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Kathryn Pannemann Date

Population-based cohort study of SIDS death rates in the United States

by race/ethnicity, 2000-2007

By

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Master of Public Health

Global Epidemiology

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Population-based cohort study of SIDS death rates in the United States

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By

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An abstract of

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Abstract

Population-based cohort study of SIDS death rates in the United States

by race/ethnicity, 2000-2007

By Kathryn Pannemann

SIDS, defined as the sudden death of an infant under 1 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, is a major cause of infant mortality in the U.S. Prior to 2000 SIDS has been reported to vary by race/ethnicity. This analysis updates previously published SIDS studies examining differences in SIDS by race/ethnicity, including information from 2000-2007. We wanted to determine if the burden of SIDS was still heaviest on non-Hispanic black and American Indian/Alaskan Native infants. We used linked birth/death certificate data from 2000-2007 to determine SIDS rates and compare them among the racial/ethnic groups. Using indirect adjustment comparing groups to non-Hispanic white and further categorized by dichotomized birthweight (< 2500g, ≥ 2500g), maternal age (< 20, ≥ 20), and education (< college, some college), the standardized mortality ratios for non-Hispanic other race were highest at 4.80 followed by non-Hispanic American Indian/Alaskan Native at 1.59 and non-Hispanic Black at 1.40. These results suggest that 1) the included covariates explain some but not all of the observed excess in SIDS for those populations and 2) SIDS ratios are more similar across populations now than in previous years. Non-Hispanic white infants do not have the lowest SIDS rate, suggesting need for continued improvement in this population. Public health interventions targeted at Hispanic infants should be specifically targeted at Puerto Rican and other Hispanic groups who have the highest standardized mortality ratio within the Hispanic group(Puerto Ricans, 0.71; Other Hispanics, 0.56; Mexicans and Cubans, 0.27; Central Americans/South Americans, 0.22). Logistic modeling confirmed maternal age, birth weight and maternal education to be significantly associated with SIDS and a more complex association of race/ethnicity with SIDS. American Indian/Alaskan Native infants born to mothers less than 20 years old were not at increased risk, whereas those born to mothers greater than 20 years old were at 1.52 times the risk of SIDS. Infants born to Asian mothers had improved protective odds ratios over time, from an adjusted odds ratio of 0.59 in 2000 to an adjusted odds ratio of 0.51 in 2007. Compared to non-Hispanic white infants, among the groups of non-Hispanic black infants categorized by maternal education, age, and birthweight and after controlling for other factors, infants born < 2500 g with mothers < 20 years old and less educated had no elevated risk of SIDS (adjusted odds ratio = 1.02, 95% confidence interval [CI] 0.91, 1.14). Conversely, non-Hispanic black infants ≥ 2500 g with older and better-educated mothers had the highest adjusted odds ratio (1.58, 95% CI 1.50, 1.68). For other subgroups of non-Hispanic black infants, adjusted odds ratios decreased over time and ranged from 1.13 to 1.56 in 2007 depending on birthweight and maternal age and education. These results suggest that young and less-educated mothers would benefit from similar and improved SIDS education, but more targeted messages may need to be developed for racial and ethnic minorities who are older and better-educated. Further, better understanding of barriers to implementing recommended actions (such as no bed sharing) may improve health professionals' ability to assist families' compliance with recommendations.

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Table of Contents

Chapter 1: Background and Literature Review

In the United States in 2007, SIDS, defined as "the sudden death of an infant under 1 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," accounted for 8% of infant deaths and was the leading cause of postneonatal death [1, 2]. For many Americans, their only exposure to Sudden Infant Death Syndrome (SIDS) is the "Back to Sleep" campaign that recommends placing infants to sleep on their backs to protect them from dying from SIDS. Previous studies have reported that the syndrome disproportionately affects non-Hispanic blacks and non-Hispanic American Indians or Alaskan Natives at rates twice and almost three times as much as non-Hispanic white infants [1]. This thesis project brings the information on race/ethnicity up-to-date which may help public health professionals make future decisions on where to target preventive measures. Linked birth/infant death records were analyzed from 2000-2007 using indirect rate adjustment and logistic regression.

The current SIDS definition replaced the more vague definition created in 1969: "The sudden death of an infant or young child which is unexpected by history, and in which a thorough postmortem examination fails to demonstrate an adequate cause of death"[2]. The older definition lacked specificity of the child's age and the death investigation. Sudden Unexpected Infant Death (SUID) is a composite classification for deaths that occur suddenly and unexpectedly, including SIDS, unknown cause and accidental suffocation and strangulation [3]. Between 1999-2001, a decrease in SIDS deaths was offset by an increase in SUID deaths with causes other than SIDS while the all-cause postneonatal death rate stayed the same [4-6]. It has been suggested that differences in reporting or classification by medical examiners and coroners during this period could have contributed to these differences in rates [4-6].

A 1966 study estimated that around 30% of infant deaths after the first week of life and before the end of the first year were due to SIDS [7]. Following the initiation of the "Back to Sleep" campaign in 1994, SIDS rates decreased more than three times as fast during 1990 - 1994 compared with 1983-1989, decreasing by 1.6% from 1983-1989 and 5.6% during 1990-1994 [8]. In 2007, SIDS was still ranked as the 3rd leading cause of death in infants, with 57 deaths per 100,000 live births [1]. Despite the decreases seen, social inequalities have remained [9]. In 1995, it was thought the racial/ethnic disparities in SIDS were wider than in 1983, with the rate for black infants having increased from 2.0 times to 2.2 times that of white infants [8, 10]. More recent data for 2007 show a SIDS rate for non-Hispanic black mothers that is 1.9 times the rate for non-Hispanic white mothers suggesting a decrease in racial disparity from 1995 [1]. In the Pacific Northwest the SIDS mortality rates for American Indian/Alaskan Native (AI/AN) infants were found to have dropped from 8.9 per 1000 live-born infants during 1985-1988 to 3.0 during 1993-1996, although there was not a comparison made to non-Hispanic white infants [11]. In 2007, AI/AN infants had higher infant mortality than white infants, and the SIDS rates were 2.4 times the rate of non-Hispanic white mothers [1]. All of these studies used vital statistics data that linked birth certificates to death certificates for infants.

