

## Infant Mortality Statistics from the 1999 Period Linked Birth/Infant Death Data Set

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

### Abstract

**Objectives**—This report presents 1999 period infant mortality statistics from the linked birth/infant death data set (linked file) by a variety of maternal and infant characteristics.

**Methods**—Descriptive tabulations of data are presented.

**Results**—In general, mortality rates were lowest for infants born to Chinese and Japanese mothers (2.9 and 3.4 per 1,000, respectively). Infants of Cuban, Central and South American, Mexican, and non-Hispanic white mothers had low rates, while rates were higher for infants of Puerto Rican and highest for non-Hispanic black mothers

(13.9). Filipino mothers also had low rates. Rates were high for infants of Hawaiian and American Indian mothers. Infant mortality rates were higher for those infants whose mothers had no prenatal care, were teenagers, had 9–11 years of education, 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 all infant deaths in the United States in 1999. Cause-specific mortality rates varied considerably by race and Hispanic origin. For infants of black mothers, the infant mortality rate for low

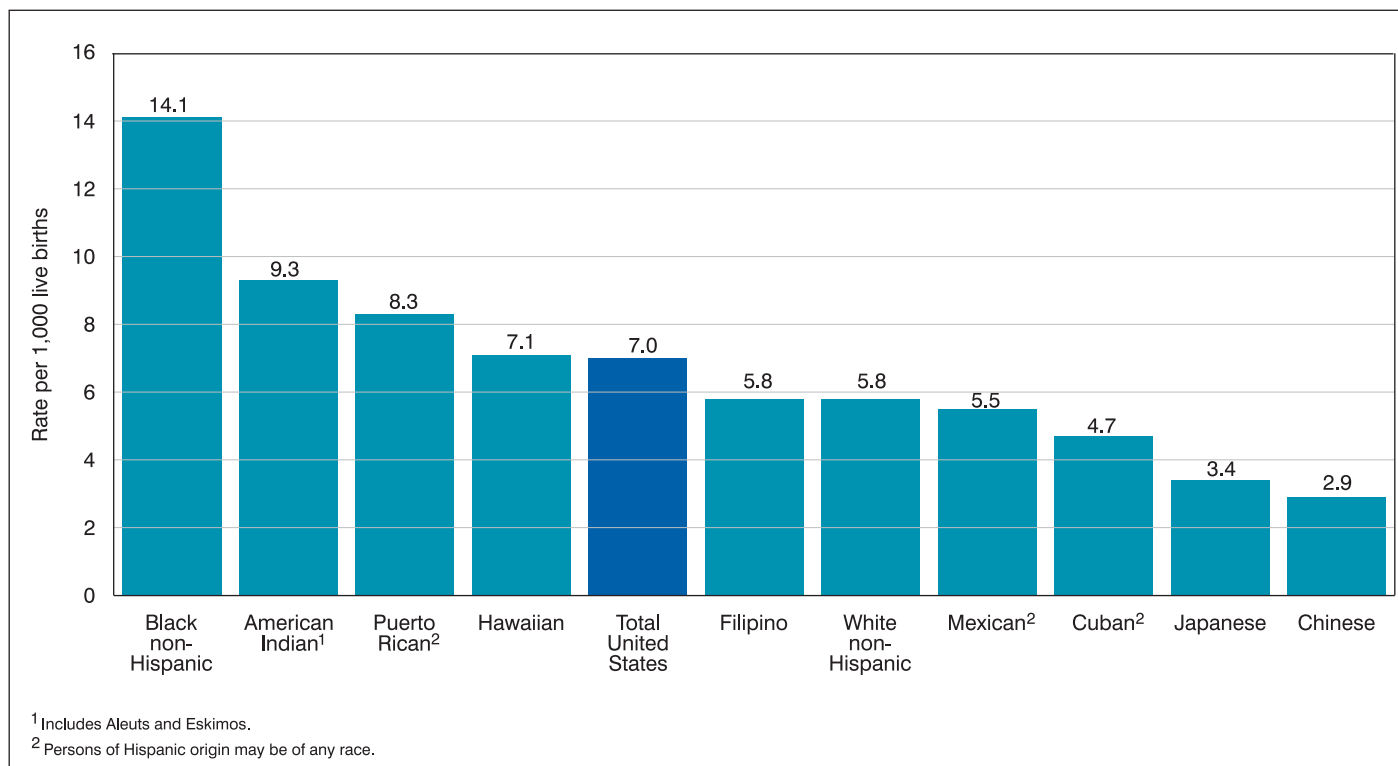


Figure 1. Infant mortality rates by race and ethnicity, 1999

birthweight was four times that for white mothers. For infants of American Indian mothers, the SIDS rate was 2.4 times that for non-Hispanic white mothers. SIDS rates for infants of Hispanic and Asian or Pacific Islander mothers, were 40–50 percent lower than those for non-Hispanic white mothers.

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

## Introduction

This report presents infant mortality data from the 1999 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 1999. 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, marital status, mother's place of birth, maternal smoking during pregnancy, age at death, and underlying cause of death (tables 1–7). Other variables that are 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; 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).

## 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 (VSCP), each State provided to the Centers for Disease Control and Prevention, 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 1999. 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 1999, 97.7 percent of all infant death records were successfully matched to their corresponding birth records. This is lower than in 1998 (98.4) but nearly the same as 1997 (97.9). A record weight was added to the linked file in 1999 to compensate for the 2.2 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.

Cause-of-death statistics in this publication are classified in accordance with the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (ICD–10) (3). Previous issues of this report 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) (4).

## 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 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 for detailed race of mother and for mothers of Hispanic origin groups. 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 data—the more “traditional” source of infant mortality data—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 (1,5). Race information reported on the birth certificate is considered to be more accurate than that on the death certificate. On the birth certificate, the race of each parent is usually reported by the mother at the time of delivery, whereas on the death certificate, race of the deceased infant is reported by the funeral director based on information provided by an informant or on observation. This difference in the method of reporting race data and using only the race of the mother in the numerator and the denominator has a larger impact for races other than white and black and can lead to differences in race-specific infant mortality rates between the two data sources (5,6).

Rates for total Asian or Pacific Islander and for Chinese, Japanese, Filipino, and other Asian or Pacific Islander mothers are reported for all 50 States and the District of Columbia. In addition, infant mortality rates for five detailed Asian or Pacific Islander 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. In 1990, more than 66 percent of the U.S. population for each of these additional Asian or Pacific Islander groups lived in the 11-State reporting area: Asian Indian, Korean, and Vietnamese, 67–72 percent; Guamanian, 77 percent; and Samoan, 87 percent (7,8).

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 (9), there are notable differences in infant mortality trends between Hispanic and non-Hispanic white women. Therefore, race-specific data for non-Hispanic mothers are presented for comparison in tables showing data for Hispanic mothers. Data for infants of Asian or Pacific Islanders and American Indian mothers are not shown separately by Hispanic origin because the vast majority of these populations are non-Hispanic. Race and ethnic differentials in infant mortality rates may 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, birth-weight, and cause-of-death classification is also presented in the [Technical notes](#).

## Results and Discussion

### Infant mortality by race and Hispanic origin of mother

The overall 1999 infant mortality rate from the linked file was 7.0 infant deaths per 1,000 live births, 3 percent lower than the 1998 level (7.2) (10). The rate as reported from the linked file differs slightly from the 1999 vital statistics mortality file, 7.1 (7.2 in 1998); see [Technical notes](#) (2). In 1990 the infant mortality rate was 8.9. There was wide variation in infant mortality rates by the race of the mother with the highest rate, 14.0 for infants of black mothers, more than four times higher than the groups with the lowest rates, 2.9 for infants of Chinese mothers and 3.4 for infants of Japanese mothers. Rates were intermediate for infants of non-Hispanic white (5.8) and Filipino

mothers (5.8), but higher for American Indian (9.3) and Hawaiian mothers (7.1) ([tables A and B](#) and [figure 1](#)).

The neonatal mortality rate (less than 28 days) for infants of black mothers (9.5) was significantly higher than for all other racial groups. Infants of black and American Indian mothers had the highest postneonatal rates (28 days to 1 year) of any group, 4.5 and 4.3, respectively. In general, the neonatal mortality rates were about twice the postneonatal rates for nearly all groups in which both rates could be reliably computed. The exception was infants of American Indian mothers whose neonatal mortality rate was not significantly different from the postneonatal rate (5.0 versus 4.3). [Figure 1](#) shows the infant mortality rate by race and ethnicity for selected race/Hispanic groups.

Data for the expanded Asian or Pacific Islander subgroups in the 11-State reporting area show infant mortality rates of 4.6 for infants of Korean, 4.4 for Asian Indian, and 4.1 for Vietnamese mothers ([table C](#)). Reliable infant mortality rates for Samoan and Guamanian mothers could not be computed due to the small numbers of infant deaths for these groups (14 and 1 infant deaths, respectively).

There was wide variation in infant mortality rates for Hispanic subgroups with the rates high for infants of Puerto Rican mothers (8.3) and low for Cuban as well as Central and South American mothers (4.7). Rates were intermediate for infants of Mexican mothers (5.5) ([table B](#)). Neonatal mortality rates followed a similar pattern.

### Infant mortality by State

Infant mortality rates for 1997–99 varied widely both by State and within States by race and Hispanic origin of mother ([table 1](#)). Rates are computed for a 3-year average to improve reliability and stability. Rates were generally highest for States in the South and lowest for States in the West and Northeast. Infant mortality rates ranged from 10.3 for Mississippi to 4.8 for New Hampshire. Although the highest rate (14.1) was noted for the District of Columbia, it is more appropriately compared with rates for other large U.S. cities because of the high concentrations of high-risk women in these areas.

Mortality rates for infants of non-Hispanic black mothers were the highest, generally more than twice those for non-Hispanic white mothers. Mortality rates for infants of non-Hispanic black mothers

**Table A. Infant, neonatal, and postneonatal deaths and mortality rates by specified race or national origin of mother: United States, 1999 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 .....	3,959,417	27,864	18,700	9,164	7.0	4.7	2.3
White .....	3,132,501	18,136	12,186	5,950	5.8	3.9	1.9
Black .....	605,970	8,480	5,739	2,741	14.0	9.5	4.5
American Indian <sup>1</sup> .....	40,170	373	202	171	9.3	5.0	4.3
Asian or Pacific Islander .....	180,776	876	574	302	4.8	3.2	1.7
Chinese .....	28,853	85	51	34	2.9	1.8	1.2
Japanese .....	8,722	30	24	6	3.4	2.8	*
Hawaiian .....	6,093	43	30	13	7.1	4.9	*
Filipino .....	30,677	179	120	59	5.8	3.9	1.9
Other Asian or Pacific Islander .....	106,431	539	348	190	5.1	3.3	1.8

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

<sup>1</sup> Includes Aleuts and Eskimos.

