Differences in Neonatal and Postneonatal Mortality by Race, Birth Weight, and Gestational Age

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Synopsis

In recent decades, neonatal and postneonatal mortality rates have declined overall in the United States. Yet, the mortality rates for black infants continue to be approximately twice those for white infants. With the use of data from 45 of the 53 vital statistics reporting areas that participated in the 1980 National Infant Mortality Surveillance project, we extended previous State analyses to describe differences, nationally, in neonatal and postneonatal mortality risks for black and white infants according to gestational age and birth weight.

After restricting our analysis to single-delivery infants with known and plausible combinations of gestational age of 26 or more weeks and birth weights of 500 grams (g) or more, the neonatal mortality risk (NMR)—that is, the number of deaths to infants less than 28 days of life per 1,000 live births—for black infants was 1.6 times higher than the NMR for whites. This difference was largely explained by two findings: First, although the NMR was lower for black than for white infants with gestational ages of less than 38 weeks and birth weights less than 3,000 g, that advantage was heavily outweighed by the higher percentage of such births among blacks, accounting for roughly two-thirds of the overall difference in NMR between blacks and whites. Second, most of the remaining difference in NMR was accounted for by higher NMRs among black infants with gestational ages of 38 or more weeks and birth weights of 3,000 g or more. A comparison of the lowest mortality risk for any combination of birth weight and gestational age showed that the black NMR was 1.89 times higher than the white NMR.

The postneonatal mortality risk (PNMR)—PNMR equals the number of deaths to infants 28 days to less than 1 year of life per 1,000 neonatal survivors—for black infants was 2.09 times the PNMR for white infants. Black infants had higher PNMRs than white infants for nearly all combinations of birth weight and gestational age. Higher PNMRs among infants with gestational ages of 38 or more weeks and birth weights of 2,500 g or more accounted for 43 percent of the difference in PNMR between black infants and white infants.

Eliminating the U.S. black-white infant mortality disparity will require not only reducing the higher frequency of prematurity and low birth weight among black infants, but also improving the survival during both the neonatal and postneonatal periods of term black infants with normal birth weights.

IN 1984, THE BLACK INFANT MORTALITY RATE in the United States was 18.4 deaths per 1,000 live births, whereas the white infant mortality rate was 9.4 (*1,2*). Although infant mortality rates have declined for both blacks and whites in recent decades, the ratio of black to white infant mortality was nearly the same in 1984 (1.96) as it was in 1960 (1.93) (*1,2*). Since 1960 that ratio has increased from 1.62 to 1.90 for neonatal mortality and has decreased from 2.89 to 2.06 for postneonatal mortality (*1,2*). This persistent gap in infant survival between blacks and whites is a major public health problem. In this report, we examine differences in black and white infant mortality with the use of two important and closely related measures of newborn health: birth weight and gestational age.

Many studies have examined differences in birth weight distribution for white infants and black infants (*2–6*); national data on these differences, based on the National Infant Mortality Surveillance project (NIMS), are reported in this issue (*7,8*). The mean birth weight for blacks is approximately 200 g lower than for whites, and the percentages of very low birth weight (less than 1,500 g) and intermediate low birth weight (1,500–2,499 g) for blacks are approximately three and two times the percentages of whites, respectively. Examination of birth-weight-specific mortality discloses a seemingly paradoxical picture: Blacks have better birth-weight-specific survival in the low birth weight ranges but considerably poorer survival in the normal and high birth weight categories.

Two recent State-based studies have gone one step further by examining the interaction between birth weight, gestational age, and neonatal outcome (*9,10*). These studies have shown three major differences between blacks and whites: First, at any birth weight and gestational age, black neonates weighing less than 3,000 g had lower mortality risks than white neonates. Second, this black survival advantage was heavily outweighed by a higher percentage of newborns with lower birth weights. Third, black neonates experienced a higher mortality risk than white neonates at birth weights of 3,000 g or more.

In addition to playing a critical role in neonatal mortality, birth weight is an important, although somewhat weaker, predictor of postneonatal mortality. The lower mortality risk of small black infants compared with small white infants does not extend to the postneonatal period. More black infants die during the postneonatal period than white infants at all birth weights (*8*), and less is known about the relationship between birth weight and gestational age as contributors to the black-white gap in postneonatal mortality.

In this paper, we use NIMS to extend the previous State-based studies and to answer these three questions concerning the differences in neonatal and postneonatal mortality:

- How do U.S. black and white infants differ in their birth weight and gestational age distributions?
- How do black and white infants differ in their neonatal and postneonatal mortality risks by birth weight and gestational age?
- In which birth weight and gestational age categories do most of the overall differences in neonatal and postneonatal mortality between black and white infants occur?