The biological reasons for SIDS are poorly understood, but there are many well-established risk factors including prone sleep position [12-14]. In 1992, the American Academy of Pediatrics (AAP) confirmed prone sleeping to be a risk factor for SIDS and recommended infants should be put to sleep on their backs or sides [4]. In 1994, the AAP, government organizations and SIDS organizations issued a joint statement on this recommendation and began a national campaign to encourage parents to place their infants to sleep in the supine position [15]. In 1996, the AAP clarified their recommendation for sleeping position by stating that the fully supine position was best and that side sleeping was better than prone but carried the risk of the infant turning to the

prone position [15]. This was followed by a recommendation in 2005 that only the supine position is safe for infants to sleep [4]. In 2011, it was added that infants should be placed in the supine position until 1 year of age or when they are able to roll themselves from supine to prone and back again at which time they can remain in whatever sleep position they go to [16].

One explanation of the differences in SIDS rates among the racial/ethnic groups may be corresponding differences in sleep positions. During the period 1983-1994 SIDS rates decreased for black infants more slowly than for white infants, from 16.7% to 10.4% [8]. By 2009 74.1% of infants of all races and ethnicities were sleeping in a supine position [17]. This was 75.6% for infants of white mothers, 73.4% of infants of Hispanic mothers, and 80% of infants of Asian mothers, while only 55.7% of infants born to black mothers were placed in this position [17]. In South Carolina, there was an increase in black infants being placed in the supine position from 22.6% in 1996 to 47.1% in 2007 [18]. The investigators did not explain what educational programs South Carolina had tried during this period, but they did discuss the need for programs to educate the populations most at risk to attempt to improve the numbers. Prone position was 2.4 times as likely for black as for white infants after control for potential confounders in a Chicago study [12]. A qualitative study investigating why non-Hispanic black mothers use the prone position found that they believed the prone position to be safer and more comfortable for the infant [19]. This study was small and took place at one medical center, so the results may not be generalized to all African American mothers. A larger national study also found that the difference between sleeping position in white and black infants could be explained by caregiver's concern about comfort and choking [20]. This study also found physician advice to be a strong predictor for supine sleeping position, although only 45% of the mothers reported getting advice from a doctor about sleeping position [20]. In another national study done at WIC centers, in which 73% of the participants were black, 80% of mothers

considered physicians highly qualified to give advice about sleep positions [21]. These studies suggest the importance of physician counseling of patients as an intervention. However, racial and ethnic differences may not be explained entirely by a lack of patient education.

One common risk factor is smoking by one or more of an infant's parents. A review performed in 2006 found that smoking has a consistent and strong positive association with SIDS [22]. An analysis performed on 2002 United States linked birth/infant death data found that prenatal smoking had an odds ratio of 2.7 for SIDS [23]. Although the study is limited by an underestimation of the number of mothers smoking, it still provides a number consistent with other findings.. Another study done in the Netherlands found that postnatal smoking had an odds ratio for SIDS of 5.7 for infants whose parents both smoked compared to those whose parents did not smoke [24]. Another study published in 2001 found that although smoking accounts for 23.6% of SIDS deaths and smoking cessation interventions are cost-effective, these interventions would only reduce SIDS deaths per year by 108 [25]. Smoking, while important in reducing SIDS deaths, cannot explain racial/ethnic differences as non-Hispanic black women (23.1%) are less likely than non-Hispanic white women who don't report the father's race/ethnicity (39%) to smoke[26]. American Indian mothers (24.7%) are more likely to smoke than non-Hispanic black mothers (23.1%) as well, and of the Hispanic groups, Puerto Rican mothers were the most likely to smoke (21%) [26].

Another important maternal characteristic is maternal place of birth – the United States or another country. Foreign-born mothers living in New York City had infants that were 0.65 times less likely to die from SIDS compared with US born mothers [27]. U.S. born black mothers had the only significant increase in risk of SIDS compared with US born white mothers when placed in a model with all of the other US born and foreign born racial/ethnic groups [27]. It has been

suggested that there may be differences in SIDS rates among the different countries of origin, with one study in the United Kingdom showing that mothers of Caribbean origin had infants with higher rates of SIDS while mothers of Indian or Bangladeshi origin had infants with lower rates when compared among the foreign born groups, although all foreign born mothers had lower rates of SIDS compared with UK born mothers [28]. There could be many reasons for these differences. One study in Boston in 1990 found that foreign-born black women, of which 72% were born in the Caribbean, had better pre-pregnancy nutritional status and attended more prenatal medical appointments when compared with U.S. born black women [29]. In addition, a study in Philadelphia in 2010 found that foreign born black women had lower rates of substance abuse and higher self-rated mental and physical health with these effects being stronger in African-born versus Caribbean-born women [30]. These all suggest the ways in which foreign born and U.S. born women differ, but do not necessarily shed light on why SIDS rates may be different in these two groups.

While differences in SIDS rates have been noted by race or ethnicity on a national scale, national data examining racial and ethnic differences while adjusting for potential confounders have not been reported for the time period 2000-2007. Moreover, it is not known how much other maternal characteristics (such as being foreign-born or of young maternal age) account for observed racial and ethnic differences. Before beginning the analysis, we hypothesized that SIDS rates will differ by race / ethnicity in the United States. With an understanding of the differences among the different racial/ethnic groups, public health professionals will know where to target interventions. We further hypothesized that these differences will be significant after controlling for selected potential confounding variables through indirect rate adjustment.

Chapter 2: Manuscript

Title, Authors, Abstract

Title: Population-based cohort study of SIDS death rates in the United States by race/ethnicity, 2000-2007

Authors: Kathryn Pannemann, Carol Hogue, Carrie Shapiro-Mendoza

Abstract: SIDS, defined as the sudden death of an infant under 1 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, is a major cause of infant mortality in the U.S. Prior to 2000 SIDS has been reported to vary by race/ethnicity. This analysis updates previously published SIDS studies examining differences in SIDS by race/ethnicity, including information from 2000-2007. We wanted to determine if the burden of SIDS was still heaviest on non-Hispanic black and non-Hispanic American Indian/Alaskan Native infants. We used linked birth/death certificate data from 2000-2007 to determine SIDS rates and compare them among the racial/ethnic groups. Logistic modeling found maternal age, birthweight, maternal education, gender, maternal tobacco use, prenatal visit in the first trimester, marital status and birth order to all be significant factors. Logistic regression revealed a more complex association of race/ethnicity with SIDS. American Indian/Alaskan Native infants born to mothers less than 20 years old were not at increased risk whereas those born to mothers greater than 20 years old were at 1.52 times at risk of SIDS. Infants born to Asian mothers had improved protective odds ratios over time, from an adjusted odds ratio of 0.59 in 2000 to an adjusted odds ratio of 0.51 in 2007.

