

Infant Mortality Statistics from the 2002 Period Linked Birth/Infant Death Data Set

by T.J. Mathews, M.S.; Fay Menacker, Dr. P.H.; and Marian F. MacDorman, Ph.D., Division of Vital Statistics

Abstract

Objectives—This report presents 2002 period infant mortality statistics from the linked birth/infant death data file by a variety of maternal and infant characteristics. The linked file differs from the mortality file, which is based entirely on death certificate data.

Methods—Descriptive tabulations of data are presented and interpreted.

Results—The U.S. infant mortality rate increased from 6.8 infant deaths per 1,000 live births in 2001 to 7.0 in 2002. The rate for infants of non-Hispanic white mothers was 5.7 in 2001 compared with 5.8 in 2002. The rate for infants of non-Hispanic black mothers was 13.5 in

2001 compared with 13.9 in 2002. Neither of the changes for non-Hispanic white nor non-Hispanic black was significant. Between 2001 and 2002, overall cause-specific rates increased 5 percent for low birthweight and 14 percent for maternal complications. The rate rose significantly for infants of mothers who smoked, 10.5 to 11.1. It also increased significantly from 10.7 to 11.5 for infants of mothers aged 15–17 years. The rate dropped significantly for triplet births, 71.4 to 60.1. Infant mortality rates ranged from 3.0 per 1,000 live births for Chinese mothers to 13.9 for non-Hispanic black mothers. Among Hispanics, rates ranged from 3.7 for Cuban mothers to 8.2 for Puerto Rican mothers. Infant mortality rates were higher for those infants

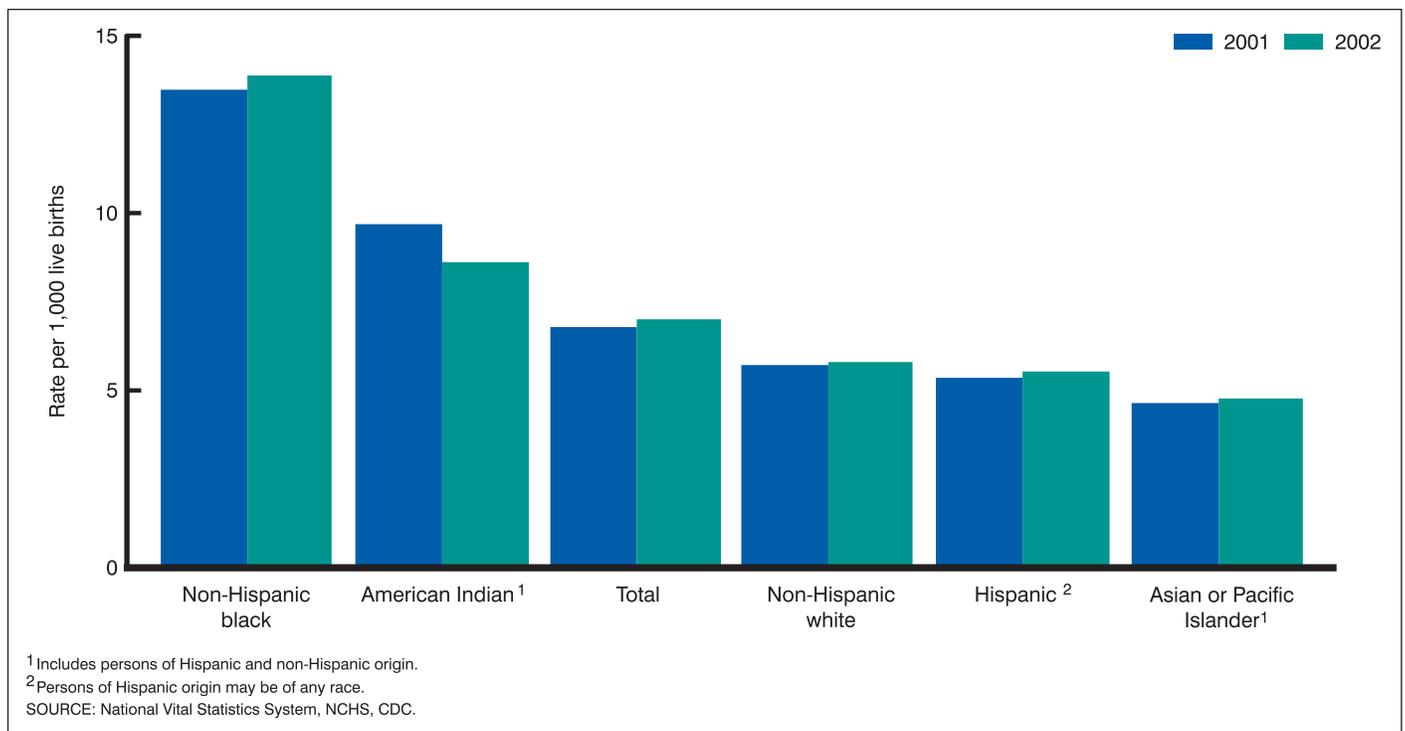


Figure 1. Infant mortality rates by race and ethnicity, 2001 and 2002

whose mothers were born in the 50 States and the District of Columbia, were unmarried, or smoked during pregnancy. Infant mortality was also higher for male infants, multiple births, and infants born preterm or at low birthweight. The three leading causes of infant death—Congenital malformations, low birthweight, and Sudden infant death syndrome (SIDS)—taken together accounted for 45 percent of all infant deaths. For infants of non-Hispanic black mothers, the cause-specific infant mortality rate for low birthweight was nearly four times that for infants of non-Hispanic white mothers. For infants of non-Hispanic black and American Indian mothers, the SIDS rates were at least double the rate for non-Hispanic white mothers. A more intensive analysis of the rise in the infant mortality rate utilizing information on maternal and infant health risk factors available in the linked birth/infant death and fetal death data files is forthcoming.

Keywords: infant mortality • infant health • birthweight • maternal characteristics

Introduction

This report presents infant mortality data from the 2002 period linked file. In the linked file, the information from the death certificate is linked to information from the birth certificate for each infant under 1 year of age who died in the 50 States, the District of Columbia, Puerto Rico, the Virgin Islands, or Guam during 2002. Linked birth/infant death data are not available for American Samoa and the Commonwealth of the Northern Marianas. The purpose of the linkage is to use the many additional variables available from the birth certificate to conduct more detailed analyses of infant mortality patterns. This report presents infant mortality data by race and Hispanic origin of the mother, birthweight, period of gestation, sex of infant, plurality, trimester of pregnancy prenatal care began, maternal age, maternal educational attainment, live-birth order, mother's marital status, mother's place of birth, maternal smoking during pregnancy, age at death, and underlying cause of death (tables 1–7, A–D, and figures 1 and 2). Other variables available in the linked file data set (1), but which are not discussed in this report include: father's age, race, and Hispanic origin; birth attendant; place of delivery; mother's weight gain during pregnancy; and many medical and health measurements. Another report, based on data from the

vital statistics mortality file, provides more detailed information on trends in infant mortality and on causes of infant death (2). Some rates calculated from the mortality file differ from those published using the linked birth/infant death file (linked file). The linked file is used for analysis and for calculating infant mortality rates by race and ethnicity that are more accurately measured from the birth certificate. A more detailed discussion of the differences in the number of infant deaths and infant mortality rates between the linked file and the mortality file is presented in the “[Technical Notes](#).”

Methods

Data shown in this report are based on birth and infant death certificates registered in all States, the District of Columbia, Puerto Rico, the Virgin Islands, and Guam. As part of the Vital Statistics Cooperative Program, each State provided to the Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS) matching birth and death certificate numbers for each infant under 1 year of age who died in the State during 2002. When the birth and death occurred in different States, the State of death was responsible for contacting the State of birth identified on the death certificate to obtain the original birth certificate number. NCHS used the matching birth and death certificate numbers provided by the States to extract final edited data from the NCHS natality and mortality statistical files. These data were linked to form a single statistical record, thereby establishing a national linked record file.

After the initial linkage, NCHS returned computer lists of unlinked infant death records and records with inconsistent data between the birth and death certificates to each State. State additions and corrections were incorporated, and a final national linked file was produced. In 2002, 99.0 percent of all infant death records were successfully matched to their corresponding birth records. This is higher than in 2001 (98.9). A record weight was added to the linked file in 2002 to compensate for the 1.0 percent of infant death records that were not linked to their corresponding birth certificates. See the “[Technical Notes](#)” for more information on the weighting of the linked file.

Information on births by age, race, or marital status of mother is imputed if it is not reported on the birth certificate. These items were not reported for less than 1 percent of U.S. births in 2002 (3).

Table A. Infant, neonatal, and postneonatal deaths and mortality rates by specified race or national origin of mother: United States, 2002 linked file

Race of mother	Live births	Number of deaths			Mortality rate per 1,000 live births		
		Infant	Neonatal	Postneonatal	Infant	Neonatal	Postneonatal
All races	4,021,825	27,970	18,791	9,179	7.0	4.7	2.3
White	3,174,807	18,395	12,352	6,044	5.8	3.9	1.9
Black	593,743	8,201	5,533	2,668	13.8	9.3	4.5
American Indian ¹	42,367	366	195	171	8.6	4.6	4.0
Asian or Pacific Islander	210,908	1,006	710	296	4.8	3.4	1.4
Chinese	33,673	101	79	22	3.0	2.4	0.7
Japanese	9,264	45	34	11	4.9	3.7	*
Hawaiian	6,772	65	38	27	9.6	5.6	4.0
Filipino	33,016	190	134	55	5.7	4.1	1.7
Other Asian or Pacific Islander	128,183	605	424	181	4.7	3.3	1.4

* Figure does not meet standard of reliability or precision; based on fewer than 20 deaths in the numerator.

¹Includes Aleuts and Eskimos.

NOTES: Infant deaths are weighted so numbers may not exactly add to totals due to rounding. Neonatal is less than 28 days, and postneonatal is 28 days to under 1 year.

Table B. Infant, neonatal, and postneonatal deaths and mortality rates by Hispanic origin of mother and by race of mother for mothers of non-Hispanic origin: United States, 2002 linked file

Hispanic origin and race of mother	Live births	Number of deaths			Mortality rate per 1,000 live births		
		Infant	Neonatal	Postneonatal	Infant	Neonatal	Postneonatal
All origins ¹	4,021,825	27,970	18,791	9,179	7.0	4.7	2.3
Total Hispanic	876,654	4,927	3,360	1,567	5.6	3.8	1.8
Mexican	627,510	3,399	2,283	1,116	5.4	3.6	1.8
Puerto Rican	57,469	471	334	137	8.2	5.8	2.4
Cuban	14,232	53	46	7	3.7	3.2	*
Central and South American	125,984	637	435	202	5.1	3.5	1.6
Other and unknown Hispanic	51,459	368	263	105	7.1	5.1	2.0
Non-Hispanic total ²	3,119,987	22,647	15,109	7,538	7.3	4.8	2.4
Non-Hispanic white	2,298,168	13,327	8,853	4,474	5.8	3.9	1.9
Non-Hispanic black	578,366	8,031	5,399	2,632	13.9	9.3	4.6
Not stated	25,184	395	322	74	...	...	...

* Figure does not meet standard of reliability or precision; based on fewer than 20 deaths in the numerator.

... Category not applicable.

¹Origin of mother not stated included in "All origins" but not distributed among origins.

²Includes races other than white or black.

NOTES: Infant deaths are weighted so numbers may not exactly add to totals due to rounding. Neonatal is less than 28 days, and postneonatal is 28 days to under 1 year.

Table C. Infant, neonatal, and postneonatal deaths and mortality rates by race or national origin of mother: Total of 11 States, 2002 linked file

Race of mother	Live births	Number of deaths			Mortality rate per 1,000 live births		
		Infant	Neonatal	Postneonatal	Infant	Neonatal	Postneonatal
All races	1,808,792	11,232	7,501	3,731	6.2	4.1	2.1
Total Asian or Pacific Islander	147,907	674	453	221	4.6	3.1	1.5
Chinese	26,727	83	63	20	3.1	2.4	0.8
Japanese	7,251	35	24	11	4.9	3.4	*
Filipino	26,982	158	111	46	5.8	4.1	1.7
Vietnamese	16,211	60	47	13	3.7	2.9	*
Asian Indian	28,532	105	71	34	3.7	2.5	1.2
Korean	10,430	38	23	15	3.7	2.2	*
Hawaiian	5,931	55	34	21	9.3	5.7	3.5
Samoan	1,616	11	5	6	*	*	*
Guamanian	529	8	2	6	*	*	*
Remaining Asian or Pacific Islander	23,698	119	71	48	5.0	3.0	2.0
White	1,433,745	7,687	5,155	2,532	5.4	3.6	1.8
Black	218,206	2,789	1,855	934	12.8	8.5	4.3
American Indian ¹	8,934	82	37	44	9.1	4.2	4.9

* Figure does not meet standard of reliability or precision; based on fewer than 20 deaths in the numerator.

¹Includes Aleuts and Eskimos.

NOTES: Infant deaths are weighted so numbers may not exactly add to totals due to rounding. States included are California, Hawaii, Illinois, Minnesota, Missouri, New Jersey, New York, Texas, Virginia, Washington, and West Virginia. Neonatal is less than 28 days, and postneonatal is 28 days to under 1 year.

Race and Hispanic origin are reported independently on the birth certificate. In tabulations of birth data by race and Hispanic origin, data for Hispanic persons are not further classified by race as the vast majority of women of Hispanic origin are reported as white. Data for American Indian and Asian or Pacific Islander (API) births are not shown separately by Hispanic origin because the vast majority of these populations are non-Hispanic.

Starting with data year 1999 cause-of-death statistics in this and similar publications are classified in accordance with the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (ICD-10) (4). Issues of this report for data years previous to 1999 included causes of death classified according to the *Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, Ninth Revision* (ICD-9) (5). Issues related to comparability between ICD revisions are discussed in the "Technical Notes."

