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Predictors of Early Death Among Infants and Toddlers

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Predictors of Early Death Among Infants and Toddlers

By

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2006

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An abstract of
A thesis submitted to the Faculty of the
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Abstract

Predictors of Early Death Among Infants and Toddlers
By Renee Malinowski

Background: Progress made in the reduction of infant and toddler mortality rates over the past two decades in the U.S. has recently stalled. A reevaluation of the data provided from birth and death certificates can lead to a better understanding of the current epidemiologic characteristics of children that are at the highest risk of early death. Risk factors for premature death among children must be identified and understood so that those at high risk for mortality can be identified and for public health policy interventions to be effective. The objective of this study was to identify maternal and infant characteristics associated with early death from SIDS and homicide in a Georgia birth cohort.

Methods: Child deaths for a 1999-2003 Georgia birth cohort were linked back to birth certificate records. Controls were selected using systematic random sampling, and deaths were compared to survivors. Descriptive, bivariate, and logistic regression analyses were performed on the data to examine the associations between selected maternal and infant characteristics and mortality from SIDS and homicide.

Results: Low maternal educational attainment and maternal tobacco use during pregnancy were the strongest predictors of post-neonate mortality from SIDS across all three maternal race/ethnicity groups. Important predictors of SIDS deaths for post-neonate non-Hispanic white children include low maternal education attainment, young maternal age, unmarried marital status, tobacco use during pregnancy, and low birth weight. The most important predictors of SIDS deaths among children of non-Hispanic black mothers include late entry into prenatal care, young maternal age, unmarried marital status, tobacco use during pregnancy, male gender, and low birth weight. Important predictors of homicide deaths for non-Hispanic whites include unmarried marital status and late entry into prenatal care. Important predictors of homicide deaths for children of non-Hispanic blacks include young maternal age, unmarried marital status, tobacco use during pregnancy, and male gender.

Conclusions: Intervention programs aimed at increasing the educational attainment levels of mothers, eliminating the use of tobacco by pregnant women, and supporting the special care needs of low birth weight and preterm infants are likely to have the greatest impact in reducing infant mortality rates.

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Introduction

Infant and child death is devastating to families and healthcare workers. Whether the death is attributed to medical causes, injuries, or intentional homicide, the sudden loss of a child is a tragic event that all too often could have been avoided. The field of public health has made dramatic improvements in child and infant outcomes in the past century. In the US, the child mortality rate (those aged 1-4 years) has declined from 1,418.8 deaths per 100,000 in 1907 to 28.6 in 2007 (1). For children 5-14 years, the child mortality rate dropped from 307.5 per 100,000 in 1907 to 15.3 in 2007. The infant mortality rate, a figure often used to compare the health and well being of populations across and within countries, has also dropped substantially, from 2,600.0 per 100,000 live births in 1960 to 639.4 in 2009 (20). Despite these massive improvements in infant and child outcomes in the US, several long-term trends persist, and we've seen a leveling off of the declines in the past decade. Although the US ranked 12th lowest in infant mortality in 1960 compared to other countries, we have now slipped to 31st as of 2006 (1). In order for the US to continue making substantial progress toward the significant reduction of infant and child death, we must identify and address the main predictors of these early deaths.

Infants and toddlers make up a significant proportion of child deaths in the US. Neonatal mortality, or death of infants within the first 27 days of life, is responsible for the majority of infant deaths. A review of the literature shows that roughly 2/3 of all infant death occurs during this period (1, 21). Preterm birth has been identified as the best predictor for neonatal mortality in the US as well as other developed countries (14, 15). Low gestational age and low birth weight contribute greatly to mortality rates for

neonates. Neonatal mortality has received an increasing amount of attention from researchers and public health officials in recent years since neonates make up the majority of infant deaths, yet the mortality rate for this subset of infants has seen the slowest rate of improvement. In 2005, the neonatal mortality rate in the US was 10.73 per 1,000 live births (34). This rate has barely changed since 1995, when the neonatal mortality rate was 11.84 per 1,000 live births (35). A specific focus is required for understanding neonatal mortality and morbidity, since previous research has shown that the epidemiology and health interventions required for this subset of children differ from that of older children (16). Specifically, previous research indicates that neonates of non-Hispanic black women have higher mortality rates than Hispanics and non-Hispanic white women, which appears to be associated with much higher rates of preterm delivery for non-Hispanic black mothers (35). Although this disparity is well documented, it is not well understood.

Infants, defined as children up to one year of age, also have a specific set of predictors for mortality. Congenital anomalies, short gestation and low birth weight, sudden infant death syndrome (SIDS), newborn complications from pregnancy, unintentional injuries, cord and placental complications, and respiratory distress syndrome (RDS) accounted for 62.1% of all infant deaths in 2007(1). SIDS, defined as the sudden and unexpected death of an apparently healthy infant not explained by careful postmortem studies, is the number 3 cause of death for infants, accounting for 8.4% of total infant deaths and resulting in the death of 2,453 infants in the US in 2007 alone (24). For infants 1-12 months of age, SIDS is the number one cause of death (25). Homicide is the leading cause of death for infants in the injury category, and among the most

disturbing and preventable (6). The risk of homicide is actually greater in the first year of life than in any other year of childhood until age 17 (26, 27).

For children ages 1-4 years, unintentional injury, developmental and congenital conditions present at birth, and cancer account for the top three causes of death (22). In the 5-14 year age range, unintentional injury, cancer, and homicide are the top causes of child mortality (22). For the age group 1-14 years as a whole, unintentional injury is a major cause of death, accounting for 32.5% of children 1-4 years and 29.6% of children 5-14 years (1). Between 1970 and 2008, the percentage of deaths due to homicide increased from 2 to 9% among children 1-4 years, and from 2 to 6% among children 5-14 years despite major declines in mortality during this time period from other leading causes of death (1). Although research has been done in recent years to link growth of socioeconomic disparities to increases in homicide-related causes of mortality in this age group, little has been done to combat this trend (28).