Compared to non-Hispanic white infants, among the groups of non-Hispanic black infants categorized by maternal education, age, and birthweight and after controlling for other factors, infants born < 2500 g with mothers < 20 years old and less educated had no elevated risk of SIDS (adjusted odds ratio = 1.02, 95% confidence interval [CI] 0.91, 1.14). Conversely, non-Hispanic black infants ≥ 2500 g with older and better-educated mothers had the highest adjusted odds ratio (1.58, 95% CI 1.50, 1.68). For other subgroups of non-Hispanic black infants, adjusted odds ratios decreased over time and ranged from 1.13 to 1.56 in 2007 depending on birthweight and maternal age and education. These results suggest that young and less-educated mothers would benefit from similar and improved SIDS education, but more targeted messages may need to be developed for racial and ethnic minorities who are older and better-educated. Further, better understanding of barriers to implementing recommended actions (such as no bed sharing) may improve health professionals' ability to assist families' compliance with recommendations.

Introduction

In the United States in 2007, SIDS, defined as "the sudden death of an infant under 1 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," accounted for 8% of infant deaths and was the leading cause of postneonatal death [1, 2]. Previous studies have reported that the syndrome disproportionately affects non-Hispanic black and non-Hispanic American Indians or Alaskan Native infants at 2 to 3 times the rate for non-Hispanic white infants [1]. However, most reports do not control for maternal and infant risk factors which may account for some racial/ethnic differences. To examine these factors, we analyzed Linked birth/infant death records from 2000-2007.

In 1966, an estimated 30% of infant deaths after the first week of life and before the end of the first year were due to SIDS [7]. Annual SIDS rates decreased by 1.6% from 1983-1989 and 5.6% during 1990-1994 [8]. However, in 2007, SIDS was still ranked as the 3rd leading cause of death in infants, with 57 deaths per 100,000 live births [1] and racial/ethnic differences have remained [8-10]. In 2007, SIDS for infants born to non-Hispanic black mothers was 1.9 times the rate for infants born to non-Hispanic white mothers [1]. SIDS mortality rates for American Indian/Alaskan Native (AI/AN) infants are also elevated. [11] and reported to be 2.4 times the rate of infants born to non-Hispanic white mothers in 2007 [1].

National data on racial and ethnic differences have not been examined in-depth for the time period 2000-2007. Moreover, it is not known how much other maternal characteristics (such as educational level or maternal age) account for observed racial and ethnic differences. An understanding of the differences among the different racial/ethnic groups may help guide public health professionals to target interventions.

Methods

This study presents U.S. SIDS death rates for each of the different racial / ethnic groups: white/Caucasian, black/African American, Asian/Pacific Islander, Hispanic and American Indian/Alaskan Native. Hispanic deaths were further divided into Hispanic origins: Mexican, Puerto Rican, Cuban, Central or South American, and other Hispanic. Because they are often used as reference groups in studies, infants born to non-Hispanic white mothers were used as the reference group for other racial/ethnic groups. Race/ethnicity of infant was defined by proxy as the mother's race/ethnicity as listed on the birth certificate.

Data were obtained from publicly available US birth certificate and death certificate data, specifically the "Linked Birth/Infant Death Records Database" obtained from the National Vital

Statistics System (NVSS). This analysis was exempted from institutional review of the Emory University Institutional Review Board. This analysis included births and infant deaths from 2000-2007, the latest years available. The National Vital Statistics database links death certificates for deaths of children under 1 year old with their birth certificate in a period-linked fashion. The denominator is all births occurring in that year whether the infants who died in that year were born in the same year or the one prior [31]. The death certificate data are linked to birth certificate data to provide additional information, such as maternal age, race, ethnicity and educational history which is found on the birth certificates [31]. A new birth certificate was instituted in 2003, which included changes to the choices for maternal education. The 1989 revised version of the birth certificate reports years of education completed, while the 2003 revised version of the birth certificate reports the grade level of education completed [32]. The new birth certificate was adopted by states at different points, with 35% of states still using the 1989 version in 2008 [33]. Although the difference between the two versions can affect the comparison of educational attainment [33], the difference is minimized by dichotomizing women by high school education or less with those with more education. SIDS is denoted by code "R95" using the ICD-10 code [32]. Starting in 1995, missing birthweight values have been imputed by NVSS if gestation is listed to reduce the effect missing values have on data analysis [34]. Maternal race/ethnicity and maternal education have also been imputed if there were other reported values to impute from such as age, race, and ethnicity[35]. Observations that were missing the variables for maternal race/ethnicity, maternal education or infant birthweight were excluded from the dataset.

First, crude odds ratios for SIDS deaths for each of the racial/ethnic groups compared to non-Hispanic whites were calculated. For the logistic regression analysis, the risk of SIDS death (the dependent variable) was modeled as a function of race / ethnicity, and the potential

confounding variables including infant's year of birth, maternal education, maternal age, birth weight, year of birth, birth order, marital status, and maternal prenatal smoking. These variables have been previously associated both with SIDS deaths and race and ethnicity. To observe a potential trend in racial/ethnic differences over time, we tested for potential interaction between race / ethnicity and year of birth. Birthweight, maternal education and maternal age were dichotomized: maternal age (greater than/equal to 20 or less than 20 years), maternal education (less than 4 years of high school or greater than/equal to 4 years of high school), and birth weight (less than 2500 grams or greater than/equal to 2500 grams). Year of birth was treated as an ordinal variable. Marital status and smoking were dichotomous variables. Birth order indicated whether they were the first through eighth live child born to the mother with anything greater than eight grouped with the eighth category. The formula for this model is:

$$P\left\{SIDS\ Death = 1 \middle| \frac{race}{ethnicity}, year\ of\ birth, education, birth\ weight, maternal\ age, smoking, marital\ stat \right.$$
$$birth\ order$$

$$\frac{1}{1+e^{-(\alpha+\sum \beta_i X_i)}}$$

Results

There were 33,487,407 births in the original dataset, and 815,819 births were excluded due to missing variables, leaving 32,671,588 births. Table 1 shows the stratifying variables for the infants that died from SIDS compared with those who were born during the same period but did not die from SIDS. SIDS deaths had more males (59.3%) than in the rest of the population (48.8%). The proportion of infants dying from SIDS whose mother was Mexican (7.7%), Central American/South American (1.1%) and non-Hispanic Asian/Pacific Islander (1.7%) was lower than their proportion in the rest of the population (16.1%, 3.4%, 5.2% respectively). The proportion of Infants who died from SIDS and whose mothers were non-Hispanic black (28.4%) or non-Hispanic American Indian/Alaskan Native (1.9%) were greater than in the rest of the population

(14.5% and 0.9% respectively) suggesting a greater burden in these populations. SIDS deaths had a higher proportion of infants with low birthweight (20.2%) and mothers with less than 12 years of education (36.5%) and mothers who were less than 20 years old (21.2%) than in the rest of the population (8.3%, 21.7% and 10.7% respectively). Maternal tobacco use was missing for 9,934,699 mothers, and there was a higher proportion of maternal tobacco use in mothers of infants who died from SIDS (34.8%) than in those whose infants did not die from SIDS (11.0%). Infants who died from SIDS had lower proportions of mothers who were married (38.3%), had prenatal visits in the first trimester (67.9%) or were first birth order (28.9%) than for infants born in the rest of the population (64.2%, 81.3%, and 39.9% respectively). Birth order was missing for 30,737 observations and prenatal visit was missing for 829,612 observations.

