

US Birth Weight/Gestational Age-Specific Neonatal Mortality: 1995–1997 Rates for Whites, Hispanics, and Blacks

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ABSTRACT. *Objective.* In recent years, gains in neonatal survival have been most evident among very low birth weight, preterm, and low birth weight (LBW) infants. Most of the improvement in neonatal survival since the early 1980s seems to be the consequence of decreasing birth weight-specific mortality rates, which occurred during a period of increasing preterm and LBW rates. Although the decline in neonatal mortality has been widely publicized in the United States, research suggests that clinicians may still underestimate the chances of survival of an infant who is born too early or too small and may overestimate the eventuality of serious disability. So that clinicians may have current and needed ethnic- and race-specific estimates of the “chances” of early survival for newborn infants, we examined birth weight/gestational age-specific neonatal mortality rates for the 3 largest ethnic/racial groups in the United States: non-Hispanic whites, Hispanics, and non-Hispanic blacks. Marked racial variation in birth weight and gestational age-specific mortality has long been recognized, and growing concerns have been raised about ongoing and increasing racial disparities in pregnancy outcomes. Our purpose for this investigation was to provide an up-to-date national reference for birth weight/gestational age-specific neonatal mortality rates for use by clinicians in care decision making and discussions with parents.

Methods. The National Center for Health Statistics linked live birth-infant death cohort files for 1995–1997 were used for this study. Singleton live births to US resident mothers with a reported maternal ethnicity/race of non-Hispanic white, non-Hispanic black, or Hispanic ($n = 10\ 610\ 715$) were selected for analysis. Birth weight/gestational age-specific neonatal mortality rates were calculated using 250 g/2-week intervals for each ethnic/racial group.

Results. The overall neonatal mortality rates for whites, Hispanics, and blacks were 3.24, 3.45, and 8.16 neonatal deaths per 1000 live births, and the proportion of births <28 weeks was 0.35%, 0.45%, and 1.39%, respectively. Newborns who weighed <1500 g comprised

<2.5% of all births in each racial/ethnic group but accounted for >50% of neonatal deaths. For whites, Hispanics, and blacks, >50% of newborns 24 to 25 weeks of gestational age survived. For most combinations of birth weights <3500 g and gestational ages of <37 weeks, the neonatal mortality rate was lowest among blacks, compared with whites or Hispanics. At these same gestational age/birth weight combinations, Hispanics have slightly lower mortality rates than whites. For combinations of birth weights >3500 g and gestational ages of 37 to 41 weeks, Hispanics had the lowest neonatal mortality rate. In these birth weight/gestational age combinations, where approximately two thirds of births occur, blacks had the highest neonatal mortality rate.

Conclusions. Compared with earlier reports, these data suggest that a substantial improvement in birth weight/gestational age-specific neonatal mortality has occurred in the United States. Regardless of ethnicity/race, the risk of a neonatal death does not exceed 50% (the suggested definition for the limit of viability), except for birth weights below 500 g and gestational ages <24 weeks. Notwithstanding, ethnic/racial variations in neonatal mortality rates continue to persist, both in overall rates and within birth weight/gestational age categories. Blacks continue to have higher proportions for preterm and LBW births, compared with either whites or Hispanics. At the same time, blacks experience lower risks of neonatal mortality for preterm and LBW infants, while having higher risks of mortality among term, postterm, normal birth weight, and macrosomic births. *Pediatrics* 2003;111:e61–e66. URL: <http://www.pediatrics.org/cgi/content/full/111/1/e61>; *birth weight, gestational age, neonatal mortality, fetal growth, race.*

ABBREVIATIONS. VLBW, very low birth weight; LBW, low birth weight; BG-NMR, birth weight/gestational age-specific neonatal mortality rate; NCHS, National Center for Health Statistics; LMP, last normal menstrual period.