Methods

The methods of the National Infant Mortality Surveillance (NIMS) project, including data collection and evaluation, are described in detail elsewhere (*8,11,12*). In brief, 53 vital statistics reporting areas participated in the project: 50 States, New York City, the District of Columbia, and Puerto Rico. These national level tabulations do not include Puerto Rico. All 53 reporting areas (subsequently referred to as States) linked birth and death certificates for infants who were born alive in 1980 and who died within the first year of life in 1980 or 1981. The completeness of birth and death certificate linkage is estimated to be approximately 95 percent (*11,12*).

States provided the Centers for Disease Control (CDC) with the number of infant deaths by birth weight, age at death, and other infant and maternal characteristics. CDC generated corresponding numbers of births from the computer tape of 1980 natality records produced by the National Center for Health Statistics (NCHS), with exceptions for Maine and New Mexico as previously described (*11*). State of residence was defined as State of mother's residence at time of birth; race of infant was based on the race of both parents, using the NCHS algorithm (*13*). For logistic reasons, categories for race of infant were limited to white, black, and all races combined. Because the NIMS data are for a birth cohort, rather than for births and deaths occurring in a given year, we use the term mortality "risk" instead of "rate." The neonatal mortality risk (NMR) was defined as the number of neonatal deaths (less than 28 days) per 1,000 live births, the postneonatal mortality risk (PNMR) as the number of postneonatal deaths (28 days to less than 1 year) per 1,000 neonatal survivors. This analysis is limited to single-delivery infants.

Table 1. Effect of sequential exclusions on numbers of births and deaths, mortality risks, relative risks, and mortality risk differences for black and white single-delivery infants, 43 States and District of Columbia, 1980 birth cohort

Pregnancy outcome by race	Number of exclusions	After excluding: Unknown birth weight or gestational age	After excluding: Birth weight less than 500 g or gestational age less than 26 weeks	After excluding: Less probable birth weight-gestational age combinations [1]
		White		
Live births:				
Number	2,538,679	2,080,406	2,075,485	2,050,212
Percent	100.0	81.9	81.8	80.8
Neonatal deaths:				
Number	15,865	12,449	9,316	8,647
Percent	100.0	78.5	58.7	54.5
Postneonatal deaths:				
Number	7,797	6,569	6,470	6,237
Percent	100.0	84.3	83.0	80.0
Neonatal mortality risk[2]	6.25	5.98	4.49	4.22
Postneonatal mortality risk[3]	3.09	3.18	3.13	3.06
		Black		
Live births:				
Number	535,194	398,700	395,254	385,062
Percent	100.0	74.5	73.9	71.9
Neonatal deaths:				
Number	6,722	4,809	2,889	2,633
Percent	100.0	71.5	43.0	39.2
Postneonatal deaths:				
Number	3,423	2,703	2,570	2,440
Percent	100.0	79.0	75.1	71.3
Neonatal mortality risk[2]	12.56	12.06	7.31	6.84
Postneonatal mortality risk[3]	6.48	6.86	6.55	6.38
		Relative risk (black versus white)		
Neonatal mortality risk[2]	2.01	2.02	1.63	1.62
Postneonatal mortality risk[3]	2.10	2.16	2.09	2.09
		Risk difference (black versus white)		
Neonatal mortality risk[2]	6.31	6.08	2.82	2.62
Postneonatal mortality risk[3]	3.39	3.69	3.42	3.33

[1] See text, pp. 184–185.
[2] Neonatal mortality risk = number of deaths to infants less than 28 days of life per 1,000 live births.
[3] Postneonatal mortality risk = number of deaths to infants 28 days to less than 1 year of life per 1,000 neonatal survivors.
SOURCE: National Infant Mortality Surveillance project.

States were requested to calculate gestational age (number of completed weeks of gestation) by subtracting the date of the last menstrual period from the date of birth. If the month, day, or year of either of these dates was unknown, the gestational age was listed as unknown. In studies of gestational age that use birth certificates, an imputation of gestational age is commonly done to decrease the frequency of unknown values, particularly when the month and year of the last menstrual period are known but the day is missing (*14*). Given the varying structures of State vital records files, however, it was not feasible in the NIMS project to ask States to perform imputations. Six States (Arizona, Connecticut, Indiana, Kansas, Kentucky, and Tennessee) were excluded from the analysis because of high proportions of unknown values for gestational age compared with remaining States (*11*); a seventh State, Maine, was excluded because of suspected errors in designation of birth weights on the 1980 U.S. natality records (*11*). Even after exclusion of these States, 19.3 percent of all single-delivery infants had unknown gestation compared with 0.2 percent having unknown birth weight.

