Birth Weight-Specific Causes of Infant Mortality, United States, 1980

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This research was supported in part by the National Institute of Child Health and Human Development, the Health Resources and Services Administration, and the National Center for Health Statistics, all Agencies of the Public Health Service.

The findings were presented in part at the annual meeting of the Population Association of America, San Francisco, CA, April 3, 1986, at the National Infant Mortality Surveillance Conference, Atlanta, GA, May 1, 1986, and at the annual meeting of the American Public Health Association, Las Vegas, NV, September 29, 1986.

Contributing to the research were the following persons from the Research and Statistics Branch: Jeanne C. Gilliland, J. Patrick Whitaker, and Evelyn L. Finch, who worked on systems design and assisted in computer programming, aggregating data from 53 vital statistics reporting areas; Sara W. Gill and Merrell Ramick, who assisted in preparing the data for processing; and Phyllis A. Wingo, who coordinated the data management. Joel C. Kleinman, PhD, and Patricia Knapp, Division of Analysis, National Center for Health Statistics, provided assistance in the use of data from the 1960 birth cohort study.

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Synopsis

To describe underlying causes of infant death by birth weight, we used data from the 1980 National Infant Mortality Surveillance project and aggregated International Classification of Diseases codes into seven categories: perinatal conditions, infections, congenital anomalies, injuries, sudden infant death syndrome (SIDS), other known causes, and nonspecific or unknown causes.

Compared with heavier infants, infants with birth weights of 500–2,499 grams (g) are at increased risk of both neonatal and postneonatal death for virtually all causes. Sixty-two percent of neonatal deaths (under 28 days of life) were attributed to "conditions arising in the perinatal period," as defined using codes from the International Classification of Diseases. Prematurity-low birth weight and respiratory distress syndrome (RDS) were the leading causes of such deaths among infants with birth weights of 500–2,499 g, while birth trauma-hypoxia-asphyxia and other perinatal respiratory conditions were the leading causes among heavier infants.

For all birth weight groups, congenital anomalies were the second leading cause, representing 27 percent of neonatal deaths. Although perinatal conditions caused nearly one-third of postneonatal deaths (28 days to under 1 year of life) among infants with birth weights of 500–1,499 g, for the other birth weight groups these conditions were much less important; predominant causes of postneonatal death were sudden infant death syndrome (SIDS), congenital anomalies, infections, and injuries.

Black infants had a roughly twofold higher risk of neonatal and postneonatal death than did white infants for all causes except congenital anomalies, which occurred with almost equal frequency in blacks and whites. However, for infants with birth weights of 500–2,499 g, blacks had lower risks of neonatal death from RDS and congenital anomalies. Between 1960 (the latest year for which national birth weight-specific mortality statistics had been available) and 1980, SIDS emerged as a major diagnostic rubric. Otherwise, except for infections and congenital anomalies among infants with birth weights of 500–1,499 g, all causes of death declined in frequency among all birth weight groups.

INFANT MORTALITY can be divided into components that reflect different aspects of maternal and infant risk and health services through examination of infant deaths by underlying cause, birth weight, and age at death. In this paper, we use data from the 1980 National Infant Mortality Surveillance (NIMS) project to describe

- causes of neonatal and postneonatal deaths by birth weight,

- differences in causes of death between white and black infants, and
- changes that occurred between 1960 (the previous year for which national birth weight-specific mortality statistics are available) and 1980 in causes of infant deaths.

Methods

The methods of the National Infant Mortality Surveillance (NIMS) project, including data collection and evaluation, are described in detail elsewhere (*1-3*). 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 approximately 95 percent (*1*, *2*). 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 (*1*). For logistic reasons, categories for race of infant were limited to white, black, and all races combined. Race of infant was based on the race of both parents, using the NCHS algorithm (*4*).

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." We define the neonatal mortality risk (NMR) as the number of neonatal deaths (under 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 per 1,000 live births. For calculation of mortality risks, infants with unknown birth weight (0.2 percent of births and 3.3 percent of infant deaths) were assigned to birth weight categories according to the proportions of births and deaths with known birth weight (*1*).

States also provided tabulations of infant deaths by individual codes for underlying cause of death, using the International Classification of Diseases, Ninth Revision (ICD-9) (*5*), and determined underlying cause of death from information provided on death certificates. Unlike other phases of the NIMS project, data collected on causes of death were limited to single-delivery infants with birth weights of 500 grams (g) or more. (In the NIMS report [*1*], infants with birth weights of less than 500 g were assigned to the ICD-9 code 765.0 [extreme immaturity]). Because we excluded infants with birth weights under 500 g from this analysis, numbers and risks of death in the "total" birth weight category will differ from the NIMS report [*1*]).