Data by maternal and infant characteristics

This report presents descriptive tabulations of infant mortality data by a variety of maternal and infant characteristics. These tabulations are useful for understanding the basic relationships between risk factors and infant mortality, *unadjusted for the possible effects of other variables*. In reality, women with one risk factor often have other risk factors as well. For example, teenage mothers are more likely to also be unmarried and of a low-income status, and mothers who do not receive prenatal care are more likely to be of a low-income status and uninsured. The preferred method for disentangling the multiple interrelationships among risk factors is multivariate analysis; however, an understanding of the basic relationships

Table D. Infant mortality rates by race and Hispanic origin of mother: United States, 1995–2002 linked files

Race and Hispanic origin of mother	1995	1996	1997	1998	1999	2000	2001	2002	Percent change 1995 to 2002	Percent change 2001 to 2002
All races	7.6	7.3	7.2	7.2	7.0	6.9	6.8	7.0	-7.9	2.9
White	6.3	6.1	6.0	6.0	5.8	5.7	5.7	5.8	-7.9	1.8**
Black	14.6	14.1	13.7	13.8	14.0	13.5	13.3	13.8	-5.5	3.8
American Indian ¹	9.0	10.0	8.7	9.3	9.3	8.3	9.7	8.6	-4.4**	-11.3**
Asian or Pacific Islander	5.3	5.2	5.0	5.5	4.8	4.9	4.7	4.8	-9.4	2.1**
Chinese	3.8	3.2	3.1	4.0	2.9	3.5	3.2	3.0	-21.1**	-6.3**
Japanese	5.3	4.2	5.3	3.5	3.4	4.5	4.0	4.9	-7.5**	22.5**
Hawaiian	6.6	5.6	9.0	10.0	7.1	9.0	7.3	9.6	45.5**	31.5**
Filipino	5.6	5.8	5.8	6.2	5.8	5.7	5.5	5.7	1.8**	3.6**
Hispanic	6.3	6.1	6.0	5.8	5.7	5.6	5.4	5.6	-11.1	3.7**
Mexican	6.0	5.8	5.8	5.6	5.5	5.4	5.2	5.4	-10.0	3.8**
Puerto Rican	8.9	8.6	7.9	7.8	8.3	8.2	8.5	8.2	-7.9**	-3.5**
Cuban	5.3	5.1	5.5	3.6	4.7	4.6	4.2	3.7	-30.2**	-11.9**
Central and South American	5.5	5.0	5.5	5.3	4.7	4.6	5.0	5.1	-7.3**	2.0**
Non-Hispanic white	6.3	6.0	6.0	6.0	5.8	5.7	5.7	5.8	-7.9	1.8**
Non-Hispanic black	14.7	14.2	13.7	13.9	14.1	13.6	13.5	13.9	-5.4	3.0**

** Not significant at $p < .05$.

¹Includes Aleuts and Eskimos.

between risk factors and infant mortality is a necessary precursor to more sophisticated types of analyses and is the aim of this publication.

Race and Hispanic origin data—Infant mortality rates are presented here for both detailed race of mother and Hispanic origin of mother. The linked file is particularly useful for computing accurate infant mortality rates for this purpose because the race of the mother from the birth certificate is used in both the numerator and denominator of the infant mortality rate. In contrast, for the vital statistics mortality file, race information for the denominator is the race of the mother as reported on the birth certificate, whereas the race information for the numerator is the race of the decedent as reported on the death certificate (1,6). Another source of misclassification is misreported race on the death certificate where the race and ethnicity of the deceased infant is reported by the funeral director based on information provided by an informant or on observation. These different reporting methods can lead to differences in race- and ethnic-specific infant mortality rates between the two data files (6,7).

Rates for API and for Chinese, Japanese, Filipino, and other API mothers are reported for all 50 States and the District of Columbia. In addition, infant mortality data for five other detailed API groups, including Vietnamese, Asian Indian, Korean, Samoan, and Guamanian mothers, are presented for an 11-State reporting area: California, Hawaii, Illinois, Minnesota, Missouri, New Jersey, New York, Texas, Virginia, Washington, and West Virginia.

Race and Hispanic origin of mother are reported as separate items on the birth certificate; thus, a mother of Hispanic origin may be of any race. Although the overwhelming majority of Hispanic-origin births are to white women (3), there are notable differences in infant mortality trends between Hispanic and non-Hispanic white women. Race and ethnic differentials in infant mortality rates reflect differences in income, educational levels, access to health care, health insurance, and other factors.

Statistical significance—Text statements have been tested for statistical significance, and a statement that a given infant mortality rate is higher or lower than another rate indicates that the rates are significantly different. Information on the methods used to test for

statistical significance, as well as information on differences between period and cohort data, the weighting of the linked file, and a comparison of infant mortality data between the linked file and the vital statistics mortality file are presented in the “[Technical Notes](#).” Additional information on maternal age, marital status, period of gestation, birthweight, and cause-of-death classification is also presented in the “[Technical Notes](#).”

Results and Discussion

Trends in infant mortality

The overall 2002 infant mortality rate from the linked file was 7.0 infant deaths per 1,000 live births, higher than the rate in 2001 (6.8) and a return to the rate in 1999 ([table D, figure 1](#)) (the overall rate in 2002 was also 7.0 from the mortality file). This was the first significant rise in the infant mortality rate since 1958 (8). Infant mortality rates for race and Hispanic origin groups were generally higher in 2002 compared with 2001 but only the increase for infants of black mothers, from 13.3 to 13.8, was statistically significant ([table D](#)).

A preliminary analysis of the 2001–02 increase in the infant mortality rate was published earlier this year (8). This analysis discussed some of the potential explanatory factors that could account for the increase (8). Currently a more intensive analysis of these factors is under way utilizing information on maternal and infant health risk factors available in the linked birth/infant death data file for 2002. The results of this analysis will be addressed in a separate publication (9).

The infant mortality rate was 8 percent lower in 2002 than in 1995 (7.6) ([table D](#)). During this period, decreases have been observed for nearly all race and ethnic groups, although only a few had significant declines. Significant declines were observed for infants of non-Hispanic white (8 percent), non-Hispanic black (5 percent), and Mexican mothers (10 percent).

Infant mortality by race and Hispanic origin of mother

There continues to be a wide variation in infant mortality rates by race of mother with the highest rate, 13.9 per 1,000 live births, for

Multiple births

For plural births, the infant mortality rate was 32.3, more than five times the rate of 6.1 for single births (table 1). Infant mortality rates that could be reliably calculated for plural births were higher than rates for single births for all race and Hispanic-origin groups.

For triplet births, the infant mortality rate declined significantly from 2001 (71.4) to 2002 (60.1). No other plurality group had a significant change from the year before.

The risk of infant death increases with the increasing number of infants in the pregnancy (11). In 2002 the infant mortality rates for quadruplets (160.4) and triplets (60.1) were more than five times and about twice, respectively, the rate for twin births (30.2). Rates for quadruplets and triplets were more than 26 and nearly 10 times, respectively, the rate for single births (6.1) (tabular data not shown).

Age at death

In 2002 two-thirds of all infant deaths (18,791 out of 27,970) occurred in the first 27 days of life, the neonatal period. The neonatal mortality rate, 4.7 deaths per 1,000 live births in 2002 was more than double the postneonatal mortality rate (28 days to under 1 year), 2.3. The neonatal mortality rate increased 4 percent from 2001 (4.5). The postneonatal mortality rate remained unchanged from the previous year.

The neonatal mortality rate for infants of non-Hispanic black mothers (9.3) was significantly higher than for all other groups. Infants of non-Hispanic black, American Indian, and Hawaiian mothers had the highest postneonatal mortality rates of any group (4.6, 4.0, and 4.0, respectively). For the total population and for infants of non-Hispanic white and non-Hispanic black mothers, the neonatal mortality rates were more than twice the postneonatal rates. For infants of Chinese mothers the neonatal rate was over three times the postneonatal rate (2.4 and 0.7, respectively). For infants of Mexican, Puerto Rican, and Central and South American mothers the neonatal mortality rate was at least double the postneonatal rate (tables A and B).

Postneonatal mortality rates appeared to be relatively stable for most race and ethnic groups, with the exception of infants of American Indian mothers. For this group, the postneonatal mortality rate declined by 26 percent from 2001 to 2002, from 5.4 to 4.0. Postneonatal mortality rates have been higher for infants of American Indian mothers than for other race and ethnic groups for many years, primarily due to their higher rates of SIDS and injuries. This decrease in postneonatal mortality accounts for the overall decline in mortality for infants of American Indian mothers suggested by the 2002 data. A recent initiative addresses American Indian postneonatal mortality (12).

Birthweight and period of gestation

Birthweight and period of gestation are the two most important predictors of an infant's subsequent health and survival. Infants born too small or too soon have a much greater risk of death and both short-term and long-term disability than those born at term (37–41 weeks of gestation) or with birthweights of 2,500 grams or more (13–15). The percent of infants born at low birthweight (less than 2,500 grams) ranged from 5.5 percent for births to Chinese mothers to 13.4 percent for births to non-Hispanic black mothers (tables 4 and 5). The percent of preterm births (those born before 37 completed

weeks of gestation) ranged from 7.7 percent for births to Chinese mothers to 17.7 percent for births to non-Hispanic black mothers.

For all race and ethnic groups studied, infant mortality rates were much higher for low-birthweight infants (59.5) than for infants with birthweights of 2,500 grams or more (2.4). Overall, the infant mortality rate for very-low-birthweight infants (those with birthweights of less than 1,500 grams) was 250.8, more than 104 times the rate for infants with birthweights of 2,500 grams or more (table 6).

Similarly, the infant mortality rate for very preterm infants (those born at less than 32 weeks of gestation) was 186.4, nearly 75 times the rate for infants born at term (2.5) (37–41 weeks of gestation) (tables 1 and 2).

At least 86 percent of infants with birthweights of less than 500 grams died within the first year of life (table 6). Reporting of deaths among these very small infants may be incomplete (data not shown). An infant's chances of survival increase rapidly with increasing birthweight. Infant mortality rates were lowest at birthweights of 3,000 to 4,999 grams.

Trends in birthweight-specific infant mortality rates for the period 1995 to 2002 are shown in table 6. Generally declines were larger for infants weighing at least 2,500 grams. The birthweight-specific decline in infant mortality was greatest (22 percent) among infants weighing 4,000 to 4,499 grams (from 1.8 to 1.4) (table 6). For infants of white mothers the largest decline was also for infants weighing 4,000 to 4,499 grams (25 percent). The largest decline by specified birthweight for infants of non-Hispanic black mothers was for those weighing 3,500 to 3,999 grams (20 percent).

There were no significant changes in birthweight-specific infant mortality for infants of American Indian mothers (table 6). Infants of API mothers weighing 1,500 to 1,999 grams had the largest decline, 44 percent (41.2 to 23.2). Among infants of Hispanic mothers the largest decline was for those weighing 3,500 to 3,999 grams (1.8 to 1.4).

Although the 1995–2002 trends in birthweight-specific infant mortality rates were down, for 2001–02, there was an increase in these rates for infants weighing less than 2,500 grams (the increase for less than 1,500 grams was significant). Changes in the distributions of births by birthweight and in birthweight-specific infant mortality rates for the more recent period, 2001–02, are addressed in the separate analysis of the 2002 increase in the infant mortality rate (9).

In recent years the number of live-born infants and fetal deaths of very low birthweights, i.e., less than 500 grams, has increased. As noted above, however, the reporting of deaths among these very small, nonviable live-born infants is incomplete. These issues are considered in detail in the forthcoming special analysis (9).

Prenatal care

Prenatal care includes patient education, early recognition of risk factors and symptoms, and monitoring. Consequently, increasing early access to prenatal care has often been the focus of efforts to reduce infant mortality, especially among women with medical and demographic risk factors for adverse outcomes. The initiation and subsequent utilization of prenatal care is viewed as an indicator for access to care (16–20).

In 2002 the mortality rate for infants of mothers who began prenatal care after the first trimester of pregnancy, or not at all, was 9.0 per 1,000. This rate was 45 percent higher than the rate for infants of mothers whose care began in the first trimester (6.2).

For each race and Hispanic origin group, infant mortality rates were higher for mothers who began prenatal care after the first trimester, or received no care, than for mothers who received early care (tables 1 and 2). These differences were significant for all but infants of American Indian and Central or South American mothers. Because of the small number of infant deaths for Cuban mothers with late or no care, a reliable rate could not be calculated.

Overall, the infant mortality rates for women who began care in the third trimester (6.0) were lower than for women who began care in the second trimester (7.3). This is because women who began prenatal care in the third trimester had to have a gestation period of at least 7 months, thus reducing the probability that the infant would be born preterm or of low birthweight (21). The relationship between month of initiation of prenatal care and length of gestation is complex. Therefore, to be able to compare women who receive the timeliest care with all other women, the category “after first trimester or no care” is reported (tables 1 and 2).

It has been suggested that especially when certain pregnancy complications are present (e.g., post-term pregnancy, pregnancy-induced hypertension), infants of both black and white women who do not obtain prenatal care are at increased risk of postneonatal death (22).

Maternal age

Infant mortality rates vary with maternal age; infants of teenage mothers and mothers aged 40 years and over have the highest rates (10.4 and 8.5, respectively). The lowest rates are for infants of mothers in their late twenties and early thirties (tables 1 and 2).

In 2002 among births to teenagers, infants of the youngest mothers (under age 15 years) had the highest rate (17.6). The rate for infants of mothers aged 15–17 years increased between 2001 and 2002, from 10.7 per 1,000 to 11.5; the rate for infants of mothers aged 18–19 years was 9.5 in 2001 compared with 9.7 in 2002 (tabular data not shown).

Within race and ethnic subgroups, among groups for which rates could be reliably computed, infant mortality rates for births to non-Hispanic white teenage mothers were higher than for mothers aged 40 years and over. In contrast, for Mexican mothers, rates for births to the oldest mothers were higher than rates for infants of teenagers.