**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, 1999 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 <sup>1</sup> .....	3,959,417	27,864	18,700	9,164	7.0	4.7	2.3
Total Hispanic .....	764,339	4,362	2,982	1,380	5.7	3.9	1.8
Mexican .....	540,674	2,979	2,015	963	5.5	3.7	1.8
Puerto Rican .....	57,138	477	339	138	8.3	5.9	2.4
Cuban .....	13,088	61	46	15	4.7	3.5	*
Central and South American .....	103,307	483	342	140	4.7	3.3	1.4
Other and unknown Hispanic .....	50,132	363	240	123	7.2	4.8	2.5
Non-Hispanic total <sup>2</sup> .....	3,147,580	23,022	15,349	7,673	7.3	4.9	2.4
Non-Hispanic white .....	2,346,450	13,522	8,987	4,535	5.8	3.8	1.9
Non-Hispanic black .....	588,981	8,327	5,634	2,693	14.1	9.6	4.6
Not stated .....	47,498	480	369	111	...	...	...

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

... Category not applicable.

<sup>1</sup> Origin of mother not stated included in "All origins" but not distributed among origins.

<sup>2</sup> Includes races other than white or black.

**Table C. Infant, neonatal, and postneonatal deaths and mortality rates by race or national origin of mother: Total of 11 States, 1999 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 .....	1,773,761	11,217	7,533	3,684	6.3	4.2	2.1
Total Asian or Pacific Islander .....	129,729	612	396	216	4.7	3.1	1.7
Chinese .....	23,291	71	47	25	3.0	2.0	1.1
Japanese .....	6,982	22	17	5	3.2	*	*
Filipino .....	25,533	148	99	49	5.8	3.9	1.9
Vietnamese .....	14,271	59	29	30	4.1	2.0	2.1
Asian Indian .....	22,060	98	71	27	4.4	3.2	1.2
Korean .....	8,906	41	26	15	4.6	2.9	*
Hawaiian .....	5,562	40	27	13	7.2	4.9	*
Samoa .....	1,660	14	7	7	*	*	*
Guamanian .....	502	1	-	1	*	*	*
Remaining Asian or Pacific Islander .....	20,962	117	73	44	5.6	3.5	2.1
White .....	1,408,897	7,550	5,085	2,465	5.4	3.6	1.7
Black .....	226,258	2,982	2,013	970	13.2	8.9	4.3
American Indian <sup>1</sup> .....	8,877	73	39	34	8.2	4.4	3.8

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

- Quantity zero.

<sup>1</sup> Includes Aleuts and Eskimos.

NOTE: States included are California, Hawaii, Illinois, Minnesota, Missouri, New Jersey, New York, Texas, Virginia, Washington, and West Virginia.

ranged from 17.4 in the District of Columbia to 8.8 in Oregon. West Virginia had the highest infant mortality rate for infants of non-Hispanic white mothers and New Jersey had the lowest rate (8.2 and 4.3, respectively).

Mortality rates for infants of American Indian and Asian or Pacific Islander mothers could be reliably computed for only 15 and 27 States, respectively. Mortality rates for infants of American Indian mothers were highest in South Dakota (15.2) and lowest in New Mexico (7.7). Overall, infant mortality rates for infants of Asian or Pacific Islander mothers were the lowest, ranging from 3.5 for Massachusetts to 7.4 for Hawaii.

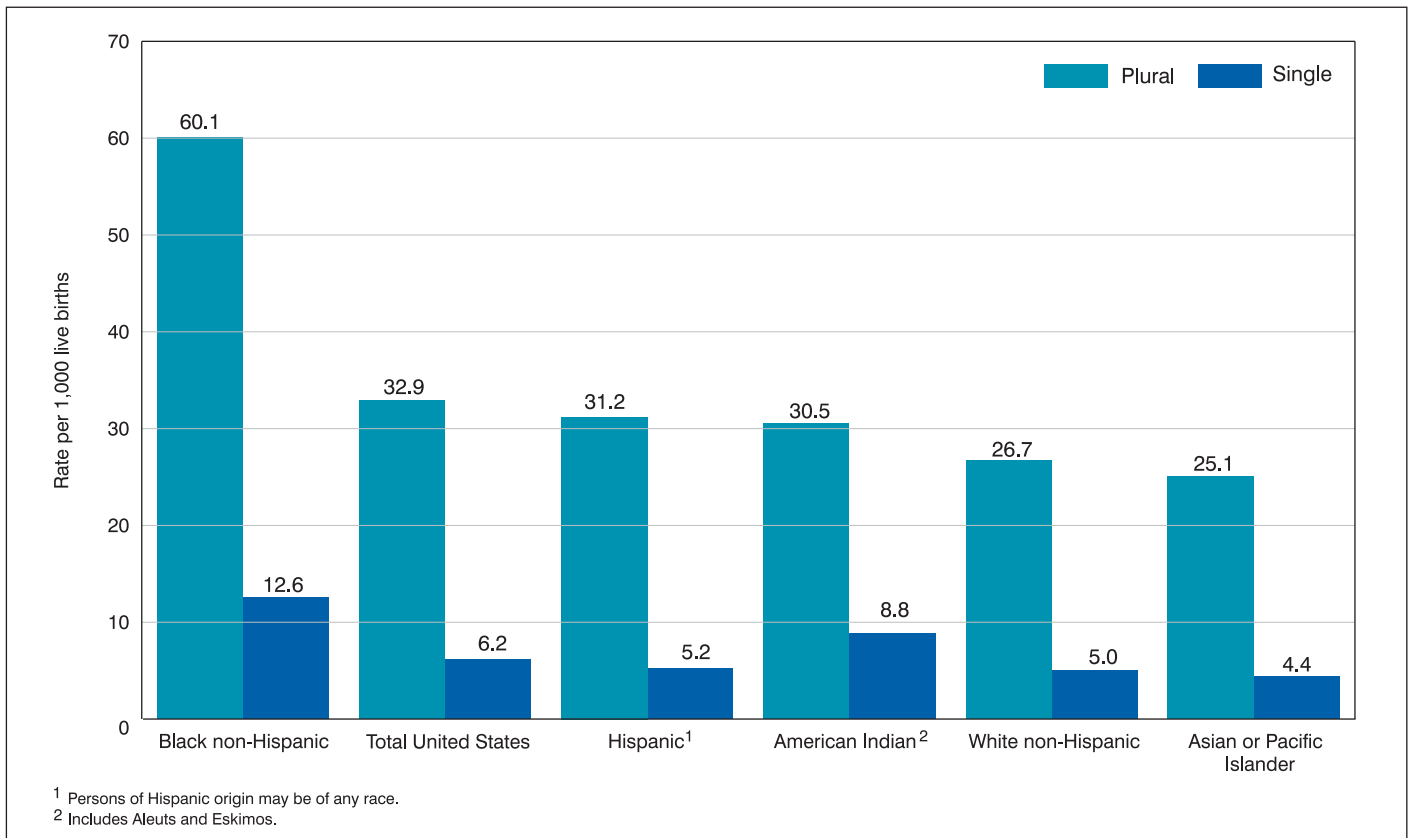
### Sex of infant

In 1999 the overall infant mortality rate for male infants was 7.7 per 1,000, 22 percent higher than the rate for female infants (6.3) (tables 2 and 3). With the exception of infants of Cuban mothers,

infant mortality rates were higher for male than female infants in each racial and Hispanic origin group. Differences were not statistically significant for infants of American Indian and Asian or Pacific Islander mothers.

### Multiple births

For plural births, the infant mortality rate was 32.9, more than five times the rate of 6.2 for single births (table 2 and figure 2). Infant mortality rates for plural births were higher than rates for single births for all race and Hispanic-origin groups. The risk of infant death increases with the increasing number of infants in the pregnancy (11). In 1999, the infant mortality rate for triplet and higher order births (69.8) was more than twice the rate for twin births (30.5), and more than 10 times the rate for single births (6.2) (tabular data not shown).



**Figure 2. Infant mortality rates by plurality and race and ethnicity, 1999**

The number of multiple births has skyrocketed in recent years—up nearly a third in the decade since 1989 (9). Factors associated with the rapid increase in multiple births include an increase in births to older women (older women are more likely to have a multiple birth even without the use of fertility therapy), and the more widespread use of fertility-enhancing therapies (fertility drugs and techniques such as in vitro fertilization) (11–13).

### 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 (14–16). The percent of infants born at low birthweight ranged from a low of 5.2 percent for births to Chinese mothers to a high of 13.2 percent for births to black mothers (tables 4 and 5). The percent of preterm births (those born before 37 completed weeks of gestation) ranged from a low of 7.6 percent for births to Chinese mothers to a high of 17.5 percent for births to black mothers.

Infant mortality rates were much higher for low birthweight infants than for infants with birthweights of 2,500 grams or more for all race and ethnic groups studied. Overall, the infant mortality rate for very low birthweight infants (those with birthweights of less than 1,500 grams) was 247.0, over nearly 100 times the rate of 2.5 for infants with birthweights of 2,500 grams or more. The rate for moderately low birthweight infants (those with birthweights of 1,500–2,499 grams) was 16.0, more than six times the rate for infants with birthweights of 2,500 grams or more.

Similarly, the infant mortality rate for very preterm infants (those born at less than 32 weeks of gestation) was 183.3, nearly 68 times the rate of 2.7 for infants born at term (37–41 weeks of gestation). The infant mortality rate for moderately preterm infants (those born at 32–36 weeks of gestation) was 9.1, more than three times the rate for term births (tables 2 and 3).

Infant mortality rates for more detailed birthweight categories are presented in table 6. Eighty-six percent of infants with birthweights of less than 500 grams died within the first year of life—most within the first few days of life. An infant's chances of survival increase rapidly with increasing birthweight. At birthweights of 1,250–1,499 grams, about 95 out of 100 infants survive the first year of life. Infant mortality rates are lowest at birthweights of 3,500–4,999 grams.

From 1995 to 1999, infants weighing 1,000–1,249 grams had the largest decline, 18.2 percent, in the infant mortality rate by specified birthweight (from 85.5 to 69.9). The only nonsignificant declines were for infants weighing 4,500–4,999, and 5,000 grams or more. For infants of white mothers, the largest significant decline was for infants weighing 1,000–1,249 grams (19.8 percent). The largest significant decline by specified birthweight for infants of black mothers was for those 4,000–4,499 grams (37.2 percent).

