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Birth Weight-Specific Infant Mortality Due to Congenital Anomalies, 1960 and 1980

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Synopsis

The impact of mortality due to congenital anomalies in single-delivery births was compared in 1960 and 1980 birth cohorts; data were used from the 1960 National Center for Health Statistics

national linkage of birth and death certificates and the 1980 National Infant Mortality Surveillance project.

In 1960 there were 14,714 deaths due to congenital anomalies, compared with 8,674 in 1980, a 41 percent reduction. The infant mortality risk (IMR) due to congenital anomalies fell 31 percent. This is in contrast with the observed 54 percent decline in IMR due to all causes. This reduction in mortality due to congenital anomalies occurred for both whites and blacks in the postneonatal period and for whites only in the neonatal period. Changes ranged from a 1.8 percent increase for the black neonatal mortality risk to a 46.6 percent decrease for the white postneonatal mortality risk. In spite of these relative reductions, the absolute percentage of all infant deaths due to congenital anomalies had increased from 15.8 percent in 1960 to 24.1 percent in 1980. Two categories, cardiovascular and central nervous system anomalies, accounted for 72 percent of infant deaths due to congenital anomalies in 1960 and for 59 percent in 1980; cardiovascular anomalies accounted for 48 percent of all deaths due to congenital anomalies in 1960 and 40 percent in 1980.

Infant mortality risks in the United States showed a 2:1 black to white ratio in both 1960 and 1980. However, for infant mortality due to congenital anomalies, the black and white mortality risks were approximately equal in both 1960 and 1980. For infants with birth weights of 500–2,499 g, the risk of neonatal mortality for blacks was less than half the risk for whites.

SECULAR TRENDS IN INFANT MORTALITY rates since 1960 show a decline, with a persistent 2:1 black-white ratio (*1*). However, the rate of decline has slowed in recent years (*2–5*), and congenital anomalies are a major cause of infant mortality in single-delivery infants. In this paper we examine the impact of deaths due to congenital anomalies on changes in infant mortality between 1960 and 1980. For this study we used race-specific and birth weight-specific mortality risks from the 1980 National Infant Mortality Surveillance (NIMS) project and data from the 1960 national linkage by the National Center for Health Statistics (NCHS) of birth and death certificates (the most recent year for which national birth weight-specific mortality statistics are available).

We examined changes since 1960 for all congenital anomalies and for subgroups of congenital anomalies and found that the overall infant mortality risk (IMR) due to congenital anomalies declined between 1960 and 1980. However, the congenital anomaly IMR declined more slowly than infant mortality due to all causes. This slower decline resulted in an increase in the proportion of infant deaths due to congenital anomalies in 1980 compared with 1960.

In contrast to the overall IMRs due to all causes for which black risks are twice that of whites, the overall black and white IMRs were approximately equal for congenital anomalies. Our analysis supports the idea that efforts to decrease infant mortality should aim at preventing congenital anomalies, since along with prematurity and sudden infant death syndrome (SIDS), they are a major contributor to infant mortality in the United States.

Methods

We used data from two sources to obtain information for this comparison. For the 1980 birth cohort, we used data from the NIMS project, which was conducted by the Centers for Disease Control (CDC). For the 1960 cohort, we used data from a previous study conducted by NCHS.

1980 birth cohort. The methods of the NIMS project, including data collection and evaluation, are described in detail elsewhere (*6–8*). 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 (*6–8*). States provided 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 NCHS, with exceptions for Maine and New Mexico (*6*).

Because of small numbers for certain categories of deaths due to congenital anomalies, numbers of infants with unknown birth weights (0.2 percent of births and 3.2 percent of infant deaths) were not assigned to other birth weight categories as was done in other NIMS analyses (*6*). Therefore, numbers and risks of death in some birth weight-specific categories will differ slightly from those presented elsewhere in this issue of *Public Health Reports* (*9*).

1960 cohort. The methods for the 1960 birth cohort analysis are described in detail elsewhere (*1,10*). Our analysis uses the same birth weight categories for 1960 as for 1980. We used black, white, and all races in the race of infant category. In previous research based on the 1960 study, slightly different birth weight categories (such as 1,000 g or fewer, 1,001–1,500 g, and 1,501–2,000 g) and a broader "nonwhite" category were used (*10*). Due to categorical differences, these numbers of deaths and mortality risks may differ from previous reports for the 1960 cohort. For comparison, we excluded all infants with birth weights of less than 500 g because in the 1980 NIMS data all these infants were assumed to have died from extreme prematurity. Because of this, numbers of births and deaths and mortality risks in the "total" birth weight category will differ slightly from previous reports for the 1960 cohort and from other articles in this issue of *Public Health* Reports.

Definitions common to 1960 and 1980. State of residence was defined as the mother's State of residence at the time she gave birth; race of infant was based on the race of both parents, using the NCHS algorithm (*11*). Because these data are for birth cohorts, rather than for births and deaths in given years, we used 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 under 1 year) per 1,000 neonatal survivors, and the infant mortality risk (IMR) as the number of infant deaths (less than 1 year) per 1,000 live births. Birth weights were grouped into 10 levels: 500-g categories from 500 to 4,499 g, 4,500 g or more, and unknowns. All analyses are limited to infants from single deliveries.

Cause of death classification. For NIMS, States provided tabulations of the number of infant deaths by individual codes for the underlying cause of death, using the International Classification of Diseases, Ninth Revision (ICD-9) (*12*). States determined underlying cause of death from information provided on death certificates. For 1960 the computer tape of linked certificates provided individual codes for the underlying cause of death from death certificates, based on the International Classification of Diseases, Seventh Revision (ICD-7) (*13*).