We excluded infants with unknown birth weight or gestational age (18.1 percent of white infants and 25.5 percent of black infants, table 1). Additionally, two preliminary findings suggested that there was substantial misclassification of gestational age as reported on birth certificates. First, misclassification of gestational age was suggested

Table 2. Percentage of births by birth weight and gestational age, white and black single-delivery infants, 43 States and the District of Columbia, 1980 birth cohort [1]

Race and gestational age (weeks)	Birth weight (g) 500-999	1,000-1,499	1,500-1,999	2,000-2,499	2,500-2,999	3,000-3,499	3,500-3,999	4,000-4,499	4,500 or more	Total
26-27:										
White	0.07	0.05	0.01							0.12
Black	0.18	0.12	0.05							0.34
28-29:										
White	0.03	0.10	0.03							0.16
Black	0.09	0.24	0.12							0.45
30-31:										
White	0.02	0.09	0.14	0.06						0.30
Black	0.05	0.24	0.32	0.21						0.81
32-33:										
White	0.01	0.05	0.21	0.25	0.15					0.67
Black	0.03	0.14	0.46	0.54	0.56					1.73
34-35:										
White		0.03	0.16	0.60	0.73	0.57	0.30			2.38
Black		0.08	0.36	1.26	1.63	1.45	0.55			5.35
36-37:										
White			0.12	0.74	2.35	2.72	1.17	0.26		7.35
Black			0.28	1.66	4.42	4.21	1.45	0.25		12.26
38-39:										
White				0.78	5.34	13.48	9.03	2.09		30.72
Black				1.80	9.17	15.27	6.86	1.19		34.29
40-41:										
White				0.49	4.11	15.31	15.76	5.36	1.08	42.11
Black				0.95	5.96	13.47	8.81	2.12	0.39	31.70
42 or more:										
White				0.20	1.46	5.30	6.02	2.55	0.66	16.18
Black				0.44	2.52	5.36	3.55	0.98	0.20	13.06
Total:										
White	0.12	0.31	0.66	3.12	14.14	37.37	32.28	10.25	1.74	100.00
Black	0.35	0.81	1.60	6.87	24.25	39.77	21.23	4.54	0.59	100.00

[1] N = 2,050,212 live births for whites, 385,062 for blacks. See text for description of exclusions.

NOTE: Darker shade depicts the birth weight and gestational age ranges in which the percentage of black infants is 1.5 or more times the percentage of white infants. White area shows the ranges in which the percentage of white infants is 1.5 or more times the percentage of black infants.

SOURCE: National Infant Mortality Surveillance project.

by improbably low gestational-age-specific mortality risks (compared with birth-weight-specific mortality risks) among infants with extremely low values for reported gestational age. Thus, we also excluded infants with reported gestational ages less than 26 weeks or birth weights less than 500 g (0.2 percent of all white infants and 0.7 percent of all black infants). Second, similar to the pattern previously described by David (*15*), an excess proportion of reported gestational ages 38 or more weeks was apparent among infants with birth weights less than 2,000 g. We constructed a birth weight-gestational age matrix using nine categories for birth weight (500–999 g, 1,000–1,499 g, 1,500–1,999 g, 2,000–2,499 g, 2,500–2,999 g, 3,000–3,499 g, 3,500–3,999 g, 4,000–4,499 g, 4,500 g or more) and nine categories for gestational age (26–27 weeks, 28–29 weeks, 30–31 weeks, 32–33 weeks, 34–35 weeks, 36–37 weeks, 38–39 weeks, 40–41 weeks, 42 or more weeks). To minimize further inclusion of infants with misclassified gestational age (*15*), we excluded birth weight and gestational age categories where, based on the reduced cohort, either less than 1 percent of gestational ages were observed for any birth weight category or less than 1 percent of birth weights were observed for any gestational age category.

The numbers of births and deaths remaining in our analysis after each of the sequential exclusions are shown in table 1. Because of exclusions, mortality risks presented in this report may differ for certain birth weight or gestational age catego-

More black infants die during the postneonatal period than white infants at all birth weights, and less is known about the relationship between birth weight and gestational age as contributors to the black-white gap in postneonatal mortality.'

ries from those presented in the NIMS report or other NIMS presentations (*7,8,11,16*).