We aggregated the ICD-9 codes into the following categories and subcategories:

perinatal conditions (referring to the time of disease onset rather than the age at death)
  prematurity and low birth weight (LBW)
  respiratory distress syndrome (RDS) and bronchopulmonary dysplasia (BPD)
  other perinatal respiratory conditions
  birth trauma-hypoxia-asphyxia
  others, excluding infection
infections
  perinatal
  others
congenital anomalies
injuries
sudden infant death syndrome (SIDS)
cardiac or respiratory arrest and other nonspecific or unknown causes
all other causes

The NIMS report lists the groupings by individual ICD-9 codes, which represent an extension of Wigglesworth's approach to identifying not only different etiologic processes but also different problems in care or prevention (*1*, *6*).

The NIMS data do not include information about whether autopsies were done. To compare the proportion of deaths of white and black infants that were accompanied by autopsy, we used the 1980 and 1981 national mortality computer tapes produced by the National Center for Health Statistics (NCHS). From these tapes we could identify deaths that occurred in 1980 and 1981 among infants born in 1980. However, because the NCHS mortality files are not linked to birth certificates, we could not determine autopsy rates by birth weight for single-delivery infants as separate from all infants, or by race at birth instead of race at death.

To compare risks of death by cause and birth

Table 1. Percent of total infant deaths[1] by birth weight, age at death, and underlying cause of death, single-delivery infants, United States, 1980 birth cohort

Cause of death	500–1,499 g	1,500–2,499 g	2,500–3,999 g	4,000 g or more	Unknown	Total[1]
Neonatal deaths						
Perinatal conditions[2]	[3]27.15	4.48	5.26	0.86	2.07	39.83
Prematurity-low birth weight	5.80	0.21	0.11	0.09	0.52	6.73
Respiratory distress syndrome-broncho-pulmonary dysplasia	8.03	1.69	0.57	0.05	0.33	10.68
Other perinatal respiratory	3.39	0.65	1.42	0.19	0.24	5.89
Birth trauma-hypoxia-asphyxia	2.68	0.76	1.74	0.31	0.30	5.80
Other perinatal	7.24	1.17	1.41	0.22	0.68	10.73
Infections[2]	0.83	0.97	1.41	0.12	0.06	3.39
Perinatal	0.67	0.64	0.77	0.06	0.05	2.20
Other	0.16	0.33	0.64	0.06	0.01	1.19
Congenital anomalies	2.42	5.28	8.18	0.73	0.79	17.40
Injuries	0.03	0.04	0.19	0.01	0.02	0.30
Sudden infant death syndrome	0.01	0.19	0.88	0.06	0.01	1.15
Cardiac-respiratory arrest and unknown	0.09	0.06	0.14	0.02	0.01	0.32
All other	0.52	0.31	0.71	0.09	0.09	1.70
Total[2]	31.05	11.32	16.75	1.89	3.06	64.08
Postneonatal deaths						
Perinatal conditions[2]	1.16	0.34	0.41	0.03	0.07	2.02
Prematurity-low birth weight	0.07	0.01	0.01	0.00	0.00	0.09
Respiratory distress syndrome-broncho-pulmonary dysplasia	0.79	0.18	0.06	0.01	0.03	1.06
Other perinatal respiratory	0.06	0.04	0.08	0.01	0.01	0.21
Birth trauma-hypoxia-asphyxia	0.04	0.04	0.12	0.01	0.01	0.22
Other perinatal	0.19	0.07	0.14	0.01	0.02	0.44
Infections[2]	0.55	0.82	3.17	0.26	0.04	4.84
Perinatal	0.04	0.04	0.04	0.00	0.00	0.13
Other	0.51	0.77	3.14	0.26	0.04	4.71
Congenital anomalies	0.49	1.54	4.12	0.42	0.09	6.66
Injuries	0.07	0.36	2.42	0.21	0.02	3.08
Sudden infant death syndrome	0.40	1.89	9.79	0.72	0.11	12.90
Cardiac-respiratory arrest and unknown	0.12	0.22	0.81	0.09	0.01	1.25
All other	0.73	0.74	3.33	0.32	0.05	5.18
Total[2]	3.54	5.89	24.04	2.06	0.39	35.92
Infant deaths						
Perinatal conditions[2]	28.32	4.83	5.67	0.90	2.14	41.84
Prematurity-low birth weight	5.87	0.22	0.12	0.09	0.52	6.82
Respiratory distress syndrome-broncho-pulmonary dysplasia	8.83	1.87	0.63	0.05	0.36	11.74
Other perinatal respiratory	3.45	0.70	1.50	0.20	0.25	6.10
Birth trauma-hypoxia-asphyxia	2.73	0.80	1.86	0.32	0.31	6.02
Other perinatal	7.44	1.24	1.55	0.23	0.70	11.16
Infections[2]	1.38	1.78	4.58	0.39	0.10	8.23
Perinatal	0.72	0.68	0.81	0.07	0.05	2.32
Other	0.66	1.10	3.77	0.32	0.05	5.90
Congenital anomalies	2.92	6.81	12.30	1.15	0.88	24.06
Injuries	0.11	0.40	2.60	0.22	0.05	3.38
Sudden infant death syndrome	0.40	2.07	10.67	0.78	0.12	14.04
Cardiac-respiratory arrest and unknown	0.21	0.28	0.94	0.11	0.03	1.57
All other	1.25	1.04	4.04	0.41	0.14	6.88
Total[2]	34.59	17.22	40.80	3.95	3.45	100.00