Not all deaths are preventable. However, many of the top five causes of death for each age group are. Identification of risk factors is crucial to affect public health policy and create effective interventions. Previous studies have consistently shown that certain maternal and infant characteristics are risk factors for infant and child mortality. Maternal characteristics most notably associated with risk of infant and child death include the mother's young age, race/ethnicity, lower level of educational attainment, no or late initiation of prenatal care, smoking during pregnancy, and multiparity. Child characteristics well documented as risk factors include low birth weight, low gestational age, male gender, and race/ethnicity. Most notably, disparities in infant and child mortality between race and ethnicity of the mother continue to persist, with infants of

non-Hispanic black mothers suffering the worst outcomes at a rate of more than three times the lowest rate for infants of Cuban mothers (1, 5). Children of non-Hispanic black mothers generally suffer double the mortality rate of other racial/ethnic groups (1).

Furthermore, previous studies have shown a distinct link between geography and poor health status. Although great variations exist in the outcomes for children in different states within the US, southern states have consistently been linked to the poorest health outcomes for children. Specifically, residence in Mississippi, Louisiana, Arkansas, Tennessee, Alabama, Georgia, North Carolina, South Carolina, and Florida is associated with higher infant and child morbidity and mortality (18). Although previous studies were able to identify region of residence as a predictor of poor child health outcomes, they did not explain the more proximal factors related to these results and thus could not suggest effective intervention strategies for the specific regions studied (18).

The objective of this study was to examine the association between maternal and infant/child characteristics and infant/child mortality for a birth cohort in one of the "Deep South" states in the US - Georgia. The main goals of this study were to: 1) identify characteristics that are independent risk factors for mortality, and 2) analyze risk factors related to two broad categories of death – SIDS and homicide. The study was conducted using a linked database with birth and death certificates for a Georgia birth cohort over a four-year period between 1999 and 2003.

Methods

The study population is a Georgia birth cohort including infants that were born between 1999 and 2003. Cause of death was obtained from death certificates. The reported deaths were linked back to the birth records. Analyses were limited to deaths of

children born in Georgia with a linked birth certificate. 739 of the 769 deaths to children (ages 1 through 4) that both lived in Georgia and were born in Georgia could be linked with a birth certificate. Study variables were obtained from longitudinally linked birth and death certificates for each individual. All live births were eligible for the study if 1) they were born in GA between January 1, 1999 and December 31, 2003, and 2) the key study variables were available in the birth and death certificates. All deaths for children ages less than five years born between January 1, 1999 and December 31, 2003 were included as cases. Controls were chosen through systematic random sampling in which every 10th live birth was identified as a control. The cohort comprised 73,712 children. Of these, 6,577 died between 1999 and 2007 and were included as cases, and 67,021 were included as controls.

The outcome variable was death. Maternal race was self-reported data obtained from the birth certificate and classified as white, black or African American, Asian, American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, or Multiracial. Ethnicity was classified as non-Hispanic or Hispanic/Latino. Due to small sample sizes for some of the race categories a new variable was created based on previous research that consolidated the race/ethnicity categories into non-Hispanic white, non-Hispanic black, and Hispanic/Latino (7, 30). Other independent variables included maternal age at birth (<20, 20-24, 25-29, 30-34, >34), mother's marital status (married/unmarried), trimester in which prenatal care began (no prenatal care, 1st trimester, 2nd trimester, 3rd trimester), tobacco use (yes/no), alcohol use (yes/no), maternal level of education (<9, 9-11, 12, 13-15, >15), and plurality (1-5). Infant/child characteristics included gestational week at birth (<33, 33-37, 38-42, >42), gender, and birth weight (<1500, 1500-2499,

2500-4000, >4000 grams). The groupings for these variables were based on previous studies (7, 29). Frequency distributions of the independent mother and infant/child risk factors among deaths were compared to survivors and the differences were analyzed using chi-square tests. Results are reported in Table 1. Odds ratios (ORs) and 95% confidence intervals (95% CIs) were computed from multiple logistic regression to analyze the associations between the risk factors and infant/child death. There was no evidence of multicollinearity between the independent variables and all independent variables were significant; therefore all predictors remained in the final model. Distributions were displayed overall and according to age group (neonates [0-24 days old], infants [25 days -1 year old], and children [older than 1 year and under 5 years]). Models were run stratified by maternal race/ethnicity (non-Hispanic white, non-Hispanic black, and Hispanic/Latino). Stepwise selection was used to choose final models.

Causes of death were classified based on an algorithm that collapsed sets of ICD-10 codes, and the distributions of deaths for each category are reported in Table 2. Classifications included drowning, fall, fire, firearm, homicide, motor vehicle accident, medical, other injury, poison, SIDS, suffocation, unknown intent, and unknown. Separate multiple logistic regression models were run for infants and children that died of SIDS and homicide by race to further evaluate the associations between the independent variables and these specific causes of death. All analyses were performed using SAS v. 9.3 and significance was evaluated at the 0.05 level.

Results

Frequency distributions for cases and survivors are shown in Table 1. The majority of cases and survivors were born to non-Hispanic white or non-Hispanic black

mothers. Infants and children that died and survivors were similar with respect to sex and mother's alcohol use during pregnancy, but those that died were more likely to be born to unmarried black mothers under the age of 24 with less than 13 years of educational attainment compared to survivors. Children that died were also more likely than survivors to have multiparous mothers that received no prenatal care, and used tobacco during pregnancy. In terms of infant/child characteristics, children that died were more likely than survivors to have been born less than 2,500 grams and less than 33 weeks gestation.