Throughout the last century in the United States, a newborn's risk of an early death declined dramatically. Between 1915 and 1998, the neonatal mortality rate (number of deaths to infants 0–27 days of age per 1000 live births) dropped by 89%, reaching a historical low in 1999 of 4.7.^{1,2} In recent years, gains in neonatal survival have been most evident among very low birth weight (VLBW; <1500 g), preterm (<37 weeks), and low birth weight (LBW; <2500 g) infants.^{3–8} Even among extremely high-risk infants, weighing between 501 and 750 g, notable improvements in survival have been realized. In 1996, 54% of these infants survived, compared with 32% in 1988.⁹ Currently, the report of the

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survival of an infant <400 and even <300 g is no longer unprecedented.^{10–12} Similarly, the gestational age limit of viability has declined to a point where for some populations 50% of infants delivered at 24 weeks' gestation are estimated to survive.¹³

Nearly all of the gains in the neonatal survival since the early 1980s seem to be the consequence of improvements in birth weight-specific mortality rates, as there has been virtually no improvement and instead some increase in the occurrence of LBW and preterm deliveries.^{2,14,15} As such, recent declines in neonatal mortality in the United States continue to be attributed to advances in high-risk obstetric and neonatal intensive care.^{16–18} Improvement in neonatal survival, despite the recent rise in preterm births, has not been accompanied by a marked increment in the rate of disability,^{19,20} although it has given rise to debates regarding the ethical and social consequences of this trend.^{21–24} Although the decline in neonatal mortality and increase in preterm and LBW births have been widely publicized in the United States, research suggests that clinicians may still underestimate the chances of survival of an infant who is born too early or too small and may overestimate the eventuality of serious disability.²⁵ This practice has been associated with the decreased use of appropriate interventions.²⁶ So that clinicians may have current and needed ethnic- and race-specific estimates of the "chances" of early survival for newborn infants, we examined 1995–1997 birth weight/gestational age-specific neonatal mortality rates (BG-NMRs) for the 3 largest ethnic/racial groups in the United States: non-Hispanic whites, Hispanics, and non-Hispanic blacks. Marked racial variation in BG-NMR has long been recognized, and growing concerns have been raised about increasing racial disparities in pregnancy outcomes.^{3,4} The purpose of this investigation was to provide an up-to-date national reference for BG-NMRs for use by clinicians in both care decision making and discussions with parents. In addition to providing the proportions of live births and neonatal deaths found within broad birth weight and gestational age categories for each ethnic/racial group, we provide ethnic/race-specific fetal growth references to aid in the interpretation of the BG-NMRs.

METHODS

The National Center for Health Statistics (NCHS) linked live birth-infant death cohort file for 1995–1997 was used for this study. These are the most recent linked live birth-infant death cohort data available for the United States. Singleton live births to US resident mothers with a reported maternal race/ethnicity of non-Hispanic white, non-Hispanic black, or Hispanic were selected for analysis. After these selections, the study sample contained 10 610 715 live births.

Ethnic/racial differences in the proportions of live births and neonatal deaths were compared within commonly used risk categories of birth weight (<500, 500–749, 750–1499, 1500–2499, 2500–3999, and 4000+ g) and gestational age (<28, 28–32, 33–36, 37–41, and 42+ weeks). BG-NMRs were calculated using 250-g/2-week intervals for each ethnic/racial group. To minimize the impact of small number fluctuation, NMRs are provided for birth weight/gestational age intervals that approximately fall above the 1st percentile and below the 99th percentile for weight in each gestational age category. Furthermore, mortality rates are not reported for any cell containing <25 neonatal deaths.

Gestational age in completed weeks is computed from the interval between the first day of the last normal menstrual period (LMP) and the date of birth. Records missing the date of LMP are imputed on the NCHS file when there is a valid month and year. Clinical estimate of gestation was used in the imputation of gestational age in cases in which no valid month and year of LMP was reported. Approximately 4% to 5% of the gestational ages during the time period were based on clinical estimate of gestation. Records with implausible or missing values for birth weight or gestational age and records with a birth weight value inconsistent with the gestational age were deleted. Procedures for imputing data and determining gestational age/birth weight inconsistency have been described in detail elsewhere.^{27,28} Nearly 2% of births to non-Hispanic whites, 2.66% of births to non-Hispanic blacks, and 3.55% of births to Hispanics were eliminated because of missing gestational age or birth weight.