Studies suggest that the higher mortality risk for infants of younger mothers may be related to socioeconomic factors as well as biologic immaturity (23); young maternal age might be a marker for poverty (24–26). Among older mothers, especially those of low socioeconomic status, infant mortality rates may be affected by pregnancy complications related to higher maternal age (e.g., gestational diabetes mellitus and hypertensive disorders) (27).

Maternal education

Infant mortality rates generally decreased with increasing educational level (tables 1 and 2). This pattern may reflect the effects of more education as well as socioeconomic differences; women with more education tend to have higher income levels (28). However, infants of mothers with 0–8 years of education had a lower infant mortality rate compared with those with 9–11 years of education. This may be because most mothers with 0–8 years of education were born outside of the 50 States and the District of Columbia (29) and their infant mortality rates tend to be lower than for native-born mothers (see “Nativity”).

Live-birth order

Infant mortality rates were generally higher for first births than for second births, and then generally increased as birth order increased (tables 1 and 2). Overall, the infant mortality rate for first births (7.0) was 15 percent higher than for second births (6.1). The rate for fifth and higher order births (11.1) was 82 percent higher than the rate for second births. The higher parities and therefore the highest order births (5th child and above) are more likely to be associated with older maternal age and lower socioeconomic status (30).

Higher live-birth order (4th child and above), which is likely to be associated with household crowding, has been associated with an increased risk of bronchiolitis-related infant mortality (31).

Marital status

Marital status may be a marker for the presence or absence of social, emotional, and financial resources (32,33). The support afforded by such resources may have a positive effect on fetal growth through fostering healthy maternal behaviors (34). Infants of mothers who are not married have been shown to be at higher risk for poor outcomes (35–37). In 2002 infants of married mothers had a mortality rate of 5.4 per 1,000. The mortality rate for infants of unmarried mothers was 9.9, more than 83 percent higher than the rate for infants of married mothers (tables 1 and 2). Within each race and Hispanic origin group, infants of unmarried mothers had higher rates of mortality and, with the exception of Cuban infants, these differences were significant.

Nativity

In 2002 the infant mortality rate for mothers born in the 50 States and the District of Columbia (7.3) was 43 percent higher than the rate for mothers born outside of the 50 States and the District of Columbia (5.1). Among race and Hispanic-origin groups for whom infant mortality rates could be calculated, all had higher infant mortality rates for mothers born in the 50 States and the District of Columbia (the difference was not significant for Puerto Rican, Cuban, and Central and South American mothers) (tables 1 and 2).

A variety of different hypotheses have been advanced to account for the lower infant mortality rate among infants of mothers born outside the 50 States and the District of Columbia, including possible differences in the level of familial integration and social support for new mothers (38–40). Also, women born outside the 50 States and the District of Columbia have been shown to have different characteristics than their U.S.-born counterparts with regard to socioeconomic and educational status, and risk behaviors such as smoking and alcohol use (40,41).

Maternal smoking

Tobacco use during pregnancy causes the passage of substances such as nicotine, hydrogen cyanide, and carbon monoxide from the placenta into the fetal blood supply. These substances restrict the growing infant’s access to oxygen and can lead to adverse pregnancy and birth outcomes such as low birthweight, preterm delivery, intrauterine growth retardation, and infant mortality (42–45).

The infant mortality rate for infants of smokers was 11.1 in 2002, 68 percent higher than the rate of 6.6 for nonsmokers and also 6 percent higher than the rate in 2001 (10.5). For each race and Hispanic-origin group for which these rates could be computed, the infant mortality rate for smokers was higher than for nonsmokers (tables 1 and 2). Infant mortality rates for API mothers who smoked during pregnancy were two and one-half times the rates for nonsmokers.

Leading causes of infant death

Infant mortality rates for the five leading causes of infant death are presented in table 7 by race and Hispanic origin of mother. The leading cause of infant death in the United States in 2002 was Congenital malformations, deformations and chromosomal abnormalities (congenital malformations), accounting for 20 percent of all infant deaths. Disorders relating to short gestation and low birthweight, not elsewhere classified (low birthweight) was second, accounting for 17 percent of all infant deaths, followed by Sudden infant death syndrome (SIDS), accounting for 8 percent of infant deaths. The fourth and fifth leading causes—Newborn affected by maternal complications of pregnancy (maternal complications), and Newborn affected by complications of placenta, cord, and membranes (cord complications), accounted for 6 and 4 percent, respectively, of all infant deaths in 2002. Together the five leading causes accounted for 55 percent of all infant deaths in the United States in 2002.

The order of the first four leading causes of death was the same in 2002 as in the previous year. However, Cord complications was the fifth leading cause in 2002, replacing Respiratory distress of newborn, which was fifth in 2001, but a close sixth in 2002.

The rank order of leading causes of infant death varied substantially by race and Hispanic origin of the mother. Congenital malformations was the leading cause of infant death for all groups except for non-Hispanic black and Puerto Rican mothers, for whom low birthweight was the leading cause.

Reflecting the overall increase in infant mortality between 2001 and 2002, cause-specific infant mortality rates increased significantly for low birthweight (up 5 percent) and maternal complications (up 14 percent), although part of the increase for maternal complications is due to a change in coding rules for this cause; see “Technical Notes.” Rates for Congenital malformations and SIDS were also higher in 2002 than in 2001, although the differences were not statistically significant. The rate for cord complications was unchanged from 2001–02.

When examined by race and ethnicity, only a few groups had significant changes by cause from 2001–02. For all Hispanic mothers, infant mortality from low birthweight and maternal complications both increased from 2001–02, while for Mexican mothers infant mortality from low birthweight increased.

When differences between cause-specific infant mortality rates were examined by race and ethnicity, infant mortality rates from Congenital malformations were 31 percent higher for non-Hispanic black and 44 percent higher for American Indian than for non-Hispanic white mothers. Rates were also 12 percent higher for Mexican than for non-Hispanic white mothers. Infant mortality rates from Congenital malformations were 18 percent lower for API than for non-Hispanic white mothers.

Infants of non-Hispanic black mothers had the highest mortality rates from low birthweight; the rate for non-Hispanic black mothers was 4.1 times the rate for non-Hispanic white mothers. The rate for Puerto Rican mothers was 2.2 times the rate for non-Hispanic white mothers.

SIDS rates were highest for American Indian and non-Hispanic black mothers—2.2 and 2.0 times those for non-Hispanic white mothers, respectively. As most SIDS deaths occur during the post-neonatal period, the high SIDS rates for infants of non-Hispanic black and American Indian mothers accounted for much of their elevated risk of postneonatal mortality. SIDS rates for API mothers were less than one-half those for non-Hispanic white mothers. The SIDS rate for Mexican mothers was 48 percent lower, and for Central and South American mothers, 62 percent lower than the rate for non-Hispanic white mothers.

For maternal complications and cord complications, infants of non-Hispanic black mothers had the highest mortality rates—2.7 and 2.5 times, respectively, than those for non-Hispanic white mothers. For maternal complications, infant mortality rates for Puerto Rican mothers were 41 percent higher than for non-Hispanic white mothers, although this difference was not statistically significant. The higher percent of non-Hispanic black and Puerto Rican infants born at low birthweight may help to explain their higher infant mortality rates from these causes, which occur predominantly among low-birthweight infants. Infant mortality rates from maternal complications were 31 and 39 percent lower, respectively, for Mexican and Central and South American women than for non-Hispanic white women.

An examination of cause-specific differences in infant mortality rates between race and Hispanic-origin groups can help the researcher to understand overall differences in infant mortality rates between these groups. For example, 30 percent of the elevated infant mortality rate for non-Hispanic black mothers, when compared with non-Hispanic white mothers, can be accounted for by their higher rate from low birthweight, 7 percent by differences in SIDS, and 7 percent by differences in maternal complications. In other words, if non-Hispanic black infant mortality rates for these three causes could be reduced to the levels for non-Hispanic white infants, the difference in the infant mortality rate between non-Hispanic black and non-Hispanic white mothers would be reduced by 44 percent.

For American Indian mothers, 24 percent of their elevated infant mortality rate, when compared with non-Hispanic white mothers, can be accounted for by their higher SIDS rates, 20 percent by differences in Congenital malformations, and 11 percent by differences in low birthweight. Thus, if American Indian infant mortality rates for these three causes could be reduced to non-Hispanic white levels, the difference in the infant mortality rate between American Indian and non-Hispanic white mothers would be reduced by 55 percent.

Similarly, 38 percent of the difference between Puerto Rican and non-Hispanic white infant mortality rates can be accounted for by differences in low birthweight, 15 percent by differences in Congenital malformations, and 6 percent by differences in maternal complications. If Puerto Rican infant mortality for these three causes could be reduced to non-Hispanic white levels, the difference in the infant mortality rate between Puerto Rican and non-Hispanic white infants would be reduced by 59 percent. In addition to helping to explain differences in infant mortality rates between various groups, comparisons such as these can be helpful in targeting prevention efforts.

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Table 1. Infant mortality rates, live births, and infant deaths, by selected characteristics and specified race of mother: United States, 2002 linked file

Characteristics	All races	Race of mother			
		White	Black	American Indian ¹	Asian or Pacific Islander
		Infant mortality rates per 1,000 live births in specified group			
Total	7.0	5.8	13.8	8.6	4.8
Age at death:					
Total neonatal	4.7	3.9	9.3	4.6	3.4
Early neonatal (less than 7 days)	3.7	3.1	7.6	3.2	2.7
Late neonatal (7–27 days)	0.9	0.8	1.7	1.4	0.7
Postneonatal	2.3	1.9	4.5	4.0	1.4
Sex:					
Male	7.6	6.4	14.8	9.7	5.1
Female	6.3	5.1	12.8	7.6	4.4
Plurality:					
Single births	6.1	5.0	12.3	7.9	4.3
Plural births	32.3	28.0	55.9	38.4	23.5
Birthweight:					
Less than 2,500 grams	59.5	54.7	76.5	64.2	41.0
Less than 1,500 grams	250.8	242.1	272.1	249.1	218.4
1,500–2,499 grams	15.1	15.3	15.4	24.0	10.7
2,500 grams or more	2.4	2.2	3.9	4.3	1.6
Period of gestation:					
Less than 32 weeks	186.4	175.8	212.9	158.6	163.4
32–36 weeks	9.2	8.7	11.1	13.1	7.3
37–41 weeks	2.5	2.2	4.0	4.3	1.7
42 weeks or more	3.1	2.8	4.7	5.9	2.5
Trimester of pregnancy prenatal care began:					
First trimester	6.2	5.2	12.8	7.9	4.4
After first trimester or no care	9.0	7.6	14.3	9.5	5.3
Second trimester	7.3	6.5	10.5	8.9	4.3
Third trimester	6.0	4.9	9.3	*	4.5
No prenatal care	38.4	29.9	58.0	*	30.5
Age of mother:					
Under 20 years	10.4	8.8	15.2	9.1	9.2
20–24 years	7.8	6.4	13.9	9.4	5.2
25–29 years	6.0	5.1	12.4	7.6	3.9
30–34 years	5.6	4.7	13.4	7.6	4.3
35–39 years	6.5	5.5	14.5	8.5	5.4
40–54 years	8.5	7.3	16.1	*	8.2
Educational attainment of mother:					
0–8 years	6.6	6.1	14.7	*	4.0
9–11 years	9.6	8.0	15.8	8.3	5.9
12 years	7.8	6.5	13.4	9.1	5.6
13–15 years	6.0	4.9	11.7	8.6	4.7
16 years and over	4.2	3.7	9.9	*	3.7
Live-birth order:					
1	7.0	5.9	14.2	9.1	4.7
2	6.1	5.2	12.3	8.4	4.0
3	6.6	5.6	12.2	6.8	5.2
4	8.3	6.7	15.1	7.9	7.8
5 or more	11.1	8.7	18.7	11.2	7.7
Marital status:					
Married	5.4	5.0	11.8	7.2	4.4
Unmarried	9.9	7.9	14.8	9.6	7.1
Mother's place of birth:					
Born in the 50 States and DC	7.3	5.9	14.2	8.7	6.6
Born elsewhere	5.1	4.9	8.8	*	4.3
Maternal smoking during pregnancy: ²					
Smoker	11.1	9.8	20.0	12.1	11.6
Nonsmoker	6.6	5.3	13.1	7.7	4.7

See footnotes at end of table.

Table 1. Infant mortality rates, live births, and infant deaths, by selected characteristics and specified race of mother: United States, 2002 linked file—Con.