To describe the components of differences in black and white neonatal mortality, we took these steps:

- First, we compared the percentage distribution of births by birth weight and gestational age for black and white infants.
- Second, we compare birth-weight- and gestation-specific mortality risks.
- Third, we determined what percentage of the overall risk difference (NMR for blacks minus the NMR for whites) was because of the combined effects of differences in the distribution of births and NMRs for each combination of birth weight and gestational age. We calculated this percentage, for each birth weight and gestational age category$_i$, using the following formula:

$$([NMR_{Bi} \times P_{Bi}] - [NMR_{Wi} \times P_{Wi}]) \div (NMR_B - NMR_W)$$

where NMR_{Bi} and NMR_{Wi} represent the NMR for black infants and white infants with birth weight and gestational age combination$_i$, P_{Bi} and P_{Wi} represent the proportion of black newborns and white newborns with birth weight and gestational combination$_i$, and NMR_B and NMR_W represent the overall NMR for black infants and white infants, respectively. The numerator in this formula is equivalent to:

$$(Deaths_{Bi} \div Births_B) - (Deaths_{Wi} \div Births_W)$$

where $Deaths_{Bi}$ and $Deaths_{Wi}$ represent the number of black and white deaths in each birth weight-gestational age category$_i$ and $Births_B$ and $Births_W$ represent the overall number of black and white births, respectively. This calculation is equivalent to equalizing the number of births in each race group and observing where in the birth weight-gestational age matrix the difference in the number of deaths occurred. We repeated the three steps for postneonatal mortality, using numbers of neonatal survivors and postneonatal deaths in the same birth weight-gestational age categories.

Because the criteria we use for excluding birth weight and gestational age are not ideal, we repeated the analyses at these times:

- after each step in the sequential exclusion process depicted in table 1,
- after using more and less restrictive criteria for excluding certain combinations of birth weight and gestational age,
- after distributing the number of infants with unknown birth weight or gestational age, or both, into the number with known values as described in the NIMS report (*11*), and
- after further limiting the number of States in the analysis to those with the lowest percentage of unknown gestational ages for both births and deaths.

These supplemental analyses did not substantially alter our conclusions regarding the pattern and the reasons for higher mortality risks among black infants. (They are not presented in this report but are available on request from Dr. Sappenfield.)

All calculations were done with a microcomputer spreadsheet, and unrounded numbers were retained for calculations at each stage. Statistical tests are not shown because, for most combinations of race, birth weight, and gestational age, the numbers of births and deaths were large enough so that differences in mortality risks of 1.5-fold or greater were statistically significant.

Results

For the 44 States included in this analysis, the NMR for black infants and white infants was 12.56 and 6.25 neonatal deaths per 1,000 live births (risk difference = 6.31 deaths per 1,000 live births) and the PNMR for black infants and white infants was 6.48 and 3.09 postneonatal deaths per 1,000 neonatal survivors (risk difference = 3.39 deaths per 1,000 neonatal survivors).

After excluding unknown, extremely low, and less probable combinations of birth weight and gestational age, the difference in NMR and PNMR between black infants and white infants was reduced to 2.62 deaths per 1,000 live births and 3.33 deaths per 1,000 neonatal survivors, respectively (table 1). A larger percentage of deaths than births were ultimately excluded. The greatest reduction in risk differences between blacks and whites occurred for NMR with the exclusion of infants with birth weights of less than 500 g or

Table 3. Neonatal mortality risk (NMR) by birth weight and gestational age, white and black single-delivery infants, 43 States and the District of Columbia, 1980 birth cohort [1]

Race and gestational age (weeks)	Birth weight (g) 500-999	1,000-1,499	1,500-1,999	2,000-2,499	2,500-2,999	3,000-3,499	3,500-3,999	4,000-4,499	4,500 or more	Total	Relative risk[2]
26-27:											
White . . .	624.63	338.51	127.27							471.89	
Black . . .	587.21	119.12	53.76							380.09	0.81
28-29:											
White . . .	590.61	220.87	128.80							271.09	
Black . . .	516.13	160.47	47.19							201.51	0.74
30-31:											
White . . .	509.15	169.15	74.11	39.97						119.19	
Black . . .	398.99	102.96	46.53	15.19						77.42	0.65
32-33:											
White . . .	494.32	200.80	51.74	28.46	10.52					50.05	
Black . . .	458.72	100.00	35.93	16.21	7.43					32.44	0.65
34-35:											
White . . .		203.13	55.61	19.60	10.29	4.90	2.64			15.64	
Black . . .		86.67	35.96	11.13	3.67	3.40	3.28			8.83	0.56
36-37:											
White . . .			67.26	15.84	4.36	2.93	2.22	4.09		5.63	
Black . . .			25.47	10.78	3.35	2.84	2.86	[3]1.04		4.58	0.81
38-39:											
White . . .				13.28	2.79	1.45	1.00	1.12		1.83	
Black . . .				7.07	2.75	1.99	1.89	2.63		2.46	1.35
40-41:											
White . . .				19.94	3.54	1.57	1.06	1.15	1.77	1.74	
Black . . .				12.52	4.23	2.37	2.27	2.08	6.02	3.02	1.74
42 or more:											
White . . .				26.01	6.16	2.44	1.86	1.45	1.77	2.66	
Black . . .				12.85	5.68	3.87	3.95	3.19	10.22	4.59	1.73
Total:											
White . . .	591.39	219.25	65.17	18.67	4.09	1.80	1.25	1.29	1.77	4.22	
Black . . .	530.69	132.12	37.60	10.81	3.70	2.51	2.50	2.40	7.47	6.84	1.62
Relative risk[2]	0.90	0.60	0.58	0.58	0.90	1.40	2.00	1.86	4.22	1.62	