Table 1. International Classification of Diseases (ICD) codes for congenital anomalies and for congenital anomaly categories, United States, 1960 and 1980

Category of anomalies	*1960: ICD-7*	*1980: ICD-9*
All congenital anomalies	750–759, 560.2, 325.4	740–759, 553.1
Central nervous system (CNS)	750–753	740–742
Cardiovascular system	754	745–747
Respiratory system	759.0	748
Digestive system	756, 560.2	749–751, 553.1
Urinary system	757	753
Chromosomal	325.4	758
All other causes	Residual	Residual

For both cohorts, our study uses the same definitions for all congenital anomalies (table 1) as used elsewhere in NIMS (*9*). We aggregated these ICD codes for congenital anomalies into seven categories: central nervous system (CNS), cardiovascular system, respiratory system, digestive system, urinary system, chromosomal, and all other defects. Although there are substantial overall differences in individual codes between ICD-7 and ICD-9, the major categories of congenital anomalies are very similar, except for the chromosomal category.

Statistical methods. We compared mortality risks using the relative risk of death for blacks compared with whites, and we calculated 95 percent confidence intervals using the test-based method described by Rothman and Boice (*14*). All calculations were made with a microcomputer spread sheet, and unrounded numbers were retained for calculations at each stage.

Results

All races. Congenital anomalies were listed as the underlying cause of death for 14,714 infant deaths in single-delivery infants in 1960 and 8,674 in 1980. Between 1960 and 1980 the total NMR,

Table 2. Numbers of deaths, mortality risks, and percentage changes from 1960 to 1980 for all races for neonatal, postneonatal, and infant deaths due to congenital anomalies in single-delivery infants, by birth weight groups, United States, 1960 and 1980 birth cohorts[1]

Birth cohorts[2]	500–1,499 g		1,500–2,499 g		2,500–3,999 g		4,000 g or more		Total	
	Number	Risk	Number	Risk	Number	Risk	Number	Risk	Number	Risk
Neonatal deaths[3]:										
1960	735	*18.98*	2,775	*11.48*	5,761	*1.64*	461	*1.20*	9,732	*2.34*
1980	874	*28.27*	1,902	*10.76*	2,949	*1.00*	263	*0.68*	6,273	*1.77*
Percent change from 1960[4]	18.9	*48.9*	−31.5	*−6.3*	−48.8	*−39.0*	−43.0	*−43.2*	−35.5	*−24.1*
Postneonatal deaths[5]:										
1960	90	*7.17*	835	*3.74*	3,736	*1.07*	321	*0.84*	4,982	*1.21*
1980	178	*9.02*	554	*3.21*	1,484	*0.51*	153	*0.40*	2,401	*0.68*
Percent change from 1960[4]	97.8	*25.8*	−33.7	*−14.2*	−60.3	*−52.8*	−52.3	*−52.7*	−51.8	*−43.8*
Infant deaths[6]:										
1960	825	*21.31*	3,610	*14.93*	9,497	*2.71*	782	*2.04*	14,714	*3.53*
1980	1,052	*34.02*	2,456	*13.89*	4,433	*1.51*	416	*1.08*	8,674	*2.45*
Percent change from 1960[4]	27.5	*59.7*	−32.0	*−7.0*	−53.3	*−44.4*	−46.8	*−47.1*	−41.0	*−30.6*

[1] Infants with unknown birth weights were handled differently in 1960 and 1980. In 1960, published data contained no infants with unknown birth weights; in 1980, they were not redistributed into known birth weight categories, but infants with unknown birth weights were included in the "Total" category.
[2] There were 4,166,897 single-delivery live births with birth weights of 500 g or more in 1960 and 3,540,163 in 1980.
[3] Neonatal mortality risk = neonatal deaths per 1,000 live births in each birth weight category.
[4] Percentage change in number of deaths or mortality risk from 1960 to 1980.
[5] Postneonatal mortality risk = postneonatal deaths per 1,000 neonatal survivors in each birth weight category.
[6] Infant mortality risk = infant deaths per 1,000 live births in each birth weight category.

Table 3. Deaths due to congenital anomalies as a percentage of neonatal, postneonatal, and infant deaths from all causes for all races in single-delivery infants, by birth weight groups, United States, 1960 and 1980 birth cohorts[1]

Birth cohorts[2]	500–1,499 g	1,500–2,499 g	2,500–3,999 g	4,000 g or more	Total
Neonatal deaths[3]:					
1960	[4]2.8	15.2	30.0	24.1	14.8
1980	7.8	46.6	48.8	38.5	27.2
Postneonatal deaths[5]:					
1960	12.6	18.3	18.2	20.0	18.2
1980	14.0	26.1	17.1	20.6	18.5
Infant deaths[6]:					
1960	3.1	15.8	23.9	22.2	15.8
1980	8.4	39.6	30.1	29.2	24.1

[1] See footnote 1, table 2.
[2] See footnote 2, table 2.
[3] Percentage is based on total neonatal deaths in each birth weight group.
[4] Explanation: Of all neonatal deaths in infants with birth weights of 500–1,499 g, 2.8 percent in 1960 were due to congenital anomalies.
[5] Percentage is based on all postneonatal deaths in each birth weight group.
[6] Percentage is based on all infant deaths in each birth weight group.