[1] Total deaths among infants with known birth weight ≥500 g plus infants with unknown birth weight, n = 36,055.

[2] Percentages may not add to totals and subtotals due to rounding.

[3] Explanation: 27.15 percent of all infant deaths were due to perinatal conditions and occurred during the neonatal period among infants with birth weights of 500–1,499 g.

weight in the 1980 and 1960 cohorts, we used data, as described in the accompanying report by Buehler and co-workers (*7*), from the national linkage of birth and death certificates done by NCHS for the 1960 birth cohort (*8*). The computer tape of linked certificates from the 1960 study provided individual codes for underlying cause of death, based on the seventh revision of the ICD (*9*). There are substantial differences between ICD-7 and ICD-9, particularly for conditions arising in

Table 2. Risk of infant deaths[1] by birth weight, age at death, and underlying cause of death, single-delivery infants, United States, 1980 birth cohort

Cause of death	500–1,499 g	1,500–2,499 g	2,500–3,999 g	4,000 g or more	Total
Neonatal mortality risk[2]					
Perinatal conditions[3]	333.47	9.57	0.68	0.85	4.05
Prematurity-low birth weight	72.94	0.46	0.02	0.09	0.68
Respiratory distress syndrome-broncho-pulmonary dysplasia	96.50	3.55	0.07	0.05	1.09
Other perinatal respiratory	41.08	1.39	0.18	0.19	0.60
Birth trauma-hypoxia-asphyxia	32.93	1.63	0.22	0.31	0.59
Other perinatal	90.03	2.55	0.18	0.22	1.09
Infection	9.79	2.01	0.18	0.12	0.34
Congenital anomalies	29.55	11.25	1.05	0.71	1.77
Injuries	0.42	0.09	0.02	0.01	0.03
Sudden infant death syndrome	0.10	0.38	0.11	0.05	0.12
Cardiac-respiratory arrest and unknown	1.11	0.13	0.02	0.02	0.03
Other	6.33	0.65	0.09	0.08	0.17
Total[3]	380.78	24.08	2.14	1.86	6.52
Postneonatal mortality risk[4]					
Perinatal conditions	22.59	0.74	0.05	0.03	0.21
Infection	10.46	1.71	0.39	0.25	0.50
Congenital anomalies	9.40	3.25	0.51	0.40	0.68
Injuries	1.42	0.75	0.30	0.20	0.32
Sudden infant death syndrome	7.51	3.97	1.21	0.68	1.32
Cardiac-respiratory arrest and unknown	2.27	0.46	0.10	0.08	0.13
Other	13.95	1.55	0.41	0.30	0.53
Total[3]	67.60	12.43	2.98	1.94	3.68

[1] For calculation of mortality risks, numbers of infants with unknown birth weight were redistributed into number with known birth weight (see text).
[2] Neonatal deaths per 1,000 live births.
[3] Risks may not add to totals and subtotals due to rounding.
[4] Postneonatal deaths per 1,000 neonatal survivors.

the perinatal period. Thus, perinatal conditions were not divided into subcategories for this comparison. In ICD-7 there was no code specific for SIDS comparable to the ICD-9 code of 798.0. In this analysis, we used the ICD-7 code 795.2 (sudden death, cause unknown) to represent SIDS. A detailed listing of categories for ICD-7 codes used in this comparison is available on request.