### Prenatal care

Improvements in the timing and quality of prenatal care are often the focus of efforts to decrease infant mortality, especially among women with risk factors for a poor outcome (17,18). This includes programs that focus on prenatal management of specific maternal risk factors (e.g., diabetes) (19). In 1999, infants of mothers who

began prenatal care after the first trimester of pregnancy or not at all had an infant mortality rate of 8.9 per 1,000, which was 44 percent higher than the rate for those whose care began in the first trimester (6.2). With the exception of infants of Mexican mothers, 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 those who received early care (tables 2 and 3). These differences were significant for all but infants of Puerto Rican, and Central and South American mothers. Because of an insufficient number of infant deaths, rates could not be calculated for infants of Cuban mothers.

Overall, the infant mortality rate for infants whose mothers began care in the third trimester (6.2) was lower than for those who began care in the second trimester (7.2). This is because women who began prenatal care in the third trimester had to have a period of gestation of at least 7 months, thus reducing the probability that the infant would be born preterm or of low birthweight. The relationship between month of initiation of prenatal care and length of gestation is complex. Therefore, prenatal care data are often grouped into two categories: mothers who began care in the first trimester and those who began care after the first trimester or not at all (20).

### Maternal age

Infant mortality rates are highest for infants of teenage mothers, lowest for mothers in their late twenties and early thirties, and again higher for mothers in their forties and over (tables 2 and 3). Among teen births, rates were higher for the younger teens. In 1999, the mortality rate for infants of mothers 15–17 years of age was 17.6, compared with a rate of 11.2 for mothers 18–19 years of age (tabular data not shown). A mortality rate for infants of mothers less than 15 years of age could not be computed because of insufficient numbers of infant deaths.

For all infants, and for infants of non-Hispanic white mothers, mortality rates were higher for teenage mothers than for mothers 40–54 years of age. For infants of non-Hispanic black, Mexican, and Central and South American mothers, mortality rates were higher for infants of mothers 40–54 years of age than for teenagers, although differences were not statistically significant.

Studies suggest that the higher mortality risk for infants of younger mothers may be related to the preponderance of teenage mothers who are from disadvantaged backgrounds, while for older mothers, both biological and sociological factors may play a role (21–25).

### Maternal education

The percent of births to mothers who had completed high school or more was 45 percent for Mexican mothers. Ninety-eight percent of Japanese mothers completed high school or more (tables 4 and 5). Infant mortality rates generally decreased with increasing educational level (tables 2 and 3). This pattern may reflect not only the education itself but also socioeconomic differences because women with more education tend to have higher family income levels (26).

Among infants of non-Hispanic white, non-Hispanic black, and Puerto Rican mothers, infant mortality rates declined steadily with increasing educational level with the highest mortality rates occurring among infants of mothers with 0–8 years of education (statistically significant for infants of non-Hispanic white mothers only). In contrast,

for infants of Central and South American mothers, mortality rates were lower for infants of mothers with 0–8 years of education than for those with 9–11 years of education, although the difference was not statistically significant. This may be due in part to the very different population composition of women with 0–8 years of education, most of whom were born outside the 50 States and the District of Columbia (27) (see section on “Nativity”). This comparison could not be made for Cuban mothers due to small numbers of infant deaths in each education subgroup.

### Live-birth order

Infant mortality rates were generally higher for first births than for second births, and then increased as birth order increased (tables 2 and 3). Overall, the infant mortality rate for first births (6.9) was 11 percent higher than for second births (6.2). The rate for fifth and higher order births (11.1) was almost 80 percent higher than the rate for second births.

### Marital status

Marital status has been associated with health effects for both the mother and infant, and is seen as a proxy measure of the availability of social and economic support (28,29). The infant mortality rate for infants of married mothers was 5.5 per 1,000 in 1999, this rate was 5.7 in 1998. The infant mortality rate for infants of unmarried mothers was the same as in 1998, 10.2, almost 80 percent higher than the rate for infants of married mothers. Infant mortality rates were significantly higher for infants of unmarried mothers in each race and Hispanic origin group. A similar comparison could not be made for infants of Cuban mothers due to an insufficient number of infant deaths.

### Nativity

In 1999 the infant mortality rate for mothers born in the 50 States and the District of Columbia (7.3) was 38 percent higher than the rate for mothers born outside of the 50 States and the District of Columbia (5.3). For each race and Hispanic-origin group, infant mortality rates were higher for infants of mothers born in the 50 States and the District of Columbia than for those born elsewhere, although the differences were not statistically significant for infants of Puerto Rican, Cuban, and Central and South American mothers. A similar comparison could not be made for infants of American Indian mothers due to insufficient number of mothers born outside the 50 States and the District of Columbia.

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 (30–33). Also, women born outside the 50 States and the District of Columbia have been shown to have different characteristics than women born within the 50 States and the District of Columbia with regard to socioeconomic and educational status, and risk behaviors such as smoking and alcohol use (33,34).

### Maternal smoking

The infant mortality rate for infants of smokers was 10.5 in 1999, 59 percent higher than the rate of 6.6 for nonsmokers. The

percentage of women who smoked during pregnancy ranged from a low of 0.5 percent for Chinese mothers to a high of 20.2 percent for American Indian mothers (tables 4 and 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, although the difference was not statistically significant for Asian or Pacific Islander mothers (tables 2 and 3).

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 (35–38).

### 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. Beginning with 1999 data, cause-of-death data in the United States are coded according to the 10th revision of the *International Statistical Classification of Diseases and Related Health Problems* (ICD–10) (3). From 1979–98 causes of death were classified according to the Ninth Revision (ICD–9) (4). This change in classification has created discontinuities in analyzing trend data by cause of death; see [Technical notes](#) (2).

The leading cause of infant death in the United States in 1999 was Congenital malformations, deformations and chromosomal abnormalities (congenital malformations), accounting for 20 percent of all infant deaths. Disorders related to short gestation and low birthweight, not elsewhere classified (low birthweight) was second, accounting for 16 percent of all infant deaths, followed by Sudden infant death syndrome (SIDS) accounting for 9 percent of infant deaths. The fourth and fifth leading causes—Newborn affected by maternal complications of pregnancy (maternal complications), and Respiratory distress of newborn, accounted for 5 and 4 percent, respectively, of all infant deaths in 1999. Together the five leading causes accounted for 54 percent of all infant deaths in the United States in 1999.

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 infants of black and Puerto Rican mothers, for whom low birthweight was the leading cause.

Infant mortality rates for Congenital malformations were 26 percent higher for infants of black mothers than for infants of non-Hispanic white mothers. The rate was also higher for infants of American Indian mothers, although the difference was not statistically significant. Infants of Asian or Pacific Islander mothers had rates of congenital malformations that were 14 percent lower than the rate of infants of non-Hispanic white mothers.

Infants of black mothers had the highest mortality rates from low birthweight, with a rate that was four times the rate for infants of non-Hispanic white mothers. Infant mortality rates from low birthweight were also elevated for infants of Puerto Rican mothers. American Indian mothers also had high rates. The rate for infants of Puerto Rican mothers was 2.4 times the rate for infants of non-Hispanic white mothers, while the rate for infants of American Indian mothers was 1.5 times the rate for infants of non-Hispanic white mothers.

For SIDS, infant mortality rates were highest among infants of American Indian mothers, and were also elevated for infants of black

mothers, compared with those for infants of non-Hispanic white mothers. SIDS rates for infants of American Indian mothers were 2.6 times and those for infants of black mothers were 2.4 times those for infants of non-Hispanic white mothers. As most SIDS deaths occur during the postneonatal period, the high SIDS rates for infants of American Indian and black mothers account for much of their elevated risk of postneonatal mortality. For infants of Asian or Pacific Islander mothers the SIDS rate of 31.0 was about one-half the non-Hispanic white rate of 62.1. For infants of Mexican mothers, the SIDS rate of 33.3 was 46 percent lower than the rate of 62.1 for infants of non-Hispanic white mothers.

Infants of black and Puerto Rican mothers had the highest mortality rates from Respiratory distress of newborn and maternal complications, which are both causes of death primarily found among low birthweight infants.

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, 28 percent of the elevated infant mortality rate for infants of black mothers, when compared with infants of non-Hispanic white mothers, can be accounted for by their higher infant mortality rate due to low birthweight, and a further 8 percent can be accounted for by differences in SIDS. In other words, if black infant mortality rates for low birthweight and SIDS could be reduced to non-Hispanic white levels, the difference in the infant mortality rate between black and non-Hispanic white mothers would be reduced by 36 percent.

For infants of American Indian mothers, nearly one-fourth (24 percent) of their elevated infant mortality rate, when compared with infants of non-Hispanic white mothers, can be accounted for by their higher SIDS rates, 13 percent by higher rates for Congenital malformations, and 11 percent by low birthweight. If American Indian infant mortality 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 almost half.

Similarly, 39 percent of the difference between Puerto Rican and non-Hispanic white infant mortality rates can be accounted for by differences in low birthweight, and 12 percent by respiratory distress of newborn. If Puerto Rican infant mortality for these two causes could be reduced to non-Hispanic white levels, the difference in the infant mortality rate between infants of Puerto Rican and non-Hispanic white mothers would be reduced by one-half (51 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 by race and Hispanic origin of mother: United States and each State, Puerto Rico, Virgin Islands, and Guam, 1997-99 linked files**

[By place of residence]