PNMR, and IMR for deaths due to congenital anomalies declined. The NMR dropped from 2.34 to 1.77 deaths per 1,000 live births, PNMR from 1.21 to 0.68 deaths per 1,000 neonatal survivors, and IMR from 3.53 to 2.45 deaths per 1,000 live births (table 2). The overall reductions in the total NMR, PNMR, and IMR were 24.1 percent, 43.8 percent, and 30.6 percent, respectively. The largest reductions in mortality risk due to congenital anomalies occurred in infants with birth weights of 2,500 g or more. However, for infants with birth weights of 500–1,499 g, the numbers of neonatal and postneonatal deaths due to congenital anomalies and the accompanying mortality risks actually increased.

Differences in declines in NMR and PNMR resulted in a change in the percentage of infant deaths in the neonatal and postneonatal periods. Between 1960 and 1980, infant deaths due to congenital anomalies that occurred in the neonatal period increased from 66.1 percent (9,732 of 14,714) to 72.3 percent (6,273 of 8,674) (table 2).

Neonatal deaths due to congenital anomalies accounted for 14.8 percent of all neonatal deaths in 1960 and 27.2 percent in 1980 (table 3). The percentage of neonatal deaths in 1980 was increased from 1960 for every birth weight group. In infants with birth weights of 1,500–3,999 g, congenital anomalies accounted for almost half of the neonatal mortality in 1980. For postneonatal deaths, the percentage due to congenital anomalies in 1980 (18.5 percent) was similar to 1960 (18.2 percent). Infant deaths due to congenital anomalies accounted for 15.8 percent of all infant deaths in 1960 and 24.1 percent of all infant deaths in 1980.

Whites and blacks. Between 1960 and 1980, overall NMR and PNMR for whites declined, but only the

Table 4. Numbers of deaths, mortality risks and percentage change from 1960 to 1980 for blacks and whites for neonatal, postneonatal, and infant deaths due to congenital anomalies in single-delivery infants, by birth weight groups, United States, 1960 and 1980 birth cohorts[1]

Birth cohorts[2]	500–1,499 g		1,500–2,499 g		2,500–3,999 g		4,000 g or more		Total	
	Number	Risk	Number	Risk	Number	Risk	Number	Risk	Number	Risk
White										
Neonatal deaths[3]:										
1960	636	*22.84*	2,433	*13.56*	5,128	*1.72*	413	*1.20*	8,610	*2.44*
1980	667	*34.85*	1,530	*12.97*	2,386	*1.01*	221	*0.64*	5,011	*1.76*
Percent change from 1960[4]	4.9	*52.6*	-37.1	*-4.4*	-53.5	*-41.2*	-46.5	*-46.6*	-41.8	*-27.8*
Postneonatal deaths[5]:										
1960	65	*7.87*	658	*4.00*	3,216	*1.09*	280	*0.81*	4,219	*1.21*
1980	96	*8.07*	396	*3.45*	1,186	*0.50*	134	*0.39*	1,833	*0.65*
Percent change from 1960[4]	47.7	*2.5*	-39.8	*-13.8*	-63.1	*-53.6*	-52.1	*-52.4*	-56.6	*-46.6*
Infant deaths[6]:										
1960	701	*25.18*	3,091	*17.23*	8,344	*2.80*	693	*2.01*	12,829	*3.64*
1980	763	*39.87*	1,926	*16.32*	3,572	*1.52*	355	*1.03*	6,844	*2.41*
Percent change from 1960[4]	8.8	*58.4*	-37.7	*-5.3*	-57.2	*-45.9*	-48.8	*-48.9*	-46.7	*-33.8*
Black										
Neonatal deaths[3]:										
1960	92	*8.95*	299	*5.09*	561	*1.17*	43	*1.24*	995	*1.70*
1980	161	*14.76*	302	*5.73*	447	*0.93*	31	*1.04*	995	*1.73*
Percent change from 1960[4]	75.0	*64.9*	1.0	*12.5*	-20.3	*-20.1*	-27.9	*-16.4*	0.0	*1.8*
Postneonatal deaths[5]:										
1960	25	*6.13*	162	*2.91*	475	*0.99*	38	*1.11*	700	*1.23*
1980	76	*10.38*	131	*2.52*	229	*0.48*	15	*0.50*	452	*0.80*
Percent change from 1960[4]	204.0	*69.2*	-19.1	*-13.3*	-51.8	*-51.9*	-60.5	*-54.6*	-35.4	*-35.1*
Infant deaths[6]:										
1960	117	*11.38*	461	*7.85*	1,036	*2.15*	81	*2.34*	1,695	*2.90*
1980	237	*21.73*	433	*8.21*	676	*1.41*	46	*1.54*	1,447	*2.52*
Percent change from 1960[4]	102.6	*90.9*	-6.1	*4.6*	-34.7	*-34.5*	-43.2	*-34.2*	-14.6	*-13.1*