We compared mortality risks using the relative risk of death for different race groups or time periods and calculated 95 percent confidence intervals using the test-based method as described by Rothman and Boice (*10*). Except for redistribution of numbers of infants with unknown birth weight in 1980, we made all calculations with a microcomputer spreadsheet and retained unrounded numbers for calculations at each stage.

Results

Number of deaths. A total of 36,055 infant deaths occurred among single-delivery infants born in 1980 with known birth weights of 500 g or more or unknown birth weight. The distribution of these deaths by underlying cause, birth weight, and age at death is shown in table 1. For neonatal deaths, major findings are

- Conditions arising in the perinatal period were the leading cause of neonatal death. Such deaths among infants with birth weights of 500–1,499 g accounted for 27 percent of all infant deaths, and most of these deaths were due to prematurity-LBW or RDS-BPD.
- As birth weight increased, birth trauma-hypoxia-asphyxia caused an increasing proportion of deaths due to perinatal conditions.
- Congenital anomalies accounted for nearly half of neonatal deaths among infants with birth weights of 1,500–2,499 g and 2,500–3,999 g.
- Perinatal infections accounted for the majority of neonatal deaths attributed to infections. Of the 792 deaths due to perinatal infections, 727 (91.8 percent) were assigned the ICD-9 code 771.8, which includes neonatal septicemia.

For postneonatal deaths, major findings are

- SIDS was the leading cause of postneonatal death. Postneonatal SIDS among infants with

Table 3. Comparison of neonatal mortality risks,[1] black and white single-delivery infants, by birth weight and underlying cause of death, United States, 1980 birth cohort

Cause of death	500–1,499 g	1,500–2,499 g	2,500–3,999 g	4,000 g or more	Total
Whites					
Perinatal conditions [2]	342.79	10.60	0.59	0.74	3.33
Prematurity-low birth weight	70.53	0.43	0.01	0.07	0.51
Respiratory distress syndrome-broncho-pulmonary dysplasia	106.62	4.28	0.07	0.04	0.96
Other perinatal respiratory	40.56	1.52	0.15	0.15	0.48
Birth trauma-hypoxia-asphyxia	34.97	1.71	0.21	0.27	0.52
Other perinatal	90.11	2.66	0.16	0.20	0.87
Infections	9.04	2.04	0.16	0.10	0.29
Congenital anomalies	36.28	13.50	1.05	0.66	1.76
Injuries	0.51	0.06	0.02	0.02	0.02
Sudden infant death syndrome	0.16	0.30	0.09	0.05	0.09
Cardiac-respiratory arrest and unknown	1.01	0.13	0.01	0.01	0.03
All other	5.76	0.76	0.08	0.08	0.15
Total [2]	395.53	27.38	2.01	1.66	5.68
Blacks					
Perinatal conditions [2]	310.66	7.33	1.07	2.05	7.59
Prematurity-low birth weight	76.02	0.51	0.05	0.29	1.55
Respiratory distress syndrome-broncho-pulmonary dysplasia	76.96	2.00	0.11	0.17	1.75
Other perinatal respiratory	41.45	1.06	0.32	0.52	1.18
Birth trauma-hypoxia asphyxia	27.85	1.44	0.30	0.64	0.95
Other perinatal	88.38	2.32	0.30	0.43	2.17
Infections	11.04	1.90	0.27	0.27	0.62
Congenital anomalies	15.58	6.04	0.98	1.10	1.73
Injuries	0.29	0.12	0.05	0.00	0.06
Sudden infant death syndrome	0.00	0.55	0.22	0.07	0.24
Cardiac-respiratory arrest and unknown	1.28	0.11	0.03	0.10	0.06
All other	7.21	0.38	0.14	0.11	0.29
Total [2]	346.06	16.43	2.76	3.69	10.60
Relative risk blacks versus whites					
Perinatal conditions	[3]0.9	[3]0.7	[3]1.8	[3]2.8	[3]2.3
Prematurity-low birth weight	1.1	1.2	[3]5.4	[3]4.0	[3]3.0
Respiratory distress syndrome-broncho-pulmonary dysplasia	[3]0.7	[3]0.5	[3]1.6	[3]4.9	[3]1.8
Other perinatal respiratory	1.0	[3]0.7	[3]2.2	[3]3.4	[3]2.5
Birth trauma-hypoxia asphyxia	[3]0.8	0.8	[3]1.4	[3]2.3	[3]1.8
Other perinatal	1.0	0.9	[3]1.9	[3]2.1	[3]2.5
Infections	1.2	0.9	[3]1.7	[3]2.8	[3]2.1
Congenital anomalies	[3]0.4	[3]0.4	0.9	[3]1.6	1.0
Injuries	0.6	1.9	[3]2.5	0.0	[3]2.4
Sudden infant death syndrome	0.0	[3]1.8	[3]2.5	1.4	[3]2.5
Cardiac-respiratory arrest and unknown	1.3	0.9	[3]1.9	[3]8.1	[3]2.5
All other	1.3	[3]0.5	[3]1.7	1.2	[3]2.0
Total	[3]0.9	[3]0.6	[3]1.4	[3]2.2	[3]1.9