RESULTS

After using our selection criteria, the study sample consisted of 6 730 137 single live births to non-Hispanic white mothers, 1 977 317 births to Hispanic mothers, and 1 650 046 births to non-Hispanic black mothers. The overall NMRs for whites, Hispanics, and blacks were 3.24, 3.45, and 8.16, respectively.

For each ethnic/racial group, Table 1 presents the proportion of live births and neonatal deaths by birth weight and gestational age categories. Birth weight-specific and gestational age-specific percentages of births and neonatal deaths are provided in the margins of each table that are labeled "total." For all ethnic/racial groups, >80% of newborns have a birth weight between 2500 and 3999 g. Similarly, >75% of births occur at 37 to 41 weeks' gestation. These term births account for approximately 25% of neonatal deaths in whites and Hispanics. For blacks, approximately 14% of neonatal deaths occur to term births. Furthermore, for all ethnic/racial groups, the birth weight/gestational age combination of 2500 to 3999 g and 37 to 41 weeks accounts for more than two thirds of live births. Among whites and Hispanics, these births account for approximately 20% of neonatal deaths, whereas among black, <10% of the total neonatal deaths occur to term, normal births.

By ethnic/racial group, the proportion of live births <28 weeks' gestation is 0.35%, 0.45%, and 1.39%, respectively, for whites, Hispanics, and blacks. For each group, slightly less than one half of the <28-week births are between 750 and 1499 g. Compared with the other groups, blacks have the highest proportion of births in gestational age and birth weight categories <37 weeks and <2500 g. Moreover, blacks have substantially more than twice the proportion of births <33 weeks and <1500 g compared with the other groups. For whites and Hispanics, <1% of newborns have a birth weight of <1500 g, compared with 2.5% of newborns to black mothers.

Although representing a very small proportion of births, newborns with birth weights <1500 g account for >50% of the neonatal deaths among whites and Hispanics. Among blacks, these VLBW infants compose >75% of the neonatal deaths. Births that occur at 20 to 27 weeks' gestation also result in a disproportionate number of neonatal deaths, approximately 45% for whites and Hispanics and 68% for blacks. It is interesting that although blacks have more than 3 times the percentage of births <28

TABLE 1. Percentage of Live Births and Neonatal Deaths for Birth Weight and Gestational Age Categories by Ethnicity/Race of Mother 1995–1997 Single Live Births to US Resident Mothers

Birth Weight	Gestational Age												Total					
	<28 Weeks			28–32 Weeks			33–36 Weeks			37–41 Weeks			42+ Weeks			W	B	H
	W	B	H	W	B	H	W	B	H	W	B	H	W	B	H			
Percentage of live births																		
4000–8500							0.16	0.16	0.23	10.81	4.60	7.79	1.35	0.60	1.04	12.33	5.36	9.05
2500–3999				0.33	0.61	0.33	4.69	7.64	6.06	71.63	68.50	72.46	6.27	6.35	6.72	82.75	83.10	85.57
1500–2499	0.01	0.06	0.02	0.45	1.18	0.51	1.80	3.76	1.84	1.77	3.75	1.96	0.11	0.25	0.12	4.13	9.00	4.46
750–1499	0.16	0.56	0.20	0.32	0.87	0.34	0.08	0.19	0.09	0.02	0.06	0.04				0.58	1.70	0.67
500–749	0.12	0.49	0.16	0.02	0.06	0.02										0.14	0.56	0.18
< 500	0.06	0.28	0.07	0.01	0.01											0.06	0.29	0.07
Total	0.35	1.39	0.45	0.96	2.73	1.21	6.72	11.75	8.21	84.24	76.91	82.24	7.74	7.21	7.89	100.00	100.00	100.00
Percentage of neonatal deaths																		
4000–8500							0.13	0.05	0.17	2.02	0.75	1.42	0.31	0.07	0.36	2.45	0.88	1.95
2500–3999				0.55	0.28	0.55	4.16	2.16	3.84	20.33	9.65	17.54	1.97	1.02	2.35	26.91	13.12	24.28
1500–2499	0.27	0.25	0.27	3.65	2.22	3.17	6.53	3.84	5.80	5.27	2.96	5.52	0.50	0.31	0.46	16.22	9.58	15.21
750–1499	7.53	7.37	7.77	5.66	4.17	5.45	1.61	0.90	1.69	0.63	0.36	0.72	0.04	0.02	0.02	15.48	12.82	15.65
500–749	19.68	28.24	22.52	1.56	1.77	1.70	0.02	0.01	0.02							21.27	30.02	24.24
< 500	17.09	32.73	18.15	0.58	0.86	0.52										17.67	33.59	18.67
Total	44.58	68.58	48.71	11.89	9.30	11.39	12.45	6.69	11.52	28.25	13.72	25.20	2.83	1.43	3.18	100.00	100.00	100.00