Crude overall odds ratios for the individual risk factors are shown in Table 1a. Low birth weight had the strongest association with death compared to survivors (OR = 18.8, $p<0.0001$). Low gestational age had the second strongest association with death compared to survivors (OR = 7.75, $p<0.0001$). Multiparity (OR = 4.63, $p<0.0001$) and non-white race of the mother (OR = 2.05, $p<0.0001$) also proved to have strong associations with infant and child death compared to survivors. All risk factors were statistically significant, and exposure to the risk factors independently was associated with increased risk of death from all cause mortality for infants and children in this study.

Crude odds ratios were then calculated for individual risk factors comparing SIDS deaths with controls. Results are shown in Table 1b. All risk factors proved to be independently statistically significant. Tobacco use during pregnancy showed the strongest association with death from SIDS (OR = 4.08, $p<0.0001$). Birth weight was also a strong predictor of infant death from SIDS (OR = 3.00, $p<0.0001$). Unmarried marital status (OR = 2.88, $p<0.0001$) and low education attainment (OR = 2.79, $p<0.0001$) were strongly associated with SIDS deaths, as well.

Crude odds ratios for the individual risk factors were then calculated comparing homicide deaths with controls. Results are reported in Table 1c. The strongest predictor of death from homicide was unmarried marital status of the mother (OR = 6.89, $p<0.0001$). The strength of the association was roughly two times greater than the next strongest predictor – low educational attainment of the mother (OR = 3.78, $p<0.0001$). Late or no entry into prenatal care was the third strongest independent predictor of death from homicide (OR = 2.86, $p<0.0001$).

Crude odds ratios for the individual risk factors were then calculated for medical deaths and injury deaths. Results are reported in Table 1d in addition to the crude odds ratios for SIDS deaths. Birth weight and preterm delivery were substantially stronger independent predictors of medical deaths than they were of SIDS or injury deaths. The single strongest independent predictor of medical death was birth weight (OR = 11.95, $p<0.0001$), with preterm delivery exhibiting the next strongest association (OR = 4.76, $p<0.0001$). Tobacco use during pregnancy was much stronger of an independent predictor for SIDS deaths (OR = 4.08, $p<0.0001$) and for injury deaths (OR = 3.02, $p<0.0001$) than for medical deaths (OR = 1.39, $p = 0.0002$).

The distribution of all causes of death is summarized in Table 2. When broken down by cause of death, medical causes were significantly more common than non-medical causes overall (Table 2a). When stratified by age group, neonates were far more likely to die from medical causes compared to non-medical causes. Infants were only slightly more likely to die from medical causes versus non-medical causes. Toddlers, however, were slightly more likely to die from non-medical causes than medical causes. Non-medical deaths were further broken down as shown in Table 2b. Looking strictly at

non-medical deaths, SIDS was the most common cause of death for neonates, infants, and overall. Homicide is the third most common cause of death overall and for children, and 4th most common for neonates and infants.

After excluding infants and children with missing values for mother's marital status, mother's educational attainment, trimester when prenatal care began, alcohol and tobacco use, plurality, and multiracial race/ethnicity of the mother, the final cohort included 67,660 children. Of these, 5,498 were cases and 62,162 were controls.

SIDS

Infants that died of SIDS were considered separately from the other causes of death and stratified by mother's race/ethnicity. The frequency distribution for these deaths is summarized in Table 3. A total of 582 deaths from SIDS were included in the study. Of these, 280 were born to non-Hispanic white mothers, 282 were born to non-Hispanic black mothers, and 20 were born to Hispanic mothers.

Adjusted odds ratios and 95% confidence intervals were calculated for SIDS cases. Results are reported in Table 4. For infants born to non-Hispanic white mothers, the most significant predictors of death from SIDS include low maternal educational attainment, tobacco use during pregnancy, and low birth weight. Notable predictors include younger mothers, unmarried marital status, late or no entry into prenatal care, and preterm delivery. Characteristics that did not appear to be important to infant mortality from SIDS include male gender.

Maternal and infant characteristics that were strong predictors of SIDS mortality for children born to non-Hispanic black mothers include low maternal educational attainment, unmarried marital status, tobacco use during pregnancy, and low birth weight.

Young maternal age at birth, late or no entry into prenatal care, male gender, and preterm delivery were also notable risk factors.

Among infants born to Hispanic mothers, characteristics that most strongly predicted SIDS mortality include tobacco use during pregnancy, male gender, and low birth weight. Low maternal educational attainment, young maternal age at birth, unmarried marital status, and preterm delivery were also notable risk factors. Maternal and infant characteristics associated with SIDS mortality did not differ significantly by trimester in which prenatal care began.

Homicide

Infants and children that died of homicide were then considered separately, also stratified by mother's race/ethnicity. Only one child born to a Hispanic mother died from homicide. This death was excluded from analysis since meaningful aORs could not be calculated; therefore only infants and children born to non-Hispanic white and non-Hispanic black mothers were compared. The frequency distribution for these deaths is summarized in Table 5. A total of 105 deaths from homicide were included in the study. Of these, 33 occurred among children of non-Hispanic white mothers and 72 occurred among non-Hispanic black mothers.

Odds ratios and 95% confidence intervals were then calculated for homicide cases. Results are reported in Table 6. For infants and children born to non-Hispanic white mothers, the most significant predictors of death from homicide include low maternal educational attainment, unmarried marital status of mothers, late entry into prenatal care, and preterm delivery. Notable predictors include male gender and low birth weight. Characteristics that did not appear to be important to infant mortality from

homicide include maternal age at birth (aOR = 0.66 & 1.01) and tobacco use during pregnancy (aOR = 1.16).