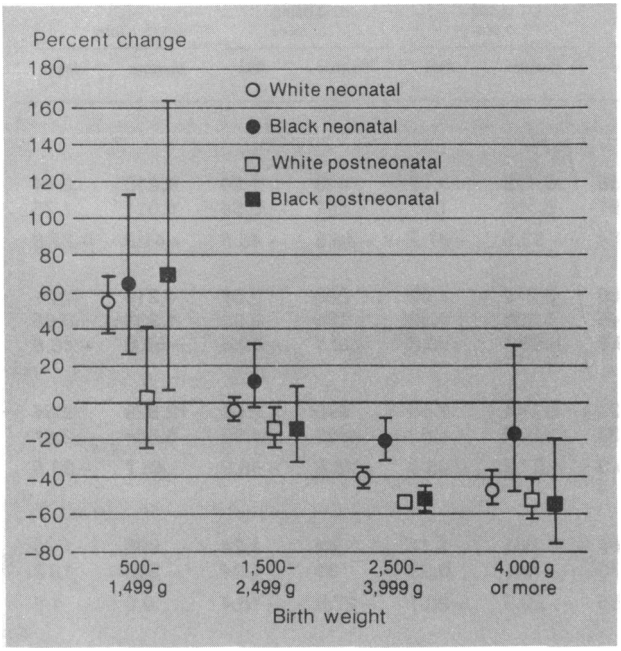
[1] See footnote 1, table 2.
[2] There were 4,166,897 single-delivery live births with birth weights of 500 g or more (3,528,375 whites and 584,671 blacks) in 1960 and 3,540,163 (2,844,227 whites and 574,178 blacks) in 1980.
[3] Neonatal mortality risk = neonatal deaths per 1,000 live births in each birth weight category.
[4] Percentage change in number of deaths or mortality risk from 1960 to 1980.
[5] Postneonatal mortality risk = postneonatal deaths per 1,000 neonatal survivors in each birth weight category.
[6] Infant mortality risk = infant deaths per 1,000 live births in each birth weight category.

PNMR for blacks declined (table 4). These changes ranged from a decrease of 46.6 percent in white PNMR to an increase of 1.8 percent in black NMR. As described for all races, the greatest reductions in mortality risks occurred in infants with birth weights of 2,500 g or more. In these birth weight groups, PNMR decreased by more than 50 percent. Figure 1 shows these percentage changes in NMR and PNMR from 1960 to 1980 for blacks and whites in four birth weight categories, with 95 percent confidence intervals. In black infants with birth weights of 500–1,499 g, NMR and PNMR increased significantly, while for white infants only NMR increased significantly. In infants with birth weights of 2,500 g or more, NMR and PNMR significantly decreased except for the NMR for black infants with birth weights of 4,000 g or more.

Comparing blacks with whites, in 1980 the relative risks for neonatal, postneonatal, and infant mortality were 1.0, 1.2, and 1.0, respectively; for 1960 these relative risks were 0.7, 1.0, and 0.8, respectively (table 5). In the two lowest birth weight categories (500–1,499 g and 1,500–2,499 g) for 1960 and 1980, the relative risks for infant mortality were 0.5. The lowest relative risk (0.4) was for neonatal mortality in the same low birth weight categories for 1960 and 1980. Significant increases in black-white relative risks occurred in 1980 for neonatal and infant mortality in infants with birth weights of 4,000 g or more and for overall postneonatal mortality.

Within birth weight groups and overall, whites had a higher proportion of deaths due to congenital anomalies than blacks except for infants with birth weights of 500–1,499 g in 1980 (table 6). In 1960, 16.8 percent of white neonatal mortality and 7.5 percent of black neonatal mortality were due

Figure 1. Percentage change from 1960 to 1980 in neonatal and postneonatal mortality risks due to congenital anomalies in white and black single-delivery infants by birth weight groups, United States, 1960 and 1980 birth cohorts



NOTE: High and low brackets show 95 percent confidence interval around point estimate.

Table 5. Black to white relative risks for neonatal, postneonatal, and infant deaths due to congenital anomalies in single-delivery infants, by birth weight group, United States, 1960 and 1980 birth cohorts[1]

Birth cohort[2]	500–1,499 g	1,500–2,499 g	2,500–3,999 g	4,000 g or more	Total
Relative risk (black to white)					
Neonatal deaths:					
1960	[3]0.4	[3]0.4	[3]0.7	1.0	[3]0.7
1980	[3]0.4	[3]0.4	0.9	[3]1.6	1.0
Postneonatal deaths:					
1960	0.8	[3]0.7	0.9	1.4	1.0
1980	1.3	[3]0.7	0.9	1.3	[3]1.2
Infant deaths:					
1960	[3]0.5	[3]0.5	[3]0.8	1.2	[3]0.8
1980	[3]0.5	[3]0.5	0.9	[3]1.5	1.0

[1] See footnote 1, table 2.
[2] See footnote 2, table 4.
[3] 95 percent confidence interval excludes 1.0 (*P* less than 0.05).

to congenital anomalies. In 1980, these percentages had increased but the twofold difference remained, with congenital anomalies accounting for 31.0 percent of white and 16.8 percent of black neonatal mortality. These differences in neonatal mortality risks between blacks and whites due to congenital anomalies are also prominent when NMRs are calculated by 500-g birth weight intervals (figs. 2 and 3). Both birth cohorts show a consistent pattern, with blacks having a lower birth weight-specific NMR at every birth weight increment below 3,500 g.

In 1960, congenital anomalies accounted for 23.1 percent of white and 8.4 percent of black postneonatal mortality; in 1980, these percentages showed a similar pattern to 1960, with 21.1 percent of white and 12.7 percent of black postneonatal mortality due to congenital anomalies.

Individual congenital anomaly categories. Anomalies of the cardiovascular system led all systems as a cause of deaths attributed to congenital anomalies (table 7). CNS anomalies ranked second among systems as a cause of mortality. In 1960 and 1980, among infants with birth weights of 2,500 g or more, cardiovascular anomalies accounted for more than 50 percent of the IMR due to congenital anomalies. Cardiovascular anomalies were also the leading system cause of mortality due to congenital anomalies for both blacks and whites, except for low birth weight whites in 1960 and 1980 (table 8). Likewise, CNS anomalies were also the second leading system cause of mortality due to congenital anomalies for both blacks and whites.