State	Total <sup>1</sup>	Race and Hispanic origin of mother						
		Race				Hispanic origin		
		White	Black	American Indian <sup>2</sup>	Asian/Pacific Islander	Hispanic	Non-Hispanic White	Non-Hispanic Black
United States <sup>3</sup> .....	7.1	5.9	13.8	9.1	5.1	5.8	5.9	13.9
Alabama .....	9.8	7.4	14.8	*	*	7.5	7.3	14.8
Alaska .....	6.5	5.5	*	9.1	*	*	5.5	*
Arizona .....	7.1	6.7	13.9	8.6	6.1	7.1	6.5	13.7
Arkansas .....	8.5	7.4	12.8	*	*	6.2	7.5	12.8
California .....	5.7	5.2	12.2	8.9	4.9	5.3	5.0	12.2
Colorado .....	6.8	6.4	13.9	*	5.9	7.0	6.3	13.7
Connecticut .....	6.7	5.8	13.9	*	*	8.9	4.8	13.4
Delaware .....	8.3	5.8	15.9	*	*	*	6.0	16.1
District of Columbia .....	14.1	5.2	17.5	*	*	*	*	17.4
Florida .....	7.2	5.7	12.5	8.5	4.5	4.7	6.0	12.5
Georgia .....	8.4	5.9	13.3	*	5.0	4.9	6.0	13.3
Hawaii .....	6.9	5.6	*	*	7.4	7.0	5.8	*
Idaho .....	6.8	6.7	*	*	*	7.0	6.6	*
Illinois .....	8.5	6.4	17.1	*	6.3	6.9	6.2	17.1
Indiana .....	7.9	7.1	15.2	*	6.4	7.4	7.0	15.2
Iowa .....	6.1	5.8	16.4	*	*	5.6	5.7	17.2
Kansas .....	7.3	6.9	12.1	*	6.8	5.8	7.1	12.0
Kentucky .....	7.4	6.9	12.2	*	*	*	6.9	12.2
Louisiana .....	9.3	6.3	13.6	*	*	*	6.4	13.7
Maine .....	5.5	5.5	*	*	*	*	5.6	*
Maryland .....	8.6	5.5	14.8	*	5.2	5.4	5.5	14.8
Massachusetts .....	5.2	4.7	10.0	*	3.5	6.3	4.4	10.8
Michigan .....	8.1	6.4	16.2	8.8	6.0	7.0	6.1	16.1
Minnesota .....	6.0	5.4	12.7	10.9	7.0	7.0	5.4	12.5
Mississippi .....	10.3	6.6	14.5	*	*	*	6.7	14.5
Missouri .....	7.6	6.1	16.4	*	5.7	5.6	6.1	16.4
Montana .....	7.0	6.4	*	12.0	*	*	6.2	*
Nebraska .....	7.2	6.5	17.1	*	*	8.7	6.3	17.0
Nevada .....	6.8	6.4	12.2	*	4.7	5.6	6.8	11.8
New Hampshire .....	4.8	4.8	*	*	*	*	4.4	*
New Jersey .....	6.5	4.9	13.5	*	4.4	6.4	4.3	13.9
New Mexico .....	6.7	6.6	*	7.7	*	6.5	6.7	*
New York .....	6.4	5.2	11.5	*	4.0	5.9	4.6	11.9
North Carolina .....	9.2	6.8	15.9	13.7	5.8	6.7	6.9	15.9
North Dakota .....	7.3	6.7	*	13.8	*	*	6.7	*
Ohio .....	8.0	6.9	14.4	*	4.9	8.8	6.8	14.5
Oklahoma .....	8.2	7.7	13.1	8.0	*	5.1	7.9	13.4
Oregon .....	5.6	5.5	9.0	*	5.2	6.2	5.4	8.8
Pennsylvania .....	7.4	6.0	15.9	*	4.7	8.2	5.8	16.0
Rhode Island .....	6.7	5.8	14.7	*	*	8.3	4.8	12.4
South Carolina .....	9.8	6.6	15.8	*	*	7.5	6.5	15.8
South Dakota .....	8.5	7.1	*	15.2	*	*	7.1	*
Tennessee .....	8.2	6.3	15.0	*	5.8	7.0	6.2	15.0
Texas .....	6.3	5.7	11.0	8.6	4.4	5.5	5.8	11.1
Utah .....	5.4	5.4	*	*	6.5	5.9	5.3	*
Vermont .....	6.2	6.1	*	*	*	*	6.0	*
Virginia .....	7.5	5.8	13.3	*	5.2	5.0	5.8	13.3
Washington .....	5.4	5.0	12.4	9.6	4.9	5.0	4.9	11.4
West Virginia .....	8.3	8.2	12.7	*	*	*	8.2	12.7
Wisconsin .....	6.8	5.8	15.7	9.2	5.7	9.2	5.6	15.7
Wyoming .....	6.7	6.6	*	*	*	*	6.3	*
Puerto Rico .....	10.7	10.8	10.0	---	---	---	---	---
Virgin Islands .....	10.6	*	12.2	*	*	*	*	12.4
Guam .....	8.1	*	*	*	8.9	*	*	*

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

--- Data not available.

<sup>1</sup> Includes non-Hispanic births of other races and births with origin not stated; not shown separately.<sup>2</sup> Includes Aleuts and Eskimos.<sup>3</sup> Excludes data for Puerto Rico, Virgin Islands, and Guam.

**Table 2. Infant mortality rates, live births, and infant deaths by selected characteristics and specified race of mother: United States, 1999 linked file**

Characteristics	All races	Race of mother			
		White	Black	American Indian <sup>1</sup>	Asian/ Pacific Islander
Infant mortality rates per 1,000 live births in specified group					
Total .....	7.0	5.8	14.0	9.3	4.8
Age at death:					
Total neonatal .....	4.7	3.9	9.5	5.0	3.2
Early neonatal (< 7 days) .....	3.8	3.1	7.6	3.6	2.6
Late neonatal (7-27 days) .....	1.0	0.8	1.9	1.5	0.5
Postneonatal .....	2.3	1.9	4.5	4.3	1.7
Sex:					
Male .....	7.7	6.4	15.2	10.2	5.0
Female .....	6.3	5.2	12.7	8.4	4.7
Plurality:					
Single births .....	6.2	5.1	12.4	8.8	4.4
Plural births .....	32.9	27.7	59.7	30.5	25.1
Birthweight:					
Less than 1,500 grams .....	247.0	236.0	270.8	276.5	209.3
1,500-2,499 grams .....	16.0	15.9	16.5	22.4	12.9
2,500 grams or more .....	2.5	2.3	4.0	4.6	1.8
Period of gestation:					
Less than 32 weeks .....	183.3	172.0	208.6	166.1	157.3
32-36 weeks .....	9.1	8.9	10.7	9.6	6.5
37-41 weeks .....	2.7	2.4	4.3	5.2	2.0
42 weeks or more .....	2.9	2.6	4.7	*	*
Trimester of pregnancy prenatal care began:					
First trimester .....	6.2	5.2	12.7	7.8	4.3
After first trimester or no care .....	8.9	7.1	14.7	10.9	5.9
Second trimester .....	7.2	6.0	11.2	10.3	5.2
Third trimester .....	6.2	5.4	8.7	9.4	*
No prenatal care .....	34.6	26.4	51.7	*	24.8
Age of mother:					
Under 20 years .....	10.3	8.6	15.2	10.0	6.7
20-24 years .....	7.8	6.3	13.5	9.0	6.1
25-29 years .....	6.0	4.9	13.4	8.0	4.4
30-34 years .....	5.8	4.9	14.0	9.6	4.3
35-39 years .....	6.5	5.7	13.9	11.6	4.7
40-54 years .....	8.7	7.7	17.2	*	6.5
Educational attainment of mother:					
0-8 years .....	7.5	6.8	16.5	13.9	6.7
9-11 years .....	9.5	8.0	15.1	11.0	5.4
12 years .....	7.6	6.1	13.9	8.5	5.6
13-15 years .....	5.9	4.8	12.0	8.5	4.4
16 years and over .....	4.4	3.9	10.2	*	3.8
Live-birth order:					
1 .....	6.9	5.8	14.0	8.6	4.6
2 .....	6.2	5.1	12.5	8.6	4.4
3 .....	7.0	5.8	13.4	9.3	4.6
4 .....	8.6	6.9	15.3	9.0	7.0
5 or more .....	11.1	8.5	18.4	12.8	9.5
Marital status:					
Married .....	5.5	5.0	11.8	8.2	4.5
Unmarried .....	10.2	7.9	15.0	10.1	7.0
Mother's place of birth:					
Born in the 50 States and D.C. ....	7.3	5.8	14.2	9.4	6.5
Born elsewhere .....	5.3	5.0	9.2	*	4.4
Maternal smoking during pregnancy: <sup>2</sup>					
Smoker .....	10.5	9.2	19.9	12.6	6.4
Nonsmoker .....	6.6	5.2	13.2	7.7	4.9

See footnotes at end of table.

**Table 2. Infant mortality rates, live births, and infant deaths by selected characteristics and specified race of mother: United States, 1999 linked file--Con.**

Characteristics	All races	Race of mother				
		White	Black	American Indian <sup>1</sup>	Asian/ Pacific Islander	
			Live births			
Total .....	3,959,417	3,132,501	605,970	40,170	180,776	
Sex:						
Male .....	2,026,854	1,605,603	307,670	20,370	93,211	
Female .....	1,932,563	1,526,898	298,300	19,800	87,565	
Plurality:						
Single births .....	3,837,789	3,035,757	586,027	39,285	176,720	
Plural births .....	121,628	96,744	19,943	885	4,056	
Birthweight:						
Less than 1,500 grams .....	58,227	36,461	19,288	510	1,968	
1,500-2,499 grams .....	243,886	169,674	60,347	2,370	11,495	
2,500 grams or more .....	3,654,764	2,924,576	525,898	37,243	167,047	
Not stated .....	2,540	1,790	437	47	266	
Period of gestation:						
Less than 32 weeks .....	76,897	48,674	24,817	813	2,593	
32-36 weeks .....	383,956	283,393	80,393	4,280	15,890	
37-41 weeks .....	3,170,780	2,538,796	453,106	30,874	148,004	
42 weeks or more .....	284,844	228,098	42,690	3,644	10,412	
Not stated .....	42,940	33,540	4,964	559	3,877	
Trimester of pregnancy prenatal care began:						
First trimester .....	3,198,714	2,597,095	429,639	26,901	145,079	
After first trimester or no care .....	646,377	456,073	150,171	11,794	28,339	
Second trimester .....	499,928	357,303	111,678	8,606	22,341	
Third trimester .....	102,202	71,262	23,943	2,452	4,545	
No prenatal care .....	44,247	27,508	14,550	736	1,453	
Not stated .....	114,326	79,333	26,160	1,475	7,358	
Age of mother:						
Under 20 years .....	485,104	342,627	125,143	8,113	9,221	
20-24 years .....	981,929	748,371	193,211	13,225	27,122	
25-29 years .....	1,078,252	873,654	138,868	9,641	56,089	
30-34 years .....	892,400	739,948	91,486	5,701	55,265	
35-39 years .....	434,294	356,959	47,277	2,844	27,214	
40-54 years .....	87,438	70,942	9,985	646	5,865	
Educational attainment of mother:						
0-8 years .....	222,661	197,659	15,345	1,727	7,930	
9-11 years .....	623,934	460,112	139,104	10,924	13,794	
12 years .....	1,254,283	960,003	234,181	15,493	44,606	
13-15 years .....	858,068	674,961	137,265	8,260	37,582	
16 years and over .....	937,071	794,890	67,430	2,838	71,913	
Not stated .....	63,400	44,876	12,645	928	4,951	
Live-birth order:						
1 .....	1,588,639	1,262,603	228,027	14,369	83,640	
2 .....	1,285,592	1,034,524	179,502	10,931	60,635	
3 .....	653,070	517,012	106,259	7,063	22,736	
4 .....	250,404	190,472	48,822	3,778	7,332	
5 or more .....	163,562	113,329	40,798	3,841	5,594	
Not stated .....	18,150	14,561	2,562	188	839	
Marital status:						
Married .....	2,650,857	2,292,949	188,494	16,493	152,921	
Unmarried .....	1,308,560	839,552	417,476	23,677	27,855	
Mother's place of birth:						
Born in the 50 States and D.C. ....	3,148,902	2,546,383	534,134	38,460	29,925	
Born elsewhere .....	797,279	577,700	68,452	1,596	149,531	
Not stated .....	13,236	8,418	3,384	114	1,320	
Maternal smoking during pregnancy: <sup>2</sup>						
Smoker .....	426,036	363,374	52,418	6,804	3,440	
Nonsmoker .....	2,957,167	2,301,012	512,215	26,940	117,000	
Not stated .....	47,182	37,903	5,845	1,520	1,914	

See footnotes at end of table.