Characteristics	All races	Race of mother			
		White	Black	American Indian ¹	Asian or Pacific Islander
		Live births			
Total	4,021,825	3,174,807	593,743	42,367	210,908
Sex:					
Male	2,058,037	1,626,328	301,530	21,423	108,756
Female	1,963,788	1,548,479	292,213	20,944	102,152
Plurality:					
Single births	3,889,276	3,069,960	572,699	41,362	205,255
Plural births	132,549	104,847	21,044	1,005	5,653
Birthweight:					
Less than 2,500 grams	315,028	216,373	79,137	3,072	16,446
Less than 1,500 grams	59,361	37,569	18,841	549	2,402
1,500–2,499 grams	255,667	178,804	60,296	2,523	14,044
2,500 grams or more	3,705,556	2,957,532	514,367	39,286	194,371
Not stated	1,241	902	239	9	91
Period of gestation:					
Less than 32 weeks	77,877	50,326	23,660	868	3,023
32–36 weeks	402,972	299,956	79,801	4,625	18,590
37–41 weeks	3,231,562	2,577,101	448,002	32,923	173,536
42 weeks or more	268,096	214,606	37,956	3,557	11,977
Not stated	41,318	32,818	4,324	394	3,782
Trimester of pregnancy prenatal care began:					
First trimester	3,301,213	2,664,128	434,099	28,833	174,153
After first trimester or no care	641,456	454,505	143,167	12,460	31,324
Second trimester	499,014	357,575	107,393	9,158	24,888
Third trimester	103,325	71,673	23,757	2,548	5,347
No prenatal care	39,117	25,257	12,017	754	1,089
Not stated	79,156	56,174	16,477	1,074	5,431
Age of mother:					
Under 20 years	432,825	309,879	106,993	7,840	8,113
20–24 years	1,022,132	783,010	194,719	14,343	30,060
25–29 years	1,060,420	851,159	136,604	10,138	62,519
30–34 years	951,229	779,538	95,013	6,338	70,340
35–39 years	453,939	369,840	48,393	2,976	32,730
40–54 years	101,280	81,381	12,021	732	7,146
Educational attainment of mother:					
0–8 years	239,622	216,932	13,913	1,705	7,072
9–11 years	614,968	461,280	128,424	11,153	14,111
12 years	1,234,741	937,997	231,845	16,446	48,453
13–15 years	851,738	664,946	135,547	8,828	42,417
16 years and over	1,026,820	854,863	73,837	3,639	94,481
Not stated	53,936	38,789	10,177	596	4,374
Live-birth order:					
1	1,594,949	1,258,506	222,845	14,837	98,761
2	1,306,795	1,049,590	173,145	11,784	72,276
3	675,278	536,537	105,569	7,568	25,604
4	264,268	202,695	49,309	4,087	8,177
5 or more	170,266	119,760	41,063	3,962	5,481
Not stated	10,269	7,719	1,812	129	609
Marital status:					
Married	2,655,815	2,270,333	188,848	17,070	179,564
Unmarried	1,366,010	904,474	404,895	25,297	31,344
Mother's place of birth:					
Born in the 50 States and DC	3,079,253	2,489,080	514,714	39,931	35,528
Born elsewhere	933,408	679,913	76,574	2,362	174,559
Not stated	9,164	5,814	2,455	74	821
Maternal smoking during pregnancy: ²					
Smoker	397,199	337,313	48,579	7,672	3,635
Nonsmoker	3,077,208	2,394,749	509,900	31,273	141,286
Not stated	18,046	14,185	2,607	389	865

See footnotes at end of table.

Table 1. Infant mortality rates, live births, and infant deaths, by selected characteristics and specified race of mother: United States, 2002 linked file—Con.

Characteristics	All races	Race of mother			
		White	Black	American Indian ¹	Asian or Pacific Islander
		Infant deaths			
Total	27,970	18,395	8,201	366	1,006
Age at death:					
Total neonatal	18,791	12,352	5,533	195	710
Early neonatal (less than 7 days)	15,020	9,804	4,506	137	573
Late neonatal (7–27 days)	3,771	2,548	1,027	58	138
Postneonatal	9,179	6,044	2,668	171	296
Sex:					
Male	15,690	10,459	4,467	208	556
Female	12,279	7,936	3,734	158	450
Plurality:					
Single births	23,691	15,465	7,025	328	874
Plural births	4,278	2,931	1,176	39	133
Birthweight:					
Less than 2,500 grams	18,758	11,830	6,056	197	675
Less than 1,500 grams	14,885	9,097	5,127	137	525
1,500–2,499 grams	3,873	2,733	929	61	150
2,500 grams or more	8,840	6,366	1,993	168	313
Not stated	371	199	152	1	19
Period of gestation:					
Less than 32 weeks	14,515	8,845	5,038	138	494
32–36 weeks	3,692	2,612	884	61	135
37–41 weeks	8,001	5,761	1,801	141	298
42 weeks or more	824	594	179	21	29
Not stated	937	582	299	6	50
Trimester of pregnancy prenatal care began:					
First trimester	20,521	13,957	5,569	227	769
After first trimester or no care	5,758	3,433	2,042	118	165
Second trimester	3,637	2,324	1,124	81	108
Third trimester	618	354	222	18	24
No prenatal care	1,503	755	697	18	33
Not stated	1,690	1,005	591	21	73
Age of mother:					
Under 20 years	4,496	2,724	1,626	72	75
20–24 years	8,016	5,014	2,711	135	156
25–29 years	6,352	4,334	1,700	77	241
30–34 years	5,312	3,695	1,269	48	299
35–39 years	2,934	2,031	701	25	176
40–54 years	858	597	194	9	59
Educational attainment of mother:					
0–8 years	1,581	1,332	205	15	28
9–11 years	5,875	3,671	2,027	93	84
12 years	9,641	6,107	3,114	150	270
13–15 years	5,099	3,236	1,587	76	200
16 years and over	4,290	3,192	731	17	349
Not stated	1,484	857	536	16	75
Live-birth order:					
1	11,139	7,383	3,155	134	467
2	7,927	5,410	2,131	99	287
3	4,481	3,008	1,289	51	133
4	2,194	1,352	746	32	64
5 or more	1,898	1,043	769	44	42
Not stated	330	199	112	5	13
Marital status:					
Married	14,404	11,277	2,220	124	783
Unmarried	13,566	7,118	5,981	243	224

See footnotes at end of table.

Table 1. Infant mortality rates, live births, and infant deaths, by selected characteristics and specified race of mother: United States, 2002 linked file—Con.

Characteristics	All races	Race of mother			
		White	Black	American Indian ¹	Asian or Pacific Islander
					Infant deaths
Mother's place of birth:					
Born in the 50 States and DC	22,581	14,706	7,293	346	236
Born elsewhere	4,777	3,338	676	16	747
Not stated	612	352	232	4	24
Maternal smoking during pregnancy: ²					
Smoker	4,406	3,298	973	93	42
Nonsmoker	20,255	12,653	6,693	239	671
Not stated	436	268	146	10	11

* Figure does not meet standard of reliability or precision; based on fewer than 20 deaths in the numerator.

¹Includes Aleuts and Eskimos.

²Excludes data for California, which does not report tobacco use on the birth certificate.

NOTES: Infant deaths are weighted so numbers may not exactly add to totals due to rounding. Not stated responses were included in totals but not distributed among groups for rate computations.

Table 2. Infant mortality rates, live births, and infant deaths, by selected characteristics and Hispanic origin of mother and by race of mother for mothers of non-Hispanic origin: United States, 2002 linked file

Characteristics	All origins ¹	Hispanic						Non-Hispanic		
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total ²	White	Black
Infant mortality rates per 1,000 live births in specified group										
Total	7.0	5.6	5.4	8.2	3.7	5.1	7.1	7.3	5.8	13.9
Age at death:										
Total neonatal	4.7	3.8	3.6	5.8	3.2	3.5	5.1	4.8	3.9	9.3
Early neonatal (less than 7 days)	3.7	3.0	2.9	4.9	2.7	2.7	4.3	3.9	3.0	7.6
Late neonatal (7–27 days)	0.9	0.8	0.8	0.9	*	0.8	0.9	1.0	0.8	1.8
Postneonatal	2.3	1.8	1.8	2.4	*	1.6	2.0	2.4	1.9	4.6
Sex:										
Male	7.6	6.0	5.9	8.7	4.5	4.9	8.0	8.0	6.5	14.9
Female	6.3	5.2	4.9	7.7	2.9	5.3	6.2	6.5	5.1	12.8
Plurality:										
Single births	6.1	5.1	4.9	7.1	3.2	4.5	6.4	6.3	5.0	12.3
Plural births	32.3	31.1	30.0	42.9	*	27.6	37.7	32.3	27.1	55.9
Birthweight:										
Less than 2,500 grams	59.5	56.7	57.0	59.2	46.6	52.0	62.2	59.7	53.4	76.5
Less than 1,500 grams	250.8	241.8	247.7	234.4	188.6	213.7	268.1	250.9	239.5	272.1
1,500–2,499 grams	15.1	16.1	16.6	14.1	*	15.2	15.3	14.9	14.9	15.4
2,500 grams or more	2.4	2.0	2.0	2.6	*	1.7	2.3	2.5	2.2	3.9
Period of gestation:										
Less than 32 weeks	186.4	160.9	159.3	182.2	144.5	147.6	176.7	191.1	179.9	212.9
32–36 weeks	9.2	8.0	7.8	8.9	*	7.7	10.2	9.4	8.9	11.1
37–41 weeks	2.5	2.1	2.1	2.7	*	1.9	2.3	2.6	2.3	4.1
42 weeks or more	3.1	2.5	2.6	*	*	*	*	3.3	2.9	4.9
Trimester of pregnancy prenatal care began:										
First trimester	6.2	5.3	5.1	7.5	3.4	4.8	6.1	6.4	5.2	12.9
After first trimester or no care	9.0	6.0	5.7	9.7	*	5.5	7.7	10.2	8.6	14.4
Second trimester	7.3	5.2	5.0	7.9	*	4.6	6.5	8.2	7.4	10.5
Third trimester	6.0	3.4	3.3	*	*	*	*	7.1	6.1	9.5
No prenatal care	38.4	23.0	19.7	49.2	*	29.3	36.5	45.5	36.4	57.9
Age of mother:										
Under 20 years	10.4	7.3	6.8	10.6	*	6.8	10.9	11.6	9.7	15.2
20–24 years	7.8	5.3	5.0	8.2	*	4.8	6.5	8.7	6.9	14.0
25–29 years	6.0	5.1	4.8	7.4	*	4.9	6.8	6.2	5.1	12.5
30–34 years	5.6	5.0	5.1	7.2	*	4.4	4.4	5.6	4.6	13.4
35–39 years	6.5	6.2	6.3	7.6	*	5.1	7.3	6.4	5.3	14.6
40–54 years	8.5	8.9	9.2	*	*	8.2	*	8.3	6.8	16.3
Educational attainment of mother:										
0–8 years	6.6	5.3	5.1	11.5	*	5.8	7.6	10.4	9.9	15.2
9–11 years	9.6	6.1	5.7	9.7	*	6.0	7.4	11.7	9.9	15.9
12 years	7.8	5.6	5.3	8.8	*	4.7	7.4	8.4	6.9	13.6
13–15 years	6.0	4.9	5.0	6.0	*	4.3	5.3	6.1	4.8	11.9
16 years and over	4.2	4.0	4.1	3.9	*	4.4	*	4.2	3.7	10.0
Live-birth order:										
1	7.0	5.8	5.7	8.2	3.8	4.9	8.2	7.2	5.8	14.3
2	6.1	5.0	5.0	7.6	*	4.4	5.4	6.3	5.1	12.4
3	6.6	5.3	5.0	7.6	*	5.4	6.2	7.0	5.7	12.2
4	8.3	5.6	5.0	7.8	*	6.4	9.8	9.4	7.3	15.3
5 or more	11.1	7.9	7.4	13.8	*	7.7	*	12.3	9.1	18.8
Marital status:										
Married	5.4	5.0	5.0	6.9	3.0	4.4	5.8	5.5	4.9	11.8
Unmarried	9.9	6.4	6.0	9.1	5.4	5.9	8.9	11.2	8.8	14.8
Mother's place of birth:										
Born in the 50 States and DC	7.3	6.6	6.3	8.2	3.9	5.5	7.5	7.4	5.8	14.2
Born elsewhere	5.1	5.0	4.8	7.9	3.6	5.0	4.7	5.3	4.6	9.1
Maternal smoking during pregnancy: ³										
Smoker	11.1	10.7	9.8	12.4	*	*	10.7	11.1	9.7	20.1
Nonsmoker	6.6	5.6	5.4	7.9	3.5	4.9	6.8	6.8	5.2	13.2

See footnotes at end of table.

Table 2. Infant mortality rates, live births, and infant deaths, by selected characteristics and Hispanic origin of mother and by race of mother for mothers of non-Hispanic origin: United States, 2002 linked file—Con.