For all races in 1960, cardiovascular and CNS anomalies combined accounted for 72 percent of mortality due to congenital anomalies (table 7). However, this percentage fell to 59 percent in 1980.

For infants with birth weights of 500–2,500 g, the birth weight-specific relative risks of neonatal mortality for blacks compared with whites in separate congenital anomalies categories were significantly less than 1.0, except for digestive anomalies in 1980 (table 8). The only significant increase in black to white relative risk for neonatal mortality occurred in 1980 for respiratory system anomalies in the total birth weight category.

Discussion

1960 to 1980 differences. Congenital anomalies, the second leading cause of both neonatal and postneonatal mortality among single-delivery infants in 1980, accounted for 24.1 percent of all infant deaths. Moreover, congenital anomalies accounted for nearly half of all neonatal deaths in infants with birth weights of 1,500–3,999 g.

The percentage of infant mortality due to congenital anomalies increased from 15.8 percent in 1960 to 24.1 percent in 1980. The proportion of

Figure 2. Birth weight-specific neonatal mortality risks due to congenital anomalies in 1960 in white and black single-delivery infants, United States, 1960 birth cohort

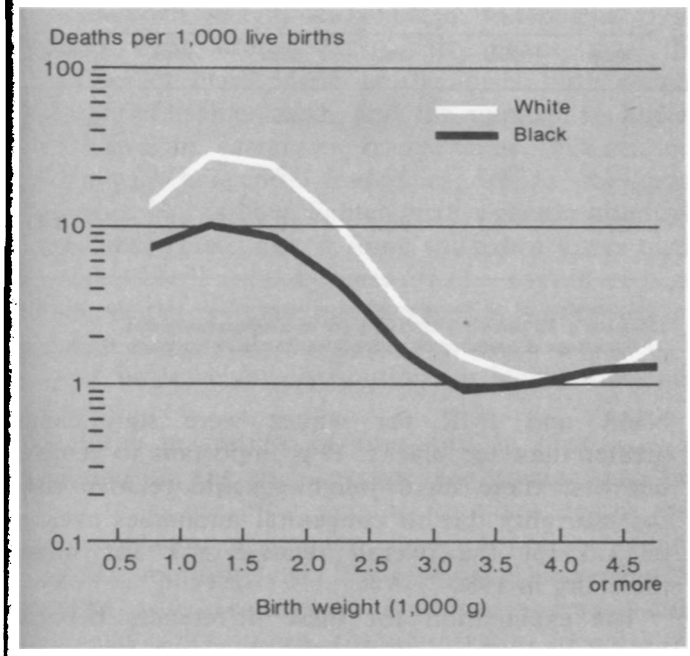
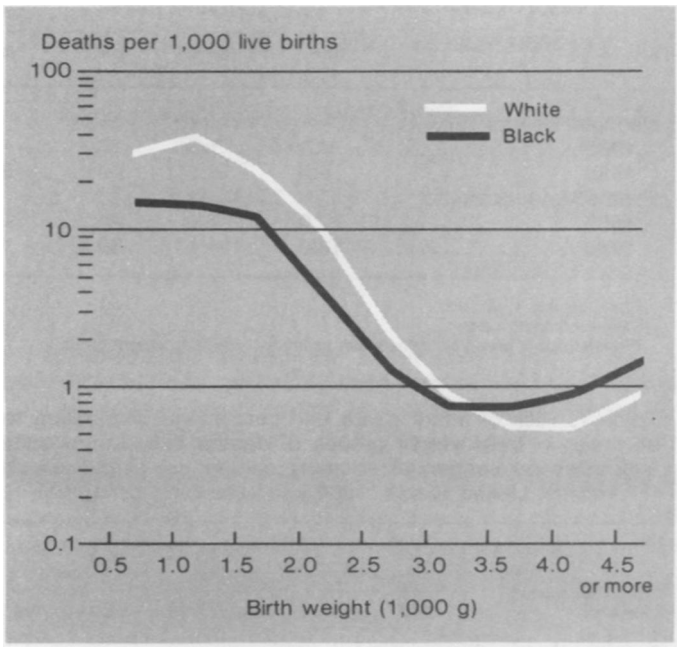


Figure 3. Birth weight-specific neonatal mortality risks due to congenital anomalies in 1980 in white and black single-delivery infants, United States, 1980 birth cohort



congenital anomaly deaths in the neonatal period also rose, from 66 percent in 1960 to 72 percent in 1980. These proportionate increases occurred because the mortality risks for congenital anomalies have declined the least among all other grouped causes of infant mortality (*9*). Although the overall IMR declined 54 percent, the IMR resulting from congenital anomalies declined only 31 percent. Other investigators have also described this increasing proportion of infant deaths due to congenital anomalies (*5*). If this trend has continued since 1980, the impact of congenital anomalies on infant mortality has continued to increase.

The distribution of improvement in mortality risks by birth weight also differed between congenital anomalies and all other causes. For congenital anomalies, large decreases in birth weight-specific mortality risks occurred only in infants with birth weights of 2,500 g or more; for all other causes, large decreases in birth weight-specific mortality risks occurred in infants with birth weights of 1,000–2,499 g (*1*). For infants with birth weights of 500–1,499 g, the risk of death due to congenital anomalies and infections actually increased (*9*). The reasons for these findings are not clear; however, more accurate ascertainment of mortality due to congenital anomalies in these low birth weight groups since 1960 is probably a factor.