Table 2 shows the results from regression analyses. The first column displays the crude odds ratios for the different racial/ethnic groups when compared to non-Hispanic white for the full dataset: Mexican, any race had an odds ratio of 0.49 (0.46, 0.52), Central American/ South American, any race had an odds ratio of 0.32 (0.28, 0.37), Other Hispanic had an odds ratio of 0.85 (0.78, 0.93), non-Hispanic black had an odds ratio of 1.98 (1.91, 2.05), Non-Hispanic, other race had an odds ratio of 6.65 (5.62, 7.88), non-Hispanic Asian had an odds ratio of 0.33 (0.29, 0.37), and non-Hispanic American Indian/Alaskan Native had an odds ratio of 2.21 (1.99, 2.47). The second column has the crude odds ratio for the dataset excluding those observations with missing values, for which Mexican, any race was 0.57 (0.53, 0.61); Central American/South American, any race was 0.35 (0.29, 0.42); other Hispanic was 0.92 (0.82, 1.02); non-Hispanic black was 2.04 (1.97, 2.12); non-Hispanic Asian was 0.39 (0.34, 0.45); non-Hispanic American Indian/Alaskan Native was 2.19 (1.96, 2.46); and non-Hispanic other race was 4.09 (1.84, 9.12). The remaining columns show the parameters for the model variables.

Table 2 shows the results of the multiple regression model with race/ethnicity; maternal age, education, tobacco use, marital status, prenatal care, infant's birthweight, birth order and gender. For this model, 22,285,643 births with no missing values for the variables in the model were used. The addition of these variables changed the crude odds ratios by more than 10% suggesting confounding for each of the following racial ethnic groups: non-Hispanic other race (2.40), Other Hispanic (including Puerto Rican and Cuban) (0.71). Non-Hispanic American Indian/Alaskan Native shows an odds ratio of 1.0 for those mothers younger than 20 years old and a greater odds ratio for those mothers over 20 years old (1.52). In this model, interaction was seen between year of birth and non-Hispanic Asian infants, with a downward trend in odds ratios from 0.59 to 0.51 over the 8 years in this study. Male gender showed a higher odds of SIDS death (1.40) than did female gender. Birth order showed an odds ratio of 1.18 which draws attention to an increased risk of SIDS death with each additional child born to a mother. The odds of a mother who uses tobacco having an infant die from SIDS is 2.75 times the odds of a mother who does not use tobacco among all infant deaths.

Non-Hispanic black and non-Hispanic American Indian/Alaskan Native show the highest risks of SIDS deaths than the other groups, although due to interaction, it depends on the stratum to determine how different the odds of SIDS death is than non-Hispanic white infants. Non-Hispanic American Indian/Alaskan Native infants with mothers less than 20 had a non-significant odds ratio of 1.00, while ones with mothers greater than 20 had an odds ratio of 1.52. There were 8 strata for non-Hispanic black infants which had odds ratios ranging from 1.02 to 1.58. The lowest group (1.02) included infants who were low birthweight with mothers who were less than 20 years old and had less than 4 years of high school. The highest group (1.58) had infants with normal birthweight and mothers who were greater than 20 years old and had more than 4 years of high school. This data points to the need for interventions to be targeted specifically at

non-Hispanic black mothers who are older and have more education. For younger, less educated mothers, it may be enough to intervene without specificity to the racial/ethnic group.

Discussion

While the biological mechanisms leading to SIDS are poorly understood, there are many well-established risk factors including prone sleep position [12-14]. Since 1992, the American Academy of Pediatrics (AAP) has led a campaign to discourage prone sleeping [4, 15, 16]. One explanation of the differences in SIDS rates among the racial/ethnic groups may be corresponding differences in sleep positions. During the period 1983-1994 SIDS rates decreased for black infants more slowly than for white infants, from 16.7% to 10.4% [8]. By 2009 74.1% of infants of all races and ethnicities were sleeping in a supine position [17]. Prevalence of supine sleeping was 75.6% for infants of white mothers, 73.4% of infants of Hispanic mothers, and 80% of infants of Asian mothers, but only 55.7% for infants born to black mothers [17]. In South Carolina, there was an increase in black infants being placed in the supine position between 1996 and 2007,from 22.6% in 1996 to 47.1% for 2007 [18]. Prone position was 2.4 times as likely for black as for white infants after control for potential confounders in a Chicago study [12]. A qualitative study investigating why non-Hispanic black mothers use the prone position found that they believed the prone position to be safer and more comfortable for the infant [19]. This study was small and took place at one medical center, so the results may not be generalizable to all African American mothers. A larger national study also found that the difference between sleeping position in white and black infants could be explained by caregiver's concern about comfort and choking [20]. This study also found physician advice to be a strong predictor for supine sleeping position, although only 45% of the mothers reported getting advice from a doctor about sleeping position [20]. Another national study done at WIC

centers, in which 73% of the participants were black, 80% of mothers considered physicians highly qualified to give advice about sleep positions [21]. These studies present a potential intervention for physicians whose education in counseling their patients could be improved. However, racial and ethnic differences may not be explained entirely by a lack of patient education.

One common risk factor is smoking by one or more of an infant's parents. A review performed in 2006 found that smoking has a as consistent and strong positive association with SIDS [22]. However, smoking cannot explain racial/ethnic differences as Hispanic and African American women are less likely than non-Hispanic women to smoke [26]. This study presents the odds of maternal smoking in infants who died of SIDS to be 2.75 times greater than infants that did not have a mother who smoked. As a variable in the model, it contributed to the explanation of SIDS rates in the different racial/ethnic groups, and it is an important potential intervention for all racial/ethnic groups.