Characteristics	All origins ¹	Hispanic						Non-Hispanic			Not stated
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total ²	White	Black	
Live births											
Total	4,021,825	876,654	627,510	57,469	14,232	125,984	51,459	3,119,987	2,298,168	578,366	25,184
Sex:											
Male	2,058,037	447,036	319,627	29,582	7,309	64,395	26,123	1,598,106	1,179,142	293,771	12,895
Female	1,963,788	429,618	307,883	27,887	6,923	61,589	25,336	1,521,881	1,119,026	284,595	12,289
Plurality:											
Single births	3,889,276	857,787	615,022	55,709	13,795	123,073	50,188	3,007,230	2,212,465	557,702	24,259
Plural births	132,549	18,867	12,488	1,760	437	2,911	1,271	112,757	85,703	20,664	925
Birthweight:											
Less than 2,500 grams	315,028	57,541	38,728	5,581	926	8,242	4,064	255,406	159,001	77,690	2,081
Less than 1,500 grams	59,361	10,359	6,771	1,143	165	1,526	754	48,494	27,225	18,485	508
1,500–2,499 grams	255,667	47,182	31,957	4,438	761	6,716	3,310	206,912	131,776	59,205	1,573
2,500 grams or more	3,705,556	818,987	588,705	51,874	13,304	117,728	47,376	2,863,735	2,138,605	500,481	22,834
Not stated	1,241	126	77	14	2	14	19	846	562	195	269
Period of gestation:											
Less than 32 weeks	77,877	14,737	9,880	1,471	222	2,133	1,031	62,573	35,662	23,244	567
32–36 weeks	402,972	84,780	59,761	6,538	1,262	11,744	5,475	315,868	215,479	78,199	2,324
37–41 weeks	3,231,562	692,314	493,514	45,212	11,808	101,253	40,527	2,520,020	1,885,188	435,923	19,228
42 weeks or more	268,096	64,998	47,247	4,016	882	8,997	3,856	201,650	149,898	36,896	1,448
Not stated	41,318	19,825	17,108	232	58	1,857	570	19,876	11,941	4,104	1,617
Trimester of pregnancy prenatal care began:											
First trimester	3,301,213	657,244	464,446	44,363	13,004	97,144	38,287	2,625,196	2,006,374	423,026	18,773
After first trimester or no care	641,456	199,151	148,970	11,155	1,134	26,287	11,605	438,624	257,102	139,867	3,681
Second trimester	499,014	152,459	113,453	8,872	944	20,236	8,954	343,841	206,536	104,923	2,714
Third trimester	103,325	34,096	25,378	1,730	149	4,910	1,929	68,609	37,993	23,085	620
No prenatal care	39,117	12,596	10,139	553	41	1,141	722	26,174	12,573	11,859	347
Not stated	79,156	20,259	14,094	1,951	94	2,553	1,567	56,167	34,692	15,473	2,730
Age of mother:											
Under 20 years	432,825	130,322	99,593	10,212	1,159	10,750	8,608	300,084	181,008	104,631	2,419
20–24 years	1,022,132	265,239	196,866	18,725	2,410	31,548	15,690	750,968	519,154	190,251	5,925
25–29 years	1,060,420	236,146	170,148	13,842	4,025	35,429	12,702	817,980	614,912	132,833	6,294
30–34 years	951,229	157,887	106,177	9,415	3,881	29,222	9,192	787,081	620,175	92,157	6,261
35–39 years	453,939	71,481	45,129	4,386	2,283	15,366	4,317	379,118	297,438	46,834	3,340
40–54 years	101,280	15,579	9,597	889	474	3,669	950	84,756	65,481	11,660	945
Educational attainment of mother:											
0–8 years	239,622	180,514	150,043	2,276	192	23,609	4,394	58,406	37,288	12,999	702
9–11 years	614,968	233,255	184,000	15,648	1,475	20,647	11,485	379,286	230,460	125,346	2,427
12 years	1,234,741	260,239	179,483	19,515	5,082	38,473	17,686	968,554	680,852	226,230	5,948
13–15 years	851,738	115,398	68,074	12,688	3,104	21,650	9,882	732,297	550,547	132,333	4,043
16 years and over	1,026,820	71,041	34,149	6,730	4,321	19,216	6,625	950,500	781,618	72,045	5,279
Not stated	53,936	16,207	11,761	612	58	2,389	1,387	30,944	17,403	9,413	6,785
Live-birth order:											
1	1,594,949	320,585	221,759	22,370	6,554	49,915	19,987	1,264,645	938,381	216,536	9,719
2	1,306,795	268,911	189,759	17,742	5,103	40,242	16,065	1,030,619	780,783	168,586	7,265
3	675,278	166,130	122,873	10,270	1,866	21,981	9,140	505,265	370,717	102,964	3,883
4	264,268	72,829	55,841	4,145	486	8,619	3,738	189,829	130,048	48,266	1,610
5 or more	170,266	46,249	35,919	2,839	209	4,978	2,304	122,734	73,547	40,367	1,283
Not stated	10,269	1,950	1,359	103	14	249	225	6,895	4,692	1,647	1,424
Marital status:											
Married	2,655,815	495,181	363,544	23,506	9,984	69,544	28,603	2,143,669	1,769,630	182,807	16,965
Unmarried	1,366,010	381,473	263,966	33,963	4,248	56,440	22,856	976,318	528,538	395,559	8,219
Mother's place of birth:											
Born in the 50 States and DC	3,079,253	321,261	226,150	37,713	6,396	14,455	36,547	2,737,913	2,161,864	507,205	20,079
Born elsewhere	933,408	553,846	400,550	19,586	7,832	111,420	14,458	375,391	132,638	68,953	4,171
Not stated	9,164	1,547	810	170	4	109	454	6,683	3,666	2,208	934
Maternal smoking during pregnancy: ³											
Smoker	397,199	18,488	8,879	4,964	378	1,265	3,002	375,981	317,666	47,852	2,730
Nonsmoker	3,077,208	592,561	386,433	50,317	13,142	99,626	43,043	2,467,722	1,805,185	496,605	16,925
Not stated	18,046	2,536	1,807	158	13	248	310	14,243	10,667	2,455	1,267

See footnotes at end of table.

Table 2. Infant mortality rates, live births, and infant deaths, by selected characteristics and Hispanic origin of mother and by race of mother for mothers of non-Hispanic origin: United States, 2002 linked file—Con.

Characteristics	All origins ¹	Hispanic						Non-Hispanic			
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total ²	White	Black	Not stated
Infant deaths											
Total	27,970	4,927	3,399	471	53	637	368	22,647	13,327	8,031	395
Age at death:											
Total neonatal	18,791	3,360	2,283	334	46	435	263	15,109	8,853	5,399	322
Early neonatal (less than 7 days)	15,020	2,673	1,794	282	38	339	219	12,056	7,002	4,386	291
Late neonatal (7–27 days)	3,771	687	489	51	8	95	44	3,053	1,851	1,014	31
Postneonatal	9,179	1,567	1,116	137	7	202	105	7,538	4,474	2,632	74
Sex:											
Male	15,690	2,699	1,886	256	33	314	210	12,760	7,665	4,377	231
Female	12,279	2,228	1,512	215	20	323	158	9,887	5,661	3,654	164
Plurality:											
Single births	23,691	4,340	3,024	395	44	557	320	19,006	11,003	6,876	345
Plural births	4,278	587	374	76	9	80	48	3,641	2,323	1,155	51
Birthweight:											
Less than 2,500 grams	18,758	3,263	2,209	330	43	428	253	15,245	8,487	5,943	250
Less than 1,500 grams	14,885	2,504	1,677	268	31	326	202	12,169	6,519	5,029	212
1,500–2,499 grams	3,873	759	532	62	12	102	51	3,075	1,968	913	38
2,500 grams or more	8,840	1,621	1,163	135	9	205	109	7,141	4,723	1,962	79
Not stated	371	43	26	5	1	4	6	262	116	126	67
Period of gestation:											
Less than 32 weeks	14,515	2,371	1,574	268	32	315	182	11,958	6,415	4,949	187
32–36 weeks	3,692	680	466	58	9	91	56	2,976	1,928	867	36
37–41 weeks	8,001	1,450	1,035	122	10	190	93	6,495	4,307	1,771	56
42 weeks or more	824	161	123	12	–	17	8	655	428	179	8
Not stated	937	266	201	10	2	25	29	563	249	264	108
Trimester of pregnancy prenatal care began:											
First trimester	20,521	3,459	2,382	334	44	464	235	16,879	10,462	5,474	184
After first trimester or no care	5,758	1,203	851	108	9	145	89	4,495	2,221	2,011	61
Second trimester	3,637	796	567	70	6	94	58	2,815	1,532	1,105	26
Third trimester	618	117	84	10	–	18	5	488	232	219	12
No prenatal care	1,503	290	200	27	3	33	26	1,191	458	687	22
Not stated	1,690	266	165	29	–	27	44	1,273	644	547	151
Age of mother:											
Under 20 years	4,496	956	673	108	7	74	94	3,477	1,765	1,588	64
20–24 years	8,016	1,399	984	154	7	152	102	6,534	3,589	2,668	83
25–29 years	6,352	1,199	824	102	12	174	86	5,075	3,108	1,666	78
30–34 years	5,312	796	544	67	15	128	41	4,422	2,855	1,235	94
35–39 years	2,934	440	285	33	11	79	32	2,438	1,566	684	56
40–54 years	858	138	88	6	1	30	13	700	444	190	20
Educational attainment of mother:											
0–8 years	1,581	961	765	26	–	136	34	606	371	198	13
9–11 years	5,875	1,422	1,049	152	12	123	85	4,432	2,274	1,998	21
12 years	9,641	1,455	952	171	19	181	131	8,131	4,674	3,066	56
13–15 years	5,099	569	340	76	9	92	53	4,502	2,668	1,571	28
16 years and over	4,290	283	141	26	13	84	19	3,988	2,906	718	19
Not stated	1,484	237	151	19	–	20	46	988	433	480	258
Live-birth order:											
1	11,139	1,873	1,257	183	25	243	164	9,124	5,470	3,087	143
2	7,927	1,356	944	135	12	178	87	6,483	4,016	2,096	88
3	4,481	883	620	78	11	118	57	3,558	2,122	1,260	40
4	2,194	405	280	32	2	55	37	1,776	954	738	13
5 or more	1,898	366	267	39	3	38	18	1,511	670	761	21
Not stated	330	43	31	3	–	4	5	197	95	90	90
Marital status:											
Married	14,404	2,477	1,812	163	30	306	166	11,690	8,661	2,164	237
Unmarried	13,566	2,450	1,587	308	23	330	202	10,957	4,665	5,867	159

See footnotes at end of table.

Table 2. Infant mortality rates, live births, and infant deaths, by selected characteristics and Hispanic origin of mother and by race of mother for mothers of non-Hispanic origin: United States, 2002 linked file—Con.

Characteristics	All origins ¹	Hispanic						Non-Hispanic			Not stated
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total ²	White	Black	
Infant deaths											
Mother's place of birth:											
Born in the 50 States and DC	22,581	2,118	1,431	309	25	80	273	20,241	12,511	7,207	222
Born elsewhere	4,777	2,744	1,939	154	28	555	68	1,975	604	627	58
Not stated	612	65	29	7	–	2	27	431	212	197	115
Maternal smoking during pregnancy: ³											
Smoker	4,406	198	87	62	3	14	32	4,165	3,078	961	43
Nonsmoker	20,255	3,322	2,100	396	46	486	294	16,756	9,316	6,579	177
Not stated	436	44	29	4	–	5	5	292	153	119	100

* Figure does not meet standard of reliability or precision; based on fewer than 20 deaths in the numerator.

– Quantity zero.

¹Includes origin not stated.

²Includes races other than black or white.

³Excludes data for California, which does not report tobacco use on the birth certificate.

NOTES: Infant deaths are weighted so numbers may not exactly add to totals due to rounding. Not stated responses were included in totals but not distributed among groups for rate computations.

Table 3. Infant mortality rates by race and Hispanic origin of mother: United States and each State, Puerto Rico, Virgin Islands, and Guam, 2000–2002 linked files

[By place of residence]

State	Total	Race and Hispanic origin of mother						
		Race				Hispanic origin		
		White	Black	American Indian ¹	Asian or Pacific Islander	Hispanic	Non-Hispanic white	Non-Hispanic black
Infant mortality rates per 1,000 live births in specified group								
United States ²	6.9	5.7	13.5	8.9	4.8	5.5	5.7	13.6
Alabama	9.3	6.8	14.8	*	*	7.0	6.8	14.7
Alaska	6.8	5.4	*	11.2	*	*	5.1	*
Arizona	6.7	6.3	14.4	9.4	5.3	6.0	6.5	14.4
Arkansas	8.3	7.2	12.8	*	*	4.5	7.5	12.8
California	5.4	5.0	11.4	7.6	4.5	5.1	4.7	11.4
Colorado	6.0	5.5	13.8	11.8	6.2	6.2	5.2	13.7
Connecticut	6.4	5.4	14.2	*	3.7	7.1	4.9	14.3
Delaware	9.6	7.9	14.8	*	*	7.9	7.9	14.9
District of Columbia	11.4	4.8	15.2	*	*	7.5	*	15.3
Florida	7.2	5.6	12.9	5.8	5.1	5.2	5.7	13.0
Georgia	8.7	6.3	13.4	*	6.8	6.0	6.3	13.4
Hawaii	7.2	6.6	*	*	7.3	6.0	6.3	*
Idaho	6.6	6.6	*	*	*	8.8	6.2	*
Illinois	7.8	6.1	15.8	*	6.5	6.4	5.9	15.8
Indiana	7.7	6.9	13.9	*	*	6.4	7.0	13.9
Iowa	5.8	5.6	11.7	*	*	6.7	5.5	11.4
Kansas	7.0	6.5	14.6	*	*	7.1	6.4	14.7
Kentucky	6.7	6.3	10.7	*	*	4.8	6.4	10.8
Louisiana	9.8	6.8	13.8	*	8.1	6.0	6.9	13.7
Maine	5.1	5.1	*	*	*	*	5.0	*
Maryland	7.7	5.3	12.6	*	4.5	5.7	5.3	12.7
Massachusetts	4.8	4.3	9.6	*	3.7	6.0	4.0	10.5
Michigan	8.1	6.3	16.9	*	4.9	6.7	6.0	16.9
Minnesota	5.5	4.9	10.8	10.3	6.1	6.5	4.7	10.8
Mississippi	10.5	7.0	14.8	*	*	*	7.0	14.7
Missouri	7.7	6.3	15.6	*	4.5	7.2	6.3	15.6
Montana	6.9	6.5	*	9.9	*	*	6.4	*
Nebraska	7.0	6.3	14.8	15.8	*	7.2	6.2	15.0
Nevada	6.0	5.3	13.6	*	4.7	5.1	5.1	13.7
New Hampshire	4.9	4.9	*	*	*	*	4.5	*
New Jersey	6.1	4.8	13.1	*	3.3	6.3	4.0	13.6
New Mexico	6.4	6.2	15.6	6.8	*	6.3	6.0	15.8
New York	6.1	5.0	10.7	*	3.4	5.5	4.8	11.2
North Carolina	8.4	6.3	15.0	10.6	5.9	5.6	6.4	15.1
North Dakota	7.8	7.2	*	13.4	*	*	6.8	*
Ohio	7.7	6.4	15.5	*	4.8	7.6	6.3	15.3
Oklahoma	8.0	7.3	14.6	7.6	*	5.7	7.4	14.5
Oregon	5.5	5.5	10.3	*	3.7	5.1	5.6	10.4
Pennsylvania	7.3	6.2	14.6	*	4.0	8.6	5.9	14.4
Rhode Island	6.7	6.2	11.9	*	*	8.0	5.3	12.6
South Carolina	9.0	5.9	15.0	*	*	4.6	6.0	14.9
South Dakota	6.4	5.5	*	11.6	*	*	5.4	*
Tennessee	9.0	7.0	17.0	*	*	6.2	7.0	17.0
Texas	5.9	5.3	11.1	*	4.0	5.1	5.5	11.1
Utah	5.3	5.2	*	*	8.4	6.5	5.0	*
Vermont	5.5	5.6	*	*	*	*	5.5	*
Virginia	7.2	5.4	13.7	*	4.6	4.8	5.5	13.6
Washington	5.5	5.3	9.5	10.6	4.8	5.1	5.2	9.5
West Virginia	7.9	7.8	12.1	*	*	*	7.7	11.7
Wisconsin	6.9	5.6	17.9	11.5	5.2	6.2	5.6	17.9
Wyoming	6.5	6.6	*	*	*	*	6.3	*
Puerto Rico	9.4	9.4	10.4	---	---	---	---	---
Virgin Islands	7.0	*	6.0	*	*	*	*	*
Guam	7.3	*	*	*	7.7	*	*	*

* Figure does not meet standard of reliability or precision; based on fewer than 20 deaths in the numerator.