It has been proposed that modern perinatal care is postponing infant deaths from the neonatal to the postneonatal period (*9,15–18*). From our analysis of the NIMS data, we found that congenital anomalies do not seem to fit into this pattern, although it seems reasonable that surgery and intensive supportive care for some severe congenital anomalies might postpone death until after the neonatal period. The proportion of postneonatal deaths caused by congenital anomalies in 1980 is almost the same as in 1960. In fact, for congenital anomalies, the PNMR declined more than 50 percent from 1960 to 1980.

Among congenital anomalies, the two major system categories of mortality—cardiovascular and central nervous system—accounted for proportionately fewer deaths in 1980 than in 1960. This relative improvement may be due to the great strides made since 1960 in cardiac surgery and neurosurgery for congenital anomalies and to the falling prevalence of CNS anomalies at birth since 1960 (*19*).

Black-white differences. The congenital anomalies category was the only cause of death category in which overall IMRs of blacks and whites were approximately equal instead of that for blacks being twice as high as for whites (*9*). Black infants with low birth weights had a NMR for congenital anomalies that was less than half that found in whites. The only other category for low birth weight infants in which blacks had lower birth

Table 6. Deaths due to congenital anomalies as a percentage of neonatal and postneonatal deaths from all causes of white and black single-delivery infants, by birth weight groups, United States, 1960 and 1980 birth cohort[1]

Birth cohort[2]	500–1,499 g		1,500–2,499 g		2,500–3,999 g		4,000 g or more		Total	
	White	Black	White	Black	White	Black	White	Black	White	Black
Neonatal deaths[3]:										
1960	[4]3.2	1.5	16.4	9.6	33.4	15.7	28.0	10.7	16.8	7.5
1980	9.2	4.6	49.1	37.8	52.4	36.5	40.1	30.7	31.0	16.8
Postneonatal deaths[5]:										
1960	17.0	7.9	24.7	9.0	22.9	8.1	23.7	10.1	23.1	8.4
1980	13.9	14.4	30.5	18.3	19.6	10.5	21.9	15.2	21.1	12.7

[1] See footnote 1, table 2.
[2] See footnote 2, table 4.
[3] Percentage is based on all neonatal deaths in each birth weight group.
[4] Explanation: of all neonatal deaths in white infants with birth weights of 500–1,499 g, 3.2 percent in 1960 were due to congenital anomalies.
[5] Percentage is based on all postneonatal deaths in each birth weight group.

Table 7. Risk of infant death and percentage distribution for all races in birth weight groups of deaths due to congenital anomalies by congenital anomaly categories, single-delivery infants, United States, 1960 and 1980 birth cohorts[1,2]

Congenital anomaly category	500–2,499 g		2,500 g or more		Total	
	1960	1980	1960	1980	1960	1980
Infant mortality risk[3]						
Central nervous system	4.19	3.35	0.61	0.25	0.85	0.45
Cardiovascular	5.62	3.97	1.41	0.79	1.70	0.98
Respiratory	0.46	1.79	0.05	0.06	0.08	0.18
Digestive	2.04	0.60	0.26	0.05	0.38	0.09
Urinary	0.76	1.26	0.09	0.05	0.14	0.12
Chromosomal	0.14	1.76	0.03	0.07	0.04	0.17
All other	2.61	4.17	0.19	0.20	0.35	0.46
Total	15.81	16.89	2.64	1.46	3.53	2.45
Percentage distribution						
Central nervous system	[4]26.5	19.8	23.0	17.2	24.0	18.4
Cardiovascular	35.5	23.5	53.4	53.9	48.0	40.2
Respiratory	2.9	10.6	2.1	4.4	2.3	7.3
Digestive	12.9	3.5	9.7	3.3	10.7	3.5
Urinary	4.8	7.4	3.5	3.1	3.9	4.9
Chromosomal	0.9	10.4	1.1	4.6	1.0	7.0
All other	16.5	24.7	7.2	13.5	10.0	18.8
Total	100.0	100.0	100.0	100.0	100.0	100.0

[1] See footnote 1, table 2.
[2] See footnote 2, table 2.
[3] Infant deaths per 1,000 live births in each birth weight category.
[4] Explanation: of all infant deaths due to congenital anomalies in infants with birth weights of 500–2,499 g, 26.5 percent in 1960 were due to central nervous system anomalies.
NOTE: Risks or percentages may not add to totals due to rounding.

weight-specific mortality risks than whites was perinatal conditions (*9*). For infants with birth weights of 2,500–3,999 g in 1980, the mortality risks due to congenital anomalies for blacks and whites were approximately equal. Finally, for infants with birth weights of 4,000 g or more the NMR and IMR for whites were significantly greater than for blacks. It is important to remember that these 'birth weight-specific relative risks for mortality due to congenital anomalies average to 1.0 for the overall relative risk for infant mortality in 1980.

The explanation for these differences between blacks and whites is unclear, but one hypothesis concerns differential ascertainment of causes of deaths. For example, underascertainment of congenital anomalies as a cause of death in low birth weight black infants or overascertainment of congenital anomalies as a cause of death in low birth weight white infants would result in these ratios. It is likely that some low birth weight infants with severe congenital anomalies (for example, anencephalus) were not considered as live births in 1960. This misclassification of pregnancy outcomes is probably more true for blacks than for whites, especially for the lowest birth weight categories (*1*). It is not possible to examine fetal death records for deaths due to congenital anomalies, preventing further study of misclassification. However, for NMR this difference between blacks and whites existed for all birth weight groups of greater than 3,000 g in 1960 and 1980. In addition, we excluded from this study infants with birth weights less than 500 g, the group most likely to be affected by these reporting problems.