Another important maternal characteristic is maternal place of birth – the United States or another country. Foreign-born mothers living in New York City had infants that were 0.65 times less likely to die from SIDS compared with US born mothers [27]. In the United Kingdom, mothers of Caribbean origin had infants with higher rates of SIDS while mothers of Indian or Bangladeshi origin had infants with lower rates when compared among the foreign born groups, although all foreign born mothers had lower rates of SIDS compared with UK-born mothers [28]. There could be many reasons for these differences. One study in Boston in 1990 found that foreign-born black women, of which 72% were born in the Caribbean, had better pre-pregnancy nutritional status and attended more prenatal medical appointments when compared with U.S. born black women [29]. In addition, a study in Philadelphia in 2010 found

that foreign born black women had lower rates of substance abuse and higher self-rated mental and physical health with these effects being stronger in African-born versus Caribbean-born women [30]. While these studies suggest ways in which foreign born and U.S. born women differ, they do not necessarily shed light on why SIDS rates may be different in these two groups. As country of origin is not included in the public-use data for 2000 – 2007, we could not examine this variable.

The strengths of the study include using population data for 7 years, with a large dataset including all of the minority racial/ethnic groups to allow for analysis. Limitations with birth and death certificate data include imputed and missing data. Dichotomizing maternal age, maternal education, marital status, and birthweight could have underestimated the effect of these variables, although they were dichotomized at points shown to be important by other studies.

Misclassification, reporting bias, and uncontrolled confounding could all bias the results of this study. Multiple studies have reported on misclassification of SIDS and accidental suffocation by medical examiners and coroners from 1999 to 2001 [4-6]. These potential discrepancies may have remained throughout the study period and could have affected the data in this study. It is also important to draw attention to reporting bias with prenatal smoking. Many women consider it undesirable to smoke during pregnancy and therefore do not report their smoking to the healthcare providers that are filling out the birth certificate. It may also be that only heavy smokers report their smoking while light smokers may not report because they consider it a lesser offense[23]. Finally, the death certificate does not include information on the sleeping position of the infant. This is a potential confounder that cannot be examined with this analysis.

The logistic modeling results show the complexity of the relationships among the variables and the different racial/ethnic groups. SIDS rates declined significantly from 2000 through 2007, and there was even more improvement over time among non-Hispanic Asian infants. Since the reference population is non-Hispanic white infants of similar birthweight and with mothers of similar age and education, the non-significant odds ratio for blacks in the highest-risk subpopulation of low birthweight with younger mothers with less education suggests a uniformly high risk in populations most likely to be served by public health practitioners. However, higher maternal education, older age, and better birthweight are not as beneficial for black as for white infants. Further research into this disparity among lower-risk infants is warranted. Some protection from SIDS is associated with early prenatal care and maternal abstinence from smoking. These should continue to be a part of health interventions. Other variables also appear to be protective, but they do not lend themselves to direct interventions: normal birthweight, maternal education greater than 12 years, mothers being married, older mothers and lower birth order. Continued research on SIDS and its biological mechanisms could shed light on the variables that seem to have the greatest effect on SIDS. With continued work, SIDS could be further reduced.

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Tables

***Table 1. Demographic Characteristics of SIDS deaths,* (Period Linked Birth/Infant Death Data Set, 2000-2007)**		
Variables	**SIDS deaths (count, %)**	**Births and other causes of death (count, %)**
Gender		
Male	10,613 (59.3)	16,719,665 (48.8)
Female	7,292 (40.7)	15,934,018 (51.2)
Race/ethnicity		
Mexican, any race	1,383 (7.7)	5,256,297 (16.1)
Puerto Rican, any race	276 (1.5)	490,718 (1.5)
Cuban, any race	18 (0.1)	121,337 (0.4)
Central American/South American, any race	194 (1.1)	1,111,028 (3.4)
Other/Unknown Hispanic	199 (1.1)	457,993 (1.4)
Non-Hispanic white	9,986 (55.8)	18,464,303 (56.6)
Non-Hispanic black	5,076 (28.4)	4,741,312 (14.5)
Non-Hispanic other race	137 (0.8)	38,084 (0.1)
Non-Hispanic Asian/Pacific Islander	301 (1.7)	1,692,851 (5.2)
Non-Hispanic American Indian/Alaskan Native	335 (1.9)	279,760 (0.9)
Maternal Education		
Less than 12 years	6,527 (36.5)	7,092,008 (21.7)
12 years or more	11,378 (63.6)	25,561,675 (78.3)
Birthweight		
Less than 2500 grams	3,620 (20.2)	2,721,695 (8.3)
2500 grams or more	14,285 (79.8)	29,931,988 (91.7)
Maternal Age		
Less than 20 years old	3,789 (21.2)	3,483,927 (10.7)
20 years or older	14,116 (78.8)	29,169,756 (89.3)
Maternal Tobacco Use (missing=9,934,699)		
Used tobacco during pregnancy	4,760 (34.8)	2,499,565 (11.0)
Did not use tobacco during pregnancy	8,931 (65.2)	20,223,633 (89.0)
Maternal Marital Status		
Married	6,854 (38.3)	20,970,739 (64.2)
Unmarried	11,051 (61.7)	11,682,944 (35.8)
Prenatal Visits (missing=829612)		
Within first trimester	11,740 (67.9)	25,861,248 (81.3)
Later or not at all	5,557 (32.1)	5,963,431 (18.7)
Birth order (missing=30737)		
First	5,154 (28.9)	13,000,667 (39.9)
Other	12,688 (71.1)	19,622,342 (60.1)
Note: Percentages may not add to 100 due to rounding.		