[1] Neonatal deaths per 1,000 live births. For calculation of mortality risks, numbers of infants with unknown birth weight were redistributed into number with known birth weight (see text).

[2] Risks may not add to totals and subtotals due to rounding.

[3] 95 percent confidence interval excludes 1.0 ($P < 0.05$).

birth weights of 2,500–3,999 g represented 10 percent of all infant deaths.

- Congenital anomalies were the second leading cause of postneonatal death, representing nearly one-fifth of postneonatal deaths.
- Infectious diseases were the third leading cause. Among the 1,699 postneonatal deaths due to nonperinatal infections, 824 (48 percent) were due to respiratory infections, and 368 (22 percent) were due to central nervous system infections.
- Injuries were the fourth leading cause. The 1,112 postneonatal deaths classified as injuries included 350 (31 percent) from suffocation, 191 (17 percent) involving motor vehicles, 168 (15 percent) from assault, and 120 (11 percent) from burns and other fire-related injuries.
- Conditions arising in the perinatal period accounted for few postneonatal deaths, except

Table 4. Comparison of postneonatal mortality risks,[1] black and white single-delivery infants, by birth weight and underlying cause of death, United States, 1980 birth cohort [2]

Cause of death	500–1,499 g	1,500–2,499 g	2,500–3,999 g	4,000 g or more	Total
Whites					
Perinatal conditions	21.33	0.82	0.05	0.03	0.16
Infections	8.38	1.37	0.31	0.20	0.37
Congenital anomalies	8.38	3.48	0.51	0.39	0.65
Injuries	0.95	0.58	0.26	0.18	0.27
Sudden infant death syndrome	7.01	3.26	1.02	0.62	1.09
Cardiac-respiratory arrest and unknown	1.99	0.33	0.07	0.07	0.09
All other	12.41	1.54	0.36	0.29	0.45
Total [2]	60.45	11.38	2.58	1.78	3.08
Blacks					
Perinatal conditions	23.64	0.61	0.08	0.04	0.43
Infections	13.95	2.48	0.74	0.71	1.06
Congenital anomalies	10.65	2.53	0.48	0.50	0.80
Injuries	2.11	1.07	0.48	0.41	0.55
Sudden infant death syndrome	8.70	5.52	2.03	1.08	2.39
Cardiac-respiratory arrest and unknown	2.69	0.70	0.20	0.27	0.28
All other	16.40	1.52	0.68	0.41	0.94
Total [2]	78.13	14.42	4.71	3.42	6.45
Relative risk blacks versus whites					
Perinatal conditions	1.1	0.7	[3]1.8	1.3	[3]2.6
Infections	[3]1.7	[3]1.8	[3]2.4	[3]3.6	[3]2.9
Congenital anomalies	1.3	[3]0.7	0.9	1.3	[3]1.2
Injuries	[3]2.2	[3]1.9	[3]1.9	[3]2.2	[3]2.1
Sudden infant death syndrome	1.2	[3]1.7	[3]2.0	[3]1.7	[3]2.2
Cardiac-respiratory arrest and unknown	1.4	[3]2.1	[3]2.7	[3]4.1	[3]3.1
All other	[3]1.3	1.0	[3]1.9	1.4	[3]2.1
Total	[3]1.3	[3]1.3	[3]1.8	[3]1.9	[3]2.1

[1] Postneonatal deaths per 1,000 neonatal survivors. For calculation of mortality risks, numbers of infants with unknown birth weight redistributed into number with known birth weight (see text).

[2] Risks may not add to totals due to rounding.

[3] 95 percent confidence interval excludes 1.0 ($P < 0.05$).

among infants with birth weights of 500–1,499 g. For these babies, perinatal conditions, primarily BPD and RDS, were the leading cause of postneonatal death. Overall, perinatal conditions caused 728 postneonatal deaths, including 201 deaths (28 percent) due to BPD and 174 deaths (24 percent) due to RDS.

