66	[0.48, 0.90]	.009

Table 6. Adjusted Odds Ratios Stratified by Race

Variable	White			Black/African American		
	OR	95% CI	*p*	*OR*	95% CI	*p*
Father absent on birth certificate						
Yes	2.55	[1.46, 4.44]	.001	1.23	[0.49, 1.61]	0.661
No[a]	1.0	-	-	1.0	-	-
Interaction Terms						
Father Absent on BC * Not Married	1.79	[0.97, 3.29]	.063	1.05	[0.41, 2.70]	.915
Father Absent on BC * < 20 years of age	1.08	[0.69, 1.68]	.743	1.02	[0.68, 1.53]	.926
Father Absent on BC * ≥ 35 years of age	0.394	[0.15, 1.06]	.066	0.52	[0.23, 1.17]	.113
Maternal Characteristics						
Maternal age						
<20	2.20	[1.62, 2.97]	.000	1.84	[1.28, 2.64]	.001
21-24	1.81	[1.41, 2.32]	.000	1.45	[1.11, 1.90]	.007
25-29[a]	1.0	-		1.0	-	
30-34	0.89	[0.72, 1.34]	.893	0.78	[0.53, 1.15]	.211
≥ 35	0.59	[0.37, 0.95]	.000	0.67	[0.38, 1.17]	.160
Maternal Ethnicity						
Hispanic/Latina	0.30	[0.22, 0.40]	.000	-	-	-
Not Hispanic/Latina[a]	1.0	-	-	1.0	-	-
Maternal Education						
<High school	3.71	[2.50, 5.50]	.000	2.39	[1.51, 3.77]	.000
High school	2.86	[1.98, 4.20]	.000	1.50	[0.97, 2.33]	.068
College/Associates	2.16	[1.47, 3.18]	.000	1.37	[0.87, 2.14]	.176
>College[a]	1.0	-	-	1.0	-	-
Married						
No[a]	1.0	-	-	1.0	-	-
Yes	0.74	[0.60, 0.92]	.007	0.87	[0.66, 1.16]	.355
Prenatal Care						
Kotelchuck Index						
Inadequate	1.22	[0.93, 1.61]	.157	1.41	[1.10, 1.81]	.007
Intermediate	1.10	[0.85, 1.43]	.455	0.86	[0.63, 1.17]	.340
Adequate[a]	1.0	-	-	1.0		-
Adequate plus [a]	0.97	[0.79, 1.19]	.765	0.93	[0.73, 1.18]	.540
First pregnancy						
Yes	0.52	[0.42, 0.64]	.000	0.52	[0.40, 0.64]	.000
No[a]	1.0	-	-	1.0	-	-
Infant Characteristics						
Sex						
Male	1.41	[1.19, 1.67]	.000	1.28	[1.06, 1.53]	.009
Female[a]	1.0	-	-	1.0	-	-
Gestational age						
Preterm	0.97	[0.73, 1.30]	.842	1.27	[0.96, 1.68]	.091
Full-term[a]	1.0	-	-	1.0	-	-
Post-term	0.77	[0.47, 1.26]	.295	0.41	[0.18, 0.94]	.036
Birth weight						
Low birth weight	2.10	[1.56, 2.82]	.000	1.32	[0.99, 1.75]	.062

Normal birth weight[a]	1.0	-	-	1.0	-	-
High birth weight	0.62	[0.43, 0.91]	.014	0.77	[0.44, 1.36]	.364