Table 2. Logistic model parameters – Characteristics of SIDS deaths as a portion of all births **(Period Linked Birth/Infant Death Data Set, 2000-2007)**					
Variables	**Crude odds ratios (95% CI) (full dataset)**	**Crude odds ratios (95% CI) (model dataset)**	**Final Model**		
			Estimate (Standard Error)	**Wald Chi-square (p-value)**	**Odds ratios (CI)**
Intercept			-6.21 (0.04)	19591.33 (<.0001)	
Mexican, any race	0.49 (0.46, 0.52)	0.57 (0.53, 0.61)	-0.73 (0.04)	314.03 (<.0001)	0.48 (0.45, 0.53)
Central American/South American, any race	0.32 (0.28, 0.37)	0.35 (0.29, 0.42)	-1.06 (0.09)	136.39 (<.0001)	0.35 (0.29, 0.41)
Other Hispanic, any race (including Puerto Rican and Cuban)	0.85 (0.78, 0.93)	0.92 (0.82, 1.02)	-0.34 (0.06)	34.42 (<.0001)	0.71 (0.64, 0.80)
Non-Hispanic black	1.98 (1.91, 2.05)	2.04 (1.97, 2.12)	0.03 (0.06)	0.23 (0.62)	See Table 3
Non-Hispanic other race	6.65 (5.62, 7.88)	4.10 (1.84, 9.12)	0.88 (0.41)	4.58 (0.03)	2.40 (1.08, 5.36)
Non-Hispanic Asian	0.33 (0.29, 0.37)	0.40 (0.34, 0.45)	-0.53 (0.12)	18.13 (<.0001)	See Table 3
Non-Hispanic American Indian/Alaskan Native	2.21 (1.99, 2.47)	2.19 (1.96, 2.46)	0.0004 (0.13)	0.00 (0.99)	See Table 3
Maternal age (20 years and greater compared with less than 20 years)			-0.51 (0.03)	272.30 (<.0001)	0.60 (0.56, 0.64)
Maternal education (12 years or greater			-0.38 (0.03)	222.08 (<.0001)	0.68 (0.65, 0.72)

compared with less than 12 years)					
Maternal tobacco use			1.01 (0.02)	2340.43 (<.0001)	2.75 (2.64, 2.87)
Prenatal visit in first trimester versus later or not at all			-0.29 (0.02)	205.32 (<.0001)	0.75 (0.72, 0.78)
Marital status (married versus not married)			-0.56 (0.02)	666.11 (<.0001)	0.57 (0.55, 0.59)
Birth order (for each additional level)			0.16 (0.006)	647.49 (<.0001)	1.18 (1.16, 1.19)
Year of birth			-0.03 (0.005)	29.67 (<.0001)	0.97 (0.97, 0.98)
Birthweight (2500 grams or greater compared with less than 2500 grams)			-0.80 (0.03)	804.71 (<.0001)	0.45 (0.43, 0.48)
Gender (Male compared with female)			0.34 (0.02)	345.11 (<.0001)	1.40 (1.35, 1.45)
Interaction between non-Hispanic black and year			-0.004 (0.009)	0.26 (0.61)	N/A
Interaction between non-Hispanic Asian and			-0.02 (0.03)	0.43 (0.51)	N/A

year					
Interaction between non-Hispanic American Indian/Alaskan Native and maternal age			0.42 (0.15)	8.34 (0.004)	N/A
Interaction between non-Hispanic black and maternal age			0.12 (0.05)	6.31 (0.01)	N/A
Interaction between non-Hispanic black and maternal education			0.18 (0.04)	18.40 (<.0001)	N/A
Interaction between non-Hispanic black and birthweight			0.14 (0.05)	8.70 (0.003)	N/A

Table 3. Stratified Analyses for variables with interaction (Period linked Birth/Infant Death Data Set, 2000-2007)	
Variable	**Odds Ratio**
Non-Hispanic American Indian/Alaskan Native, Maternal age less than or equal to 20	1.00 (0.78, 1.29)
Non-Hispanic American Indian/Alaskan Native, Maternal age greater than 20	1.52 (1.34, 1.73)
Non-Hispanic Asian, 2000	0.59 (0.46, 0.75)
Non-Hispanic Asian, 2001	0.58 (0.47, 0.70)
Non-Hispanic Asian, 2002	0.56 (0.48, 0.66)
Non-Hispanic Asian, 2003	0.55 (0.48, 0.64)
Non-Hispanic Asian, 2004	0.54 (0.46, 0.63)
Non-Hispanic Asian, 2005	0.53 (0.44, 0.64)
Non-Hispanic Asian, 2006	0.52 (0.41, 0.66)
Non-Hispanic Asian, 2007	0.51 (0.38, 0.68)
Non-Hispanic black, maternal age ≥20, ≥4 years high school, normal birth weight (≥2500 grams)	1.58 (1.50, 1.68)
Non-Hispanic black, maternal age <20, ≥4 years high school, normal birth weight (≥2500 grams)	1.40 (1.27, 1.55)
Non-Hispanic black, maternal age ≥20, ≥4 years high school, low birth weight (<2500 grams)	1.38 (1.27, 1.51)
Non-Hispanic black, maternal age <20, ≥4 years high school, low birth weight (<2500 grams)	1.22 (1.08, 1.38)
Non-Hispanic black, maternal age ≥20, < 4 years high school, normal birth weight (≥2500 grams)	1.32 (1.22, 1.43)
Non-Hispanic black, maternal age <20, < 4 years high school, normal birth weight (≥2500 grams)	1.17 (1.07, 1.28)
Non-Hispanic black, maternal age ≥20, < 4 years high school, low birth weight (<2500 grams)	1.15 (1.04, 1.28)
Non-Hispanic black, maternal age <20, < 4 years high school, low birth weight (<2500 grams)	1.02 (0.91, 1.14)

Chapter 3: Additional Analyses

We originally used indirect rate adjustment because we expected that the SIDS counts would be too small to do logistic modeling on all of the racial/ethnic groups. The explanations and results of the indirect rate adjustment and one additional logistic regression model are provided here.

Table 4 shows a breakdown of the number of births and SIDS deaths for each of the 8 years of this analysis.

Indirect Adjustment

Indirect rate adjustment is appropriate for analyses of rare occurrences in relatively small sample sizes [1]. With the indirect rate adjustment, a Standardized Mortality Ratio (SMR) can be calculated from this adjustment by dividing the observed number of deaths by the expected number of deaths and a chi-square test can be used to compare the observed rates with what is expected [36]. These ratios demonstrate which race/ethnicities have larger than expected SIDS death rates that cannot be explained by the stratifying characteristics.

For the indirect adjustment, the data were stratified by race/ethnicity, maternal age (greater than/equal to 20 or less than 20 years), maternal education (less than 4 years of high school or greater than/equal to 4 years of high school), and birth weight (less than 2500 grams or greater than/equal to 2500 grams). The standard population was defined as infants born to non-Hispanic white mothers. The SIDS death rate was calculated for each stratum of the standard population (Table 5). Then, the SIDS death rate for the standard population was multiplied by the number of births in each of the strata for each other specific race/ethnicity (Table 3). Stratum-specific expected deaths were then summed to obtain an expected number of SIDS deaths for that racial group. The standardized mortality ratio (SMR) was the total observed SIDS

death count for that population over the total expected death count for SIDS for all strata within that population.