Risks of death. When we examined birth weight-specific mortality risks in 500 g intervals (not shown here) we found that the lowest mortality risk for neonatal deaths occurred in the 3,500–3,999 g range, and for postneonatal deaths, in the 4,000–4,499 g range. In general, the lowest risks by cause group fluctuated around these two birth weight groups.

The degree of increased risk of neonatal death associated with lower birth weight varied greatly by cause (table 2). For example, the risk of death for perinatal conditions among infants with birth weights of 500–1,499 g was nearly 500 times as great as the risk for the 2,500–3,999 g group, while the difference in magnitude for congenital anomalies was 28-fold.

For postneonatal deaths, the risk for all causes was higher among the lower birth weight groups, and the increase in risk for those with birth weights of 500–1,499 g compared with 2,500–3,999 g ranged from more than 450-fold for perinatal conditions to approximately 5-fold for injuries.

Race-specific mortality risks. Except for congenital anomalies, the overall neonatal mortality risks of blacks were approximately twice those of whites for all causes of death (table 3). There was an abrupt increase in the relative risk of death due to perinatal conditions for black compared with white infants that occurred between birth weights of 1,500–2,499 g to 2,500–3,999 g, particularly for prematurity-LBW, RDS-BPD, and other perinatal respiratory conditions (table 3).

During the postneonatal period, blacks were at higher risk of death for nearly all birth weight and cause groups (table 4). Only for congenital anoma-

Table 5. Percent of infant deaths with autopsy, by race of infant and underlying cause United States, 1980 birth cohort

Cause of death	White	Black	All [1]
Perinatal conditions	[2]34.1	30.3	32.9
Prematurity-low birth weight	18.6	20.2	19.2
Respiratory distress syndrome-bronchopulmonary dysplasia	40.3	36.1	39.0
Other perinatal respiratory	38.1	41.7	39.2
Birth trauma-hypoxia-asphyxia	39.8	34.7	38.6
Other perinatal	31.7	26.7	30.1
Infections	61.8	58.3	60.4
Congenital anomalies	53.8	53.0	53.7
Injuries	60.2	68.5	62.6
Sudden infant death syndrome	83.3	81.7	82.6
Cardiac-respiratory arrest and unknown	59.9	51.4	56.1
All other	57.5	57.0	57.2
Total	49.2	45.8	48.3

[1] All includes infants of white, black, other, and unknown races.
[2] Explanation: 34.1 percent of white infants whose deaths were attributed to perinatal conditions were autopsied.
SOURCE: NCHS 1980 and 1981 mortality tapes, not limited to single-delivery infants (see text).

lies in the 1,500–2,499 g birthweight range did blacks have a significantly lower postneonatal mortality risk than did whites (table 4).

Autopsies were performed on comparable percentages of black and white infants, as determined from the 1980 and 1981 NCHS mortality tapes (table 5).

1960–80 comparison. The risks of infant death by cause and birth weight for the 1960 birth cohort and the relative risk of death in 1980 compared with 1960 are shown in table 6. For infants with birth weights of 500–1,499 g, the risk of death due to perinatal conditions, the predominant cause of death, declined. Deaths due to infections and congenital anomalies increased, injuries declined, and other conditions increased. Among deaths due to other conditions in this weight group, no individual cause represented more than 10 percent of deaths, except for "other diseases of lung" (ICD-9 code 518) and "renal failure, unspecified" (ICD-9 code 586). There were no deaths classified as SIDS in 1960 for this weight group.

For the 1,500–2,499 g, 2,500–3,999 g, and 4,000 g or more groups, the risk of death for all causes declined, except for sudden death (table 6).

Overall, the risk of SIDS increased more than 50-fold. For the 1960 cohort, there were 112 deaths attributed to "sudden death, cause unknown"—the 1960 category used for SIDS in this comparison. If deaths that were assigned ICD-7 code E924.0 (accidental mechanical suffocation in bed and cradle) are added to the SIDS group for 1960, then there would have been 960 deaths classified as SIDS, and the apparent increase in the risk of SIDS is diminished considerably, although a sixfold increase remains (table 6).

From 1960 to 1980, the greatest declines in the risk of death occurred for infections and perinatal conditions, while the least decline occurred for congenital anomalies. As a result, in 1960, perinatal conditions and congenital anomalies accounted for 56.4 percent and 15.8 percent of infant deaths, and in 1980, 41.8 percent and 24.1 percent, respectively.