[1] N = 2,050,212 live births for whites, 385,062 for blacks. See text for description of exclusions.

[2] NMR for black infants ÷ NMR for white infants.

[3] N = 1 neonatal death.

NOTE: White area shows birth weight and gestational age ranges in which the NMR for white infants is 1.5 or more times the NMR for black infants. Darker shade depicts the ranges in which the NMR for black infants is 1.5 or more times the NMR for white infants.

SOURCE: National Infant Mortality Surveillance project.

gestational age of less than 26 weeks. In addition, a greater percentage of neonatal deaths than postneonatal deaths were excluded, and a greater percentage of black births and deaths than white births and deaths were excluded.

Neonatal mortality.

Distribution of birth weights and gestational ages. The percentage of all newborns falling into each birth weight category of less than 3,500 g and each gestational age category of less than 40 weeks was greater for blacks than for whites (table 2). The percentage of infants with birth weights of 500–1,499 g and 1,500–2,499 g was 0.43 percent and 3.78 percent for whites and 1.16 percent and 8.47 percent for blacks, and the percentage with reported gestational ages of 26–31 weeks and 32–37 weeks was 0.58 percent and 10.41 percent for whites and 1.60 percent and 19.34 percent for blacks (table 2). For all combinations of birth weights of less than 3,500 g and gestational ages of less than 36 weeks, the percentage of black infants is at least twice the percentage of white infants (table 2). For example, the proportion of total infants with birth weights of less than 2,500 g and

Table 4. Percentage of the overall risk difference in neonatal mortality, black versus white single-delivery infants[1], by birth weight and gestational age, 43 States and District of Columbia, 1980 birth cohort [2]

	Birth weight (g)									
Gestational age (weeks)	500–999	1,000–1,499	1,500–1,999	2,000–2,499	2,500–2,999	3,000–3,499	3,500–3,999	4,000–4,499	4,500 or more	Total
26–27	24.46	2.83	0.47	...	...	...	...	...	...	27.76
28–29	10.65	6.85	0.42	...	...	...	...	...	...	17.92
30–31	4.72	3.62	1.76	0.33	...	...	...	...	...	10.43
32–33	3.34	1.41	2.23	0.61	0.97	...	...	...	...	8.56
34–35	...	0.40	1.96	0.83	-0.59	0.82	0.40	...	...	3.82
36–37	...	...	-0.30	2.35	1.74	1.52	0.60	-0.31	...	5.60
38–39	...	...	...	0.91	3.94	4.13	1.51	0.30	...	10.79
40–41	...	...	...	0.82	4.05	3.03	1.25	-0.66	0.17	8.65
42 or more	...	...	...	0.24	2.03	3.00	1.07	-0.23	0.35	6.46
Total	43.17	15.11	6.54	6.10	12.14	12.51	4.82	-0.90	0.51	100.00

[1] Risk difference = 2.62 deaths per 1,000 live births.
[2] N = 2,050,212 live births for whites; 385,062 for blacks. See text for description of exclusions.

NOTE: Percentages may not add to total due to rounding.
SOURCE: National Infant Mortality Surveillance project.

gestational ages of less than 38 weeks was 6.43 percent for blacks and 2.75 percent for whites. In contrast, blacks generally had lower percentages of infants with higher birth weight and gestational age combinations. Birth weight and gestational age ranges in which the percentage of black newborns was 1.5 or more or 1.5 or less times the percentage of white newborns are highlighted in table 2.

Birth-weight-specific mortality risks. For all combinations of birth weights of less than 3,500 g and gestational ages of less than 38 weeks, the NMR was lower among blacks than whites (table 3). In contrast, for all combinations of birth weights of more than 3,000 g and gestational ages of 38 or more weeks, the NMR was higher for blacks than whites (table 3). Birth weight and gestational age ranges in which the black NMR was 1.5 or more or 1.5 or less times the white NMR are highlighted in table 3.