The most significant predictors of death from homicide for infants and children born to non-Hispanic black mothers include low maternal educational attainment, young maternal age at birth, unmarried marital status, tobacco use during pregnancy, and male gender. Late entry into prenatal care was a notable risk factor, as was preterm delivery. The only characteristics that did not appear to be an important risk factor for death from homicide for this maternal racial group includes birth weight (aOR = 1.14).

Discussion

This study was able to identify several maternal and infant/child characteristics associated with infant and child mortality from two of the most common non-medical causes of death. Medical causes of death for this cohort far outnumbered non-medical causes up until the first year of life, which was expected based on existing literature. Non-medical deaths still comprise a large figure, with 1,422 children overall dying before the age of 5. A very large number of neonates and infants were lost to SIDS in this cohort (n = 650), confirming the need for further study and interventions to better understand the mechanisms that trigger these deaths.

When independent predictors for SIDS deaths, medical deaths, and injury deaths were compared to controls, low birth weight and preterm delivery displayed a much stronger association to medical deaths than to SIDS deaths or injury deaths. The results overall showed that the strength of the associations with the examined risk factors for SIDS deaths were more similar to injury deaths than to medical deaths. This has implications for future research. Previous research has shown that additional risk factors

for SIDS deaths include co-sleeping and sleeping in a prone position, among other behavioral practices (8, 10). Future research is needed to better understand the medical and non-medical relationships between death from SIDS and the documented risk factors; however, these results suggest that a greater understanding of the non-medical risk factors could be more important to the odds of SIDS deaths compared to the medical risk factors. Therefore, more research should go into exploring the relationships between behavioral practices that could lead to SIDS deaths in post-neonates with the aim of developing effective interventions that lower the mortality rate from SIDS.

Tobacco use during pregnancy was found to be a significant predictor of mortality from SIDS, as well as for homicide for children of non-Hispanic black mothers. The strength of this predictor was especially strong for SIDS deaths compared to overall mortality. This finding could be skewed due to bias, since mothers are often reluctant to report tobacco use given its association with infant and child morbidity and mortality. Therefore, true odds could be much higher than what was found in this study, especially in relation to death from SIDS. Interventions targeted at reducing rates of maternal tobacco use during pregnancy could have a significant impact on SIDS-related mortality rates.

In the context of SIDS, tobacco use during pregnancy, low educational attainment by the mother, and low birth weight were important predictors of infant and child mortality across all races. These factors must be studied further to understand the mechanisms by which they lead to higher odds of death in children from SIDS. Of particular interest is the fact that 90% of Hispanic mothers completed 12 years or less of school compared to 77% of non-Hispanic white mothers and 77% of non-Hispanic black

mothers, yet infants and children of Hispanic mothers with low educational attainment had the lowest odds of dying from SIDS compared to the other two racial groups when controlling for the other risk factors in the study. Although this could be due to the small sample size for Hispanics skewing the results for that group, previous research has documented a similar epidemiological phenomenon in which Hispanics have shown the lowest risk for postneonatal mortality despite low educational attainment and low levels of prenatal care (7, 32, 33). It has been theorized that Hispanic women, and immigrants in general, are more likely to have greater family support, healthier diets, and take fewer risks that are associated with poor birth outcomes compared to those of other races in the US (7). The data in this study only supports the lower rates of risky behavior among Hispanic mothers in terms of lower rates of tobacco and alcohol use during pregnancy. Other factors that would need to be examined to assess this theory were not measured, and therefore cannot lend evidence for or against this theory. Additional research is needed to explain this paradox.

Furthermore, late entry into prenatal care appears to be a stronger predictor of death from SIDS for infants and children of non-Hispanic black mothers than for Hispanics or non-Hispanic whites. Non-Hispanic black mothers also had the highest frequency of late entry into prenatal care compared to the other two racial groups. It's unclear if this discrepancy is a result of unequal access to care or other factors. Further qualitative research is needed to understand the reason that fewer non-Hispanic black mothers are entering prenatal care early on in their pregnancy. Interventions should be targeted to non-Hispanic black mothers to increase the utilization of prenatal care services.

It's important to note that the small sample size of Hispanics in this study call into question how meaningful the results are for this subset in this analysis. Although in many ways the data does support findings in other studies for Hispanics, additional research with larger sample sizes is needed to substantiate the findings for this group.

Finally, in terms of death from homicide, infants and children of non-Hispanic black mothers had greater odds of death if the mother completed 12 years of education, had a younger age at birth, was unmarried, used tobacco during pregnancy, or entered prenatal care in the third trimester or not at all, and if the child was male. The characteristics associated with higher odds of death from homicide for non-Hispanic whites include less than 12 years of education for the mother, unmarried marital status, late entry into prenatal care, and low gestational week at birth. Notably, late entry into prenatal care and unmarried marital status were much stronger predictors of death from homicide for children of non-Hispanic white mothers vs. children of non-Hispanic black mothers. Likewise, young maternal age at birth was a significant predictor for children of non-Hispanic black mother, but was not important to children of non-Hispanic white mothers. Further research is needed to evaluate the underpinnings of these findings. It is likely that these results reflect the impacts of socio-demographic factors.

Strengths of this study include a large overall sample size, a population-based design, and analyses using a comparison group. This study was also able to assess risk factors simultaneously while controlling for other factors in the study. Since race and ethnicity were self-reported by mothers from birth certificate records, misclassification is less likely than it would be had it been pulled from other sources. Further, findings from

this study were able to support previous findings and national trends based on other study populations.

