RACE/ETHNIC DISPARITIES IN CAUSE -SPECIFIC INFANT MORTALITY CHANGE OVER TWO DECADES *

By

Seung-eun Song**
University of Texas

and

W. Parker Frisbie
University of Texas

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** Direct all correspondence to: Seung-eun Song, Population Research Center, 1 University Station, G1800, University of Texas at Austin, Austin, TX 78712.
Email: sesong@hotmail.com

Abstract

It has been argued that "the past two decades have witnessed the most profound alterations ever recorded in the structure of infant mortality patterns in the United States" (Gortmaker and Wise 1997: 152). But despite the fact that race/ethnic disparities have increased during a time period when infant mortality was falling for virtually all groups, no research exists that models changes in cause-specific infant mortality by race/ethnicity over this crucial time period. Here we document and model black-white change in infant mortality for 1983-2001 using the NCHS linked birth/infant death files. We also use data for the nine states (including all four states bordering on Mexico) and the District of Columbia that included Hispanic identifiers throughout this time period to carry out an analysis for Hispanics paralleling the one just mentioned. Preliminary results indicate substantial variation in race/ethnic changes in cause-specific infant mortality and identify important inflection points in the secular trends.

RACE/ETHNIC DISPARITIES IN CAUSE -SPECIFIC INFANT MORTALITY CHANGE OVER TWO DECADES

INTRODUCTION

The higher infant mortality rates among socially disadvantaged minorities, as compared to the white majority has long been a major health concern, and the need to reduce or eliminate this disparity has been a consistent theme of health policy in the U.S. as seen, e.g., in the Healthy People 2010 report (U.S. Department of Health and Human Services 2000). Giving impetus to this concern is the conclusion that "the past two decades have witnessed the most profound alterations ever recorded in the structure of infant mortality patterns in the United States" (Gortmaker and Wise 1997: 152). Major innovations in perinatal care and technology have allowed the live birth of many low birth weight (LBW) and short gestation infants who previously would have been stillborn (MacDorman et al. 2007). However, the growing proportion of high-risk births has been offset by other advances in perinatal care as shown by the substantial declines in infant mortality that occurred across race/ethnic groups. While these declines have been clearly documented, we are unaware of any analytic studies of these "profound alterations" by specific cause of infant death and race/ethnicity that span the two decades just mentioned.

As examples of the need for overtime analysis, consider the following examples. Despite the decreases in infant mortality that have occurred across race/ethnic groups, the relative disparity between blacks and whites has not only persisted, but has actually increased. The black/white ratios for the infant mortality rate (IMR) and the neonatal mortality rate (NMR) stood at 2.0 and 1.9, respectively, in 1980. By the early 1990s, both ratios had risen to approximately 2.3, where they plateaued until 1997 (Guyer et al. 1998). Since then, widening of the gap has resumed, and by the year 2000, the black/white rate ratio stood at 2.4-2.5 (Hoyert et al. 2001; Mathews et al. 2002; Minino et al. 2002). There also continues to be considerable interest in Hispanic (especially Mexican origin)[1] infant mortality, and in general, "(a)n examination of cause-specific differences in infant mortality rates between race and Hispanic origin groups can help the researcher to understand overall differences between these groups" (Mathews et al. 2002: 7). However, there have been no cause-of-death-specific studies of infant mortality for this minority covering two decades, likely because a Hispanic identification item was not included on the birth certificates of a large number of states until 1989.

Research has shown that the social, economic, and health care disadvantages under which blacks and most Hispanics exist underlie the higher mortality rates among these minorities. In addition, a prominent general conceptual model of health inequalities among race/ethnic groups is based on the premise that, as advances in health care occur, the ability of individuals to reduce the risk of disease and death "is shaped by resources of knowledge, money, power, prestige, and beneficial social connections" (Link and Phelan 2002: 730). Susser used the term, "technological backlash," to refer to this combination of "accelerated discovery and technical efficacy in maintaining health…(and) concurrent maldistribution of technical and overall advantage in society at large" (2000: 883). Gortmaker and Wise (1997) provide a similar argument that focuses directly on infant mortality. These authors warn that greater racial disparity in infant mortality between non-Hispanic whites (NHWs) and minority groups may accompany advances in health services technology (which have been numerous and highly beneficial over the past couple of decades) because the "first injustice," i.e., social and economic inequality, is apt to translate into differential access to health care. This does not imply that high-risk minority infants will be denied therapeutic intervention or be accorded lower quality of care. Rather, we hypothesize that infant mortality will be greater among minority groups who lack the socioeconomic resources to acquire access to, are even learn about, innovations in health care.

[1] The term "Mexican Origin" is employed throughout to denote both Mexican Americans and immigrants from Mexico.

OBJECTIVES

The general objective of the present research is to conduct analyses, spanning the period 1983 to 2001, for three of the five leading causes of infant death among non-Hispanic whites (NHWs), non-Hispanic blacks (NHBs), and Hispanics. The causes examined are congenital anomalies, respiratory distress syndrome (RDS) and Sudden Infant Death Syndrome (SIDS), the three leading causes for which infant mortality fell most dramatically over this time interval. [2] Two separate analyses will be required. Blacks and whites are identified throughout the entire period, and these two groups will be the focus of the first set of models. Second, Hispanics were identified on birth certificates of only nine states and the District of Columbia throughout the 1983-2001 interval, but these nine states consistently include the four states that border Mexico (Arizona, California, New Mexico, and Texas) where the Mexican Origin population is heavily concentrated. Thus, while the second analysis will use data on NHWs, NHBs, and Hispanics, the latter group is very largely of Mexican origin—and it is in this population that we are primarily interested. [3] The method of modeling is similar in the two analyses. The limitation to a small number of states (and DC) in the second analysis is not ideal, but we believe it is better to learn what we can about the risk factors associated with changes in infant mortality of Hispanics (as compared to the other two race/ethnic groups) than to completely ignore Hispanics over this crucial period of time.

The specific aims are: (1) to compare the magnitude and trajectory of race/ethnic changes in rates of infant death due to three leading causes (as well as mortality from all other causes), (2) to model the extent to which demographic, social, and biomedical risk factors are associated with relative disparities across the race/ethnic populations at different periods of time, and (3) to include time period as a covariate that can then be used in an interaction term in order to identify important points of inflection in infant

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[2] The other two leading causes are: "Short Gestation and Unspecified Low Birth Weight" and "Maternal Complications." The IMRs for both evidenced very little change in recent times, though the former has shown a slight upward inflection.

[3] Even though we are primarily interested in the Mexican origin population, we continue to use the term "Hispanic" inasmuch as the data include other Hispanic subpopulations.

mortality change for each group and, insofar as possible, account for race/ethnic differentials in the inflections. Accomplishing the third aim will serve an important descriptive purpose. Despite the great benefits of the advanced statistical modeling techniques that are available, "Careful description of current patterns and over-time trends in demographic and health outcomes will continue to serve as the foundation of public health and demographic research" (Hummer 2005: 408; emphasis in the original).

Our findings should also have considerable analytic importance because there is evidence that changes across race/ethnic groups were not uniform over time. As Wise notes, there can be no doubt that "the epidemiology and social meaning of disparities in infant mortality are intensely dynamic" (2003: 343). To briefly illustrate based on studies of 1990's data, Hamvas et al. (1996) using data from three St. Louis hospitals, demonstrated that, after the Food and Drug Administration (FDA) approved the use of pulmonary surfactant therapy in August, 1990, what had been a black survival advantage at low birth weight from RDS, compared to whites, changed to a black disadvantage in the post-surfactant period. Further, the black SIDS disadvantage widened between 1989-91 and 1995-98. In contrast, the Mexican American infant survival disadvantage with respect to SIDS eroded during this period, but the SIDS survival disadvantage changed to a survival advantage among infants born to U.S. women of Mexican descent—i.e., Mexican American women (Frisbie et al. 2004; Frisbie et al. 2005). Moreover, the analysis of over time changes in the risk of infant death from specific causes allows an opportunity to test (indirectly) the Gortmaker and Wise proposition that relative majority-minority disparities are likely to widen following advances in perinatal care.