W indicates non-Hispanic white; B, non-Hispanic black; H, Hispanic.

weeks' gestation compared with whites and Hispanics, the difference in the percentage of neonatal deaths in this gestational age category is approximately 1.5-fold. At gestational age categories above 28 weeks and above 750 g, blacks have the lowest proportion of neonatal deaths compared with the other ethnic/racial groups.

Tables 2 to 4 present BG-NMRs for each ethnic/racial group. Birth weight-specific and gestational age-specific mortality rates are provided in the margins of each table that are labeled "total." The overall NMR is indicated in the "total/total" cell. Accompanying these rates are the birth weight values for the 5th, 10th, 50th, and 90th percentiles for each gestational age interval. The overall 50th percentile of birth weight varies from 3430 g for whites to 3183 g for blacks and 3360 g for Hispanics.

For most combinations of birth weights <3500 g and gestational ages of <37 weeks, the NMR is lowest among blacks, compared with whites or Hispanics. At these same gestational age/birth weight combinations, Hispanics have slightly lower NMRs than whites. For combinations of birth weights >3500 g and gestational ages of 37 to 41 weeks, Hispanics have the lowest NMR. In these birth weight/gestational age combinations, where approximately two thirds of births occur, blacks had the highest NMR.

For all ethnic/racial groups, >50% of newborns 24 to 25 weeks of gestational age or more survive. Furthermore, the risk of neonatal mortality is <10% for all birth weight/gestational age categories at or above 1000 to 1249 g and 26 to 27 weeks' gestation and <1% for categories above 2250 g and 34 weeks. There are only 4 birth weight/gestational age combinations for which there is >50% risk of mortality: 22 to 23 weeks and 250 to 749 g, 24 to 25 weeks and 250 to 499 g, and 26 to 27 weeks and 250 to 499 g. The 250 to 499 g birth weight category is the only one in which 50% of the infants do not survive; however, Hispanics and non-Hispanic whites are approaching the 50% mark for the 250 to 499 g and 26 to 27 weeks combination.

DISCUSSION

Blacks continue to have higher proportions for preterm and LBW births, compared with either whites or Hispanics. At the same time, blacks experience lower risks of neonatal mortality for preterm and LBW infants, while having higher risks of mortality among term, postterm, normal birth weight, and macrosomic births. Of interest, Hispanics exhibit the lowest risks of neonatal mortality between 36 and 39 weeks and 2750 to 3999 g. Whites have the most favorable NMRs only above 40 weeks and 4000 g, but because of their overall greater percentage of term births, they have the lowest overall NMRs.

Regardless of ethnicity/race, the risk of a neonatal death does not exceed 50% (the suggested definition for the limit of viability), except for birth weights below 500 g and gestational age <24 weeks.^{3,13} The risk of a neonatal death is <1 death per 10 live births for infants 28+ weeks and is <1.5 per 1000 for infants ≥38 weeks and 1000 g. These national data confirm previous state and hospital reports that the limit of

TABLE 2. BG-NMRs 1995–1997 Single Live Births to US Non-Hispanic White Resident Mothers