Table 6 shows a summary of the indirect adjustment results. The indirect adjustment produced two Standard Mortality Ratios above one: non-Hispanic American Indian/Alaskan Native with 1.95 (1.74, 2.15), and non-Hispanic Black with 1.88 (1.83, 1.94). Among those who are Hispanic, Puerto Ricans had the highest with 0.73 (0.64, 0.83), followed by Hispanic, other race with 0.48 (0.40, 0.56), Mexican with 0.26 (0.24, 0.27), Cuban with 0.26 (0.07, 0.40), and Central American/South American with 0.22 (0.19, 0.26). The SMR for non-Hispanic Asian was 0.43 (0.38, 0.48) and the SMR for non-Hispanic other race was 0.25 (0.05, 0.44).

The indirect adjustment results show similar results to prior analyses of SIDS deaths and suggest that there is still work to be done to reduce SIDS deaths in non-Hispanic black and non-Hispanic American Indian/Alaskan Native infants. The non-Hispanic other race group showed a surprisingly high standardized mortality ratio compared to the other groups and may suggest there is something different about this group and even a misclassification bias. The results also suggest that among Hispanic infants, public health efforts should be focused on Puerto Ricans and other Hispanics. It may also be important to determine if there are individual groups within other Hispanics that will require special targeting. Non-Hispanic white was chosen as the reference group, but their rates were above all of the Hispanic groups suggesting this group also needs to be targeted. These results also show that birth weight, maternal education, and maternal age play a role in SIDS deaths.

Additional Logistic Model

Model 2 included the variables that were a part of the indirect rate adjustment: birthweight, maternal education and maternal age. These variables were dichotomized in the same way as

they were in the indirect rate adjustment. All observations were included in the model since observations were excluded in the data cleaning stage if they were missing any of these variables.

This model shows that among the Hispanic groups, other Hispanics had the highest odds ratio at 0.85 (0.78, 0.93) while still being less than non-Hispanic white infants. Mexican infants had an odds ratio of 0.49 (0.46, 0.52) and Central American/South American infants had an odds ratio of 0.32 (0.28, 0.37). Non-Hispanic, other race had an odds ratio of 5.35 (4.51, 6.34). The Hispanic groups demonstrate some confounding when comparing the crude odds ratios to the adjusted odds ratios. This seems to disappear when looking at the second model. Non-Hispanic Asian showed a downward trend over the years going from 0.51 to 0.20. American Indian/Alaskan Native shows an odds ratio close to 1 for those mothers younger than 20 years old (0.94) and an odds ratio twice as much for those mothers over 20 years old (2.09). Maternal age showed that the odds of mothers over 20 years old having an infant die from SIDS was 0.59 times less than for mothers less than 20 years old. The odds of an infant born with a birth weight greater than 2500 grams and dying from SIDS was 0.40 times that of infants born with a birth weight less than 2500 grams among all of the infant deaths. For mothers with more than 12 years of education, the odds of their infants dying from SIDS was 0.42 times less than the odds of an infant dying from SIDS born to a mother with less than 12 years of education among all of the infant deaths. The second model's additional variables seem to have explained the relationship more fully for non-Hispanic black infants eliminating the interaction with year and suggesting there is not a trend over time.

Tables

Table 4. Births and SIDS deaths by year (Period linked Birth/Infant Death Data Set, 2000-2007)		
Year	**Births**	**SIDS deaths (% of total births)**
2000	3,994,654	2,421 (0.06)
2001	3,981,621	2,174 (0.05)
2002	3,974,441	2,218 (0.06)
2003	4,048,433	2,097 (0.05)
2004	4,067,950	2,192 (0.05)
2005	4,101,671	2,168 (0.05)
2006	4,228,327	2,253 (0.05)
2007	4,274,491	2,382 (0.06)
Total	**32,671,588**	**17,905 (0.05)**
Note: 3297 infants were included in the birth year 2000 that were actually born in 1999		

Table 5. Calculating the SIDS Rate of the Standard Population (non-Hispanic whites) **(Period Linked Birth/Infant Death Data Set, 2000-2007)**			
Variables	**Births**	**SIDS deaths**	**SIDS death rates (per 1,000)**
Non-Hispanic white, maternal age ≥20, < 4 years high school, low birth weight (<2500 grams)	137150	382	2.79
Non-Hispanic white, maternal age <20, < 4 years high school, low birth weight (<2500 grams)	76251	269	3.53
Non-Hispanic white, maternal age ≥20, < 4 years high school, normal birth weight (≥2500 grams)	1244881	1602	1.29
Non-Hispanic white, maternal age <20, < 4 years high school, normal birth weight (≥2500 grams)	685038	1003	1.46
Non-Hispanic white, maternal age ≥20, ≥4 years high school, low birth weight (<2500 grams)	1089919	979	0.90
Non-Hispanic white, maternal age <20, ≥4 years high school, low birth weight (<2500 grams)	54788	126	2.30
Non-Hispanic white, maternal age ≥20, ≥4 years high school, normal birth weight (≥2500 grams)	14541466	5101	0.35
Non-Hispanic white, maternal age <20, ≥4 years high school, normal birth weight (≥2500 grams)	618656	524	0.85

Table 6. Standardized Mortality Ratio Within Racial / Ethnic Groups, using non-Hispanic whites as the Standard Population **(Period Linked Birth/Infant Death Data Set, 2000-2007)**			
Variables	**Expected count of SIDS deaths**	**Observed count of SIDS deaths**	**Standardized Mortality Ratio (CI)**
Mexican, any race	5130.22	1383	0.26 (0.24, 0.27)
Puerto Rican, any race	389.61	276	0.73 (0.64, 0.83)
Cuban, any race	66.05	18	0.26 (0.07, 0.40)
Central American/South American, any race	887.85	194	0.22 (0.19, 0.26)
Other Hispanic, any race	355.64	199	0.48 (0.40, 0.56)
Non-Hispanic black	3612.89	5076	1.88 (1.83, 1.94)
Non-Hispanic other race	28.52	137	0.25 (0.05, 0.44)
Non-Hispanic Asian	861.48	301	0.43 (0.38, 0.48)
Non-Hispanic American Indian/Alaskan Native	211.19	335	1.95 (1.74, 2.15)