DATA AND METHOD

The data used are the NCHS Linked Cohort Birth/Infant Death Files over the time period from 1983 through 2001. No linked cohort files were produced for 1992-94, and linked files for 2002 and beyond were not available at the time of this analysis. A data set with a very large number of cases is required for the construction of multivariate models from which reasonably stable estimates of the effects of risk factors on infant mortality risk from which specific causes can be derived. This means recourse must be made to vital statistics. The linked cohort files include all recorded births and deaths of infants in the U.S. The data set consists of millions of cases each year, and the match rate is exceptional—from 1983 onward, more than 97% of the records were successfully linked (U.S. DHHS 1995). As recommended by NCHS, infants are classified according to mother's race/ethnicity.

Because a Hispanic identifier was available for only a very limited number of states prior to 1989, while blacks and whites are identified throughout the entire 1983-2001 period, two separate analyses must be conducted. The first compares infant mortality for only blacks and white for all states. The second compares non-Hispanic whites (NHWs), non-Hispanic blacks (NHBs), and Hispanics for the nine states (and DC), that identified Hispanic births and deaths, and which were linked over the nearly two-decade time frame.

We document trends in race/ethnic disparities in cause-specific infant mortality using rate ratios to describe relative change and percentage differences in rates to describe absolute changes. Multivariate analyses of relative disparities will be conducted through multinomial logistic regression with results presented as odds ratios. The outcome variable consists of five categories: deaths due to (1) congenital anomalies, (2) RDS, (3) SIDS, (4) an all other causes residual, and (5) survival (the reference group). Since our data set consists of virtually all vital events, the conventional reason for use of tests of statistical significance, i.e., assessing the probability of error in generalizing from a sample to a population, does not pertain. Nonetheless, tests of significance retain utility "in order to rule out the simple 'chance processes' alternative" (Blalock 1979: 242). We first consider infants born at all weights of 500 grams or more. [4] Infants weighing less than 500 grams at birth are excluded because of concern that many of these extremely low weight births are either misclassified stillbirths or reflect errors in the recording of birth weight.

[4] Thus, the rates we present will tend to be a bit lower than those appearing in governmental descriptive data in which all births, including those in the < 500 gram weight category, are included.

We also provide companion models for low birth weight LBW (< 2500 grams) infants, inasmuch as it is these high-risk (i.e., low weight) births that are the cause of greatest concern due to the disproportionately large number of infant deaths that occur among LBW infants. It is also possible that mortality trends are different for low weight births. For example, Gage et al. "attribute lower birth-weight-specific infant mortality in the compromised subpopulation to higher rates of fetal loss," where the "compromised population" refers to African Americans, as compared to European Americans (2004: 337; see also Gage, 2002). Assuming the argument of Gage and associates is correct (Gage, 2002; Gage et al. 2004), the fetuses of women who are members of disadvantaged minorities, and who are born alive, represent the most robust infants within disadvantaged populations. If so, and since the NHB and Hispanic populations are clearly disadvantaged groups, then when only infants born at low weight are analyzed, we are dealing with a group with quite different and probably more positive health characteristics as compared to births at all weights. Thus, analyses of these two groups may yield somewhat different results. In regressions involving LBW infants, controls for birth weight and gestational age not included.

Although there is a definite need to examine two decades of change in cause-specific infant mortality, doing so has obvious limitations. Besides the Hispanic identifier, the pre-1989 revision of birth certificates provided either no, or very limited, information on several important variables. While 47 states, plus the District of Columbia, provided data on maternal education prior to 1989, three states (California, Texas, and Washington) did not report this information. California and Texas, of course, are the two states with the largest Hispanic populations. Hence, the models estimated in the analysis that includes Hispanics will lack a control for this risk factor. We intend to include education in the models that compare only blacks and whites based on the 47 states that include the education item. At least two approaches to the problem of missing education data in modeling black-white infant mortality differences were implemented: (1) models for the reporting states only and (2) models using all states with a missing category for education. The results from the two approaches were highly similar, so we utilized the second of the two (including the models for Hispanics), which has proven successful in previous research (Frisbie et al. 1998; Singh and Yu 1996).

Gestational age was obtained by subtracting date of last normal menses from date of the infant's birth, except for New Mexico, which provides information directly on months and days of gestation. [5] Prenatal care (PNC), from 1983 onward, is coded as four categories: none, and the time prenatal care was initiated (first, second, or third trimester). [6] Items on maternal smoking, maternal weight gain, and maternal morbidities did not appear on birth certificates until 1989 and so are not included. In addition to race/ethnicity and time period, the maternal predictor variables available for the entire 1983-2001 interval are age, marital status, education (in the black-white analysis), plurality, parity, prenatal care, and whether the mother had a history of previous pregnancy loss. Infant covariates include sex, birth weight, and length of gestation.

The classification of causes of death was according to ICD-9 for 1983-1998, but from 1999 onward, the ICD-10 revision was applied. However, we anticipate that this will have very little impact on the conclusions reached. A special study (Anderson et al. 2001) based on 1996 cause of death data coded according to both the ICD-9 and ICD-10 cause-of-death revisions produced the following comparability ratios: Congenital Anomalies: 0.91; SIDS: 1.04; RDS: 1.03. From examination of the Anderson et al. study and more recent documentation (U.S. DHHS 2003), it can be seen that the codes for SIDS and RDS translate on close to a one-to-one basis. A lesser, but still high, degree of comparability has been achieved for congenital anomalies. As the first research effort of this sort, precision would seem to be more than adequate.

[5] It would be preferable to have clinical estimates of gestational age (Mustafa and David 2001), but the subtraction method is the only means of estimating gestation age that is available to us for the entire period (1983-2001).
[6] The information necessary to construct other more recent and more precise PNC measures such as Kotelchuck's APNCU (Kotelchuck 1994a, 1994b) or Alexander's GINDEX (Alexander and Kotelchuck 2001) is not available in the 1983-88 linked files.

The data are divided into several time intervals: 1983-85, 1986-88, 1989-91, 1995-98, and 1999-2001 for two reasons. [7] The first is to assure that a sufficient number of cases are available to produce reasonably stable estimates of effects. The second reason is more substantive in nature. The 1999-2001 period encompasses all of the ICD-10 coding. Though we do not believe it necessary, this allows readers who have a lesser degree of confidence in regard to coding comparability to focus their attention on the remainder of the time periods.

The 1989-91 and 1995-98 groupings permit assessing the effects of well-documented perinatal care and technology advances in a "before and after" context. Specifically, following approval of pulmonary surfactant replacement for general use in August, 1990, RDS infant mortality dropped substantially for all three race/ethnic groups by the mid-to-late 1990s, but the decline was considerably smaller for blacks (Frisbie et al. 2004; Hamvas et al. 1996; Malloy and Freeman 2000; Ranganathan et al. 2000). Following the recommendation by the American Academy of Pediatrics (AAP) in 1992 that infants not be put to sleep in the prone position and the educational campaign promoting "back to sleep" that was mounted nationwide in 1994 (Gibson et al. 2000; Pollack and Frohna 2001, 2002; Willinger et al. 1998), the SIDS rate dropped by more than one-third among singleton births in the U.S. between 1989 and 1997 (Pollack and Frohna 2001). Prior to 1992, the SIDS mortality rate changed little, even though infant death rates from many other causes were on the decline (Willinger et al. 1998). Once again, however, the improvement in survivability was less for blacks than for the other two race/ethnic populations (Frisbie et al. 2005). Examination of data from the 15 state Pregnancy Risk Monitoring system indicates that the odds of a prone sleeping position are significantly higher, and odds of use of the AAP-recommended supine (back) position are significantly lower, for blacks. While Mexican Americans were significantly less likely to put infants to sleep on their stomach, they were also less likely than NHWs (but much more

[7] Recall that no linked files exist for 1992-1994.

likely than NHBs) to adopt the back to sleep recommendation, which means that a fairly substantial percentage of Mexican Origin parents chose the lateral (side) sleeping position.