--- Data not available.

¹Includes Aleuts and Eskimos.²Excludes data for Puerto Rico, Virgin Islands, and Guam.

Table 4. Percent of live births with selected maternal and infant characteristics by specified race of mother: United States, 2002 linked file

Characteristic	All races	White	Black	American Indian ¹	Asian or Pacific Islander					
					Total	Chinese	Japanese	Hawaiian	Fillipino	Other
Birthweight:										
Less than 1,500 grams	1.5	1.2	3.2	1.3	1.1	0.7	1.0	1.6	1.3	1.2
Less than 2,500 grams	7.8	6.8	13.3	7.3	7.8	5.5	7.6	8.2	8.6	8.2
Preterm births ²	12.1	11.1	17.6	13.1	10.4	7.7	9.2	13.5	12.7	10.5
Prenatal care beginning in the first trimester	83.7	85.4	75.2	69.8	84.8	87.2	90.5	78.1	85.4	83.9
Births to mothers under 20 years	10.8	9.8	18.0	18.5	3.8	0.9	1.7	14.6	4.5	4.0
Fourth and higher order births	10.8	10.2	15.3	19.1	6.5	2.1	3.9	16.3	7.3	7.1
Births to unmarried mothers	34.0	28.5	68.2	59.7	14.9	9.0	10.3	50.4	20.0	13.5
Mothers completing 12 or more years of school	78.5	78.4	75.6	69.2	89.7	88.7	97.8	85.7	94.7	88.4
Mothers born in the 50 States and DC	76.7	78.5	87.0	94.4	16.9	10.0	40.4	97.4	21.5	11.6
Mother smoked during pregnancy ³	11.4	12.3	8.7	19.7	2.5	0.5	4.0	13.7	2.9	2.1

¹Includes births to Aleuts and Eskimos.²Born prior to 37 completed weeks of gestation.³Excludes data for California, which does not report tobacco use on the birth certificate.**Table 5. Percent of live births with selected maternal and infant characteristics by Hispanic origin of mother and race of mother for mothers of non-Hispanic origin: United States, 2002 linked file**

Characteristic	All origins ¹	Hispanic						Non-Hispanic		
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total ²	White	Black
Birthweight:										
Less than 1,500 grams	1.5	1.2	1.1	2.0	1.2	1.2	1.5	1.6	1.2	3.2
Less than 2,500 grams	7.8	6.6	6.2	9.7	6.5	6.5	7.9	8.2	6.9	13.4
Preterm births ³	12.1	11.6	11.4	14.0	10.5	11.2	12.8	12.2	11.0	17.7
Prenatal care beginning in the first trimester	83.7	76.7	75.7	79.9	92.0	78.7	76.7	85.7	88.6	75.2
Births to mothers under 20 years	10.8	14.9	15.9	17.8	8.1	8.5	16.7	9.6	7.9	18.1
Fourth and higher order births	10.8	13.6	14.7	12.2	4.9	10.8	11.8	10.0	8.9	15.4
Births to unmarried mothers	34.0	43.5	42.1	59.1	29.8	44.8	44.4	31.3	23.0	68.4
Mothers completing 12 or more years of school	78.5	51.9	45.8	68.5	88.2	64.2	68.3	85.8	88.3	75.7
Mothers born in the 50 States and DC	76.7	36.7	36.1	65.8	45.0	11.5	71.7	87.9	94.2	88.0
Mother smoked during pregnancy ⁴	11.4	3.0	2.2	9.0	2.8	1.3	6.5	13.2	15.0	8.8

¹Includes origin not stated.²Includes races other than black or white.³Born prior to 37 completed weeks of gestation.⁴Excludes data for California, which does not report tobacco use on the birth certificate.

Table 6. Live births, infant, neonatal, and postneonatal deaths and mortality rates, by race and Hispanic origin of mother and birthweight: United States, 2002 linked file, and percent change in birthweight-specific infant mortality, 1995–2002 linked file

Race and birthweight	Number in 2002				Mortality rate per 1,000 live births in 2002			Percent change in infant mortality rate 1995–2002
	Live births	Infant deaths	Neonatal deaths	Postneonatal deaths	Infant	Neonatal	Postneonatal	
All races ¹	4,021,825	27,970	18,791	9,179	7.0	4.7	2.3	-7.9
Less than 2,500 grams	315,028	18,758	15,324	3,434	59.5	48.6	10.9	-7.9
Less than 1,500 grams	59,361	14,885	13,078	1,807	250.8	220.3	30.4	-6.6
Less than 500 grams	6,780	5,844	5,688	156	861.9	838.9	23.0	-4.6**
500–749 grams	11,290	5,528	4,792	736	489.6	424.4	65.2	-7.3
750–999 grams	11,803	1,831	1,374	458	155.1	116.4	38.8	-14.8
1,000–1,249 grams	13,599	1,000	712	243	70.3	52.4	17.9	-17.8
1,250–1,499 grams	15,889	726	512	214	45.7	32.2	13.5	-16.3
1,500–1,999 grams	61,705	1,636	1,067	569	26.5	17.3	9.2	-20.2
2,000–2,499 grams	193,962	2,237	1,180	1,057	11.5	6.1	5.4	-14.8
2,500 grams or more	3,705,556	8,840	3,103	5,737	2.4	0.8	1.5	-20.0
2,500–2,999 grams	688,845	3,082	1,208	1,874	4.5	1.8	2.7	-16.7
3,000–3,499 grams	1,522,223	3,435	1,107	2,328	2.3	0.7	1.5	-20.7
3,500–3,999 grams	1,126,215	1,771	560	1,211	1.6	0.5	1.1	-20.0
4,000–4,499 grams	314,255	427	164	264	1.4	0.5	0.8	-22.2
4,500–4,999 grams	48,621	98	46	52	2.0	0.9	1.1	-9.1**
5,000 grams or more	5,397	27	18	9	5.0	*	*	-40.5**
Not stated	1,241	371	363	8	...	...	...	...
White	3,174,807	18,395	12,352	6,044	5.8	3.9	1.9	-7.9
Less than 2,500 grams	216,373	11,830	9,787	2,043	54.7	45.2	9.4	-8.4
Less than 1,500 grams	37,569	9,097	8,104	992	242.1	215.7	26.4	-7.1
Less than 500 grams	3,873	3,368	3,277	91	869.6	846.1	23.5	-4.6**
500–749 grams	6,690	3,382	3,003	379	505.5	448.9	56.7	-7.5
750–999 grams	7,370	1,201	936	265	163.0	127.0	36.0	-15.5
1,000–1,249 grams	8,937	652	516	136	73.0	57.7	15.2	-19.7
1,250–1,499 grams	10,699	492	371	121	46.0	34.7	11.3	-17.1
1,500–1,999 grams	43,113	1,142	792	350	26.5	18.4	8.1	-20.2
2,000–2,499 grams	135,691	1,591	890	701	11.7	6.6	5.2	-14.6
2,500 grams or more	2,957,532	6,366	2,370	3,996	2.2	0.8	1.4	-18.5
2,500–2,999 grams	495,210	2,133	900	1,233	4.3	1.8	2.5	-18.9
3,000–3,499 grams	1,191,645	2,463	848	1,615	2.1	0.7	1.4	-22.2
3,500–3,999 grams	948,175	1,354	444	910	1.4	0.5	1.0	-22.2
4,000–4,499 grams	275,107	321	129	191	1.2	0.5	0.7	-25.0
4,500–4,999 grams	42,764	74	34	39	1.7	0.8	0.9	-15.0**
5,000 grams or more	4,631	21	13	8	4.5	*	*	-41.6**
Not stated	902	199	195	4	...	...	...	...
Black	593,743	8,201	5,533	2,668	13.8	9.3	4.5	-5.5
Less than 2,500 grams	79,137	6,056	4,830	1,226	76.5	61.0	15.5	-3.4**
Less than 1,500 grams	18,841	5,127	4,397	731	272.1	233.4	38.8	-4.7
Less than 500 grams	2,617	2,231	2,173	58	852.5	830.3	22.2	-4.7**
500–749 grams	4,095	1,907	1,584	323	465.7	386.8	78.9	-6.7**
750–999 grams	3,827	541	371	170	141.4	96.9	44.4	-13.3
1,000–1,249 grams	3,970	258	160	98	65.0	40.3	24.7	-12.8**
1,250–1,499 grams	4,332	190	109	82	43.9	25.2	18.9	-9.7**
1,500–1,999 grams	15,156	409	216	193	27.0	14.3	12.7	-16.7
2,000–2,499 grams	45,140	520	218	302	11.5	4.8	6.7	-14.8
2,500 grams or more	514,367	1,993	554	1,439	3.9	1.1	2.8	-13.3
2,500–2,999 grams	140,541	798	239	558	5.7	1.7	4.0	-8.1**
3,000–3,499 grams	226,502	774	192	582	3.4	0.8	2.6	-17.1
3,500–3,999 grams	117,810	322	88	234	2.7	0.7	2.0	-22.9
4,000–4,499 grams	25,298	79	23	55	3.1	0.9	2.2	-27.9**
4,500–4,999 grams	3,741	16	7	9	*	*	*	*
5,000 grams or more	475	5	5	-	*	*	*	*
Not stated	239	152	149	3	...	...	...	...

See footnotes at end of table.

Table 6. Live births, infant, neonatal, and postneonatal deaths and mortality rates, by race and Hispanic origin of mother and birthweight: United States, 2002 linked file, and percent change in birthweight-specific infant mortality, 1995–2002 linked file—Con.

Race and birthweight	Number in 2002				Mortality rate per 1,000 live births in 2002			Percent change in infant mortality rate 1995–2002
	Live births	Infant deaths	Neonatal deaths	Postneonatal deaths	Infant	Neonatal	Postneonatal	
American Indian ²	42,367	366	195	171	8.6	4.6	4.0	-4.4**
Less than 2,500 grams	3,072	197	146	51	64.1	47.5	16.6	11.3**
Less than 1,500 grams	549	137	113	24	249.5	205.8	43.7	5.4**
Less than 500 grams	57	50	47	3	877.2	824.6	*	-1.3**
500–749 grams	103	42	37	5	407.8	359.2	*	-33.1**
750–999 grams	113	14	10	4	*	*	*	*
1,000–1,249 grams	124	14	9	5	*	*	*	*
1,250–1,499 grams	152	16	9	7	*	*	*	*
1,500–1,999 grams	591	19	15	4	*	*	*	*
2,000–2,499 grams	1,932	41	18	23	21.2	*	11.9	10.4**
2,500 grams or more	39,286	168	49	119	4.3	1.2	3.0	-18.9**
2,500–2,999 grams	6,746	45	17	28	6.7	*	4.2	-36.8**
3,000–3,499 grams	15,490	74	18	56	4.8	*	3.6	0.0**
3,500–3,999 grams	12,304	33	9	24	2.7	*	2.0	-34.1**
4,000–4,499 grams	3,870	10	3	7	*	*	*	*
4,500–4,999 grams	769	4	2	2	*	*	*	*
5,000 grams or more	107	1	–	1	*	*	*	*
Not stated	9	1	–	1	...	...	...	...
Asian or Pacific Islander	210,908	1,006	710	296	4.8	3.4	1.4	-9.4
Less than 2,500 grams	16,446	675	561	113	41.0	34.1	6.9	-11.4
Less than 1,500 grams	2,402	525	464	60	218.6	193.2	25.0	-8.8**
Less than 500 grams	233	195	192	3	836.9	824.0	*	-7.5**
500–749 grams	402	197	167	29	490.0	415.4	72.1	-5.1**
750–999 grams	493	75	57	18	152.1	115.6	*	-20.4**
1,000–1,249 grams	568	31	26	5	54.6	45.8	*	-39.9**
1,250–1,499 grams	706	27	22	5	38.2	31.2	*	-48.4**
1,500–1,999 grams	2,845	66	44	22	23.2	15.5	7.7	-43.7
2,000–2,499 grams	11,199	85	54	31	7.6	4.8	2.8	-26.9**
2,500 grams or more	194,371	313	130	183	1.6	0.7	0.9	-27.3
2,500–2,999 grams	46,348	106	52	54	2.3	1.1	1.2	-34.3
3,000–3,499 grams	88,586	123	49	74	1.4	0.6	0.8	-26.3
3,500–3,999 grams	47,926	61	19	42	1.3	*	0.9	-7.1**
4,000–4,499 grams	9,980	18	8	10	*	*	*	*
4,500–4,999 grams	1,347	4	2	2	*	*	*	*
5,000 grams or more	184	–	–	–	*	*	*	*
Not stated	91	19	19	–	...	...	...	...
Hispanic	876,654	4,927	3,360	1,567	5.6	3.8	1.8	-11.1
Less than 2,500 grams	57,541	3,263	2,695	569	56.7	46.8	9.9	-7.5
Less than 1,500 grams	10,359	2,504	2,203	301	241.7	212.7	29.1	-8.2
Less than 500 grams	1,070	875	848	27	817.8	792.5	25.2	-6.4**
500–749 grams	1,951	985	863	123	504.9	442.3	63.0	-6.7**
750–999 grams	2,085	328	247	81	157.3	118.5	38.8	-17.0
1,000–1,249 grams	2,390	172	140	32	72.0	58.6	13.4	-15.6**
1,250–1,499 grams	2,863	144	105	38	50.3	36.7	13.3	-7.5**
1,500–1,999 grams	10,952	321	230	90	29.3	21.0	8.2	-13.3**
2,000–2,499 grams	36,230	438	261	177	12.1	7.2	4.9	-6.9**
2,500 grams or more	818,987	1,621	624	997	2.0	0.8	1.2	-20.0
2,500–2,999 grams	149,252	552	255	297	3.7	1.7	2.0	-17.8
3,000–3,499 grams	349,880	615	204	411	1.8	0.6	1.2	-21.7
3,500–3,999 grams	245,269	354	116	238	1.4	0.5	1.0	-22.2
4,000–4,499 grams	63,677	69	30	39	1.1	0.5	0.6	-26.7**
4,500–4,999 grams	9,692	23	14	9	2.4	*	*	-20.0**
5,000 grams or more	1,217	8	5	3	*	*	*	*
Not stated	126	43	42	1	...	...	...	...

