

Infant Mortality Statistics from the 1998 Period Linked Birth/Infant Death Data Set

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Abstract

Objectives—This report presents 1998 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 Cuban mothers (3.6 per 1,000), Central and South American (5.3), Asian or Pacific Islander (5.5), Mexican (5.6), and non-Hispanic white mothers (6.0), followed by Puerto Rican (7.8), American Indian (9.3), and black mothers (13.8). Infant mortality rates (IMRs) 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. In 1998, 65 percent of all infant deaths occurred to the 7.6 percent of infants born at low birthweight. The three leading causes of infant death—Congenital anomalies, Disorders relating to short gestation and unspecified low birthweight (low birthweight), and Sudden infant death syndrome (SIDS)—taken together accounted for 46 percent of all infant deaths in the United States in 1998. Cause-specific mortality rates varied considerably by race and Hispanic origin. For infants of black mothers, the IMR for low

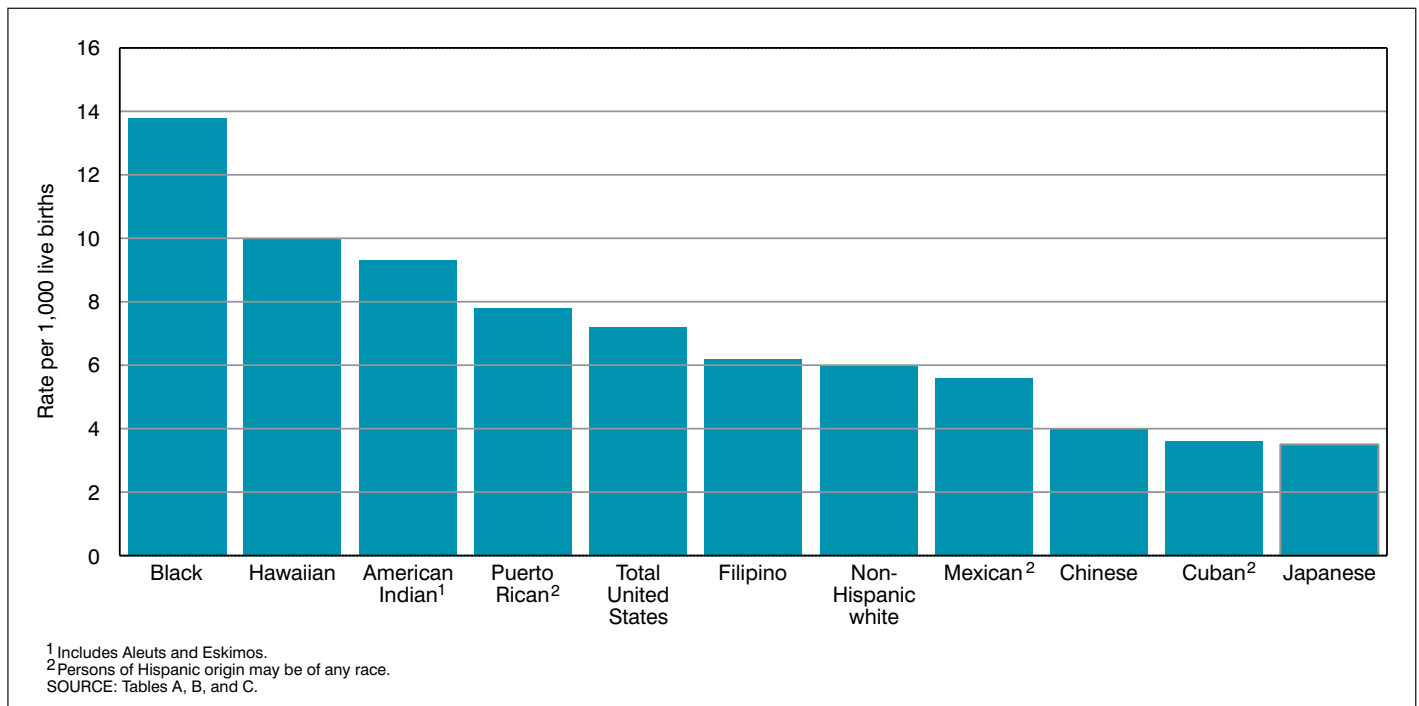


Figure 1. Infant mortality rates by race and ethnicity, 1998

birthweight was nearly four times that for white mothers. For infants of American Indian mothers, the SIDS rate was 3.8 times that for Asian or Pacific Islander (API) mothers. For infants of Hispanic mothers, the SIDS rate was 44 percent lower than that for non-Hispanic white mothers.

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

Introduction

This report presents infant mortality data from the 1998 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 1998. There is no linked file data 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 in [tables 1–7](#). Other variables that are available on the linked file data tapes (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.