Several study limitations are also recognized. This study was limited to data available on birth and death certificates. Therefore, specific modifiers concerning causes of death, especially homicide, could not be examined, and socioeconomic status could not be factored into the analyses. Much of the data used in the study was self-reported, and therefore could have been under-reported as a result of social desirability response bias. The results of this study represent a birth cohort from only one state, and therefore may not be generalizable to the rest of the country. The use of birth and death certificates does not allow for distinctions to be made for quality of prenatal care or infant/child medical care, or psychosocial factors that can influence birth outcomes (7). Finally, analyses concerning death from homicide were run with a relatively small sample size.

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Tables

Table 1. Distribution of maternal and infant/child characteristics among deaths and survivors

Characteristic	Deaths (n = 6,577)	%	Survivors (n = 67,021)	%	p-value
Maternal Characteristics					
Race					<0.0001
White	(3,091)	47.00	(43,264)	64.55	
Black	(3,308)	50.30	(21,544)	32.16	
Asian	(140)	2.13	(1,886)	2.81	
American Indian/Alaskan Native	(16)	0.24	(139)	0.21	
Native Hawaiian/Pacific Islander	(2)	0.03	(36)	0.05	
Multiracial	(20)	0.30	(142)	0.21	
Ethnicity					<0.0001
Non-Hispanic	(5,782)	87.91	(57,831)	86.29	
Hispanic/Latino	(509)	7.74	(7,462)	11.13	
Unknown	(286)	4.35	(1,728)	2.58	
Educational attainment (years)					<0.0001
<9	(351)	11.31	(3,935)	5.87	
9-11	(1,493)	22.70	(11,728)	17.5	
12	(2,264)	34.42	(20,554)	30.67	
13-15	(1,155)	17.56	(13,619)	20.31	
≥16	(885)	13.46	(16,037)	23.93	
Unknown	(429)	6.52	(1,148)	1.71	
Age at birth (years)					<0.0001
<20	(1,260)	19.15	(8,705)	12.98	
20-24	(2,044)	31.09	(18,473)	27.56	
25-29	(1,441)	21.90	(17,941)	26.76	
30-34	(1,098)	16.69	(14,250)	21.26	
≥35	(734)	11.17	(7,652)	11.41	
Marital Status					<0.0001
Married	(3,060)	46.53	(42,228)	63.01	
Unmarried	(3,505)	53.29	(24,777)	36.97	
Unknown	(12)	0.18	(16)	0.02	
Trimester Prenatal Care Began					<0.0001
First trimester	(4,928)	74.93	(55,904)	83.41	
Second trimester	(772)	11.74	(7,170)	10.7	
Third trimester	(113)	1.72	(1,473)	2.20	
No care	(255)	3.88	(552)	0.82	
Unknown	(509)	7.74	(1,922)	2.87	
Tobacco Use During Pregnancy					<0.0001
Yes	(756)	11.49	(5,301)	7.91	
No	(5,492)	83.50	(60,638)	90.48	
Unknown	(329)	5.00	(1,082)	1.61	
Alcohol Use During Pregnancy					<0.0001
Yes	(72)	1.09	(493)	0.67	
No	(6,173)	93.86	(65,433)	88.77	
Unknown	(332)	5.05	(1,095)	1.49	

Plurality					<0.0001
One	(5,745)	87.35	(64,987)	96.97	
Two	(758)	11.53	(1,940)	2.89	
Three	(65)	0.99	(86)	0.13	
Four - Five	(9)	0.14	(8)	0.01	
Infant/Child Characteristics					
Sex					<0.0001
Female	(2,799)	42.56	(32,721)	48.82	
Male	(3,778)	57.44	(34,300)	51.18	
Gestational week at birth					<0.0001
<33	(3,365)	51.16	(1,436)	2.14	
33-37	(1,137)	17.29	(13,224)	19.73	
38-42	(2,030)	30.87	(51,626)	77.03	
>42	(45)	0.68	(735)	1.10	
Birth weight (grams)					<0.0001
<1,500	(3,230)	49.11	(888)	1.32	
1,500-2,499	(936)	14.23	(4,754)	7.09	
2,500-4,000	(2,275)	34.59	(55,677)	83.07	
>4,000	(136)	2.07	(5,702)	8.51	

Table 1a. Strength of association of maternal and infant/child characteristics among deaths and survivors

Characteristic	Deaths (n = 6,577)	Survivors (n = 67,021)	odds ratio	p-value
Maternal Characteristics				
Race			2.05	<0.0001
White	3,091	43,264		
Other Race	3,486	23,757		
Ethnicity			1.47	<0.0001
Non-Hispanic	5,782	57,831		
Hispanic/Latino	509	7,462		
Educational attainment (years)			1.42	<0.0001
≤12	4,108	36,217		
≥13	2,469	30,804		
Age at birth (years)			1.59	<0.0001
<20	1,260	8,705		
≥20	5,317	58,316		
Marital Status			1.95	<0.0001
Married	3,060	42,228		
Unmarried	3.505	24,777		
Trimester Prenatal Care Began			1.41	<0.0001
First trimester	4,928	55,904		
Late or no prenatal care	1,140	9,195		
Tobacco Use During Pregnancy			1.58	<0.0001
Yes	756	5,301		
No	5,492	60,638		
Alcohol Use During Pregnancy			1.55	<0.001
Yes	72	493		
No	6,173	65,433		
Plurality			4.63	<0.0001
One	5,745	64,987		
Multiplurality	832	2,034		
Infant/Child Characteristics				
Sex			1.29	<0.0001
Female	2,799	32,721		
Male	3,778	34,300		
Gestational week at birth			7.75	<0.0001
≤37	4,502	14,660		
≥38	2,075	52,361		
Birth weight (grams)			18.8	<0.0001
≤2,499	4,166	5,642		
≥2,500	2,411	61,379		