**Table 2. Infant mortality rates, live births, and infant deaths by selected characteristics and specified race of mother: United States, 1999 linked file--Con.**

Characteristics	All races	Race of mother			
		White	Black	American Indian <sup>1</sup>	Asian/ Pacific Islander
		Infant deaths			
Total .....	27,864	18,136	8,480	373	876
Age at death:					
Total neonatal .....	18,700	12,186	5,739	202	574
Early neonatal (< 7 days) .....	14,874	9,635	4,616	143	479
Late neonatal (7-27 days) .....	3,827	2,551	1,122	59	95
Postneonatal .....	9,164	5,950	2,741	171	302
Sex:					
Male .....	15,596	10,238	4,689	208	462
Female .....	12,268	7,898	3,790	166	414
Plurality:					
Single births .....	23,864	15,456	7,288	346	774
Plural births .....	4,000	2,680	1,191	27	102
Birthweight:					
Less than 1,500 grams .....	14,380	8,605	5,223	141	412
1,500-2,499 grams .....	3,893	2,698	994	53	148
2,500 grams or more .....	9,197	6,622	2,104	172	299
Not stated .....	395	210	159	8	17
Period of gestation:					
Less than 32 weeks .....	14,092	8,372	5,178	135	408
32-36 weeks .....	3,511	2,510	857	41	103
37-41 weeks .....	8,479	6,090	1,930	162	297
42 weeks or more .....	826	590	200	19	18
Not stated .....	956	574	316	17	49
Trimester of pregnancy prenatal care began:					
First trimester .....	19,809	13,522	5,458	209	620
After first trimester or no care .....	5,763	3,256	2,212	128	166
Second trimester .....	3,602	2,147	1,251	89	116
Third trimester .....	630	383	209	23	14
No prenatal care .....	1,530	727	752	16	36
Not stated .....	2,292	1,358	809	36	89
Age of mother:					
Under 20 years .....	5,003	2,955	1,904	81	62
20-24 years .....	7,625	4,737	2,604	119	165
25-29 years .....	6,460	4,275	1,862	77	247
30-34 years .....	5,177	3,606	1,280	55	237
35-39 years .....	2,836	2,018	659	33	127
40-54 years .....	763	545	172	8	38
Educational attainment of mother:					
0-8 years .....	1,680	1,350	253	24	53
9-11 years .....	5,946	3,658	2,094	120	74
12 years .....	9,542	5,895	3,265	132	251
13-15 years .....	5,091	3,209	1,646	70	166
16 years and over .....	4,107	3,136	688	12	270
Not stated .....	1,499	888	534	15	63
Live-birth order:					
1 .....	11,016	7,315	3,192	124	385
2 .....	7,923	5,318	2,244	94	267
3 .....	4,587	2,990	1,426	66	104
4 .....	2,142	1,313	745	34	51
5 or more .....	1,811	959	750	49	53
Not stated .....	386	241	123	6	15
Marital status:					
Married .....	14,547	11,501	2,229	135	681
Unmarried .....	13,318	6,634	6,250	238	194

See footnotes at end of table.

**Table 2. Infant mortality rates, live births, and infant deaths by selected characteristics and specified race of mother: United States, 1999 linked file--Con.**

Characteristics	All races	Race of mother			
		White	Black	American Indian <sup>1</sup>	Asian/Pacific Islander
Infant deaths					
Mother's place of birth:					
Born in the 50 States and D.C. ....	22,962	14,823	7,584	361	194
Born elsewhere .....	4,190	2,891	631	11	657
Not stated .....	713	423	264	1	25
Maternal smoking during pregnancy: <sup>2</sup>					
Smoker .....	4,481	3,329	1,044	86	22
Nonsmoker .....	19,571	12,028	6,758	208	576
Not stated .....	923	627	241	28	28

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

<sup>1</sup> Includes Aleuts and Eskimos.

<sup>2</sup> Excludes data for California and South Dakota, which do not report tobacco use on the birth certificate.

NOTE: 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, 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, 1999 linked file**

Characteristics	All origins <sup>1</sup>	Hispanic						Non-Hispanic			Not stated
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total <sup>2</sup>	White	Black	
Infant mortality rates per 1,000 live births in specified group											
Total .....	7.0	5.7	5.5	8.3	4.7	4.7	7.2	7.3	5.8	14.1	...
Age at death:											
Total neonatal .....	4.7	3.9	3.7	5.9	3.5	3.3	4.8	4.9	3.8	9.6	...
Early neonatal (< 7 days) .....	3.8	3.1	2.9	5.0	2.3	2.5	3.8	3.9	3.0	7.7	...
Late neonatal (7-27 days) .....	1.0	0.8	0.8	0.9	*	0.8	1.0	1.0	0.8	1.9	...
Postneonatal .....	2.3	1.8	1.8	2.4	*	1.4	2.5	2.4	1.9	4.6	...
Sex:											
Male .....	7.7	6.2	6.0	9.3	4.5	5.2	7.8	8.0	6.4	15.4	...
Female .....	6.3	5.2	5.0	7.4	4.7	4.1	6.6	6.6	5.1	12.8	...
Plurality:											
Single births .....	6.2	5.2	5.0	7.3	4.0	4.2	6.6	6.4	5.0	12.6	...
Plural births .....	32.9	31.2	30.2	44.9	*	25.4	38.2	32.9	26.7	60.1	...
Birthweight:											
Less than 1,500 grams .....	247.0	246.9	248.7	271.5	164.1	215.3	272.9	245.1	229.7	270.5	...
1,500-2,499 grams .....	16.0	15.4	16.1	13.6	*	15.0	12.0	16.0	16.0	16.5	...
2,500 grams or more .....	2.5	2.1	2.2	2.3	*	1.5	2.9	2.6	2.3	4.0	...
Period of gestation:											
Less than 32 weeks .....	183.3	163.4	158.3	198.4	133.0	148.2	189.6	185.8	172.7	208.8	...
32-36 weeks .....	9.1	7.9	7.9	9.5	*	6.7	6.9	9.4	9.2	10.6	...
37-41 weeks .....	2.7	2.2	2.3	2.5	*	1.6	2.9	2.8	2.4	4.3	...
42 weeks or more .....	2.9	2.5	2.5	*	*	*	*	3.0	2.6	4.6	...
Trimester of pregnancy prenatal care began:											
First trimester .....	6.2	5.3	5.3	7.7	4.4	4.2	5.9	6.4	5.2	12.9	...
After first trimester or no care .....	8.9	5.6	5.3	8.1	*	5.0	7.4	10.3	8.2	14.9	...
Second trimester .....	7.2	4.7	4.5	6.6	*	4.4	5.4	8.2	6.9	11.3	...
Third trimester .....	6.2	3.8	3.4	*	*	*	*	7.3	6.7	8.9	...
No prenatal care .....	34.6	21.0	19.1	33.5	*	*	38.0	40.0	30.7	51.9	...
Age of mother:											
Under 20 years .....	10.3	6.9	6.3	9.8	*	6.1	9.7	11.5	9.6	15.4	...
20-24 years .....	7.8	5.6	5.5	7.7	*	4.5	6.4	8.4	6.6	13.6	...
25-29 years .....	6.0	4.9	4.6	7.1	*	4.1	6.6	6.2	4.9	13.6	...
30-34 years .....	5.8	5.4	5.3	7.7	*	4.5	7.5	5.8	4.7	14.2	...
35-39 years .....	6.5	6.4	7.0	9.8	*	4.5	5.9	6.5	5.4	14.0	...
40-54 years .....	8.7	9.6	8.5	*	*	8.6	*	8.6	7.4	16.6	...
Educational attainment of mother:											
0-8 years .....	7.5	5.7	5.7	13.3	*	4.6	6.6	11.9	10.9	17.5	...
9-11 years .....	9.5	6.1	5.7	9.6	*	4.8	9.0	11.3	9.5	15.3	...
12 years .....	7.6	5.4	5.1	7.7	*	4.8	6.6	8.1	6.4	14.1	...
13-15 years .....	5.9	5.1	5.0	7.1	*	4.3	4.7	6.1	4.7	12.1	...
16 years and over .....	4.4	4.1	4.2	4.2	*	3.6	3.9	4.4	3.9	10.3	...
Live-birth order:											
1 .....	6.9	5.8	5.7	8.1	4.0	4.9	6.7	7.1	5.7	14.2	...
2 .....	6.2	5.0	4.8	7.6	*	3.8	6.5	6.4	5.2	12.6	...
3 .....	7.0	5.2	5.0	7.9	*	4.3	6.7	7.5	6.0	13.6	...
4 .....	8.6	6.8	6.1	10.9	*	7.5	8.4	9.2	7.0	15.3	...
5 or more .....	11.1	7.9	7.7	11.8	*	5.6	10.6	12.2	8.7	18.5	...
Marital status:											
Married .....	5.5	5.1	5.0	7.0	5.1	4.0	6.4	5.5	5.0	11.9	...
Unmarried .....	10.2	6.6	6.2	9.3	*	5.5	8.3	11.3	8.6	15.1	...
Mother's place of birth:											
Born in the 50 States and D.C. ....	7.3	6.5	6.1	8.3	5.0	6.1	7.2	7.4	5.7	14.3	...
Born elsewhere .....	5.3	5.0	5.0	8.2	4.2	4.5	4.6	5.5	4.9	9.8	...
Maternal smoking during pregnancy: <sup>3</sup>											
Smoker .....	10.5	9.8	8.8	11.8	*	*	9.8	10.5	9.1	19.8	...
Nonsmoker .....	6.6	5.8	5.6	8.0	4.3	4.5	6.9	6.8	5.1	13.4	...

See footnotes at end of table.