	Gestational Age											Total
	22–23	24–25	26–27	28–29	30–31	32–33	34–35	36–37	38–39	40–41	42–43	
Birth weight												
Total	737.93	370.66	151.45	74.22	34.38	15.66	7.00	2.59	1.02	0.83	1.08	3.24
4500+									0.77	0.62		0.90
4000–4499								1.41	0.58	0.51	0.60	0.60
3750–3999								1.30	0.47	0.50	0.57	0.55
3500–3749						4.46	1.80	1.07	0.54	0.59	0.76	0.65
3250–3499						4.00	2.26	1.21	0.69	0.67	0.74	0.77
3000–3249					4.93	5.24	2.68	1.44	0.91	1.01	1.12	1.10
2750–2999					7.79	9.16	3.18	1.95	1.34	1.44	1.72	1.71
2500–2749				15.15	8.73	9.91	5.44	2.91	2.57	3.03	3.76	3.29
2250–2499				19.78	27.84	12.80	6.41	4.73	5.50	5.89	8.50	6.33
2000–2249				45.46	30.01	12.37	11.14	9.73	12.03	15.91		12.45
1750–1999			69.31	61.44	23.41	16.92	18.53	21.80	29.47			22.27
1500–1749			96.99	55.33	24.60	23.65	32.40	48.42				34.38
1250–1499		89.55	56.73	43.84	37.94	34.84	51.90					47.00
1000–1249	247.86	143.32	91.58	55.54	48.02	60.74						69.01
750–999	319.21	233.51	128.54	94.05	86.01							145.12
500–749	737.72	433.38	271.87	216.43	233.74							463.39
250–499	906.05	772.97	556.96									855.45
Birth weight percentiles for gestational age (overall mean birth weight = 3413 g)												
90th	794	964	1330	1928	2795	3260	3554	3742	4000	4167	4196	4082
50th	545	709	936	1219	1673	2211	2722	3090	3402	3572	3572	3430
10th	400	510	624	794	1100	1531	2041	2495	2845	3017	2977	2778
5th	363	454	539	675	936	1361	1829	2296	2693	2863	2807	2522

TABLE 3. BG-NMRs 1995–1997 Single Live Births to US Non-Hispanic Black Resident Mothers

	Gestational Age											Total
	22–23	24–25	26–27	28–29	30–31	32–33	34–35	36–37	38–39	40–41	42–43	
Birth weight												
Total	637.10	270.23	119.56	50.05	21.62	9.60	4.20	2.47	1.27	1.16	1.38	8.16
4500+												2.24
4000–4499								1.56	1.34	1.07	0.82	1.19
3750–3999								1.95	0.93	0.59	0.47	0.84
3500–3749						3.19	2.02	1.07	0.74	0.74	0.70	0.85
3250–3499						3.78	1.64	0.93	0.82	0.74	0.77	0.85
3000–3249					2.02	1.97	1.50	1.16	0.82	1.07	1.17	1.06
2750–2999					1.66	2.76	2.23	1.61	1.44	1.43	1.69	1.59
2500–2749					5.18	6.16	3.68	2.28	1.80	1.78	2.97	2.36
2250–2499				5.13	6.37	6.82	4.07	3.57	3.30	4.10	5.04	4.13
2000–2249				7.44	13.95	10.36	5.72	7.88	6.53	9.69		8.17
1750–1999			31.92	17.89	15.43	12.37	8.23	13.95	13.52			13.88
1500–1749			44.94	26.90	20.39	11.39	17.69	27.76				22.03
1250–1499		37.36	34.23	27.23	20.64	20.47	20.58					27.55
1000–1249	127.78	78.68	53.46	35.33	31.79	44.97						45.24
750–999	174.12	140.28	84.92	65.92	58.32							101.63
500–749	615.30	319.00	237.10	195.78	232.98							400.14
250–499	873.04	704.95	626.58									842.31
Birth weight percentiles for gestational age (overall mean birth weight = 3133 g)												
90th	850	1020	1474	2183	2863	3232	3487	3600	3799	3965	3960	3827
50th	540	709	935	1247	1744	2294	2693	2948	3204	3361	3345	3183
10th	397	510	620	800	1110	1559	1970	2353	2665	2807	2760	2438
5th	360	454	523	680	957	1375	1758	2183	2500	2650	2580	2041

viability is now at 23 weeks' gestation in the United States.^{4,29} It has been suggested that physicians may underestimate the survivability of newborns at the extreme limits of viability.²⁶ In a recent commentary concerning the care of an infant who is born at 25 weeks, the parents were informed in antepartum counseling that their infant had a 50% chance of survival.³⁰ However, these national data indicate that for all 3 major ethnic/racial groups, the chance of survival at 24 to 25 weeks is at least 63% and, when that infant's birth weight is taken into account (830 g),³⁰ the chances of survival are indicated to be

nearly 80%. Until now, physicians have relied on state-specific data or large cohort studies for reliable estimates of survivability.^{3,4,9,20,29,31,32} Although these studies have documented the rapid decline in neonatal mortality during the past decade, this investigation provides ethnic/racial, BG-NMRs for the entire US population.