Perinatal health innovations designed to reduce infant death from congenital anomalies occurred in a somewhat more incremental fashion. During the 1990s, advances such as growth in the ability to detect congenital malformations in the course of prenatal care, consumption of folic acid prior to conception and in the early stages of pregnancy to reduce the risk of neural tube defects (Lee et al. 2001), and innovations aimed at preserving the life of newborns as seen in neonatal intensive care units were introduced, or came into more widespread use. Nevertheless, certain recommendations and/or actual interventions can be attached to specific dates that correspond fairly well to our time period cutpoints. For example, in 1994, and again in 1999, Congress provided the Centers for Disease Control and Prevention (CDC) with appropriations that went to several states "to establish or improve their birth defect surveillance systems" (Erickson 2000: 2). In addition, in 1998, the FDA mandated "the fortification of enriched grain products with folic acid" (Williams et al. 2005). Unfortunately, access to these interventions appears to be much more limited for "low-income women and women of color" (Nsiah-Jefferson 1993:308), and NHBs appear to have benefited less from these advances than did NHWs and Hispanics (Williams et al. 2005). A substantive rationale for the 1983-85 and 1986-88 subdivisions is more difficult to develop. But clearly, these years need to be considered separately from the 1990s onward when the advances enumerated above came into existence or grew in the breadth of application. In addition, it will be useful to examine whether the effects of covariates on the outcome variables changed between 1983-85 and 1986-88.

DIFFERENTIALS IN INFANT MORTALITY AMONG BLACK AND WHITES: 1983-2001

Descriptive Findings for Infant Mortality Among Blacks and Whites: 1983-2001

Changes in Black and White Mortality for Infants Born at Weights ≥ 500 Grams: 1983-2001

Table 1a shows a decline in infant mortality for both black and whites over all time periods except for a slight increase in the RDS infant mortality rate among blacks from 1986-88 to 1989-91.
In comparing absolute percentage change in rates of infant mortality, the largest gains in survivorship were typically recorded by whites. Note that the largest absolute percentage declines (Table 1b) for SIDS and RDS occurred between 1989-91 and 1995-98—that is, the greatest reduction in risk of infant death from these causes took place over the interval when pulmonary surfactant therapy (introduced specifically to reduce mortality from RDS) and the back-to-sleep program (designed specifically to reduce SIDS deaths) were implemented. Since no linked files were generated by NCHS for 1992-94, the time interval between 1989-91 and 1995-98 is longer than any other interval analyzed here. Thus, while the direction and great magnitude of the change between 1989-91 and 1995-98 suggest we are picking up the effects of the advances in perinatal care documented in clinical studies, it is likely that a substantial portion of the magnitude of the change is partly due to the longer interval. However, inasmuch as all race/ethnic groups are encompassed by the longer interval, the changes in race/ethnic differentials from 1989-91to1995-98 are in no way distorted.

The rate ratios (Table 1c) show a relative increase in disparities for the overall IMR and for each category of causes from the earliest time (1983-85) to the most recent time period (1999-2001). Also, quite large increases in relative disparities for SIDS and RDS are found between 1989-91 and 1995-98—the "pre"- and "post-intervention periods." [8] The disparity continued into the years from 1999 through 2001. Thus, the descriptive analysis supports the Gortmaker and Wise (1997) argument that a widening of the infant mortality gap between whites and blacks is likely to follow in the wake of advances in perinatal care.

--Table 1 about here--

[8] Actually, the largest rise in the rate ratios for RDS occurred between 1986-88 and 1989-91, but our diagnostics indicate that this is because surfactant replacement was in widespread use for all of 1991.

Changes in Black and White Mortality for Infants Born at Low Birth Weight: 1983-2001

Table 2 displays changes in infant mortality per 1000 live births for infants born at low weights (≤ 2500 grams) in a format analogous to that used in Table 1. Just as in Table 1, reductions in infant mortality emerge for LBW infants for the total IMR and for each category of causes (except for the residual between the two most recent time periods—though, of course, the mortality rates are higher for infants born at low weights. In Table 2b, far and away the largest absolute percentage declines for SIDS and RDS are observed between 1989-91 and 1995-98; i.e., over the period when specific life-preserving interventions were introduced. The greatest percentage reductions also occurred for white infants over this interval, while those for blacks were delayed until the next time interval. The largest increase in relative race disparities, due to mortality from these two causes, as indicated by rate ratios (Table 2c), also were also recorded between1989-91 and 1995-98, and the reversal from a black survival advantage to a survival disadvantage with respect to RDS was also observed after 1988—a reversal that is most apparent between 1989-91 and 1995-98. A black congenital anomalies survival advantage exists throughout, but this advantage was eroded over time.

--Table 2 about here--

Multivariate Analysis of Black-White Change In Infant Mortality: 1983-2001

Regression Analysis for Infants Born at All Weights ≥ 500 Grams

The bivariate model shows that black, compared to white, infants are more than twice as apt to die from SIDS, RDS, and all other causes, and that their risk of death from congenital anomalies is about 15% higher than is the case for whites (Model 1 of Table 3a). The odds ratios associated with time period are consistently less than unity, as would have to be the case in light of the declines shown in the descriptive data, but the control for time period has almost no effect on the black risk of infant mortality, relative to white infants (Model 2). Model 3 adds the race x time period interaction. The black risk declines in this model, but with few exceptions, the interaction term is greater than unity which indicates a deleterious offset to the declines in black mortality seen in the main effect for race. To illustrate, the odds ratio (OR) associated with RDS for the interaction term in Model 3 is 1.499 in 1995-98 and 1.565 in 1999-2001. This bolsters the clinical finding by Hamvas et al (1996) that white infants benefited much more from pulmonary surfactant therapy than did black infants. The full model (Model 4), which incorporates controls for demographic, social, and biomedical (e.g., previous loss, prenatal care, as well as birth weight and gestational age), results in a dramatic decline in the odds ratio for black infant mortality. Indeed, the higher risk among black infants of dying from congenital anomalies and RDS is reversed to become a significant survival advantage for these causes (ORs = 0.706 and 0.760 for congenital anomalies and RDS, respectively). This narrowing of the racial gap is not surprising, especially since low birth weight rates are much higher among blacks, and LBW is the strongest predictor of infant mortality, but the magnitude of the change warrants special attention.

--Table 3 about here--

Regression Analysis for Low Birth Weight Infants

Among LBW (< 2500 grams) infants, it can be seen (Table 3b) that, for black infants, the risk of death, relative to their white infants, is much lower than that observed for births at all weights (≥ 500 grams), consistent with previous findings that LBW black infants have a survival advantage (Gage 2002; Gage et al. 2004; Wilcox and Russell 1990). Indeed, black infants have a survival advantage with respect to RDS in Models 2-4. The odds ratios associated with time period once more document the decline in infant mortality over time. And, just as in Table 3a, the race x time period interaction almost always indicates an offset to the survival gains seen in the main effects, especially in regard to RDS (Model 3). As we are looking at LBW infants, birth weight and gestational age are not among the controls, but the full model (Model 4) still shows a very substantial reduction in the risk of black infant death.