Table 1b. Strength of association of maternal and infant/child characteristics among SIDS deaths and survivors

Characteristic	Deaths (n = 582)	Survivors (n = 62,162)	odds ratio	p-value
Maternal Characteristics				
Educational attainment (years)			2.79	<0.0001
≤12	449	34,034		
≥13	133	28,128		
Age at birth (years)			2.33	<0.0001
≤20	200	11,407		
≥21	382	50,755		
Marital Status			2.88	<0.0001
Married	216	39,158		
Unmarried	366	23,004		
Trimester Prenatal Care Began			2.01	<0.0001
First trimester	437	53,355		
Late or no prenatal care	145	8,807		
Tobacco Use During Pregnancy			4.08	<0.0001
Yes	153	4,997		
No	429	57,165		
Infant/Child Characteristics				
Sex			1.25	0.0038
Female	252	30,365		
Male	330	31,797		
Gestational week at birth			1.92	<0.0001
≤37	201	13,426		
>37	381	48,736		
Birth weight (grams)			3.00	<0.0001
Up to 2,499	123	5,105		
≥2,500	459	57,057		

Table 1c. Strength of association of maternal and infant/child characteristics among homicide deaths and survivors

Characteristic	Deaths (n = 106)	Survivors (n = 62,162)	odds ratio	p-value
Maternal Characteristics				
Educational attainment (years)			3.78	<0.0001
≤12	87	34,034		
≥13	19	28,128		
Age at birth (years)			2.59	<0.0001
<20	39	11,407		
≥20	67	50,755		
Marital Status			6.89	<0.0001
Married	21	39,158		
Unmarried	85	23,004		
Trimester Prenatal Care Began			2.86	<0.0001
First trimester	72	53,355		
Late or no prenatal care	34	8,807		
Tobacco Use During Pregnancy			2.34	0.0004
Yes	18	4,997		
No	88	57,165		
Infant/Child Characteristics				
Sex			1.64	0.0066
Female	39	30,365		
Male	67	31,797		
Gestational week at birth			1.79	0.0022
≤37	35	13,426		
≥38	71	48,736		
Birth weight (grams)			1.99	0.0050
<2,500	16	5,105		
≥2,500	90	57,057		

Table 1d. Strength of association of maternal and infant/child characteristics independently among post-neonate SIDS deaths, medical deaths, and injury deaths compared to survivors

Characteristic	odds ratio (p-value) for SIDS deaths (n = 582)	odds ratio (p-value) for medical deaths (n = 1,258)	odds ratio (p-value) for injury deaths (n = 450)
Maternal Characteristics			
Educational attainment (years)	2.79 (<0.0001)	1.70 (<0.0001)	2.38 (<0.0001)
≤12			
≥13			
Age at birth (years)	2.33 (<0.0001)	1.45 (<0.0001)	2.12 (<0.0001)
≤20			
≥21			
Marital Status	2.88 (<0.0001)	1.81 (<0.0001)	1.83 (<0.0001)
Married			
Unmarried			
Trimester Prenatal Care Began	2.01 (<0.0001)	1.28 (0.0004)	1.58 (<0.0001)
First trimester			
Late or no prenatal care			
Tobacco Use During Pregnancy	4.08 (<0.0001)	1.39 (0.0002)	3.02 (<0.0001)
Yes			
No			
Infant/Child Characteristics			
Sex	1.25 (0.0038)	1.36 (<0.0001)	1.41 (0.0002)
Female			
Male			
Gestational week at birth	1.92 (<0.0001)	4.76 (<0.0001)	1.25 (0.0211)
≤37			
>37			
Birth weight (grams)	3.00 (<0.0001)	11.95 (<0.0001)	1.49 (0.0031)
Up to 2,499			
≥2,500			

Table 2. Distribution of Cause of Death by Infant/Child Age Group

	Overall (n = 6,577) %	Neonates (n = 3,869) 58.83%	Infants (n = 1,960) 29.80%	Children (n = 748) 11.37%
Cause of Death				
Drowning	(94) 1.43	(2) 0.05	(9) 0.46	(83) 11.10
Fall	(8) 0.12	(1) 0.03	(3) 0.15	(4) 0.53
Fire	(58) 0.88	(0) 0.00	(8) 0.41	(50) 6.68
Firearm	(3) 0.05	(0) 0.00	(0) 0.00	(3) 0.40
Homicide	(133) 2.02	(8) 0.21	(54) 2.76	(71) 9.49
MVA	(134) 2.04	(2) 0.05	(38) 1.94	(94) 12.57
Medical	(5,155) 78.38	(3,761) 97.21	(1,037) 52.91	(357) 47.73
Other Injury	(59) 0.90	(5) 0.13	(20) 1.02	(34) 4.55
Poison	(15) 0.23	(1) 0.03	(8) 0.41	(6) 0.80
SIDS	(650) 9.88	(50) 1.3	(600) 30.61	(0) 0.00
Suffocation	(124) 1.89	(9) 0.23	(93) 4.74	(22) 2.94
Unknown Intent	(20) 0.30	(2) 0.05	(9) 0.46	(9) 1.20
Unknown	(124) 1.89	(28) 0.72	(81) 4.13	(15) 2.01

Table 2a. Distribution of Medical and Non-Medical Deaths by Infant/Child Age Group

	Overall (n = 6,577) %	Neonates (n = 3,869) 58.83%	Infants (n = 1,960) 29.80%	Children (n = 748) 11.37%
Cause of Death				
Medical	(5,155) 78.38	(3,761) 97.21	(1,037) 52.91	(357) 47.73
Non-Medical	(1,422) 21.62	(108) 2.79	(923) 47.09	(391) 52.27