The accuracy, completeness, and limitations of reporting gestational age on US vital records and linking live birth and infant death certificates have been well documented.^{27,28,33} Previous research has indicated that the reporting of gestational age on birth

TABLE 4. BG-NMRs 1995–1997 Single Live Births to US Hispanic Resident Mothers

	Gestational Age											Total
	22–3	24–5	26–7	28–9	30–1	32–3	34–5	36–7	38–9	40–1	42–3	
Birth weight												
Total	651.82	320.22	131.87	68.50	25.48	10.92	5.03	2.32	0.95	0.84	1.27	3.45
4500+												1.38
4000–4499								1.91	0.50	0.46	1.02	0.65
3750–3999								1.02	0.40	0.44	0.63	0.51
3500–3749								1.14	0.48	0.46	0.81	0.59
3250–3499						1.53	1.58	0.73	0.53	0.65	0.79	0.66
3000–3249					7.90	3.28	2.43	1.04	0.79	0.66	1.32	0.92
2750–2999					3.76	2.54	2.73	1.80	1.19	1.39	1.67	1.51
2500–2749				12.66	8.83	6.04	3.91	2.56	2.37	2.98	4.24	2.97
2250–2499				11.67	18.28	8.68	5.66	4.62	3.84	6.41	5.60	5.38
2000–2249				40.82	20.24	10.55	9.29	12.10	12.20	16.33		12.54
1750–1999			38.10	24.74	21.56	17.20	15.14	24.71	24.35			21.57
1500–1749			52.02	55.78	18.25	14.42	32.06	41.32				30.25
1250–1499		31.75	30.53	42.40	25.09	34.70	52.82					40.31
1000–1249	123.08	85.89	69.38	46.98	36.70	78.68						61.30
750–999	291.67	193.10	109.72	110.35	112.75							143.43
500–749	648.62	390.10	292.44	260.42	236.84							440.51
250–499	873.56	741.29	525.86									800.57
Birth weight percentiles for gestational age (overall mean birth weight = 3341 g)												
90th	850	997	1459	2183	2948	3355	3657	3745	3925	4082	4082	3980
50th	567	710	960	1275	1814	2466	2892	3090	3345	3487	3487	3360
10th	410	510	642	822	1150	1616	2103	2495	2807	2948	2920	2722
5th	369	462	539	683	990	1417	1899	2320	2655	2805	2765	2467

certificates may be subject to increasingly greater inaccuracies at gestational ages <37 weeks. In this study, we attempted to eliminate some of these potentially inaccurate values by removing cases with inconsistent gestational age/birth weight values. Nevertheless, it is possible that some preterm cases have incorrect gestational age. As a result, the BG-NMR may be underestimated for large-for-gestational-age preterm newborns. Moreover, it should be emphasized that these BG-NMRs are based on crude mortality rates for each ethnic/racial group and have not been standardized to control for group variations in maternal risk characteristics.

Noted ethnic/racial variations in BG-NMRs were identified by this study. These variations in mortality have persisted for some time,^{3,4,34,35} and reducing racial variation in newborn mortality has been identified as a national health objective.³⁶ When compared with earlier reports, these data suggest that substantial improvements in neonatal mortality have occurred, particularly among LBW and preterm infants.^{4,34,35,37} Notwithstanding, additional research is needed to determine how these improvements have affected the disparities in newborn survival between ethnic/racial groups and to identify where there has been a lack of progress. This study provides a foundation with which to examine these issues while providing reference data to assist physicians who work with newborns at the extreme limits of viability.

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