See footnotes at end of table.

Table 6. Live births, infant, neonatal, and postneonatal deaths and mortality rates, by race and Hispanic origin of mother and birthweight: United States, 2002 linked file, and percent change in birthweight-specific infant mortality, 1995–2002 linked file—Con.

Race and birthweight	Number in 2002				Mortality rate per 1,000 live births in 2002			Percent change in infant mortality rate 1995–2002
	Live births	Infant deaths	Neonatal deaths	Postneonatal deaths	Infant	Neonatal	Postneonatal	
Non-Hispanic white	2,298,168	13,327	8,853	4,474	5.8	3.9	1.9	-7.9
Less than 2,500 grams	159,001	8,487	7,008	1,480	53.4	44.1	9.3	-9.2
Less than 1,500 grams	27,225	6,519	5,819	700	239.4	213.7	25.7	-7.2
Less than 500 grams	2,745	2,437	2,373	64	887.8	864.5	23.3	-3.7**
500–749 grams	4,733	2,383	2,120	262	503.5	447.9	55.4	-8.1
750–999 grams	5,316	875	691	184	164.6	130.0	34.6	-14.0
1,000–1,249 grams	6,554	478	374	104	72.9	57.1	15.9	-20.8
1,250–1,499 grams	7,877	346	260	86	43.9	33.0	10.9	-21.0
1,500–1,999 grams	32,175	817	559	258	25.4	17.4	8.0	-23.0
2,000–2,499 grams	99,601	1,151	630	521	11.6	6.3	5.2	-16.5
2,500 grams or more	2,138,605	4,723	1,730	2,993	2.2	0.8	1.4	-18.5
2,500–2,999 grams	346,644	1,575	637	939	4.5	1.8	2.7	-18.2
3,000–3,499 grams	842,563	1,840	641	1,199	2.2	0.8	1.4	-21.4
3,500–3,999 grams	702,068	992	324	669	1.4	0.5	1.0	-22.2
4,000–4,499 grams	210,936	252	100	152	1.2	0.5	0.7	-25.0
4,500–4,999 grams	33,000	50	20	30	1.5	0.6	0.9	-21.1**
5,000 grams or more	3,394	13	8	5	*	*	*	*
Not stated	562	116	115	1	...	...	...	...
Non-Hispanic black	578,366	8,031	5,399	2,632	13.9	9.3	4.6	-5.4
Less than 2,500 grams	77,690	5,943	4,733	1,209	76.5	60.9	15.6	-3.2**
Less than 1,500 grams	18,485	5,029	4,311	719	272.1	233.2	38.9	-4.6
Less than 500 grams	2,561	2,185	2,127	57	853.2	830.5	22.3	-4.7**
500–749 grams	4,030	1,878	1,558	320	466.0	386.6	79.4	-6.3**
750–999 grams	3,760	527	360	166	140.2	95.7	44.1	-14.3
1,000–1,249 grams	3,898	255	157	98	65.4	40.3	25.1	-12.0**
1,250–1,499 grams	4,236	184	107	78	43.4	25.3	18.4	-10.0**
1,500–1,999 grams	14,890	402	211	191	27.0	14.2	12.8	-16.4
2,000–2,499 grams	44,315	512	212	300	11.6	4.8	6.8	-13.4
2,500 grams or more	500,481	1,962	542	1,420	3.9	1.1	2.8	-15.2
2,500–2,999 grams	137,618	783	233	549	5.7	1.7	4.0	-8.1**
3,000–3,499 grams	220,512	761	187	574	3.5	0.8	2.6	-14.6
3,500–3,999 grams	113,987	321	88	233	2.8	0.8	2.0	-20.0
4,000–4,499 grams	24,313	77	22	54	3.2	0.9	2.2	-27.3**
4,500–4,999 grams	3,589	16	7	9	*	*	*	*
5,000 grams or more	462	5	5	-	*	*	*	*
Not stated	195	126	124	2	...	...	...	...

** Not significant at $p < .05$.

* Figure does not meet standard of reliability or precision; based on fewer than 20 deaths in the numerator.

... Category not applicable.

- Quantity zero.

¹Includes races other than white or black.²Includes Aleuts and Eskimos.

NOTES: Infant deaths are weighted so numbers may not exactly add to totals due to rounding. Neonatal is less than 28 days, and postneonatal is 28 days to under 1 year.

Table 7. Infant deaths and mortality rates for the five leading causes of infant death, by race and Hispanic origin of mother: United States, 2002 linked file

[Rates per 100,000 live births in specified group]

Cause of death (Based on the <i>International Classification of Diseases, Tenth Revision, 1992</i>)	All races			Non-Hispanic white			Non-Hispanic black ¹			American Indian ^{2,3}			Asian or Pacific Islander ⁴		
	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate
All causes . . . . .	...	27,970	695.4	...	13,327	579.9	...	8,031	1,388.6	...	366	864.8	...	1,006	477.2
Congenital malformations, deformations and chromosomal abnormalities. (Q00–Q99)	1	5,630	140.0	1	2,999	130.5	2	987	170.6	1	80	188.1	1	225	106.8
Disorders related to short gestation and low birthweight, not elsewhere classified (P07)	2	4,636	115.3	2	1,769	77.0	1	1,828	316.0	3	46	108.0	2	161	76.4
Sudden infant death syndrome (R95)	3	2,295	57.1	3	1,269	55.2	3	642	110.9	2	52	123.3	4	51	24.3
Newborn affected by maternal complications of pregnancy. (P01) ⁵	4	1,704	42.4	4	797	34.7	4	548	94.8	4	22	52.6	3	68	32.1
Newborn affected by complications of placenta, cord and membranes (P02)	5	1,013	25.2	5	491	21.3	6	308	53.2	9	7	*	6	32	15.0

Cause of death (Based on the <i>International Classification of Diseases, Tenth Revision, 1992</i>)	Total Hispanic			Mexican			Puerto Rican ⁶			Central and South American ⁷		
	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate
All causes . . . . .	...	4,927	562.0	...	3,399	541.6	...	471	818.9	...	637	505.6
Congenital malformations, deformations and chromosomal abnormalities. (Q00–Q99)	1	1,277	145.6	1	914	145.6	2	96	166.6	1	172	136.4
Disorders related to short gestation and low birthweight, not elsewhere classified (P07)	2	759	86.6	2	503	80.1	1	97	168.6	2	93	74.1
Sudden infant death syndrome (R95)	3	260	29.7	3	181	28.8	3	31	54.3	5	26	20.8
Newborn affected by maternal complications of pregnancy. (P01) ⁵	4	241	27.5	4	149	23.8	4	28	48.9	4	27	21.1
Newborn affected by complications of placenta, cord and membranes (P02)	5	158	18.0	5	112	17.8	6	18	*	9	12	*

... Category not applicable.

* Figure does not meet standard of reliability or precision; based on fewer than 20 deaths in the numerator.

¹For non-Hispanic blacks, Respiratory distress of newborn was the fifth leading cause of death, with 319 deaths and a rate of 55.1.

²Includes Aleuts and Eskimos.

³For American Indians, Accidents (unintentional injuries) was the fifth leading cause of death; however, with only 16 deaths, a reliable infant mortality rate could not be computed.

⁴For Asian or Pacific Islanders, Diseases of the circulatory system was the fifth leading cause of death, with 34 deaths and a rate of 16.2.

⁵Cause-of-death coding changes may affect comparability with the previous year's data for this cause; see "Technical Notes."

⁶For Puerto Ricans, Respiratory distress of newborn was the fifth leading cause of death, with 20 deaths and a rate of 35.1.

⁷For Central and South Americans, Respiratory distress of newborn was the third leading cause of death, with 32 deaths and a rate of 25.1.

NOTE: Reliable cause-specific infant mortality rates cannot be computed for Cubans because of the small number of infant deaths (53).

Technical Notes

Differences between period and cohort data

From 1983 to 1991 NCHS produced linked files in a birth cohort format (46). Beginning with 1995 data, linked files are produced first using a period format and then subsequently using a birth cohort format (both available on CD ROM). Thus, the 2002 period linked file contains a numerator file that consists of all infant deaths occurring in 2002 that have been linked to their corresponding birth certificates, whether the birth occurred in 2001 or in 2002. In contrast, the 2002 birth cohort linked file will contain a numerator file that consists of all infant deaths to babies born in 2002 whether the death occurred in 2002 or 2003.

For the 2002 file, NCHS accepted birth records that could be linked to infant deaths even if registered after the closure of the 2002 birth file (slightly more than 100 cases). This improved the infant birth/death linkage and made the denominator file distinctly different from the official 2002 birth file.

The release of linked file data in two different formats allows NCHS to meet demands for more timely linked files while still meeting the needs of data users who prefer the birth cohort format. While the birth cohort format has methodological advantages, it creates substantial delays in data availability, since it is necessary to wait until the close of the following data year to include all infant deaths in the birth cohort. Beginning with 1995 data, the period linked file is the basis for all official NCHS linked file statistics.

Weighting

A record weight is added to the linked file to compensate for the 1.0 percent (in 2002) of infant death records that could not be linked to their corresponding birth certificates. This procedure was initiated in 1995. Records for Puerto Rico, the Virgin Islands, and Guam are not weighted. The percentage of records linked varied by registration area (from 93.9 to 100.0 percent with all but three areas—Alaska, Oklahoma, and Texas at 97 percent or higher) (table I). The number of infant deaths in the linked file for the 50 States and the District of Columbia was weighted to equal the sum of the linked plus unlinked infant deaths by State of occurrence at birth and age at death (less than 7 days, 7–27 days, and 28 days to under 1 year). The addition of the weight greatly reduced the potential for bias in comparing infant mortality rates by characteristics.

The 2002 linked file started with 28,016 infant death records. Of these 28,016 records, 27,722 were linked; 294 were unlinked because corresponding birth certificates could not be identified. The 28,016 linked and unlinked records contained 46 records of infants whose mother's usual place of residence is outside of the United States. These 46 records were excluded to derive a weighted total of 27,970 infant deaths. Thus, all total calculations for 2002 in this report used a weighted total of 27,970 infant deaths (tables A, B, D, 1, 2, 6, and 7).

Comparison of infant mortality data between the linked file and the vital statistics mortality file

The overall infant mortality rate from the 2002 period linked file of 7.0 is the same as the 2002 vital statistics mortality file. The number of infant deaths differs slightly; the number in the mortality file

Table I. Percent of infant death records that were linked to their corresponding birth records: United States and each State, Puerto Rico, Virgin Islands, and Guam, 2002 linked file

State	Percent linked by State of occurrence of death
United States ¹	99.0
Alabama	100.0
Alaska	93.9
Arizona	99.6
Arkansas	99.7
California	97.9
Colorado	100.0
Connecticut	100.0
Delaware	100.0
District of Columbia	99.5
Florida	99.6
Georgia	100.0
Hawaii	100.0
Idaho	100.0
Illinois	97.3
Indiana	98.4
Iowa	99.4
Kansas	99.2
Kentucky	99.7
Louisiana	97.5
Maine	98.3
Maryland	99.6
Massachusetts	97.2
Michigan	99.7
Minnesota	100.0
Mississippi	100.0
Missouri	100.0
Montana	98.7
Nebraska	100.0
Nevada	99.5
New Hampshire	100.0
New Jersey	97.9
New Mexico	99.4
New York	99.0
North Carolina	99.9
North Dakota	100.0
Ohio	99.7
Oklahoma	95.8
Oregon	100.0
Pennsylvania	99.7
Rhode Island	100.0
South Carolina	100.0
South Dakota	100.0
Tennessee	99.9
Texas	96.8
Utah	99.3
Vermont	100.0
Virginia	99.7
Washington	99.8
West Virginia	100.0
Wisconsin	100.0
Wyoming	100.0
Puerto Rico	100.0
Virgin Islands	100.0
Guam	100.0

¹Excludes data for Puerto Rico, Virgin Islands, and Guam.

was 28,034 (2). Differences in numbers of infant deaths between the two data sources can be traced to three different causes:

1. geographic coverage differences
2. additional quality control
3. weighting

Differences in geographic coverage are due to the fact that for the vital statistics mortality file, all deaths occurring in the 50 States and the District of Columbia are included regardless of the place of birth of the infant. In contrast, to be included in the linked file, both the birth and death must occur in the 50 States and the District of Columbia. In addition to the mortality quality control review, the linkage process subjects infant death records to an additional round of quality control (2). Every year, a few records are voided from the file at this stage because they are found to be fetal deaths, deaths at ages over 1 year, or duplicate death certificates. Finally, although every effort has been made to design weights that will accurately reflect the distribution of deaths by characteristics, weighting may contribute to small differences in numbers and rates by specific variables between these two data sets.

Marital status

National estimates of births to unmarried women are based on two methods of determining marital status. In 2002 marital status was based on a direct question in 48 States and the District of Columbia. In the two States (Michigan and New York) that used inferential procedures to compile birth statistics by marital status, a birth is inferred as nonmarital if either of these factors, listed in priority-of-use order, is present: a paternity acknowledgment was received or the father's name is missing. For more information on the inferential procedures and on the changes in reporting, see the "Technical Notes" in *Births: Final Data for 2002* (3).