***Table 7. Additional logistic model – Characteristics of SIDS deaths as a portion of all births* (Period Linked Birth/Infant Death Data Set, 2000-2007)**				
Variables	**Crude Odds Ratios (95% CI)**	**Estimate (Standard Error)**	**Wald Chi-square (p-value)**	**Odds ratios (Confidence Intervals)**
Intercept		-5.50 (0.03)	29811.57 (<.0001)	
Mexican, any race	0.49 (0.46, 0.52)	-1.17 (0.03)	1424.35 (<.0001)	0.31 (0.29, 0.33)
Central American/South American, any race	0.32 (0.28, 0.37)	-1.40 (0.07)	350.68 (<.0001)	0.25 (0.21, 0.29)
Other Hispanic, any race (including Puerto Rican and Cuban)	0.85 (0.78, 0.93)	-0.4464 (0.05)	88.07 (<.0001)	0.64 (0.58, 0.70)
Non-Hispanic black	1.98 (1.91, 2.05)	-0.15 (0.05)	8.08 (0.005)	See Table 9
Non-Hispanic other race	6.65 (5.62, 7.88)	1.68 (0.09)	370.74 (<.0001)	5.35 (4.51, 6.34)
Non-Hispanic Asian	0.33 (0.29, 0.37)	-0.67 (0.10)	46.19 (<.0001)	See Table 8
Non-Hispanic American Indian/Alaskan Native	2.21 (1.99, 2.47)	-0.06 (0.13)	0.23 (0.63)	See Table 8
Maternal age (20 years and greater compared with less than 20 years)		-0.53 (.03)	451.38 (<.0001)	0.59
Birthweight (2500 grams or greater compared with less than 2500 grams)		-0.92 (0.02)	1498.88 (<.0001)	0.40
Maternal education (12 years or greater compared with less than 12 years)		-0.88 (0.02)	1597.95 (<.0001)	0.42
Year of birth		-0.02 (0.004)	25.90 (<.0001)	0.59
Interaction between non-Hispanic black and year		-0.02 (0.007)	9.91 (0.002)	N/A
Interaction between non-Hispanic Asian and year		-0.13 (0.03)	23.53 (<.0001)	N/A
Interaction between non-Hispanic American		0.80 (0.14)	31.85 (<.0001)	N/A

Indian/Alaskan Native and maternal age				
Interaction between non-Hispanic black and maternal age		0.49 (0.04)	122.96 (<.0001)	N/A
Interaction between non-Hispanic black and maternal education		0.24 (0.04)	39.49 (<.0001)	N/A
Interaction between non-Hispanic black and birthweight		0.16 (0.04)	16.09 (<.0001)	N/A

Table 8. Stratified Analyses for variables with interaction (Period linked Birth/Infant Death Data Set, 2000-2007)	
Variable	**Odds Ratio**
Non-Hispanic American Indian/Alaskan Native, Maternal age less than or equal to 20	0.94
Non-Hispanic American Indian/Alaskan Native, Maternal age greater than 20	2.09
Non-Hispanic Asian, 2000	0.51
Non-Hispanic Asian, 2001	0.45
Non-Hispanic Asian, 2002	0.39
Non-Hispanic Asian, 2003	0.35
Non-Hispanic Asian, 2004	0.30
Non-Hispanic Asian, 2005	0.27
Non-Hispanic Asian, 2006	0.23
Non-Hispanic Asian, 2007	0.20

Table 9. Stratified analysis for black (Period linked Birth/Infant Death Data Set, 2000-2007)								
Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Non-Hispanic black, maternal age ≥20, ≥4 years high school, normal birth weight (≥2500 grams)	2.11	2.06	2.01	1.97	1.92	1.88	1.83	1.79
Non-Hispanic black, maternal age <20, ≥4 years high school, normal birth weight (≥2500 grams)	1.29	1.26	1.23	1.2	1.17	1.15	1.12	1.09
Non-Hispanic black, maternal age ≥20, ≥4 years high school, low birth weight (<2500 grams)	1.8	1.75	1.71	1.67	1.64	1.6	1.56	1.53
Non-Hispanic black, maternal age <20, ≥4 years high school, low birth weight (<2500 grams)	1.1	1.07	1.05	1.02	1.00	0.98	0.95	0.93
Non-Hispanic black, maternal age ≥20, < 4 years high school, normal birth weight (≥2500 grams)	1.65	1.61	1.58	1.54	1.51	1.47	1.44	1.40
Non-Hispanic black, maternal age <20, < 4 years high school, normal birth weight (≥2500 grams)	1.01	0.98	0.96	0.94	0.92	0.9	0.88	0.86
Non-Hispanic black, maternal age ≥20, < 4 years high school, low birth weight (<2500 grams)	1.41	1.37	1.34	1.31	1.28	1.25	1.22	1.20
Non-Hispanic black, maternal age <20, < 4 years high school, low birth weight (<2500 grams)	0.86	0.84	0.82	0.8	0.78	0.76	0.75	0.73

Chapter 4: Summary, Public Health Implications, Possible Future Directions

SIDS has been a part of overall health efforts to decrease infant mortality. Without fully understanding the biological mechanism that causes this syndrome, it has been difficult to explain all of the targeted interventions, such as the guideline to place infants to sleep on their backs. This is one of the biggest areas of future research for SIDS as it would help inform public health decision making and help everyone understand SIDS better and how present and future interventions are able to impact it.

Despite this gap in knowledge, the research on risk factors and risk groups has provided guidance for health interventions. The “Back to Sleep” campaign seems to have been the biggest contributor to the decreases that were seen. Although decreases were seen, the decreases did not necessarily continue at the same rate for each of the racial/ethnic groups. This suggests deficiencies either in the uptake of this intervention or in other variables that increase mortality due to SIDS. Non-Hispanic black and non-Hispanic American Indian/Alaskan Native infants are impacted more than other racial/ethnic groups, and this analysis suggests the rates have not increased but there has not been much improvement either. The analysis also includes the breakdown within the Hispanic groups and can lead public health organizations to target particular groups, such as Puerto Ricans. It is important to note that the Hispanic groups are doing better than non-Hispanic white infants possibly suggesting differences that could lead to interventions to improve this group as well. All of this information can help public health organizations target their interventions

This project is important because it can help public health organizations, such as health departments, target their interventions to groups that seem to be the most affected. One study estimated that a 10% increase in local public health spending, regardless of how the money was

spent, could decrease infant mortality by 6.85 infant deaths per 1,000 live births[37]. Although this figure reflects general infant mortality and not specifically SIDS, infant mortality saw the biggest decrease among the preventable deaths listed in the study and therefore suggests optimism in possibly affecting SIDS in particular[37]. It will be important to continue to monitor the SIDS mortality rates in all racial/ethnic groups. Current health interventions should be monitored to determine what is working the best both in reducing SIDS mortality and in convincing the public to place infants to sleep in the supine position. Foreign-born mothers and their infant care practices should also be investigated to determine what is keeping some of these groups safer than others in regards to SIDS.