Table 2b. Distribution of Non-Medical Causes of Death by Infant/Child Age Group

	Overall (n = 1,422) %	Neonates (n = 108) 7.59%	Infants (n = 923) 64.91%	Children (n = 391) 27.50%
Cause of Death				
Drowning	(94) 6.61	(2) 1.85	(9) 0.98	(83) 21.23
Fall	(8) 0.56	(1) 0.93	(3) 0.33	(4) 1.02
Fire	(58) 4.09	(0) 0.00	(8) 0.87	(50) 12.79
Firearm	(3) 0.21	(0) 0.00	(0) 0.00	(3) 0.77
Homicide	(133) 9.35	(8) 7.41	(54) 5.85	(71) 18.16
MVA	(134) 9.42	(2) 1.85	(38) 4.12	(94) 24.04
Other Injury	(59) 4.15	(5) 4.63	(20) 2.17	(34) 8.70
Poison	(15) 1.05	(1) 0.93	(8) 0.87	(6) 1.53
SIDS	(650) 45.71	(50) 46.30	(600) 65.01	(0) 0.00
Suffocation	(124) 8.72	(9) 8.33	(93) 10.08	(22) 5.63
Unknown Intent	(20) 1.41	(2) 1.85	(9) 0.98	(9) 2.30
Unknown	(124) 8.72	(28) 25.93	(81) 8.78	(15) 3.84

Table 3. Frequency distributions for death from SIDS by maternal race

Characteristic	Non-Hispanic White n=280	Non-Hispanic Black n=282	Hispanic n=20
Maternal Characteristics			
Educational attainment (years)			
<9	17 (6)	10 (4)	9 (45)
9-12	198 (71)	206 (73)	9 (45)
≥13	65 (23)	66 (23)	2 (10)
Age at birth (years)			
≤20	90 (32)	104 (37)	6 (30)
≥21	190 (68)	178 (63)	14 (70)
Marital Status			
Married	156(56)	50 (18)	10 (50)
Unmarried	124 (44)	232 (82)	10 (50)
Trimester Prenatal Care Began			
First trimester	231 (83)	192 (68)	14 (70)
Late or no prenatal care	49 (18)	90 (32)	6 (30)
Tobacco Use During Pregnancy			
Yes	117 (42)	35 (12)	1 (5)
No	163 (58)	247 (88)	19 (95)
Alcohol Use During Pregnancy			
Yes	2 (1)	4 (1)	0 (0)
No	278 (99)	278 (99)	20 (100)
Plurality			
One	269 (96)	260 (92)	19 (95)
Two or More	11 (4)	22 (8)	1 (5)
Infant/Child Characteristics			
Sex			
Female	125 (45)	121 (43)	6 (30)
Male	155 (55)	161 (57)	14 (70)
Gestational week at birth			
≤37	89 (32)	107 (38)	5 (25)
>37	191 (68)	175 (62)	15 (75)
Birth weight (grams)			
Up to 2,499	53 (19)	68 (24)	2 (10)
≥2,500	227 (81)	214 (76)	18 (90)

Table 4. Adjusted odds ratios (95% CI) for deaths from SIDS by maternal race

Characteristic	Non-Hispanic White	Non-Hispanic Black	Hispanic
Maternal Characteristics			
Educational attainment (years)			
<9	2.80 (1.57, 4.96)	1.72 (0.85, 3.48)	1.53 (0.32, 7.40)
9-12	2.17 (1.59, 2.98)	1.38 (1.01, 1.87)	1.16 (0.24, 5.59)
≥13	1.00	1.00	1.00
Age at birth (years)			
≤20	1.41 (1.06, 1.87)	1.29 (0.99, 1.69)	1.44 (0.53, 3.87)
≥21	1.00	1.00	1.00
Marital Status			
Married	1.00	1.00	1.00
Unmarried	1.47 (1.12, 1.93)	1.67 (1.19, 2.33)	1.30 (0.52, 3.22)
Trimester Prenatal Care Began			
First trimester	1.00	1.00	1.00
Late or no prenatal care	1.27 (0.92, 1.75)	1.47 (1.13, 1.90)	1.10 (0.41, 2.91)
Tobacco Use During Pregnancy			
Yes	3.16 (2.43, 4.10)	2.51 (1.73, 3.64)	4.74
No	1.00	1.00	1.00
Infant/Child Characteristics			
Sex			
Female	1.00	1.00	1.00
Male	1.19 (0.94, 1.51)	1.34 (1.06, 1.70)	2.21 (0.85, 5.76)
Gestational week at birth			
≤37	1.29 (0.96, 1.73)	1.31 (0.98, 1.73)	1.40 (0.45, 4.29)
>37	1.00	1.00	1.00
Birth weight (grams)			
Up to 2,499	2.35 (1.65, 3.35)	1.76 (1.27, 2.43)	1.73 (0.34, 8.74)
≥2,500	1.00	1.00	1.00

Table 5. Frequency distributions for death from homicide by maternal race/ethnicity N=105