Discussion

Low birth weight is associated with an increased risk of both neonatal and postneonatal death, although the magnitude of the increase in risk varies greatly by cause of death and age at death. Low birth weight places some infants at higher risk of postneonatal death, and conditions that contribute to low birth weight also contribute independently to the risk of postneonatal death (*11*). Two-thirds of infant deaths are accounted for by perinatal conditions and congenital anomalies. More than half of the former occur among infants with birth weights of 500–1,499 g, highlighting the importance of both preventing low birth weight and insuring the appropriate level of care for women in premature labor and for small newborns (*12–14*). As suggested by changes from 1960 to 1980, congenital anomalies may become an increasingly prominent contributor to infant mortality, while deaths due to more readily preventable or treatable conditions decline more rapidly (*15*).

Strategies for preventing infant mortality vary by cause of death and birth weight (*16*). Although smaller infants are at higher risk of death, infants with birth weights of 2,500–3,999 g represent the majority of deaths for certain causes, particularly during the postneonatal period. This observation reflects the distribution of live births by birth weight and birth weight-specific mortality risks. For example, the majority of postneonatal deaths due to infections, injuries, and SIDS occur among infants with birth weights of 2,500–3,999 g. Reducing deaths coded to these categories will require different techniques from those needed to prevent low birth weight and neonatal death—techniques ranging from public health measures to limit communicable diseases, to interventions for pre-

Table 6. Comparison of infant mortality risks,[1] 1960 and 1980 United States birth cohorts, by birth weight and underlying cause of death

Cause of death	500–1,499 g	1,500–2,499 g	2,500–3,999 g	4,000 g or more	Total
1960 Birth cohort Infant mortality risk					
Perinatal conditions	653.18	61.20	3.17	3.05	12.57
Infections	11.36	11.07	3.28	2.29	3.71
Congenital anomalies	21.31	14.93	2.71	2.04	3.53
Injuries	2.30	1.81	0.78	0.59	0.84
Sudden infant death syndrome	0.00	0.08	0.02	0.03	0.03
Cardiac-respiratory arrest and unknown	2.87	1.60	0.36	0.34	0.46
All other	3.33	3.63	1.01	0.81	1.16
Total[2]	694.34	94.32	11.33	9.16	22.29
Sudden infant death syndrome—extra[3]	0.31	0.54	0.22	0.15	0.23
1980 Birth cohort Infant mortality risk					
Perinatal conditions	347.46	10.29	0.73	0.88	4.26
Infections	16.27	3.68	0.57	0.36	0.84
Congenital anomalies	35.37	14.41	1.56	1.11	2.45
Injuries	1.30	0.82	0.32	0.21	0.34
Sudden infant death syndrome	4.75	4.26	1.32	0.73	1.43
Cardiac respiratory arrest and unknown	2.52	0.58	0.12	0.10	0.16
All other	14.97	2.17	0.50	0.39	0.70
Total[2]	422.64	36.21	5.12	3.79	10.18
Relative risk of death, 1980 versus 1960					
Perinatal conditions	0.5	0.2	0.2	0.3	0.3
Infections	1.4	0.3	0.2	0.2	0.2
Congenital anomalies	1.7	1.0	0.6	0.5	0.7
Injuries	0.6	0.5	0.4	0.4	0.4
Sudden infant death syndrome	...	51.5	56.9	25.5	53.2
Cardiac-respiratory arrest and unknown	0.9	0.4	0.3	0.3	0.4
All other	4.5	0.6	0.5	0.5	0.6
Total	0.6	0.4	0.5	0.4	0.5
Sudden infant death syndrome—extra[3]	15.3	7.9	6.1	4.8	6.2

[1] Infants deaths per 1,000 live births. For calculation of mortality risks, numbers of infants with unknown birth weight redistributed into number with known birth weight (see text).

[2] Risks may not add to totals due to rounding. Total risks for 1980 may differ from other presentations of NIMS data due to the effect of redistributing unknown birth weights within categories for causes of death.

[3] Sudden infant death syndrome deaths for the 1960 cohort (see text) plus deaths assigned to ICD-7 code E924.0 (accidental mechanical suffocation in bed and cradle).

venting injuries, to improving our understanding of SIDS.

When we compared black and white infants, deaths due to RDS-BPD were substantially lower among blacks with birth weights under 2,500 g. One explanation for this observation is that pulmonary maturity may be achieved earlier in gestation among blacks compared with whites, as manifested by the greater responsiveness of black infants to antenatal steroids used to prevent RDS (*17,18*). Differences in pulmonary maturity may also contribute to the lower risks of death due to other perinatal respiratory conditions and to birth trauma-hypoxia-asphyxia among small black infants. However, this does not explain the higher risk of RDS-BPD among heavier black infants (unless misclassification of cause of death is much greater among blacks compared with whites in this category) or the higher risk of death due to other perinatal respiratory conditions and birth trauma-hypoxia-asphyxia among heavier black infants. In addition to pulmonary maturity, the risk of mortality from these latter disorders may be more dependent on access to obstetric and newborn care (*19,20*).