DIFFERENTIALS IN INFANT MORTALITY AMONG NON-HISPANIC WHITES, NON-HISPANIC BLACKS, AND HISPANICS: 1983-2001

Descriptive Findings for Changes in Infant Mortality Among Non-Hispanic Whites, Non-Hispanic Blacks and Hispanics: 1983-2001

Changes in Mortality for Infants for Three Race/Ethnic Groups Born at Weights ≥ 500 Grams: 1983-2001

Table 4 displays descriptive changes over time for the three race/ethnic groups for the nine states (and DC) following the same format used in Table 1. All three race/ethnic groups consistently exhibit declining infant mortality over almost all time periods. [9] Non-Hispanic black (NHB) infants have the highest IMRs, while non-Hispanic whites (NHWs) and Hispanic typically have lower and very similar rates of death (Table 4a). In other words, the epidemiologic paradox, a term coined by Markides and Coreil (1986) to denote the fact that Hispanics (particularly the Mexican origin population), have mortality rates similar to, and sometimes lower than, those of NHWs, and much lower rates than those of NHBs, even though the risk profile for Hispanics is much more similar to that of NHBs, can be observed over the past two decades (See Frisbie 2005 and Markides and Eschbach 2005) for recent summary discussions).

Although we make no claim that the results of the analysis that includes Hispanic infants based on the few states for which data are available are generalizable to the U.S. as a whole, it is important to note that the greatest absolute percentage declines took place during what might we have termed the "period of greatest innovations" (Table 4b). The relative disparities (as seen in the rate ratios) between NHBs and NHWs persist among infants born at all weights (Table 4c)—all consonant with the patterns found in Table 1. Non-Hispanic black infants have IMRs that are roughly twice those for NHW infants, with the exception of congenital anomalies. Hispanic to NHW infant rate ratios are generally close to unity, except for the comparatively large and consistent survival advantage enjoyed by Hispanic infants in regard to SIDS.

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[9] The IMRs for the residual (all other causes) is an exception to the general pattern in that rates increased slightly for this category of causes between 1995-98 and 1999-2001. This may be evidence of lack of generalizability. Alternatively, this single exception to the overall pattern may presage the upturn in infant mortality that was documented between 2001 and 2002.

--Table 4 about here—

Changes in Mortality for Infants for Three Race/Ethnic Groups Born at Weights < 2500 Grams: 1983-2001

Mortality rates for LBW infants are, of course, several times higher than for infants born at all weights, but the almost completely monotonic declines for each race/ethnic group continued from one time period to another. (Table 5a). As we have come to expect, the greatest drop in infant mortality occurred between 1989-91 and 1995-98 (Table 5b)—in this case, this pattern is perfectly consistent for the overall IMR and for the rates of every cause of death category. The relative disparity in LBW infant mortality between NHBs and NHWs tends to increase as we move from the earliest to the most recent time period, but the disparities are small, with the exception of SIDS for which the NHB/NHW rate ratio grew from 1.28 in 1983-85 to 1.71 in 1999-2001. However, throughout the period, NHB infants have a fairly large survival advantage in the case of congenital anomalies (Table 5c). The rate ratio for the total IMR comparing LBW NHW and Hispanic infants is very small, but this overall similarity is largely the result of risk of lower Hispanic mortality attributable to SIDS deaths combined with higher Hispanic death rates due to RDS.

--Table 5 about here—

Multivariate Analysis of Change In Infant Mortality for Non-Hispanic Whites, Non-Hispanic Blacks, and Hispanics: 1983-2001

Regression Analysis for Infants Born at All Weights ≥ 500 Grams

In the bivariate effects of race/ethnicity for infants born at weights ≥500 grams, (Model 1in Table 6a), the risk of death for NHB infants is approximately double that of NHW infants, with the (by now, expected) exception of congenital anomalies for which the odds ratio is 1.092. Hispanic infants are also at a very slightly higher risk of death from this cause (OR = 1.032), but the difference is significant. With respect to every other cause of death category, Hispanic infants either have a significant survival advantage (SIDS) or are statistically identical in risk to NHW infants.

Model 2 of Table 6a controls for time period, which again shows the overall drop in infant mortality over time. Model 3, which adds a race/ethnic x time period interaction, shows a pattern that is more complex than when only blacks and whites were compared. Most interactions indicate a deleterious offset for NHB infants, but there are exceptions. Several of the interaction terms fail to reach statistical significance, almost certainly because this portion of the analysis uses data for only nine states (and DC), so that the number of cases is greatly reduced. Interestingly, the interaction involving Hispanic infants reinforces what is already a survival advantage, relative to NHW infants (OR = 0.744, $p \leq .01$ in the SIDS main effect for Hispanics).

Model 4 (Table 6a) contains all control variables. For each of the three specific causes, and for both race/ethnic groups, the risk of death becomes either less than, or statistically identical to, that of NHW infants. A notable difference seen in the full model is that the higher risk of death among NHB infants from all three specific causes is reversed to a lower risk, relative to their NHW counterparts. Also, there is a striking reversal in risk for SIDS. In Model 3, NHB infants were almost 90% more likely to die from SIDS ($p \leq .01$), as compared to NHW infants. In Model 4, NHB infants were four percent less apt to die of SIDS than their NHW counterparts. Even though the estimate in Model 4 is not significant, the magnitude of the change is quite substantial. A similar pattern is observed for Hispanic infants, although there is some difference in regard to significance levels. To illustrate, statistical equivalence in risk from congenital anomalies in Model 3 changes dramatically to a significant NHB survival advantage (OR = 0.650, $p \leq .01$). A similar, but more modest, reversal occurs for Hispanics in Model 4 of Table 6a. As anticipated, demographic, social and biomedical risk factors appear to underlie most of the infant mortality disparities across race/ethnic groups. On the other hand, the interaction terms indicates a fairly large offset to the RDS survival advantage of NHB infants observed in the main effects. The magnitude of the offset is quite large for the post-surfactant era—significant interaction ORs of 1.611 and 1.543, in 1995-98 and 1999-2001, respectively. The Hispanic x time period interaction offsets the main effect survival advantage of Hispanic infants with respect to congenital anomalies, but the magnitude of the interaction term is relatively small. It is interesting to note that the same interaction reinforces the Hispanic survival advantage in the case of SIDS, but the interaction term rarely attains statistical significance.

Regression Analysis for Infants Born at Weights < 2500 Grams

The logistic regression for LBW infants of all three race/ethnic differences (Table 6b) produces interesting and somewhat different findings compared to the analogous regression for infants born at all weights (≥ 500 grams). In the bivariate model, both minorities are at lower risk of infant death from congenital anomalies than are NHW infants, and the estimate for NHB infants is statistically significant (OR = 0.556, $p \leq .01$). The general decline in infant mortality is again reflected in the odds ratios for time period, which are below unity and almost always highly significant. Model 2 of Table 6b also shows reversals in that the survival advantage of LBW Hispanic infants for congenital anomalies, RDS, and the residual category in Model 1 evidences a survival disadvantage in Model 2.

In Model 3 of Table 6b (which adds the interaction term), two changes in the direction of the odds ratios associated with race/ethnicity warrant mention. First, in Model 3, the risk of NHB infant death from RDS is 12% lower ($p \leq .05$) than the NHW risk, a reversal from the 4% greater risk for NHBs estimated under Model 2. Second, among Hispanic infants, there is another reversal of the same sort for congenital anomalies. In Model 2, Hispanic infants were three percent (marginally significant) more apt to die of congenital anomalies, but once the interaction term is introduced, they were 11% less apt to die from this cause ($p \leq .05$), compared to NHW infants. No such reversals are seen in the regression for infants born at all weights. In Model 3, the estimates for the interaction terms are fairly similar to those in Model 2, but the interactions more consistently offset, to some degree, the main effect survival gains for Hispanic infants in regard to congenital anomalies. Moreover, from 1989-91 onward, the interaction terms work to diminish the lower risk of infant mortality from RDS among NHB infants observed in the main effects.