Another explanation is the same as that described for perinatal conditions (*20,21*): at a given gestational age blacks have matured more than whites. This maturation factor might have some effect on overall survival, but one would expect this factor to have a greater effect on the category of perinatal conditions than on the category of congenital anomalies.

A more likely hypothesis is that black and white birth weights are distributed unequally for births

and for deaths due to congenital anomalies. For all infants, blacks have lighter birth weights, on average, than whites, so that there is a shift to a lower birth weight distribution for blacks compared with whites (*22*). This means that the number of black births in the lower birth weight categories is increased, and the number in higher birth weight categories is decreased. For infants born with congenital anomalies, we do not know whether blacks have lighter birth weights, although it is likely that there is some shift to a lower birth weight distribution because of the overall risk of lower birth weights in blacks. For infant deaths due to congenital anomalies, we found a shift to a lower birth weight distribution for blacks (data not shown).

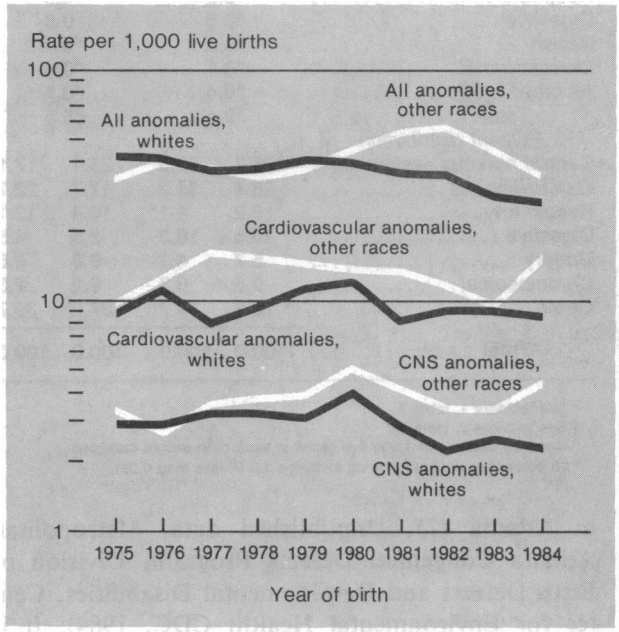
If the magnitude of this shift in birth weight distribution for all black births is greater than the shift to lighter birth weights for black deaths due to congenital anomalies, then the birth weight-specific mortality risks for congenital anomalies in blacks will decrease. This occurs because this unequal shift causes the numerator (deaths) to increase less than the denominator (births) for blacks in the lower birth weight categories. The opposite would occur for blacks in the higher birth weight categories. This would lead to lower mortality risks and black-to-white relative risks for congenital anomalies in the lower birth weight categories. Another way to describe this situation is that causes of low birth weight other than congenital anomalies are more prevalent in blacks than whites. We have some evidence to support this hypothesis.

First, the fact that whites have a higher proportion of all neonatal deaths due to congenital anomalies than blacks supports this hypothesis. This means that a larger proportion of neonatal mortality in blacks than in whites in all birth weight groups is due to causes other than congenital anomalies. Another supporting fact is that although black and white low birth weight infants have different mortality risks, they have similar distributions in congenital anomaly categories. This similar distribution suggests that these differences between blacks and whites are not the result of differences in the distribution of anomalies between blacks and whites. But to evaluate this similar distribution further, we need to know more about the birth prevalence of congenital anomalies.

Although data on race-specific birth weight distributions for congenital anomalies do not exist, we do have data about the overall black and white birth prevalence of congenital anomalies. One

'The congenital anomalies category was the only cause of death category in which overall black and white infant mortality risks were approximately equal instead of blacks being twice as high as whites.'

Figure 4. Birth prevalence of all congenital anomalies, cardiovascular anomalies, and central nervous system (CNS) anomalies in whites and other races, Atlanta, GA, 1975-84



SOURCE: Metropolitan Atlanta Congenital Defects Program (CDC).

analysis of the Collaborative Perinatal Project (*23*) showed that the incidence of anomalies was higher in blacks, the death-to-case ratio lower, and the perinatal mortality risk lower. However, the differences were small and would not account for the differences seen in our study. Moreover, another report from the Collaborative Perinatal Project concluded that there were no differences in major malformations between blacks and whites but that the differences seen in total malformations were due to increases in a few minor malformations among blacks (*24*).

Figure 4 shows population-based birth prevalence data for congenital malformations from 1975 to 1984 for whites and other races (mostly blacks)

Table 8. Risk of neonatal death, relative risk, and percent distribution in white and black birth weight groups of deaths due to congenital anomalies by congenital anomaly categories, single-delivery infants, United States, 1960 and 1980 birth cohorts[1,2]