For both blacks and whites, the lowest NMR was observed among infants with birth weights of 3,500–3,999 g and gestational ages of 38–39 weeks (excluding the black category represented by birth weights of 4,000–4,499 g and gestational ages of 36–37 weeks, where only one death occurred). At this optimal combination of birth weight and gestational age, however, the NMR was 1.89 for blacks and 1.00 for whites.

Components of the risk difference. Examination of the components of the risk difference in black-white NMR demonstrates that the neonatal survival advantage of black infants with lower birth weight and gestational age is overwhelmingly offset by the higher proportion of such births among blacks (table 4). As seen in table 4, the cell represented by birth weights of 500-999 g and gestational ages of 26–27 weeks contributes nearly one-fourth of the total difference in NMR. Cells represented by combinations of birth weights of less than 1,500 g and gestational ages of less than 34 weeks contribute 58 percent of the risk difference, and extending to cells represented by combinations of birth weights of less than 2,500 g and gestational ages of less than 38 weeks, these categories account for 69 percent of the risk difference. A second important component of the risk difference occurs at birth weights of 2,500 g or more and gestational ages of 38 or more weeks; these cells contribute 24 percent of the risk difference (table 4). Most of the contribution to the risk difference from this second component occurred in the 2,500–3,499 g birth weight ranges and the 38–41 week gestational age ranges—the birth weight and gestational age ranges where most births occurred. Thus, the difference in NMR for blacks and whites reflects primarily the increased frequency of lower gestational ages and lower birth weights among black newborns and secondarily the higher risk of neonatal death among term newborns.

Postneonatal mortality. Reflecting the birth weight-gestational age distribution for live births and neonatal mortality patterns, there are proportionately more black neonatal survivors with lower birth weights and gestational ages and fewer black neonatal survivors with higher birth weights and gestational ages compared with white neonatal survivors (data not shown).

For nearly all combinations of birth weight and

Table 5. Postneonatal mortality risk (PNMR) by birth weight and gestational age, white and black single-delivery infants, 43 States and the District of Columbia, 1980 birth cohort [1]

Race and gestational age (weeks)	Birth weight (g) 500-999	1,000-1,499	1,500-1,999	2,000-2,499	2,500-2,999	3,000-3,499	3,500-3,999	4,000-4,499	4,500 or more	Total	Relative risk[2]
26-27:											
White . . .	159.05	86.07	41.67							107.20	
Black . . .	183.10	77.35	22.73							102.19	0.95
28-29:											
White . . .	146.25	42.26	23.26							48.47	
Black . . .	169.70	58.23	37.74							65.26	1.35
30-31:											
White . . .	99.38	39.92	24.13	13.57						28.62	
Black . . .	126.05	61.05	29.11	11.57						37.45	1.31
32-33:											
White . . .	101.12	31.25	16.30	9.50	7.41					13.06	
Black . . .	169.49	49.15	24.46	15.51	11.24					20.33	1.56
34-35:											
White . . .		30.50	17.30	8.47	5.20	4.32	3.63			6.62	
Black . . .		36.50	23.22	12.71	7.06	6.47	4.23			9.45	1.43
36-37:											
White . . .			17.12	9.75	5.21	3.26	2.94	3.55		4.70	
Black . . .			18.39	12.01	6.43	5.20	4.49	4.16		6.75	1.44
38-39:											
White . . .				9.33	3.98	2.38	1.78	2.04		2.64	
Black . . .				12.65	5.96	3.78	2.99	4.83		4.71	1.79
40-41:											
White . . .				10.63	4.64	2.56	1.77	1.60	1.59	2.41	
Black . . .				15.44	7.66	4.85	3.52	2.33	6.06	5.17	2.14
42 or more:											
White . . .				15.66	5.83	2.61	2.05	1.76	2.36	2.70	
Black . . .				11.83	8.52	5.15	3.15	3.74	3.87	5.36	1.98
Total:											
White . . .	141.15	44.34	19.01	9.95	4.67	2.58	1.89	1.78	1.88	3.06	
Black . . .	167.46	57.87	24.92	13.03	6.92	4.58	3.37	3.39	5.31	6.38	2.09
Relative risk[2].	1.19	1.31	1.31	1.31	1.48	1.77	1.79	1.91	2.82	2.09	

[1] N = 2,041,565 neonatal survivors for whites, 382,429 for blacks. See text for description of exclusions.