In the full model (Model 4), as expected, the odds ratios are reduced for both minority groups, with the exception of what is essentially a non-change in estimate for congenital anomalies. The most notable change is that, for NHB infants, the odds of death from SIDS in Model 3 ($OR = 1.282$, $p < .01$) were reversed in Model 4 ($OR = 0.800$, $p \leq .01$).

CONCLUSIONS

Black-White Differentials and Changes in Infant Mortality

The infant mortality rates for both blacks and whites dropped substantially over the 1983-2001 time period. However, between each specific time period, the largest absolute percentage decline was most apt to occur among white infants. This pattern was also reflected in relative changes as shown in the black to white rate ratios. Thus, with respect specific aim (1), it is clear from Table 1 that the infant mortality disparity between whites and blacks has existed and increased at least since 1983, not only for the total IMR (as was documented earlier), but also for three leading causes of infant death which, ironically, were those for which the greatest improvements occurred due to advances in perinatal care. The one qualification that warrants mention is that, at low birth weights, black infants maintained a survival advantage with respect to congenital anomalies over the entire time period covered by this analysis, but this advantage was slightly eroded over time.

The conclusion with regard to second objective can be answered in a quite straightforward manner by considering the changes in the risk of death for black infants when controls were added for demographic, social, and biomedical risk factors. In every instance, adjustment for these risk factors sharply reduced the race disparities and for some specific causes resulted in a reversal such that what was a higher risk of death for black infants became a survival advantage. In the regression involving infants born at all weights, there can be little doubt that a very substantial proportion of the changes observed in the full model is due to the fact that birth weight and gestational age are included in the controls. The same conclusion, of course, does not apply in the analysis that includes LBW infants only.

Specific aim (3) involved inclusion of time period as a covariate in an effort to identify the most prominent inflection points in the secular trend, to observe the effect of a race x time period interaction term, and to gain some insight into the proposition that greater race/ethnic disparities are apt to follow in the wake of advances in perinatal health care (in the context of race/ethnic social inequality). For infants born at all weights $\geq$ 500 grams as well as for low weight births, the interaction term typically worked to offset gains in black infant survivorship. Importantly, the largest inflections deleterious to black infant survival is observed over the period of time after beneficial innovations in perinatal technology and care occurred, thereby supporting the proposition by Gortmaker and Wise (1997). This widening disparity occurred, not because black infants did not benefit from the improvements, but because whites benefited more.

Differentials and Changes in Infant Mortality for Three Race/Ethnic Groups

In order to address the three specific aims for Hispanics from 1983 through 2001, we were forced to rely on data from only those states that reported Hispanic ethnicity over this time interval. Thus, the analysis comparing NHW, NHB, and Hispanic infant mortality could be conducted for only nine states and the District of Columbia. The comparisons drawn pertain largely to the Mexican origin populations because four of the nine states with the necessary Hispanic identifier were Arizona, California, New Mexico, and Texas—the region in which the Mexican origin population (the largest Hispanic subpopulation) is heavily concentrated.

The findings that bear on the specific aims in the three-minority analysis are largely the same when one focuses on NHW and NHB infants (as compared simply to black-white comparisons). First, descriptive data showed that there were consistent declines for Hispanics overall and for each specific cause of death, just as was the case for NHW and NHB infants. Consistent with the notion of "epidemiologic paradox," Hispanic infant mortality rates were quite similar to the rates of NHW infants in regard to the total IMR. Further, among infants born at all weights, the percentage reduction in infant death rates from 1983 through 2001 was larger for Hispanic infants for the total IMR and especially for the SIDS mortality rate. There was also a slightly greater percentage decline among Hispanic infants in regard to RDS and the all other cause residual. Turning to relative differences among LBW infants, Hispanic/NHW rate ratios were usually not greatly different than unity for either births at all weights or at low weights in the most recent time period (1999-2001). An important exception is that the Hispanic/NHW rate ratio for SIDS was only 0.59 for births at all weights and 0.67 for LBW infants.

Conclusions concerning Aim (2) are analogous to those reached based on black-white comparisons and thus can be very briefly stated. The risk of death was reduced by adjusting for available risk factors among infants of both minorities, relative to NHW infants, in both of the two birth weight groups. Reductions produced by controls were generally of lesser magnitude for Hispanic infants, but of course, the odds ratios for Hispanic and NHW infants were, for the most part, quite similar to begin with.

Among NHB infants, the regression models that included Hispanic infants with time period as a covariate, lead to much the same conclusions, for both births at all weights and low weight births, as the regressions that employed data for the entire U.S. in making only black-white comparisons (Aim 3). A few differences emerged, and it impossible to know to what extent the findings for the few states involved in the analysis that included Hispanics are generalizable to the country as a whole. For both Hispanic infants and NHB infants the interaction effects were most often in a direction which either offset minority survival advantages or incremented minority survival disadvantages. The interaction terms were more prominent among NHB infants than among Hispanic infants.

To summarize, infant mortality rates dropped for each of the three race ethnic groups over the entire 1983-2001 time period, with the greatest declines occurring among NHW infants born at low weight, but percentage declines were often larger for Hispanic infants born at all weights $\geq$ 500 grams.

Throughout, differentials in rates tended to be similar for NHW and Hispanic infants. In these data, wider majority-minority disparities did tend to follow advances in perinatal care, but the differentials were substantially reduced by controls for demographic, social, and biomedical risk factors.

Between 1983-85 and 1999-2001, greater relative race/ethnic disparities emerged for certain specific causes of infant death. Even more discouraging, high-risk (LBW) minority infants either experienced widening disparities compared to the majority (NHW) infants or an erosion of, and sometimes an outright reversal of, a previous minority survival advantage. It is ironic that, while advances in perinatal care and technology have resulted in a larger proportion of LBW and preterm babies being born alive, it is the latter group of infants that are at the greatest of death in the first year of life. Thus, considerable research is needed to learn more about the prevention of short gestation and low weight births, how to insure that more high-risk births survive the first year of life, and how to more adequately deal with the health problems that tend to plague surviving high-risk infants during childhood and even in their adult years. In this context, it is crucial that more attention be given to the task of insuring that infants born to mother who are members of disadvantaged minority groups receive the same benefits as those enjoyed by infants born to NHW mothers.

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TABLE 1a. Infant Mortality Rates among All Weight Births by Race: United States, 1983-2001

	1983-1985		1986-1988		1989-1991		1995-1998	
	WHITE	BLACK	WHITE	BLACK	WHITE	BLACK	WHITE	BLACK
IMR per 1000	7.58	14.34	6.76	13.24	6.11	12.85	4.76	9.57
Con.	2.09	2.27	1.86	2.07	1.73	1.98	1.42	1.68
SIDS	1.18	2.29	1.16	2.19	1.11	2.19	0.62	1.43
RDS	0.75	1.30	0.61	1.20	0.50	1.21	0.22	0.58
Other	3.56	8.47	3.13	7.78	2.77	7.47	2.49	5.87

SOURCE: NCHS Linked Birth/Infant Death Files. 1983-1995, 1986-1988, 1989-1991, 1995-1998, and 1999-2001.