Period of gestation and birthweight

The primary measure used to determine the gestational age of the newborn is the interval between the first day of the mother's last normal menstrual period (LMP) and the date of birth. It is subject to error for several reasons, including imperfect maternal recall or misidentification of the LMP because of postconception bleeding, delayed ovulation, or intervening early miscarriage. These data are edited for LMP-based gestational ages that are clearly inconsistent with the infant's plurality and birthweight (see below), but reporting problems for this item persist and many occur more frequently among some subpopulations and among births with shorter gestations (47,48).

The U.S. Standard Certificate of Live Birth contains an item, "clinical estimate of gestation," which is compared with length of gestation computed from the date the LMP began when the latter appears to be inconsistent with birthweight. This is done for normal-weight births of apparently short gestations and very-low-birthweight births reported to be full term. The clinical estimate was also used if the LMP date was not reported. The period of gestation for 4.6 percent of the births in 2002 was based on the clinical estimate of gestation. For 97 percent of these records, the clinical estimate was used because the LMP date was not reported. For the remaining 3 percent, the clinical estimate was used because it was consistent with the reported birthweight, whereas the LMP-based gestation was not. In cases where the

reported birthweight was inconsistent with both the LMP-computed gestation and the clinical estimate of gestation, the LMP-computed gestation was used and birthweight was re-classified as "not stated." This was necessary for about 284 births or 0.007 percent of all birth records in 2002 (3).

For the linked file, not stated birthweight was imputed for 1,814 records or 0.04 percent of the birth records in 2002 when birthweight was not stated but the period of gestation was known. In this case, birthweight was assigned the value from the previous record with the same period of gestation, maternal race, sex, and plurality. If birthweight and period of gestation were both unknown the not stated value for birthweight was retained. This imputation was done to improve the accuracy of birthweight-specific infant mortality rates, since the percentage of records with not stated birthweight was higher for infant deaths (3.85 percent before imputation) than for live births (0.07 percent before imputation). The imputation reduced the percent of not stated records to 1.42 percent for infant deaths, and 0.04 percent for births. The not stated birthweight cases in the natality/birth file, as distinct from the linked file, are not imputed (3).

Cause-of-death classification

The mortality statistics presented in this report were compiled in accordance with the World Health Organization (WHO) regulations, which specify that member nations classify and code causes of death in accordance with the current revision of the *International Statistical Classification of Diseases and Related Health Problems* (ICD). The ICD provides the basic guidance used in virtually all countries to code and classify causes of death. The ICD not only details disease classification but also provides definitions, tabulation lists, the format of the death certificate, and the rules for coding cause of death. Cause-of-death data presented in this report were coded by procedures outlined in annual issues of the *NCHS Instruction Manual* (49,50).

In this report tabulations of cause-of-death statistics are based solely on the underlying cause of death. The underlying cause is defined by WHO as "the disease or injury which initiated the train of events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury" (4). It is selected from the conditions entered by the physician in the cause-of-death section of the death certificate. When more than one cause or condition is entered by the physician, the underlying cause is determined by the sequence of conditions on the certificate, provisions of the ICD, and associated selection rules and modifications. Generally, more medical information is reported on death certificates than is directly reflected in the underlying cause of death. This is captured in NCHS multiple cause-of-death statistics (51,52).

About every 10 to 20 years, the ICD is revised to take into account advances in medical knowledge. Effective with deaths occurring in 1999, the United States began using the Tenth Revision of the ICD (4); during the period 1979–98, causes were coded and classified according to the Ninth Revision of the ICD (5).

Changes in classification of causes of death due to these revisions may result in discontinuities in cause-of-death trends. Measures of this discontinuity are essential to the interpretation of mortality trends, and are discussed in detail in other NCHS publications (2,53).

Maternal complications—In addition to changes due to the implementation of a new ICD revision, rules for coding a cause of death may

occasionally require modification at other times, when evidence suggests that such modifications will improve the quality of cause-of-death data. These changes may affect comparability of data between years for select causes of death. For example, between 2001 and 2002 a change in the coding rules was implemented that resulted in some deaths that would have previously been assigned to Atelectasis, instead being assigned to maternal complications. This change accounts for part (about one-half) of the large increase in maternal complications from 2001–02 (2).

Tabulation lists and cause-of-death ranking

The cause-of-death rankings for ICD–10 are based on the List of 130 Selected Causes of Infant Death. The tabulation lists and rules for ranking leading causes of death are published in the *NCHS Instruction Manual*, Part 9, “ICD–10 Cause-of-Death Lists for Tabulating Mortality Statistics, Effective 1999” (54). Briefly, category titles that begin with the words “Other” and “All other” are not ranked to determine the leading causes of death. When one of the titles that represents a subtotal is ranked (for example, Influenza and pneumonia (J10–J18)), its component parts are not ranked (in this case, Influenza (J10–J11) and Pneumonia (J12–18)).

Computation of rates

Infant mortality rates are the most commonly used index for measuring the risk of dying during the first year of life. For the linked birth/infant death data set they are calculated by dividing the number of infant deaths in a calendar year by the number of live births registered for the same period and are presented as rates per 1,000 or per 100,000 live births. Both the mortality file and the linked birth/infant death file use this computation method but due to unique numbers of infant deaths, as explained in the section above on the comparison of these two files, the rates will often differ for specific variables (particularly for race and ethnicity). Infant mortality rates use the number of live births in the denominator to approximate the population at risk of dying before the first birthday. In contrast to the infant mortality rates based on live births, infant death rates, used only in age-specific death rates with the mortality file, use the estimated population of persons under 1 year of age as the denominator. For all variables, not stated responses were shown in tables of frequencies, but were dropped before rates were computed.

As stated previously, infant death records for the 50 States and the District of Columbia in the linked file are weighted so that the infant mortality rates are not underestimated for those areas that did not successfully link all records.

Random variation in infant mortality rates

The number of infant deaths and live births reported for an area represent complete counts of such events. As such, they are not subject to sampling error, although they are subject to nonsampling error in the registration process. However, when the figures are used for analytic purposes, such as the comparison of rates over time, for different areas, or among different subgroups, the number of events that actually occurred may be considered as one of a large series of possible results that could have arisen under the same circumstances (55). As a result, numbers of births, deaths, and infant mortality rates

are subject to random variation. The probable range of values may be estimated from the actual figures according to certain statistical assumptions.

In general, distributions of vital events may be assumed to follow the binomial distribution. When the number of events is large, the relative standard error is usually small. When the number of events is small (perhaps fewer than 100) and the probability of such an event is small, considerable caution must be observed in interpreting the data. Such infrequent events may be assumed to follow a Poisson probability distribution (2). Estimates of relative standard errors (RSEs) and 95-percent confidence intervals are shown below.

The formula for the RSE of infant deaths and live births is:

$$RSE(D) = 100 \cdot \sqrt{\frac{1}{D}}$$

where D is the number of deaths and

$$RSE(B) = 100 \cdot \sqrt{\frac{1}{B}}$$

where B is the number of births.

For example, let us say that for group A the number of infant deaths was 112 while the number of live births was 28,560, yielding an infant mortality rate of 3.9 infant deaths per 1,000 live births.

$$\text{The RSE of the deaths} = 100 \cdot \sqrt{\frac{1}{112}} = 9.45,$$

$$\text{while the RSE of the births} = 100 \cdot \sqrt{\frac{1}{28,560}} = 0.59.$$

The formula for the RSE of the infant mortality rate (IMR) is:

$$RSE(IMR) = 100 \cdot \sqrt{\frac{1}{D} + \frac{1}{B}}$$

$$\text{The RSE of the IMR} = 100 \cdot \sqrt{\frac{1}{112} + \frac{1}{28,560}} = 9.47.$$

Binomial distribution—When the number of events is greater than 100, the binomial distribution is used to estimate the 95-percent confidence intervals as follows:

$$\text{Lower: } R_1 - 1.96 \cdot R_1 \cdot \frac{RSE(R_1)}{100}$$

$$\text{Upper: } R_1 + 1.96 \cdot R_1 \cdot \frac{RSE(R_1)}{100}$$

Thus, for group A:

$$\text{Lower: } 3.9 - \left(1.96 \cdot 3.9 \cdot \frac{9.47}{100}\right) = 3.2$$

$$\text{Upper: } 3.9 + \left(1.96 \cdot 3.9 \cdot \frac{9.47}{100}\right) = 4.6$$

Thus the chances are 95 out of 100 that the true IMR for group A lies somewhere in the 3.2 to 4.6 interval.

Poisson distribution—When the number of events in the numerator is less than 100 the confidence interval for the rate can be estimated based on the Poisson distribution using the values in [table II](#).

$$\text{Lower: } \text{IMR} \cdot L (.95, D_{\text{adj}})$$

$$\text{Upper: } \text{IMR} \cdot U (.95, D_{\text{adj}})$$

where D_{adj} is the adjusted number of infant deaths (rounded to the nearest integer) used to take into account the RSE of the number of infant deaths and live births, and is computed as follows:

$$D_{\text{adj}} = \frac{D \cdot B}{D + B}$$

$L (.95, D_{\text{adj}})$ and $U (.95, D_{\text{adj}})$ refer to the values in [table II](#) corresponding to the value of D_{adj} .

For example, let us say that for group B the number of infant deaths was 58, the number of live births was 9,801, and the infant mortality rate was 5.9.

$$D_{\text{adj}} = \frac{(58 \cdot 9,801)}{(58 + 9,801)} = 58$$

Therefore the 95-percent confidence interval (using the formula in [table II](#) for 1–99 infant deaths) =

$$\text{Lower: } 5.9 \cdot 0.75934 = 4.5$$

$$\text{Upper: } 5.9 \cdot 1.29273 = 7.6$$

Comparison of two infant mortality rates—If either of the two rates to be compared is based on less than 100 deaths, compute the confidence intervals for both rates and check to see if they overlap. If

Table II. Values of L and U for calculating 95-percent confidence limits for numbers of events and rates when the number of events is less than 100

N	L	U	N	L	U
1	0.02532	5.57164	51	0.74457	1.31482
2	0.12110	3.61234	52	0.74685	1.31137
3	0.20622	2.92242	53	0.74907	1.30802
4	0.27247	2.56040	54	0.75123	1.30478
5	0.32470	2.33367	55	0.75334	1.30164
6	0.36698	2.17658	56	0.75539	1.29858
7	0.40205	2.06038	57	0.75739	1.29562
8	0.43173	1.97040	58	0.75934	1.29273
9	0.45726	1.89831	59	0.76125	1.28993
10	0.47954	1.83904	60	0.76311	1.28720
11	0.49920	1.78928	61	0.76492	1.28454
12	0.51671	1.74680	62	0.76669	1.28195
13	0.53246	1.71003	63	0.76843	1.27943
14	0.54671	1.67783	64	0.77012	1.27698
15	0.55969	1.64935	65	0.77178	1.27458
16	0.57159	1.62394	66	0.77340	1.27225
17	0.58254	1.60110	67	0.77499	1.26996
18	0.59266	1.58043	68	0.77654	1.26774
19	0.60207	1.56162	69	0.77806	1.26556
20	0.61083	1.54442	70	0.77955	1.26344
21	0.61902	1.52861	71	0.78101	1.26136
22	0.62669	1.51401	72	0.78244	1.25933
23	0.63391	1.50049	73	0.78384	1.25735
24	0.64072	1.48792	74	0.78522	1.25541
25	0.64715	1.47620	75	0.78656	1.25351
26	0.65323	1.46523	76	0.78789	1.25165
27	0.65901	1.45495	77	0.78918	1.24983
28	0.66449	1.44528	78	0.79046	1.24805
29	0.66972	1.43617	79	0.79171	1.24630
30	0.67470	1.42756	80	0.79294	1.24459
31	0.67945	1.41942	81	0.79414	1.24291
32	0.68400	1.41170	82	0.79533	1.24126
33	0.68835	1.40437	83	0.79649	1.23965
34	0.69253	1.39740	84	0.79764	1.23807
35	0.69654	1.39076	85	0.79876	1.23652
36	0.70039	1.38442	86	0.79987	1.23499
37	0.70409	1.37837	87	0.80096	1.23350
38	0.70766	1.37258	88	0.80203	1.23203
39	0.71110	1.36703	89	0.80308	1.23059
40	0.71441	1.36172	90	0.80412	1.22917
41	0.71762	1.35661	91	0.80514	1.22778
42	0.72071	1.35171	92	0.80614	1.22641
43	0.72370	1.34699	93	0.80713	1.22507
44	0.72660	1.34245	94	0.80810	1.22375
45	0.72941	1.33808	95	0.80906	1.22245
46	0.73213	1.33386	96	0.81000	1.22117
47	0.73476	1.32979	97	0.81093	1.21992
48	0.73732	1.32585	98	0.81185	1.21868
49	0.73981	1.32205	99	0.81275	1.21746
50	0.74222	1.31838			

so, the difference is not statistically significant at the 95-percent level. If they do not overlap, the difference is statistically significant. If both of the two rates (R_1 and R_2) to be compared are based on 100 or more deaths, the following z-test may be used to define a significance test statistic:

$$z = \frac{R_1 - R_2}{\sqrt{R_1^2 \left(\frac{\text{RSE}(R_1)}{100} \right)^2 + R_2^2 \left(\frac{\text{RSE}(R_2)}{100} \right)^2}}$$

If $|z| \geq 1.96$, then the difference is statistically significant at the 0.05 level and if $|z| < 1.96$, the difference is not significant.

Availability of linked file data

Linked file data are available on CD ROM from the National Center for Health Statistics (NCHS) at 1-866-441-6247. Data are also available in selected issues of the *Vital and Health Statistics*, Series 20 reports, the *National Vital Statistics Reports* (formerly the *Monthly Vital Statistics Report*) through NCHS. Additional unpublished tabulations are available from NCHS through the Internet site at <http://www.cdc.gov/nchs>. Selected variables from the linked file are also available for tabulation on CDC WONDER at <http://wonder.cdc.gov/lbdJ.html>.

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National Center for Health Statistics

Director, Edward J. Sondik, Ph.D.
Deputy Director, Jack R. Anderson

Division of Vital Statistics

Director, Charles J. Rothwell

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National Center for Health Statistics
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