[2] PNMR for black infants ÷ PNMR for white infants.

NOTE: White area shows birth weight and gestational age ranges in which the PNMR for white infants is 1.5 or more times the PNMR for black infants. Darker shade depicts the ranges in which the PNMR for black infants is 1.5 or more times the PNMR for white infants.

SOURCE: National Infant Mortality Surveillance project.

gestational age, the PNMR was higher for black than white infants, although black PNMRs that were 1.5 or more times the white PNMR were more common among birth weights of 2,500 g or more (table 5).

Combinations of birth weights of less than 2,500 g and gestational ages of less than 38 weeks contribute 33 percent of the risk difference, while combinations of birth weights of 2,500 g or more and gestational ages of 38 or more weeks contribute 43 percent of the risk difference (table 6).

Discussion

In this paper, we use the birth and death certificate information collected in NIMS to show that, nationally, the higher overall neonatal mortality risk for blacks is due to a substantially higher frequency of lower birth weight, earlier gestational age births and a higher mortality risk for higher birth weight, term, black newborns. These findings extend those of previous studies from selected States regarding the role of birth weight, gestational age, and birth-weight- and gestation-specific mortality in the higher overall neonatal mortality risk of black infants (*9,10*).

Black newborns with birth weights less than 3,000 g have lower neonatal mortality risks when compared with white neonates. Some have sug-

Table 6. Percentage of the overall risk difference in postneonatal mortality, black versus white single-delivery infants[1], by birth weight and gestational age, 43 States and District of Columbia, 1980 birth cohort[2]

Gestational age (weeks)	Birth weight (g) 500–999	1,000–1,499	1,500–1,999	2,000–2,499	2,500–2,999	3,000–3,499	3,500–3,999	4,000–4,499	4,500 or more	Total
26–27	2.91	1.39	0.20	...	...	...	...	...	...	4.50
28–29	1.66	2.66	1.05	...	...	...	...	...	...	5.37
30–31	0.94	3.05	1.75	0.49	...	...	...	...	...	6.22
32–33	0.65	1.44	2.33	1.81	1.55	...	...	...	...	7.78
34–35	...	0.58	1.83	3.28	2.33	2.09	0.38	...	...	10.49
36–37	...	...	0.93	3.83	4.89	3.94	0.93	0.03	...	14.56
38–39	...	...	...	4.68	10.11	7.76	1.35	0.45	...	24.35
40–41	...	...	...	2.86	8.02	7.91	0.93	−1.08	0.19	18.82
42 or more	...	...	...	0.67	3.90	4.17	−0.35	−0.25	−0.24	7.91
Total	6.17	9.12	8.09	17.61	30.79	25.87	3.26	−0.85	−0.04	100.00

[1] Risk difference = 3.33 deaths per 1,000 neonatal survivors.
[2] N = 2,041,565 neonatal survivors for whites, 382,429 for blacks. See text for description of exclusions.

NOTE: Percentages may not add to total due to rounding.
SOURCE: National Infant Mortality Surveillance project.

gested that this is because of a higher percentage of small-for-gestational-age newborns among low birth weight blacks (*17*). However, this national study, as well as other studies from California and South Carolina (*9,10*), shows that the lower NMR for small black infants persists across gestational age categories. When the underlying cause of death has been examined by others and in the NIMS data, it appears that the lower mortality risk for low birth weight black newborns largely is accounted for by a lower mortality risk for respiratory distress syndrome and congenital abnormalities (*16,18,19*).

Our data similarly confirm the findings of others that in the higher birth weight, higher gestational age ranges, blacks have higher mortality than whites. The lowest mortality for both blacks and whites occurs at 3,500–3,999 g and 38–39 weeks, but as others have found (*9,10*), the mortality risk for blacks at the optimal birth weight-gestational age combination is nearly twice that of whites. When causes of death are examined for infants with birth weights of 2,500 g or more, black infants have elevated risks for most cause of death categories (*16*).

Splitting the risk difference in mortality between race groups into the contribution from each cell in the birth weight-gestational age matrix provides a useful way of looking at the joint contribution of birth weight distribution and birth-weight-specific mortality to overall differences in neonatal mortality risks between whites and blacks. Some authors have questioned the usefulness of birth weight standardization (*10,20,21*). However, the approach in this study empirically measures where differences in deaths occur without attempting to adjust for differences in distribution. Nearly 60 percent of the difference in neonatal mortality risks is accounted for by births of black infants less than 1500 g and 34 weeks' gestation. Twenty-four percent is accounted for by the lowest birth weight and gestational age category of 500-999 g, 26-27 weeks. For low birth weight and gestational age categories, the black survival advantage is heavily outweighed by the higher frequency of such births.