TABLE 1b. Percentage Change in Infant Mortality Rates among All Weight Births by Race: United States, 1983-2001

	83-85 and 86-88		86-88 and 89-91		89-91 and 95-98		95-98 and 99-01		83-85 and 99-01	
	WHITE	BLACK	WHITE	BLACK	WHITE	BLACK	WHITE	BLACK	WHITE	BLACK
IMR per 1000	-10.92	-7.63	-9.53	-3.00	-22.14	-25.50	-6.63	-2.82	-41.41	-35.14
Con.	-11.29	-8.94	-6.67	-4.49	-17.95	-15.17	-14.04	-9.99	-41.61	-33.60
SIDS	-2.24	-4.39	-4.33	-0.05	-43.78	-34.52	-20.26	-18.03	-58.08	-48.71
RDS	-18.13	-7.76	-17.54	0.65	-55.81	-51.77	-32.61	-29.60	-79.90	-68.47
Other	-12.07	-8.14	-11.58	-4.00	-10.00	-21.34	3.31	5.60	-27.71	-26.75

Source: See Table 1a.

TABLE 1c. Rate Ratios of Backs in Comparison with Whites in Infant Mortality Rates among All Weight Births: United States, 1983-2001

	83-85	86-88	89-91	95-98	99-01
IMR per 1000	1.89	1.96	2.10	2.01	2.09
Con.	1.09	1.12	1.14	1.18	1.24
SIDS	1.94	1.90	1.98	2.31	2.37
RDS	1.75	1.97	2.40	2.62	2.74
Other	2.38	2.48	2.70	2.36	2.41

Source: See Table 1a.

TABLE 2a. Infant Mortality Rates among Low Weight Births by Race/Ethnicity: United States, 1983-2001

	1983-1985		1986-1988		1989-1991		1995-1998	
	WHITE	BLACK	WHITE	BLACK	WHITE	BLACK	WHITE	BLACK
IMR per 1000	73.48	73.48	63.63	66.91	55.97	63.04	40.62	48.62
Con.	17.28	9.20	16.14	9.03	15.08	8.21	11.90	7.86
SIDS	3.50	5.29	3.24	4.86	3.19	4.59	1.73	3.16
RDS	13.31	10.50	10.83	9.53	8.77	9.15	3.43	4.54
Other	39.39	48.48	33.42	43.49	28.93	41.08	23.56	33.06

Source: See Table 1a.

TABLE 2b. Percentage Change in Infant Mortality Rates among Low Weight Births by Race: United States, 1983-2001

	83-85 and 86-88		86-88 and 89-91		89-91 and 95-98		95-98 and 99-01		83-85 and 99-01	
	WHITE	BLACK	WHITE	BLACK	WHITE	BLACK	WHITE	BLACK	WHITE	BLACK
IMR per 1000	-13.41	-8.94	-12.04	-5.79	-27.43	-22.87	-6.68	-0.74	-48.41	-34.32
Con.	-6.59	-1.85	-6.56	-9.13	-21.11	-4.23	-14.05	-12.06	-40.82	-24.89
SIDS	-7.37	-8.15	-1.62	-5.51	-45.83	-31.28	-24.37	-21.75	-62.67	-53.33
RDS	-18.66	-9.25	-19.03	-3.89	-60.84	-50.46	-34.19	-29.41	-83.03	-69.50
Other	-15.16	-10.30	-13.43	-5.54	-18.56	-19.51	2.36	7.89	-38.78	-26.42

Source: See Table 1a.

TABLE 2c. Rate Ratios of Blacks in Comparison with Whites in Infant Mortality Rates among Low Weight Births: United States, 1983-2001

	83-85	86-88	89-91	95-98	99-01
IMR per 1000	1.00	1.05	1.13	1.20	1.27
Con.	0.53	0.56	0.54	0.66	0.68
SIDS	1.51	1.50	1.44	1.83	1.89
RDS	0.79	0.88	1.04	1.32	1.42
Other	1.23	1.30	1.42	1.40	1.48

Source: See Table 1a.

TABLE 3a. Odds Ratios for Effects of Risk Factors on Infant Mortality among All Weight Births: United States

	Model 1				Model 2				Model 3				Model 4			
	Con.	**SIDS**	**RDS**	**Oth.**	**Con.**	**SIDS**	**RDS**	**Oth.**	**Con.**	**SIDS**	**RDS**	**Oth.**	**Con.**	**SIDS**	**RDS**	**Oth.**
Race [White]																
Black	1.154 ***	2.071 ***	2.163 ***	2.478 ***	1.153 ***	2.062 ***	2.153 ***	2.478 ***	1.095 ***	1.952 ***	1.757 ***	2.394 ***	0.706 ***	1.049 **	0.760 ***	1.200 ***
Year [83-85]																
86-88					0.890 ***	0.970 **	0.843 ***	0.891 ***	0.886 ***	0.977 *	0.818 ***	0.879 ***	0.885 ***	0.956 ***	0.790 ***	0.856 ***
89-91					0.834 ***	0.939 ***	0.738 ***	0.810 ***	0.827 ***	0.934 ***	0.674 ***	0.776 ***	0.820 ***	0.857 ***	0.603 ***	0.731 ***
95-98					0.687 ***	0.551 ***	0.334 ***	0.695 ***	0.677 ***	0.524 ***	0.297 ***	0.698 ***	0.645 ***	0.480 ***	0.221 ***	0.604 ***
99-01					0.596 ***	0.443 ***	0.229 ***	0.723 ***	0.582 ***	0.418 ***	0.200 ***	0.721 ***	0.547 ***	0.381 ***	0.141 ***	0.605 ***
Interaction																
Black*86-88									1.026	0.978	1.126 ***	1.044 ***	1.007	0.978	1.097 **	1.022
Black*89-91									1.050 *	1.022	1.375 ***	1.134 ***	0.995	1.027	1.293 ***	1.068 ***
Black*95-98									1.084 ***	1.188 ***	1.499 ***	0.990	1.106 ***	1.300 ***	1.687 ***	1.052 ***
Black*99-01									1.135 ***	1.221 ***	1.565 ***	1.011	1.182 ***	1.398 ***	1.854 ***	1.121 ***
Intercept	-6.406 ***	-7.019 ***	-7.751 ***	-5.848 ***	-6.171 ***	-6.748 ***	-7.247 ***	-5.640 ***	-6.162 ***	-6.733 ***	-7.193 ***	-5.630 ***	-6.782 ***	-7.537 ***	-11.213 ***	-6.911 ***
-2LL		946683 ***				926847 ***				926464 ***				116105 ***		

SOURCE: See Table 1a.
Note: Brackets [ ] indicate reference groups. *** p ≤ 0.01. ** p ≤ 0.05. * p ≤ 0.10.
ᵀ Model Covariates: Model 1 is the bivariate relationship. Model 2 adds time period. Model 3 adds the race x time period interaction.
Model 4 controls ALL risk factors, and includes the race x time period interaction.