The lower mortality risk among black compared with white infants for deaths due to perinatal conditions wanes in the postneonatal period. Overall, except for congenital anomalies, blacks have a twofold or greater risk of postneonatal death for all causes. In this analysis, race is most likely acting as a surrogate for social and economic status, and the postneonatal mortality risk is sensitive not only to access to care but also to

social and environmental hazards that affect infant health in general (*21*). This explanation is consistent with the differences between blacks and whites for deaths due to infections, injuries, and possibly SIDS.

Infant deaths due to congenital anomalies, which occur with roughly equal frequency in blacks and whites, are the exception in the black-white comparison. Our finding that the risk of neonatal death due to congenital anomalies was slightly lower among blacks compared with whites is consistent with observations from the Collaborative Perinatal Project, where the incidence of major anomalies was higher in blacks, the death-to-case ratio lower, and the perinatal mortality risk lower (*22*). The question of black-white differences in deaths due to congenital anomalies is examined in greater detail in the accompanying article by Berry and co-workers (*23*).

Attention has recently been focused on the possibility that some infant deaths are being postponed from the neonatal to the postneonatal period by modern perinatal care (*24–27*). Several findings in our study suggest that this is occurring. First, among infants with birth weights of 500–1,499 g, who are all candidates for intensive care services, perinatal conditions are a leading cause of postneonatal death. Second, bronchopulmonary dysplasia, a condition that can follow treatment for respiratory distress syndrome, accounts for a substantial proportion of deaths due to perinatal conditions that occur in the postneonatal period. Third, between 1960 and 1980, risks of infant death due to perinatal conditions decreased among very small newborns, but rates of deaths due to other causes increased. This finding suggests that some infants who might have died from perinatal conditions in the past are now surviving the first weeks of life, but dying later from other diseases—an observation limited by possible changes in the use of various diagnostic rubrics between 1960 and 1980. Although the question of postponement is important to the health policy debate regarding the care of very small newborns, this effect of postponement probably did not have a major impact on postneonatal mortality risks for the 1980 cohort for three reasons. First, infants with birth weights of less than 1,500 g represent only 10 percent of postneonatal deaths. Second, conditions arising in the perinatal period represented only 6 percent of postneonatal deaths. Third, the *infant* mortality risk is declining for all birth weight groups.

From 1960 to 1980, risks of death for all major causes, except SIDS, declined among infants with birth weights of 1,500 g or more. Comparison of cause-specific mortality risks from 1960 to 1980 is complicated by changes in ICD codes between 1960 and 1980 and by the emergence of SIDS as a major diagnostic category. SIDS remains largely a diagnosis of exclusion, and autopsies were done in more than 80 percent of SIDS deaths. However, the quality of these autopsies cannot be determined from vital records, and autopsy alone may fail to identify some causes of death in SIDS cases, particularly among disadvantaged groups (*28*). Khoury and co-workers, in an examination of NCHS mortality data, considered the possibility that SIDS deaths may have previously been assigned a variety of other diagnoses, as suggested by our findings regarding ICD-7 codes that might reflect SIDS cases (*29*).

This study is based on vital records, and the accuracy of information on birth and infant death certificates may vary widely (*30*). Despite this limitation, the use of linked birth and death certificates offers a plausible description of major components in infant mortality by cause of death and highlights the many different problems that need to be addressed to reduce infant mortality.

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

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This research was supported in part by the National Institute of Child Health and Human Development, the Health Resources and Services Administration, and the National Center for Health Statistics (NCHS), all Agencies of the Public Health Service.

The preliminary findings were presented in part at the National Infant Mortality Surveillance Conference, Atlanta, GA, May 1, 1986.

Contributing to the research were the following persons from the Research and Statistics Branch, Division of Reproductive Health, CHPE, CDC: Jeanne C. Gilliland, J. Patrick Whitaker, and Evelyn L. Finch for their systems design and computer programming assistance with aggregating data from 53 vital statistics reporting areas; Sara W. Gill and Merrell Ramick for assistance with preparing the data for processing; and Phyllis A. Wingo for coordinating data management. Joel C. Kleinman, PhD, and Patricia Knapp, Division of Analysis, NCHS, provided assistance in the use of data from the 1960 birth cohort study.

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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