Nearly one-fourth of the overall neonatal mortality difference occurs among black infants 2,500 g or more and 38 weeks or more gestational age. This second contribution to the risk difference reflects both the large proportion of black infants and white infants in this category (76 and 88 percent, respectively, after our exclusion) as well as higher birth-weight- and gestational-age-specific mortality risks among black infants. Our findings emphasize that reductions in black neonatal mortality should focus primarily on efforts to reduce low birth weight and prematurity, but that emphasis should also be placed on reducing mortality among term, black infants having normal birth weights.

Our findings also emphasize the importance of the postneonatal period to the black-white gap in infant mortality, and efforts to reduce low birth weight alone will have much less impact on this aspect of infant mortality. In the postneonatal period, blacks had higher mortality rates in nearly all birth weight and gestational age categories. In contrast to the pattern for neonatal mortality, infants having low birth weights and early gestational ages accounted for a much smaller percentage of the postneonatal risk difference, and 43 percent of the difference in the postneonatal period occurred among infants with birth weights of 2,500 g or more and gestational ages of 38 or more weeks. It is noteworthy, as well, that after exclusion from our analyses of infants with birth weights of less than 500 g and gestational ages less than 26 weeks, the risk difference for postneonatal mortality exceeded that for neonatal mortality. Substantial reductions in mortality are unlikely in these birth weight and gestational age ranges, and excluding these infants from our analyses sets aside a component of the black-white mortality gap that cannot be addressed by newborn care providers. This exclusion, however, should not diminish the importance of these infants in the broader context of black-white mortality gaps, nor should it diminish the importance of efforts to prevent such extremely premature births.

Excluding records with unknown values had the effect of lowering the risk difference in neonatal mortality between blacks and whites. The effects of exclusions on risk differences in the postneonatal period were considerably less. Even when we included infants with unknown, extremely low, or improbable values, however, our findings on neonatal mortality were essentially unchanged: Blacks have a higher rate of lower birth weight, earlier gestational age infants; the birth-weight-specific neonatal mortality for these lower birth weight, earlier gestational age black infants is less; in the higher birth weight and term categories, black neonatal mortality is greater; and overall differences in neonatal mortality for blacks and whites result from a combination of a higher frequency of black low birth weight births and a higher mortality rate among higher birth weight, term infants.

Reporting of gestational age was poorer for black infants than for whites, and the proportion of records with very low birth weights and gestational ages and less probable combinations of birth weight and gestational age were higher for blacks. The percentage of neonatal deaths with excluded values was more than twice as great as the percentage of births with excluded values for both races, and the percentage of postneonatal deaths with excluded values was approximately similar to the percentage of births with exclusions. These findings demonstrate that a more exact understanding of black-white mortality differences will depend on improvements in the quality of reporting about gestational age on birth certificates and more refined techniques to identify misclassified values for gestational age.

Further comparisons of birth-weight-specific mortality risks among blacks and whites should focus on specific birth weight and gestational age categories to define how deficiencies in maternal and infant care are contributing to the higher risks of neonatal and postneonatal deaths suffered by blacks.

> *'When the underlying cause of death has been examined by others and in the NIMS data, it appears that the lower mortality risk for low birth weight black newborns largely is accounted for by a lower mortality risk for respiratory distress syndrome and congenital abnormalities.'*

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Young Maternal Age and Infant Mortality: the Role of Low Birth Weight

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Synopsis

In 1980, there were 562,330 babies born in the United States to teenage mothers (19 years of age or younger). The offspring of teenage mothers have long been known to be at increased risk of infant mortality, largely because of their high prevalence of low birth weight (less than 2,500 grams).

We used data from the National Infant Mortality Surveillance (NIMS) project to examine the effect of young maternal age and low birth weight on infant mortality among infants born in 1980 to U.S. residents. This analysis was restricted to single-delivery babies who were either black or white, who were born to mothers ages 10-29 years, and who were born in one of 48 States or the District of Columbia. Included were 2,527,813 births and 28,499 deaths (data from Maine and Texas were excluded for technical reasons). Direct standardization was used to calculate the relative risks, adjusted for birth weight, of neonatal mortality (less than 28 days of life) and postneonatal mortality (28 days to less than 1 year of life) by race and maternal age.

There was a strong association between young maternal age and high infant mortality and between young maternal age and a high prevalence of low birth weight. Neonatal mortality declined steadily with increasing maternal age. After adjusting for birth weight, the race-specific relative risks for babies born to mothers less than 16 years of age were still elevated from 11 to 40 percent,