**Table 3. 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, 1999 linked file--Con.**

Characteristics	All origins <sup>1</sup>	Hispanic						Non-Hispanic			Not stated
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total <sup>2</sup>	White	Black	
Infant deaths											
Total .....	27,864	4,363	2,979	477	61	483	363	23,023	13,522	8,327	480
Age at death:											
Total neonatal .....	18,700	2,982	2,015	339	46	342	240	15,350	8,987	5,634	369
Early neonatal (< 7 days) .....	14,874	2,357	1,592	287	30	258	190	12,177	7,059	4,535	339
Late neonatal (7-27 days) .....	3,827	625	424	53	15	84	49	3,172	1,927	1,099	30
Postneonatal .....	9,164	1,379	963	138	15	140	123	7,673	4,535	2,693	111
Sex:											
Male .....	15,596	2,430	1,652	270	30	278	200	12,890	7,665	4,603	277
Female .....	12,268	1,932	1,327	207	30	205	163	10,132	5,857	3,724	204
Plurality:											
Single births .....	23,864	3,863	2,660	408	51	422	322	19,603	11,392	7,156	397
Plural births .....	4,000	498	318	69	10	60	41	3,420	2,130	1,171	83
Birthweight:											
Less than 1,500 grams .....	14,380	2,176	1,413	290	32	256	185	11,932	6,278	5,136	271
1,500-2,499 grams .....	3,893	615	427	58	11	81	38	3,219	2,056	975	58
2,500 grams or more .....	9,197	1,514	1,101	121	16	144	132	7,560	5,055	2,062	123
Not stated .....	395	55	38	7	1	1	8	312	133	154	27
Period of gestation:											
Less than 32 weeks .....	14,092	2,048	1,314	275	29	248	182	11,789	6,186	5,096	256
32-36 weeks .....	3,511	574	399	61	13	67	34	2,897	1,927	837	41
37-41 weeks .....	8,479	1,351	975	112	14	134	116	7,017	4,683	1,895	110
42 weeks or more .....	826	148	105	12	2	15	14	661	434	192	16
Not stated .....	956	242	186	18	2	19	17	657	292	305	57
Trimester of pregnancy prenatal care began:											
First trimester .....	19,809	2,927	2,031	318	52	315	211	16,630	10,467	5,375	252
After first trimester or no care .....	5,763	1,058	757	97	5	110	89	4,631	2,186	2,170	74
Second trimester .....	3,602	664	480	61	1	73	49	2,901	1,484	1,228	37
Third trimester .....	630	128	87	8	4	18	11	495	254	205	6
No prenatal care .....	1,530	265	189	28	-	19	29	1,234	448	736	31
Not stated .....	2,292	378	191	62	4	58	63	1,761	869	782	155
Age of mother:											
Under 20 years .....	5,003	873	591	118	6	63	95	4,067	2,053	1,887	62
20-24 years .....	7,625	1,298	933	141	11	117	96	6,210	3,391	2,554	118
25-29 years .....	6,460	993	679	97	19	118	80	5,366	3,224	1,833	100
30-34 years .....	5,177	712	460	66	14	108	64	4,354	2,828	1,251	111
35-39 years .....	2,836	373	253	37	5	55	23	2,390	1,598	641	75
40-54 years .....	763	115	63	19	5	23	5	634	428	160	13
Educational attainment of mother:											
0-8 years .....	1,680	909	754	37	2	91	25	757	440	246	12
9-11 years .....	5,946	1,273	913	158	6	88	108	4,626	2,382	2,064	47
12 years .....	9,542	1,202	774	145	18	151	114	8,255	4,678	3,221	86
13-15 years .....	5,091	521	299	87	13	76	46	4,529	2,681	1,625	41
16 years and over .....	4,107	224	110	24	19	48	23	3,822	2,868	676	61
Not stated .....	1,499	234	130	26	2	29	47	1,033	473	495	233
Live-birth order:											
1 .....	11,016	1,655	1,121	180	23	193	138	9,188	5,566	3,143	173
2 .....	7,923	1,157	775	135	18	128	101	6,628	4,092	2,198	137
3 .....	4,587	734	509	77	10	81	57	3,795	2,231	1,404	57
4 .....	2,142	415	285	44	4	54	28	1,709	899	727	18
5 or more .....	1,811	325	244	32	4	24	21	1,462	624	739	25
Not stated .....	386	75	44	9	1	3	18	239	110	114	70
Marital status:											
Married .....	14,547	2,249	1,633	161	49	233	173	12,024	9,069	2,171	276
Unmarried .....	13,318	2,113	1,345	316	12	250	190	10,999	4,453	6,156	205

See footnotes at end of table.

**Table 3. 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, 1999 linked file--Con.**

Characteristics	All origins <sup>1</sup>	Hispanic						Non-Hispanic			Not stated
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total <sup>2</sup>	White	Black	
Infant deaths											
Mother's place of birth:											
Born in the 50 States and D.C. ....	22,962	1,941	1,276	307	27	66	265	20,695	12,688	7,506	324
Born elsewhere .....	4,190	2,330	1,660	165	32	415	58	1,822	589	580	38
Not stated .....	713	89	42	5	1	2	39	505	245	240	118
Maternal smoking during pregnancy: <sup>3</sup>											
Smoker .....	4,481	187	74	67	4	8	34	4,219	3,098	1,020	75
Nonsmoker .....	19,571	2,826	1,750	388	51	348	289	16,473	9,079	6,655	272
Not stated .....	923	73	43	10	1	7	12	757	476	230	92

... Category not applicable.

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

- Quantity zero.

<sup>1</sup> Origin of mother not stated included in "All origins" but not distributed among origins.<sup>2</sup> Includes races other than black or white.<sup>3</sup> Excludes data for California and South Dakota, which do not report tobacco use on the birth certificate.

NOTE: 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 4. Percent of live births with selected maternal and infant characteristics by specified race of mother: United States, 1999 linked file**

Characteristic	All races	White	Black	American Indian <sup>1</sup>	Asian or Pacific Islander					
					Total	Chinese	Japanese	Hawaiian	Filipino	Other
Birthweight:										
Less than 1,500 grams .....	1.5	1.2	3.2	1.3	1.1	0.7	0.9	1.4	1.4	1.1
Less than 2,500 grams .....	7.6	6.6	13.2	7.2	7.5	5.2	8.0	7.7	8.3	7.8
Preterm births <sup>2</sup> .....	11.8	10.7	17.5	12.9	10.4	7.6	9.3	12.3	12.4	10.7
Prenatal care beginning in the first trimester .....	83.2	85.1	74.1	69.5	83.7	88.5	90.7	79.6	84.2	81.8
Births to mothers under 20 years .....	12.3	10.9	20.7	20.2	5.1	0.9	2.1	18.2	5.9	5.5
Fourth and higher order births .....	10.5	9.7	14.9	19.1	7.2	2.3	3.9	14.3	7.2	8.4
Births to unmarried mothers .....	33.0	26.8	68.9	58.9	15.4	6.9	9.9	50.4	21.1	14.5
Mothers completing 12 or more years of school ...	78.3	78.7	74.0	67.8	87.6	88.0	98.0	83.2	93.7	85.2
Mothers born in the 50 States and D.C. ....	79.8	81.5	88.6	96.0	16.7	9.7	41.3	97.8	20.1	10.9
Mother smoked during pregnancy <sup>3</sup> .....	12.6	13.6	9.3	20.2	2.9	0.5	4.5	14.7	3.3	2.3

<sup>1</sup> Includes births to Aleuts and Eskimos.

<sup>2</sup> Born prior to 37 completed weeks of gestation.

<sup>3</sup> Excludes data for California and South Dakota, which do 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, 1999 linked file**

Characteristic	All origins <sup>1</sup>	Hispanic						Non-Hispanic		
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total <sup>2</sup>	White	Black
Birthweight:										
Less than 1,500 grams .....	1.5	1.2	1.1	1.9	1.5	1.2	1.4	1.5	1.2	3.2
Less than 2,500 grams .....	7.6	6.4	6.0	9.3	6.8	6.4	7.7	7.9	6.7	13.3
Preterm births <sup>3</sup> .....	11.8	11.4	11.1	13.7	11.5	11.4	11.9	11.9	10.5	17.6
Prenatal care beginning in the first trimester .....	83.2	74.4	73.1	77.7	91.4	77.6	74.8	85.3	88.4	74.1
Births to mothers under 20 years .....	12.3	16.7	17.4	21.1	7.7	10.0	19.5	11.2	9.2	20.7
Fourth and higher order births .....	10.5	13.5	14.6	11.9	5.3	11.2	10.6	9.8	8.5	14.9
Births to unmarried mothers .....	33.0	42.2	40.1	59.6	26.4	43.7	45.8	30.9	22.1	69.1
Mothers completing 12 or more years of school ...	78.3	50.9	44.8	65.6	87.7	62.1	67.5	84.8	87.4	74.1
Mothers born in the 50 States and D.C. ....	79.8	39.2	38.7	64.6	41.4	10.4	74.6	89.5	94.8	89.9
Mother smoked during pregnancy <sup>4</sup> .....	12.6	3.7	2.6	10.5	3.3	1.4	7.7	14.1	15.9	9.4

<sup>1</sup> Includes origin not stated.

<sup>2</sup> Includes races other than black or white.

<sup>3</sup> Born prior to 37 completed weeks of gestation.

<sup>4</sup> Excludes data for California and South Dakota, which do not report tobacco use on the birth certificate.

**Table 6. Live births, infant, neonatal, and postneonatal deaths and mortality rates by race of mother and birthweight: United States, 1999 linked file, and percent change in birthweight-specific infant mortality, 1995-99 linked file**