Congenital anomaly category	500–2,499 g				2,500 g or more				Total			
	1960		1980		1960		1980		1960		1980	
	White	Black	White	Black	White	Black	White	Black	White	Black	White	Black
Neonatal mortality risk[3]												
Central nervous system	4.39	1.16	3.70	1.24	0.37	0.16	0.17	0.13	0.61	0.28	0.36	0.26
Cardiovascular	4.21	1.88	2.83	1.65	0.86	0.62	0.49	0.53	1.06	0.77	0.61	0.67
Respiratory	0.47	0.23	1.67	0.88	0.04	0.04	0.05	0.06	0.07	0.06	0.14	0.18
Digestive	2.00	1.03	0.41	0.33	0.16	0.15	0.02	0.02	0.27	0.25	0.04	0.06
Urinary	0.84	0.23	1.58	0.41	0.06	0.07	0.04	0.04	0.11	0.09	0.12	0.08
Chromosomal	0.12	0.01	1.48	0.53	0.01	0.01	0.03	0.04	0.02	0.01	0.11	0.09
All other	2.78	1.12	4.36	2.23	0.15	0.13	0.16	0.13	0.30	0.24	0.39	0.40
Total	14.81	5.67	16.02	7.28	1.67	1.17	0.97	0.94	2.44	1.70	1.76	1.73
Relative risk (blacks-whites)												
Central nervous system	[4]0.3		[4]0.3		[4]0.4		[4]0.8		[4]0.5		[4]0.7	
Cardiovascular	[4]0.4		[4]0.6		[4]0.7		1.1		[4]0.7		1.1	
Respiratory	[4]0.5		[4]0.5		1.0		1.1		0.9		[4]1.3	
Digestive	[4]0.5		0.8		0.9		1.2		0.9		1.5	
Urinary	[4]0.3		[4]0.3		1.2		0.9		0.9		[4]0.6	
Chromosomal	[4]0.1		[4]0.4		0.4		1.2		0.3		0.9	
All other	[4]0.4		[4]0.5		0.8		0.8		0.8		1.0	
Total	[4]0.4		[4]0.5		[4]0.7		1.0		[4]0.7		1.0	
Percent distribution												
Central nervous system	[5]29.7	20.5	23.1	17.1	22.3	13.7	17.8	14.0	24.9	16.4	20.2	15.1
Cardiovascular	28.4	33.2	17.7	22.7	51.8	52.8	50.9	56.1	43.4	45.1	34.7	38.5
Respiratory	3.2	4.1	10.4	12.1	2.5	3.5	5.7	6.5	2.8	3.7	8.0	10.4
Digestive	13.5	18.2	2.5	4.5	9.8	12.4	1.7	2.1	11.1	14.7	2.2	3.3
Urinary	5.7	4.1	9.8	5.6	3.8	6.3	4.3	3.8	4.4	5.4	6.8	4.4
Chromosomal	0.8	0.3	9.2	7.3	0.8	0.5	3.3	4.0	0.8	0.4	6.0	5.3
Other	18.8	19.7	27.2	30.7	9.0	10.8	16.5	13.6	12.5	14.3	22.0	23.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] See footnote 1, table 2.
[2] See footnote 2, table 4.
[3] Neonatal deaths per 1,000 live births in each birth weight category.
[4] 95 percent confidence interval excludes 1.0 (*P* less than 0.05).
[5] Explanation: of all neonatal deaths due to congenital anomalies in white infants with birth weights of 500–2,499 g, 29.7 percent in 1960 were due to central nervous system anomalies.
NOTE: Risks or percentages may not add to totals due to rounding.

in Atlanta (*25*, Unpublished data, Metropolitan Atlanta Congenital Defects Program, Division of Birth Defects and Developmental Disabilities, Center for Environmental Health, CDC, 1984). It is apparent that "other races" had an equal or greater prevalence at birth than whites for all anomalies, CNS anomalies, and cardiovascular anomalies. Although we do not have data on the birth weight distribution of congenital anomaly births, it is unlikely that the birth prevalence in low birth weight black infants is half that of whites or that the birth prevalence in higher birth weight black infants is higher than that for whites. Because of the similarity in the prevalence rates of blacks and whites, it is likely that there is not enough difference in the birth prevalences to account for these mortality risk differences.

Differences in the case-facility rate between blacks and whites could be important contributors to this difference in mortality risk if the black case-fatality rate is half the rate in low birth weight white infants or the black rate is higher in the higher birth weight infants. These results could result from different rates of survival for blacks and whites in individual defect categories, especially if there was a different distribution of these fatal defects in blacks and whites. However, the racial differences in table 8 are not great enough to account for a twofold difference in NMR in low birth weight infants. Because the distribution of categories of congenital anomalies is similar between blacks and whites and the prevalence of anomalies is similar, it is unlikely that racial differences in case-fatality rate could completely explain the differences between blacks and whites.

Thus, we suggest that unequal birth weight distributions for blacks and whites could account for the conflicting findings of survival from life-threatening congenital anomalies for infants born at different weights. The relative twofold higher mortality risks that blacks experience for other causes of death are not seen for life-threatening

congenital anomalies, probably because white infants born with such anomalies are at equal risk of death because of their condition. If this hypothesis is true, it would further suggest that for improvement to occur in black infant mortality related to causes other than congenital anomalies, improvement in their birth weight distribution and improvement in survival, regardless of birth weight, needs to occur.

There are a number of limitations in comparing mortality in 1960 with 1980 (*1*). Changes have occurred in the completeness of birth and death registration from 1960 to 1980, and the effect of these changes on the 1960–80 comparison cannot be determined fully. Our study is based on vital records, and the accuracy of congenital anomaly information on birth and death certificates may vary widely (*26*).

It is important to remember that the issue of morbidity has not been addressed. For congenital anomalies, as mortality falls in the absence of a decline in birth prevalence, morbidity increases. Congenital anomalies, a major cause of infant mortality and morbidity, must be prevented to eliminate their impact on death and disability. Efforts to decrease infant mortality should aim to prevent congenital anomalies, perinatal conditions, and sudden infant death syndrome, the three major causes of infant mortality.

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