Characteristic	Non-Hispanic White n=33 (31.13%)	Non-Hispanic Black n=72 (67.92%)
Maternal Characteristics		
Educational attainment (years)		
≤11	16 (48.48)	28 (38.89)
12	9 (27.27)	33 (45.83)
≥13	8 (24.24)	11 (15.28)
Age at birth (years)		
<20	7 (21.21)	24 (33.33)
20-24	12 (36.36)	31 (43.06)
≥25	14 (42.42)	17 (23.61)
Marital Status		
Married	11 (33.33)	9 (12.50)
Unmarried	22 (66.67)	63 (87.50)
Trimester Prenatal Care Began		
First trimester	18 (54.55)	54 (75.00)
Second trimester	10 (30.30)	11 (15.28)
Third trimester or None	5 (15.15)	7 (9.72)
Tobacco Use During Pregnancy		
Yes	10 (30.30)	8 (11.11)
No	23 (69.70)	64 (88.89)
Alcohol Use During Pregnancy		
Yes	0 (0.00)	0 (0.00)
No	33 (100)	72 (100)
Plurality		
One	32 (96.97)	68 (94.44)
Two or More	1 (3.03)	4 (5.56)
Infant/Child Characteristics		
Sex		
Female	13 (39.39)	26 (36.11)
Male	20 (60.61)	46 (63.89)
Gestational week at birth		
≤37	11 (33.33)	24 (33.33)
≥38	22 (66.67)	48 (66.67)
Birth weight (grams)		
<2,500	4 (12.12)	12 (16.67)
≥2,500	29 (87.88)	60 (83.33)

Table 6. Adjusted odds ratios (95% CI) for deaths from homicide by maternal race/ethnicity

Characteristic	Non-Hispanic White	Non-Hispanic Black
Maternal Characteristics		
Educational attainment (years)		
≤11	2.30 (0.80, 6.60)	1.90 (0.85, 4.23)
12	1.16 (0.42, 3.22)	2.03 (0.99, 4.15)
≥13	1.00	1.00
Age at birth (years)		
<20	0.66 (0.23, 1.91)	2.31 (1.12, 4.78)
20-24	1.01 (0.44, 2.35)	1.91 (1.02, 3.57)
≥25	1.00	1.00
Marital Status		
Married	1.00	1.00
Unmarried	4.52 (1.91, 10.67)	1.91 (0.89, 4.09)
Trimester Prenatal Care Began		
First trimester	1.00	1.00
Second trimester	4.20 (1.89, 9.35)	0.77 (0.40, 1.48)
Third trimester or None	7.39 (2.65, 20.65)	1.62 (0.72, 3.62)
Tobacco Use During Pregnancy		
Yes	1.16 (0.52, 2.59)	2.43 (1.12, 5.24)
No	1.00	1.00
Infant/Child Characteristics		
Sex		
Female	1.00	1.00
Male	1.45 (0.72, 2.91)	1.77 (1.09, 2.86)
Gestational week at birth		
≤37	1.68 (0.76, 3.71)	1.28 (0.74, 2.24)
≥38	1.00	1.00
Birth weight (grams)		
<2,500	1.23 (0.39, 3.86)	1.14 (0.57, 2.31)
≥2,500	1.00	1.00

Table 7a. Final Model For Death From SIDS Among Non-Hispanic Whites

Characteristic	Parameter Estimate	Standard Error	p-value
Maternal Characteristics			
Educational attainment (years)			<0.0001
<9	0.44	0.18	0.0119
9-12	0.17	0.11	0.1009
Age at birth (years)	0.17	0.07	0.0165
Marital Status	0.20	0.07	0.0033
Tobacco Use During Pregnancy	0.58	0.07	<0.0001
Infant/Child Characteristics			
Birth weight (grams)	0.50	0.08	<0.0001

Table 7a. Final Model For Death From SIDS Among Non-Hispanic Blacks

Characteristic	Parameter Estimate	Standard Error	p-value
Maternal Characteristics			
Trimester prenatal care began	0.21	0.07	0.0016
Age at birth (years)	0.17	0.07	0.0101
Marital Status	0.30	0.08	0.0003
Tobacco Use During Pregnancy	0.49	0.09	<0.0001
Infant/Child Characteristics			
Sex	0.15	0.06	0.0131
Birth weight (grams)	0.36	0.07	<0.0001

Table 8a. Final Model For Death From Homicide Among Non-Hispanic Whites

Characteristic	Parameter Estimate	Standard Error	p-value
Maternal Characteristics			
Marital Status	0.87	0.19	<0.0001
Trimester prenatal care began			
Second trimester	0.31	0.27	0.2609
Third trimester or none	0.91	0.33	0.0058

Table 8b. Final Model For Death From SIDS Among Non-Hispanic Blacks

Characteristic	Parameter Estimate	Standard Error	p-value
Maternal Characteristics			
Age at birth (years)			
<20	0.44	0.18	0.0147
20-24	0.16	0.16	0.3366
Marital Status	0.39	0.19	0.0413
Tobacco Use During Pregnancy	0.52	0.19	0.0067
Infant/Child Characteristics			
Sex	0.28	0.12	0.0209

Appendix

February 6, 2012

Renee Malinowski
Rollins School of Public Health
1518 Clifton Rd.
Atlanta, GA 30322

RE: Determination: No IRB Review Required
IRB00055503; *Predictors of premature death in infants and toddlers by cause of death*
PI: Malinowski

Dear Ms. Malinowski:

Thank you for requesting a determination from our office about the above-referenced project. Based on our review of the materials you provided, we have determined that it does not require IRB review because it does not meet the definition of a study involving "human subjects" as set forth in Emory policies and procedures and federal rules, if applicable. Specifically, in this project, you will analyze data regarding premature death in infants and toddlers born to a Georgia birth cohort between 1999 and 2003. There are no identifiers available to your team as part of this study.

HHS regulations define *human subject* at 45 CFR 46.102(f) as follows:

Human subject means a living individual about whom an investigator (whether professional or student) conducting research obtains

(1) data through intervention or interaction with the individual, or
(2) identifiable private information.

This determination could be affected by substantive changes in the study design, subject populations, or identifiability of data. If the project changes in any substantive way, please contact our office for clarification.

Thank you for consulting the IRB.

Sincerely,

Sam Roberts, CIP
Research Protocol Analyst
This letter has been digitally signed