Race and birthweight	Number in 1999				Mortality rate per 1,000 live births in 1999			Percent change in infant mortality rate 1995-99
	Live births	Infant deaths	Neonatal deaths	Postneonatal deaths	Infant	Neonatal	Postneonatal	
All races <sup>1</sup> .....	3,959,417	27,864	18,700	9,164	7.0	4.7	2.3	-7.9
Less than 2,500 grams .....	302,113	18,273	14,960	3,313	60.5	49.5	11.0	-6.3
Less than 1,500 grams .....	58,227	14,380	12,684	1,696	247.0	217.8	29.1	-8.0
Less than 500 grams .....	6,318	5,408	5,316	92	856.0	841.4	14.6	-5.3
500-749 grams .....	11,344	5,507	4,814	693	485.5	424.4	61.1	-8.1
750-999 grams .....	11,738	1,779	1,332	447	151.6	113.5	38.1	-16.7
1,000-1,249 grams .....	13,314	930	688	242	69.9	51.7	18.2	-18.2
1,250-1,499 grams .....	15,513	756	534	221	48.7	34.4	14.2	-10.8
1,500-1,999 grams .....	59,599	1,714	1,114	600	28.8	18.7	10.1	-13.3
2,000-2,499 grams .....	184,287	2,179	1,162	1,017	11.8	6.3	5.5	-12.6
2,500 grams or more .....	3,654,764	9,197	3,366	5,831	2.5	0.9	1.6	-16.7
2,500-2,999 grams .....	653,618	3,010	1,211	1,798	4.6	1.9	2.8	-14.8
3,000-3,499 grams .....	1,470,522	3,585	1,197	2,387	2.4	0.8	1.6	-17.2
3,500-3,999 grams .....	1,137,786	1,916	656	1,260	1.7	0.6	1.1	-15.0
4,000-4,499 grams .....	332,995	536	226	310	1.6	0.7	0.9	-11.1
4,500-4,999 grams .....	53,773	103	44	59	1.9	0.8	1.1	-13.6
5,000 grams or more .....	6,070	47	31	16	7.7	5.1	*	-8.3
Not stated .....	2,540	395	374	20	...	...	...	...
White .....	3,132,501	18,136	12,186	5,950	5.8	3.9	1.9	-7.9
Less than 2,500 grams .....	206,135	11,303	9,361	1,942	54.8	45.4	9.4	-8.2
Less than 1,500 grams .....	36,461	8,605	7,692	913	236.0	211.0	25.0	-9.4
Less than 500 grams .....	3,495	2,997	2,951	46	857.5	844.3	13.2	-5.9
500-749 grams .....	6,597	3,292	2,945	347	499.0	446.4	52.6	-8.6
750-999 grams .....	7,297	1,143	905	238	156.6	124.0	32.6	-18.8
1,000-1,249 grams .....	8,674	632	484	148	72.9	55.8	17.1	-19.8
1,250-1,499 grams .....	10,398	541	406	135	52.0	39.0	13.0	-6.3
1,500-1,999 grams .....	41,091	1,191	814	376	29.0	19.8	9.2	-12.7
2,000-2,499 grams .....	128,583	1,507	854	653	11.7	6.6	5.1	-14.6
2,500 grams or more .....	2,924,576	6,622	2,626	3,996	2.3	0.9	1.4	-14.8
2,500-2,999 grams .....	468,901	2,052	918	1,134	4.4	2.0	2.4	-17.0
3,000-3,499 grams .....	1,151,179	2,586	939	1,647	2.2	0.8	1.4	-18.5
3,500-3,999 grams .....	959,764	1,441	525	916	1.5	0.5	1.0	-16.7
4,000-4,499 grams .....	291,909	428	190	238	1.5	0.7	0.8	-6.3
4,500-4,999 grams .....	47,584	83	34	49	1.7	0.7	1.0	-15.0
5,000 grams or more .....	5,239	34	20	13	6.5	3.8	*	-15.6
Not stated .....	1,790	210	199	11	...	...	...	...
Black .....	605,970	8,480	5,739	2,741	14.0	9.5	4.5	-4.1
Less than 2,500 grams .....	79,635	6,217	4,990	1,227	78.1	62.7	15.4	-1.4
Less than 1,500 grams .....	19,288	5,223	4,497	726	270.8	233.2	37.6	-5.2
Less than 500 grams .....	2,590	2,214	2,168	47	854.8	837.1	18.1	-4.5
500-749 grams .....	4,300	1,998	1,673	325	464.7	389.1	75.6	-6.9
750-999 grams .....	3,971	557	366	191	140.3	92.2	48.1	-13.9
1,000-1,249 grams .....	4,045	268	177	91	66.3	43.8	22.5	-11.0
1,250-1,499 grams .....	4,382	186	113	73	42.4	25.8	16.7	-12.8
1,500-1,999 grams .....	15,542	429	242	187	27.6	15.6	12.0	-14.8
2,000-2,499 grams .....	44,805	565	251	314	12.6	5.6	7.0	-6.7
2,500 grams or more .....	525,898	2,104	595	1,509	4.0	1.1	2.9	-11.1
2,500-2,999 grams .....	139,324	801	225	576	5.7	1.6	4.1	-8.1
3,000-3,499 grams .....	229,856	823	210	614	3.6	0.9	2.7	-12.2
3,500-3,999 grams .....	124,040	374	111	263	3.0	0.9	2.1	-14.3
4,000-4,499 grams .....	27,918	76	29	47	2.7	1.0	1.7	-37.2
4,500-4,999 grams .....	4,206	16	9	7	*	*	*	*
5,000 grams or more .....	554	12	10	2	*	*	*	*
Not stated .....	437	159	154	5	...	...	...	...

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

†... Category not applicable.

<sup>1</sup> Includes races other than white or black.

NOTE: Infant deaths are weighted so numbers may not exactly add to totals due to rounding.

**Table 7. Infant deaths and mortality rates for the five leading causes of infant death by race and Hispanic origin of mother: United States, 1999 linked file**

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

Cause of death (Based on the Tenth Revision, International Classification of Diseases, 1992)	All races			White			Black			American Indian <sup>1,2</sup>			Asian and Pacific Islander <sup>3</sup>		
	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate
All causes .....	...	27,864	703.7	...	18,136	579.0	...	8,480	1399.4	...	373	928.6	...	876	484.6
Congenital malformations, deformations and chromosomal abnormalities (Q00-Q99) .....	1	5,480	138.4	1	4,204	134.2	2	1,002	165.4	1	71	176.7	1	204	112.8
Disorders related to short gestation and low birth weight, not elsewhere classified (P07) .....	2	4,377	110.5	2	2,366	75.5	1	1,842	304.0	3	44	109.5	2	124	68.6
Sudden infant death syndrome (R95) .....	3	2,643	66.8	3	1,741	55.6	3	787	129.9	2	59	146.9	3	56	31.0
Newborn affected by maternal complications of pregnancy (P01) .....	4	1,387	35.0	4	871	27.8	4	465	76.7	4	12	*	4	39	21.6
Respiratory distress of newborn (P22) .....	5	1,127	28.5	5	716	22.9	5	373	61.6	7	9	*	7	29	16.0

Cause of death (Based on the Tenth Revision International Classification of Diseases, 1992)	Total Hispanic <sup>4</sup>			Mexican			Puerto Rican			Central and South American <sup>5</sup>			Non-Hispanic White		
	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate
All causes .....	...	4,363	570.8	...	2,979	551.0	...	477	834.8	...	483	467.5	...	13,522	576.3
Congenital malformations, deformations and chromosomal abnormalities (Q00-Q99) .....	1	1,073	140.4	1	793	146.7	2	77	134.8	1	130	125.8	1	3,082	131.3
Disorders related to short gestation and low birth weight, not elsewhere classified (P07) .....	2	643	84.1	2	421	77.9	1	98	171.5	2	54	52.3	2	1,666	71.0
Sudden infant death syndrome (R95) .....	3	284	37.2	3	180	33.3	3	38	66.5	4	19	*	3	1,457	62.1
Newborn affected by maternal complications of pregnancy (P01) .....	5	172	22.5	5	109	20.2	4	30	52.5	7	12	*	4	682	29.1
Respiratory distress of newborn (P22) .....	4	195	25.5	4	112	20.7	4	30	52.5	3	32	31.0	5	511	21.8

... Category not applicable.

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

<sup>1</sup> Includes Aleuts and Eskimos.

<sup>2</sup> For American Indians, Necrotizing enterocolitis of newborn (P77) and Accidents (unintentional injuries) (V01-X59) were tied for the fifth leading cause of death; however with only 11 deaths each, reliable infant mortality rates could not be computed.

<sup>3</sup> For Asian and Pacific Islanders, Newborn affected by complications of placenta, cord and membranes (P02) was the fifth leading cause of death, with 38 deaths and a rate of 21.1.

<sup>4</sup> Includes Cuban and other and unknown Hispanic.

<sup>5</sup> For Central and South Americans, Intrauterine hypoxia and birth asphyxia (P20-P21) was the fifth leading cause of death, however with only 16 deaths, a reliable infant mortality rate could not be computed.

NOTE: Reliable cause-specific infant mortality rates cannot be computed for Cubans because of the small number of infant deaths (61).

## Technical notes

### Differences between period and cohort data

From 1983–91, NCHS produced linked files in a birth cohort format (39). Beginning with 1995 data, linked files are produced first using a period format and then subsequently using a birth cohort format. Thus, the 1999 period linked file contains a numerator file that consists of all infant deaths occurring in 1999 that have been linked to their corresponding birth certificates, whether the birth occurred in 1999 or in 1998. This cross-sectional approach is used to improve timeliness of the file release. In contrast, the 1999 birth cohort linked file will contain a numerator file that consists of all infant deaths to babies born in 1999 whether the death occurred in 1999 or 2000. In both the cohort and the period file, the denominator file is the 1999 natality file, which contains all births occurring in 1999. In practice, there is very little difference in rates between the period and the cohort files.

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 to the birth cohort. Beginning with 1995 data, the period linked file is the basis for all official NCHS linked file statistics (except for special cohort studies).

### Weighting

A record weight is added to the linked file to compensate for the 2.3 percent (in 1999) 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 percent of records linked varied by registration area (from 91.0–100.0 percent with all but eight areas—the District of Columbia, Hawaii, New Jersey, New Mexico, New York, Ohio, Oklahoma, and Utah at 97 percent or higher) (table 1). The percent linked also varied by age at death, from 97.1 percent for infants who died during the early neonatal period (within the first 7 days of life), to 98.3 percent for infants who died during the postneonatal period (28 days–11 months of age). 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 residence at birth and age at death (less than 1 day, 1–27 days, and 28 days–11 months). The addition of the weight greatly reduced the potential for bias in comparing infant mortality rates by characteristics.

The 1999 linked file includes 27,281 unweighted infant death records. An additional 633 records could not be linked to their corresponding birth certificates because the birth certificate could not be identified. Thus, the linked file was weighted to match the total of 27,914 linked plus unlinked records. Since the data included in this report are tabulated by place of residence of the mother, 50 infant deaths to mothers whose usual place of residence is outside of the United States were excluded from tables shown in this report, leading to a weighted total of 27,864 infant deaths.

**Table 1. Percent of infant death records which were linked to their corresponding birth records: United States and each State, Puerto Rico, Virgin Islands, and Guam, 1999 linked file**

State	Percent linked by State of occurrence of death
United States <sup>1</sup> .....	97.7
Alabama .....	100.0
Alaska .....	98.0
Arizona .....	98.4
Arkansas .....	98.5
California .....	97.1
Colorado .....	99.1
Connecticut .....	100.0
Delaware .....	99.1
District of Columbia .....	94.3
Florida .....	99.2
Georgia .....	99.9
Hawaii .....	96.7
Idaho .....	99.1
Illinois .....	97.5
Indiana .....	98.6
Iowa .....	100.0
Kansas .....	98.3
Kentucky .....	98.6
Louisiana .....	97.6
Maine .....	96.9
Maryland .....	99.4
Massachusetts .....	97.1
Michigan .....	97.3
Minnesota .....	100.0
Mississippi .....	100.0
Missouri .....	98.7
Montana .....	98.5
Nebraska .....	99.4
Nevada .....	97.4
New Hampshire .....	100.0
New Jersey .....	96.2
New Mexico .....	91.8
New York .....	96.5
North Carolina .....	99.8
North Dakota .....	98.3
Ohio .....	90.9
Oklahoma .....	91.0
Oregon .....	99.6
Pennsylvania .....	97.7
Rhode Island .....	100.0
South Carolina .....	99.8
South Dakota .....	100.0
Tennessee .....	100.0
Texas .....	97.2
Utah .....	96.3
Vermont .....	100.0
Virginia .....	98.5
Washington .....	99.0
West Virginia .....	98.8
Wisconsin .....	100.0
Wyoming .....	100.0
Puerto Rico .....	99.4
Virgin Islands .....	100.0
Guam .....	100.0

<sup>1</sup> Excludes data for Puerto Rico, Virgin Islands, and Guam.