TABLE 3b. Odds Ratios for Effects of Risk Factors on Infant Mortality among Low Weight Births: United States

	Model 1				Model 2				Model 3				Model 4			
	Con.	**SIDS**	**RDS**	**Oth.**	**Con.**	**SIDS**	**RDS**	**Oth.**	**Con.**	**SIDS**	**RDS**	**Oth.**	**Con.**	**SIDS**	**RDS**	**Oth.**
Race [White]																
Black	0.601 ***	1.641 ***	1.026 *	1.384 ***	0.593 ***	1.597 ***	0.986	1.369 ***	0.533 ***	1.513 ***	0.788 ***	1.231 ***	0.551 ***	1.006	0.784 ***	1.176 ***
Year [83-85]																
86-88					0.934 ***	0.914 ***	0.828 ***	0.856 ***	0.924 ***	0.916 **	0.805 ***	0.840 ***	0.936 ***	0.903 ***	0.796 ***	0.830 ***
89-91					0.861 ***	0.877 ***	0.702 ***	0.761 ***	0.857 ***	0.894 ***	0.646 ***	0.721 ***	0.900 ***	0.844 ***	0.640 ***	0.726 ***
95-98					0.695 ***	0.515 ***	0.290 ***	0.606 ***	0.665 ***	0.477 ***	0.249 ***	0.578 ***	0.721 ***	0.471 ***	0.242 ***	0.582 ***
99-01					0.598 ***	0.393 ***	0.195 ***	0.631 ***	0.570 ***	0.360 ***	0.163 ***	0.590 ***	0.627 ***	0.361 ***	0.158 ***	0.597 ***
Interaction																
Black*86-88									1.054	0.995	1.120 ***	1.061 ***	1.043	0.995	1.121 ***	1.057 ***
Black*89-91									1.030	0.960	1.334 ***	1.162 ***	0.995	0.952	1.319 ***	1.133 ***
Black*95-98									1.251 ***	1.218 ***	1.690 ***	1.150 ***	1.192 ***	1.271 ***	1.686 ***	1.124 ***
Black*99-01									1.283 ***	1.264 ***	1.817 ***	1.215 ***	1.215 ***	1.356 ***	1.824 ***	1.194 ***
Intercept	-4.234 ***	-5.955 ***	-4.901 ***	-3.489 ***	-4.003 ***	-5.600 ***	-4.303 ***	-3.195 ***	-3.982 ***	-5.580 ***	-4.243 ***	-3.158 ***	-3.741 ***	-6.256 ***	-4.793 ***	-3.558 ***
-2LL		78809 ***				63150 ***				62684 ***				37473 ***		

SOURCE: See Table 1a.
Note: Brackets [ ] indicate reference groups. *** p ≤ 0.01. ** p ≤ 0.05. * p ≤ 0.10.
ᵀ Model Covariates: Model 1 is the bivariate relationship. Model 2 adds time period. Model 3 adds the race x time period interaction.
Model 4 controls ALL risk factors, and includes the race x time period interaction.

TABLE 4a. Infant Mortality Rates among All Weight Births by Race/Ethnicity: United States, 1983-2001

	1983-1985			1986-1988			1989-1991			1995-1998		
	NHW	NHB	HIS.	NHW	NHB	HIS.	NHW	NHB	HIS.	NHW	NHB	HIS.
IMR per 1000	7.31	13.59	7.71	6.56	12.97	6.81	5.94	12.58	6.08	4.68	8.74	4.57
Con.	1.99	2.06	2.00	1.79	1.91	1.94	1.65	1.92	1.81	1.38	1.50	1.51
SIDS	1.18	2.22	0.88	1.15	1.93	0.79	1.13	1.83	0.80	0.60	1.24	0.41
RDS	0.69	1.37	0.82	0.53	1.15	0.70	0.42	1.15	0.51	0.19	0.50	0.22
Other	3.46	7.95	4.01	3.08	7.98	3.38	2.73	7.69	2.96	2.51	5.50	2.43

Source: See Table 1a.

TABLE 4b. Percentage Change in Infant Mortality Rates among All Weight Births by Race/Ethnicity: United States, 1983-2001

	between 83-85 and 86-88			between 86-88 and 89-91			between 89-91 and 95-98			between 95-98 and 99-01		
	NHW	NHB	HIS.	NHW	NHB	HIS.	NHW	NHB	HIS.	NHW	NHB	HIS.
IMR per 1000	-10.33	-4.54	-11.78	-9.43	-2.97	-10.71	-21.20	-30.57	-24.73	-9.03	-6.17	-9.33
Con.	-9.72	-7.09	-3.12	-7.89	0.39	-6.72	-16.44	-21.79	-16.37	-16.96	-13.57	-13.41
SIDS	-2.57	-13.18	-9.96	-1.52	-5.01	1.36	-46.98	-32.41	-49.10	-28.48	-29.58	-37.51
RDS	-22.96	-15.69	-14.85	-20.65	-0.53	-27.71	-55.31	-56.51	-55.71	-31.18	-37.16	-33.74
Other	-10.81	0.44	-15.87	-11.34	-3.63	-12.29	-8.11	-28.46	-17.92	1.64	3.91	0.19

Source: See Table 1a.

TABLE 4c. Rate Ratios of Minorities in Comparison with Non-Hispanic Whites in Infant Mortality Rates among All Weight Births: United States, 1983-2001

	83-85		86-88		89-91		95-98		99-01	
	NHB	HIS.	NHB	HIS	NHB	HIS.	NHB	HIS.	NHB	HIS.
IMR per 1000	1.86	1.05	1.98	1.04	2.12	1.02	1.87	0.98	1.93	0.97
Con.	1.03	1.01	1.07	1.08	1.16	1.09	1.09	1.10	1.13	1.14
SIDS	1.88	0.74	1.67	0.69	1.61	0.71	2.06	0.68	2.03	0.59
RDS	1.98	1.19	2.16	1.32	2.71	1.20	2.64	1.19	2.41	1.14
Other	2.30	1.16	2.59	1.10	2.81	1.08	2.19	0.97	2.24	0.95

Source: See Table 1a.

TABLE 5a. Infant Mortality Rates among Low Weight Births by Race/Ethnicity: United States, 1983-2001

	1983-1985			1986-1988			1989-1991			1995-1998		
	NHW	NHB	HIS.	NHW	NHB	HIS.	NHW	NHB	HIS.	NHW	NHB	HIS.
IMR per 1000	71.65	69.96	69.98	61.81	65.09	62.46	54.49	62.79	55.70	40.24	46.50	41.67
Con.	16.80	8.31	14.99	15.87	7.79	15.93	14.93	7.93	15.18	11.78	7.30	12.99
SIDS	3.74	4.80	2.30	3.29	3.99	2.21	3.29	4.08	2.42	1.77	2.69	0.97
RDS	12.41	10.96	13.67	9.58	8.97	11.40	7.56	8.54	8.36	2.98	4.03	3.48
Other	38.70	45.90	39.01	33.07	44.34	32.92	28.72	42.23	29.73	23.72	32.48	24.23

Source: See Table 1a.

TABLE 5b. Percentage Change in Infant Mortality Rates among Low Weight Births by Race/Ethnicity: United States, 1983-2001

	between 83-85 and 86-88			between 86-88 and 89-91			between 89-91 and 95-98			between 95-98 and 99-01		
	NHW	NHB	HIS.	NHW	NHB	HIS.	NHW	NHB	HIS.	NHW	NHB	HIS.
IMR per 1000	-13.72	-6.96	-10.74	-11.85	-3.54	-10.82	-26.15	-25.95	-25.20	-10.90	-4.45	-8.06
Con.	-5.52	-6.26	6.27	-5.96	1.83	-4.74	-21.08	-7.95	-14.45	-17.65	-13.81	-15.02
SIDS	-11.84	-16.82	-3.78	-0.24	2.25	9.52	-46.27	-34.23	-60.08	-39.79	-32.38	-26.12
RDS	-22.82	-18.12	-16.63	-21.03	-4.81	-26.60	-60.66	-52.83	-58.40	-33.81	-36.48	-32.15
Other	-14.55	-3.40	-15.62	-13.17	-4.75	-9.67	-17.39	-23.09	-18.50	-2.53	3.93	-0.15

Source: See Table 1a.

TABLE 5c. Rate Ratios of Minorities in Comparison with Non-Hispanic Whites in Infant Mortality Rates among Low Weight Births: United States, 1983-2001

	83-85		86-88		89-91		95-98		99-01	
	NHB	HIS.	NHB	HIS	NHB	HIS.	NHB	HIS.	NHB	HIS.
IMR per 1000	0.98	0.98	1.05	1.01	1.15	1.02	1.16	1.04	1.24	1.07
Con.	0.49	0.89	0.49	1.00	0.53	1.02	0.62	1.10	0.65	1.14
SIDS	1.28	0.62	1.21	0.67	1.24	0.74	1.52	0.55	1.71	0.67
RDS	0.88	1.10	0.94	1.19	1.13	1.11	1.35	1.17	1.30	1.20
Other	1.19	1.01	1.34	1.00	1.47	1.04	1.37	1.02	1.46	1.05

Source: See Table 1a.