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

The overall infant mortality rate from the 1999 period linked file of 7.0 is 0.1 lower than from the 1999 vital statistics mortality file (7.1) (2). The number of infant deaths also differs slightly (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. Also, the linkage process subjects infant death records to an additional round of quality control review. Every year, a few records are voided from the file at this stage because they are found to be fetal deaths, deaths at ages greater than 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.

### Age of mother

Age of mother is computed in most cases from the mother's and infant's dates of birth as reported on the birth certificate. The mother's age is directly reported by five States (Kentucky, Nevada, North Dakota, Virginia, and Wyoming). From 1964–96, births reported to occur to mothers younger than age 10 or older than age 49 years had age imputed according to the age of mother from the previous record with the same race and total birth order (total of live births and fetal deaths). Beginning in 1997, age of mother is imputed if less than 10 or greater than 54 years. A review and verification of unedited birth data for 1996 showed that the vast majority of births reported as occurring to women aged 50 years and over were to women aged 50–54 years. The numbers of births and infant deaths to women aged 50–54 years are too small for computing age-specific infant mortality rates.

### Marital status

National estimates of births to unmarried women are based on two methods of determining marital status. For 1994 through 1996, birth certificates in 45 States and the District of Columbia included a question about the mother's marital status. Beginning in 1997, California added a direct question to their birth certificate; thus by 1997, all but four States (Connecticut, Michigan, Nevada, and New York) included a direct question on their birth certificates. Beginning in 1997, the marital status of women giving birth in California and Nevada is determined by a direct question in the birth registration process. Beginning June 15, 1998, Connecticut discontinued inferring the mother's marital status and added a direct question on mother's marital status to the State's birth certificate.

In the two States (Michigan and New York), which used inferential procedures to compile birth statistics by marital status in 1999, 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 Technical notes in *Births: Final Data for 1999* (9).

### 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 (40–41).

The U.S. Standard Certificate of Live Birth contains an item, "clinical estimate of gestation," which is being 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 5.1 percent of the births in 1999 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 reclassified as "not stated." This was necessary for about 350 births or less than 0.01 percent of all birth records in 1999 (9).

For the linked file not stated birthweight was imputed for 2,276 records, or 0.06 percent of the birth records in 1999 when birthweight was not stated and 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 (2,540 records in 1999) the not stated value for birthweight was retained. This imputation was done to improve the accuracy of birthweight-specific infant mortality rates, since the percent of records with not stated birthweight was higher for infant deaths (3.82 percent before imputation) than for live births (0.12 percent before imputation). The imputation reduced the percent of not stated records to 1.42 percent for infant deaths, and 0.06 percent for births. The not stated birthweight cases in the natality/birth file, as distinct from the linked file, are not imputed (9).

### 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*. The ICD provides the basic guidance used in virtually all countries to code and classify causes of death. The ICD not only details disease classifications 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 the 1999 issue of the *NCHS Instruction Manual* (42–43).

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” (3). 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 (44–45).

### Changes in Cause-of-Death Classification

About every 10–20 years, the *International Classification of Diseases* 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 *International Statistical Classification of Diseases and Related Health Problems* (ICD–10) (3); during the period 1979–98, causes were coded and classified according to the Ninth Revision (ICD–9) (4). ICD–10 has many changes from ICD–9(3). As a result, it can be difficult to compare cause-of-death data for 1999 with that for previous years. To assist in this comparison, **comparability ratios** are computed, and are shown in [table II](#) for causes of death shown in this report. Comparability ratios measure the net effect of the new revision on statistics for a particular cause of death and can be used as a factor to adjust mortality statistics for causes of death classified by a previous revision to be comparable to those for the same cause classified by the new revision. A comparability ratio near 1.0 indicates little or no net change in cause-of-death classification for the category. Ratios divergent from 1.0 indicate a greater discontinuity. For more information on the computation and uses of comparability ratios, see *Comparability of cause of death between ICD-9 and ICD-10: Preliminary estimates* (46).

### Tabulation lists and cause-of-death ranking

Tabulation lists for ICD–10 were developed to maximize continuity with ICD–9. This continuity is especially useful in trend analysis and in identifying causes of death, which are of public health and medical importance. 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” (47). Briefly, ranking of causes of infant death is based on the List of 130 Selected Causes of Infant Death. 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. 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. Infant mortality rates use the number of live births in the denominator to approximate the population at risk of dying before the first birthday. 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. For the Virgin Islands and Guam, the infant death records are not weighted due to the small number of cases for the Virgin Islands and Guam. However, the percent of records linked has been very high (greater than 99 percent) for Puerto Rico as well as the Virgin Islands and Guam, and thus the effect of not weighting the data have been minimal. The infant death records are also not weighted for Puerto Rico. There is no linked file data for American Samoa and the Commonwealth of the Northern Marianas.

### 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 (48). As a result, numbers of births, deaths, and infant mortality rates

**Table II. List of ICD–10 five leading causes of infant death for 1999, comparable ICD–9 causes of infant death, and estimated comparability ratios**

ICD–10 cause of death	ICD–9 cause of death	Estimated comparability ratio
Congenital malformations, deformations and chromosomal abnormalities . . . . . (Q00–Q99)	Congenital anomalies . . . . . (740–759)	0.9064
Disorders related to short gestation and low birthweight, not elsewhere classified . . . . . (P07)	Disorders relating to short gestation and unspecified low birthweight . . . . . (765)	1.1060
Sudden infant death syndrome . . . . . (R95)	Sudden infant death syndrome . . . . . (798.0)	1.0362
Newborn affected by maternal complications of pregnancy . . . . . (P01)	Newborn affected by maternal complications of pregnancy . . . . . (761)	1.0295
Respiratory distress of newborn . . . . . (P22)	Respiratory distress syndrome . . . . . (769)	1.0257



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 less 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. Estimates of relative standard errors (RSE's) and 95-percent confidence intervals are shown below.

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

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

where  $D$  is the number of deaths and

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

where  $B$  is the number of births.

For example, let us say that for group A the number of infant deaths was 104 while the number of live births was 27,380 yielding an infant mortality rate of 3.8 infant deaths per 1,000 live births.

$$\text{The RSE of the deaths} = 100 \cdot \sqrt{\frac{1}{104}} = 9.81,$$

$$\text{while the RSE of the births} = 100 \cdot \sqrt{\frac{1}{27,380}} = 0.60$$

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

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

$$\text{The RSE of the IMR} = 100 \cdot \sqrt{\frac{1}{104} + \frac{1}{27,380}} = 9.82$$

*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:

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

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

Thus, for Group A:

$$\text{Lower: } 3.8 - 1.96 \cdot 3.8 \cdot \frac{9.82}{100} = 3.1$$

$$\text{Upper: } 3.8 + 1.96 \cdot 3.8 \cdot \frac{9.82}{100} = 4.5$$

Thus the chances are 95 out of 100 that the true infant mortality rate for Group A lies somewhere in the 3.1–4.5 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 III.

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

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

where  $D_{\text{adj}}$  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 III corresponding to the value of  $D_{\text{adj}}$ .

For example, let us say that for Group B the number of infant deaths was 47, the number of live births was 8,901, and the infant mortality rate was 5.3.

$$D_{\text{adj}} = \frac{(47 \cdot 8,901)}{(47 + 8,901)} = 47$$

Therefore the 95-percent confidence interval (using the formula for 1–99 infant deaths) =

$$\text{Lower: } 5.3 \cdot 0.73476 = 3.9$$

$$\text{Upper: } 5.3 \cdot 1.32979 = 7.0$$

*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 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  $z \leq -1.96$ , the difference is not significant.

### Availability of linked file data

Linked file data are available on CD-ROM from the National Technical Information Service (NTIS) and the Government Printing Office (GPO). Data are also available in selected issues of the *Vital and Health Statistics*, Series 20 reports, the *Monthly Vital Statistics Reports* and the *National Vital Statistics Report* through NCHS. Additional unpublished tabulations are available from NCHS or through our Internet site at <http://www.cdc.gov/nchswww>. Selected variables from the linked file are also available for tabulation on CDC WONDER at <http://wonder.cdc.gov/lbdj.shtml>.

Table III. 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

<i>N</i>	<i>L</i>	<i>U</i>	<i>N</i>	<i>L</i>	<i>U</i>
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			

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Acknowledgments

This report was prepared in the Division of Vital Statistics under the general direction of Stephanie J. Ventura, Chief of the Reproductive Statistics Branch (RSB). Steve Steimel, Gail Parr, Manju Sharma, Jordan Sachs, and Jaleh Mousavi of the Systems, Programming, and Statistical Resources Branch (SPSRB) provided computer programming support and statistical tables. Melissa Park and Yashu Patel of RSB provided assistance with content review. Van L. Parsons of the Office of Research and Methodology provided information on the statistical methodology. The Registration Methods staff and the Data Acquisition and Evaluation Branch provided consultation to State vital statistics offices regarding collection of the birth and death certificate data on which this report is based. This report was edited by Gail V. Johnson and typeset by Jacqueline M. Davis; graphics were produced by Jarmila Ogburn of the Publications Branch, Division of Data Services.

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**Suggested citation**

Mathews TJ, MacDorman MF, Menacker F. Infant mortality statistics from the 1999 period linked birth/infant death data set. National vital statistics reports; vol 50 no 4. Hyattsville, Maryland: National Center for Health Statistics. 2002.

**National Center for Health Statistics**

Director, Edward J. Sondik, Ph.D.  
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**Division of Vital Statistics**

Director, Mary Anne Freedman

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DEPARTMENT OF  
HEALTH & HUMAN SERVICES

Centers for Disease Control and Prevention  
National Center for Health Statistics  
6525 Belcrest Road  
Hyattsville, Maryland 20782-2003

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DHHS Publication No. (PHS) 2002-1120  
PRS 02-0108 (1/2002)

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