TABLE 6a. Odds Ratios for Effects of Risk Factors on Infant Mortality among All Weight Births: United States

	Model 1				Model 2				Model 3				Model 4			
	Con.	**SIDS**	**RDS**	**OTH.**	**Con.**	**SIDS**	**RDS**	**OTH.**	**Con.**	**SIDS**	**RDS**	**OTH.**	**Con.**	**SIDS**	**RDS**	**OTH.**
Race [NHW]																
NHB	1.092 ***	1.792 ***	2.276 ***	2.435 ***	1.098 ***	1.808 ***	2.315 ***	2.449 ***	1.041	1.889 ***	1.990 ***	2.314 ***	0.650 ***	0.962	0.823 ***	1.105 ***
Hispanics	1.032 ***	0.627 ***	1.042	1.005	1.082 ***	0.690 ***	1.213 ***	1.047 ***	1.007	0.744 ***	1.192 ***	1.161 ***	0.918 ***	0.506 ***	1.042	0.957 **
Year [83-85]																
86-88					0.922 ***	0.936 ***	0.807 ***	0.907 ***	0.902 ***	0.974	0.770 ***	0.891 ***	0.899 ***	0.947 *	0.734 ***	0.866 ***
89-91					0.862 ***	0.920 ***	0.659 ***	0.821 ***	0.830 ***	0.958	0.610 ***	0.790 ***	0.817 ***	0.906 ***	0.533 ***	0.729 ***
95-98					0.713 ***	0.509 ***	0.290 ***	0.683 ***	0.693 ***	0.507 ***	0.273 ***	0.725 ***	0.648 ***	0.465 ***	0.193 ***	0.600 ***
99-01					0.606 ***	0.349 ***	0.192 ***	0.693 ***	0.575 ***	0.363 ***	0.187 ***	0.736 ***	0.533 ***	0.335 ***	0.125 ***	0.595 ***
Interaction																
NHB*86-88									1.029	0.891 **	1.095	1.126 ***	0.991	0.884 **	1.048	1.083 ***
NHB*89-91									1.122 **	0.860 ***	1.372 ***	1.224 ***	1.052	0.842 ***	1.291 ***	1.152 ***
NHB*95-98									1.048	1.093	1.332 ***	0.951 *	1.100 *	1.195 ***	1.611 ***	1.066 **
NHB*99-01									1.090	1.076	1.216	0.972	1.162 **	1.209 **	1.543 ***	1.125 ***
HIS*86-88									1.073 *	0.924	1.105	0.943 *	1.080 *	0.928	1.132 *	0.955
HIS*89-91									1.086 **	0.951	1.007	0.933 **	1.104 **	0.956	1.069	0.964
HIS*95-98									1.087 **	0.913	0.997	0.833 ***	1.140 ***	0.991	1.180 **	0.932 **
HIS*99-01									1.134 ***	0.797 ***	0.960	0.821 ***	1.188 ***	0.869 *	1.167	0.931 **
Intercept	-6.436 ***	-7.006 ***	-7.842 ***	-5.852 ***	-6.239 ***	-6.711 ***	-7.309 ***	-5.651 ***	-6.214 ***	-6.734 ***	-7.271 ***	-5.660 ***	-6.783 ***	-7.217 ***	-10.894 ***	-6.764 ***
-2LL		308436 ***				301121 ***				300878 ***				44862 ***		

Source: See Table 1a.
Note: Brackets [ ] indicate reference groups. *** p ≤ 0.01. ** p ≤ 0.05. * p ≤ 0.10.
[1] Model Covariates: Model 1 is the bivariate relationship. Model 2 adds time period. Model 3 adds the race/ethnicity x time period interaction.
Model 4 controls ALL risk factors, and includes the race/ethnicity x time period interaction.

TABLE 6b. Odds Ratios for Effects of Risk Factors on Infant Mortality among Low Weight Births: United States

	Model 1				Model 2				Model 3				Model 4			
	Con.	**SIDS**	**RDS**	**OTH.**	**Con.**	**SIDS**	**RDS**	**OTH.**	**Con.**	**SIDS**	**RDS**	**OTH.**	**Con.**	**SIDS**	**RDS**	**OTH.**
Race [NHW]																
NHB	0.556 ***	1.365 ***	1.065 **	1.374 ***	0.550 ***	1.330 ***	1.036	1.363 ***	0.494 ***	1.282 ***	0.881 **	1.184 ***	0.495 ***	0.800 ***	0.846 ***	1.084 ***
Hispanics	0.995	0.594 ***	0.990	0.976 *	1.032 *	0.648 ***	1.134 ***	1.019	0.891 **	0.614 ***	1.100 *	1.006	0.869 ***	0.446 ***	1.076	0.965
Year [83-85]																
86-88					0.962	0.869 ***	0.790 ***	0.874 ***	0.935 **	0.872 *	0.764 ***	0.846 ***	0.950	0.851 **	0.752 ***	0.837 ***
89-91					0.913 ***	0.886 **	0.636 ***	0.785 ***	0.872 ***	0.863 **	0.598 ***	0.729 ***	0.903 ***	0.823 ***	0.574 ***	0.704 ***
95-98					0.746 ***	0.469 ***	0.260 ***	0.621 ***	0.678 ***	0.457 ***	0.232 ***	0.593 ***	0.730 ***	0.441 ***	0.216 ***	0.567 ***
99-01					0.624 ***	0.304 ***	0.171 ***	0.618 ***	0.556 ***	0.274 ***	0.153 ***	0.575 ***	0.612 ***	0.271 ***	0.141 ***	0.553 ***
Interaction																
NHB*86-88									0.997	0.949	1.067	1.137 ***	0.984	0.940	1.070	1.132 ***
NHB*89-91									1.086	0.977	1.293 ***	1.253 ***	1.049	0.956	1.297 ***	1.245 ***
NHB*95-98									1.264 ***	1.194	1.546 ***	1.164 ***	1.200 **	1.261 *	1.574 ***	1.166 ***
NHB*99-01									1.326 ***	1.344 *	1.488 ***	1.244 ***	1.244 **	1.445 **	1.525 ***	1.246 ***
HIS*86-88									1.128 *	1.094	1.083	0.990	1.125 *	1.103	1.095	0.997
HIS*89-91									1.143 **	1.202	1.007	1.030	1.132 **	1.230	1.033	1.049
HIS*95-98									1.239 ***	0.893	1.065	1.017	1.188 ***	0.965	1.108	1.040
HIS*99-01									1.280 ***	1.097	1.093	1.043	1.202 ***	1.178	1.144	1.061
Intercept	-4.241 ***	-5.914 ***	-4.971 ***	-3.488 ***	-4.065 ***	-5.534 ***	-4.359 ***	-3.220 ***	-4.012 ***	-5.515 ***	-4.315 ***	-3.178 ***	-3.805 ***	-5.894 ***	-4.832 ***	-3.487 ***
-2LL		27437 ***				22330 ***				22196 ***				15028 ***		

Source: See Table 1a.
Note: Brackets [ ] indicate reference groups. *** p ≤ 0.01. ** p ≤ 0.05. * p ≤ 0.10.
[1] Model Covariates: Model 1 is the bivariate relationship. Model 2 adds time period. Model 3 adds the race/ethnicity x time period interaction.
Model 4 controls ALL risk factors, and includes the race/ethnicity x time period interaction.