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 matching birth and death certificate numbers for each infant under 1 year of age that died in the State in 1998. 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. The National Center for Health Statistics (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 1998, 98.4 percent of all infant death records were successfully matched to their corresponding birth records. This is improved over the 97.9 for 1997. A record weight was added to the linked file in 1998 to compensate for the 1.6 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 *Ninth Revision, International Classification of Diseases (ICD–9)(2)*.

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 analysis, and is the aim of this publication.

Race and Hispanic origin data—Infant mortality rates are presented for detailed race and Hispanic origin groups. The linked file is particularly useful for computing accurate IMRs for this purpose because the race of the mother from the birth certificate is used in both the numerator and denominator of the IMR. 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 (3,4). 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 has a larger impact for races other than white and black and can lead to differences in race-specific IMRs between the two data sources (4,5).

IMRs for five detailed API groups (in addition to those obtained for all States and the District of Columbia), including Vietnamese, Asian Indian, Korean, Samoan, and Guamanian, are presented for a nine-State reporting area: California, Hawaii, Illinois, Minnesota, New Jersey, New York, Texas, Virginia, and Washington. In 1990, more than 65 percent of the U.S. population for each of these additional API groups lived in the nine-State reporting area: Asian Indian, Korean, and Vietnamese, 66–71 percent; Guamanian, 77 percent; and Samoan, 85 percent (6,7). Unless specified, rates for total API and for Chinese, Japanese, Filipino, and other API are reported for all 50 States and the District of Columbia.

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, 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. Race and ethnic differentials in IMRs 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 IMR 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 file are presented in the

Technical notes. Additional information on maternal age, marital status, period of gestation, birthweight, and cause-of-death classification is also presented in the [Technical notes](#).

Results and Discussion

Infant mortality by race and Hispanic origin of mother

The overall 1998 infant mortality rate (IMR) from the linked file was 7.2 infant deaths per 1,000 live births, unchanged from the 1997 level (8). In 1991 the IMR was 8.6. There was wide variation in IMRs by the race of the mother with the highest rate, 13.8 for infants of black mothers, more than three times higher than the groups with the lowest rates, 3.5 for infants of Japanese mothers and 4.0 for infants of Chinese mothers ([table A](#)). Rates were intermediate for infants of non-Hispanic white (6.0) and Filipino mothers (6.2), but higher for American Indian (9.3) and Hawaiian mothers (10.0).

The neonatal mortality rate (less than 28 days) for infants of black mothers (9.4) was significantly higher than for all other racial groups except Hawaiian mothers (7.3). Infants of black and American Indian mothers had the highest postneonatal rates (28 days to 1 year) of any group, 4.4 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 IMR by race and ethnicity.

Data for the expanded Asian or Pacific Islander (API) subgroups in the nine-State reporting area show IMRs of 4.2 for infants of Korean mothers, 4.8 for Vietnamese mothers, and 5.6 for Asian Indian mothers ([table B](#)). Reliable IMRs for Samoan and Guamanian mothers could not be computed due to the small numbers of infant deaths for these groups (18 and 5 infant deaths, respectively).

There was wide variation in IMRs for Hispanic subgroups with the rate for infants of Puerto Rican mothers (7.8) more than twice the rate for Cuban mothers (3.6). Rates were intermediate for infants of Central or South American mothers (5.3) and Mexican mothers (5.6) ([table C](#)).

The neonatal mortality rates for these mothers followed a similar pattern—the rate for infants of Puerto Rican mothers was twice that of Cuban mothers.

Infant mortality by State

IMRs for the years 1996–98 combined by race and Hispanic origin are shown in [table 1](#) for the 50 States, the District of Columbia, Puerto Rico, the Virgin Islands, and Guam. State-specific rates were calculated for infants of black, American Indian, API, and Hispanic mothers for all States with at least 20 infant deaths in the specified group.

The IMRs by State ranged from 10.5 per 1,000 live births in Mississippi to 4.5 in New Hampshire (in the District of Columbia the rate was 13.8). For infants of non-Hispanic white mothers the IMRs by State ranged from 8.0 in West Virginia to 4.2 in New Hampshire.

Rates for infants of black mothers are shown in [table 1](#) for 38 States and the District of Columbia. The rates ranged from 17.1 in Illinois and Nebraska to 10.1 in Massachusetts (in the District of Columbia the rate was 17.2). Twelve States and the District of Columbia had IMRs at or above 15.0 for black mothers.

Rates of infant mortality for infants of American Indian mothers are shown for 13 States. These rates ranged from 15.3 in Minnesota to a rate of less than one-half of that in New Mexico (7.2).

Infants of API women have among the lowest overall IMRs. Rates for 25 States are shown for API mothers. Of those, rates ranged from 8.0 in Indiana to 3.1 in Massachusetts.

Rates of infant mortality for Hispanic mothers are shown for 37 States. Rates ranged from 10.3 in Wisconsin to a rate less than one-half of that in Florida and Washington (4.9).

Infant mortality by selected infant and maternal characteristics

IMRs by a variety of infant and maternal characteristics are presented in [table 2](#) for infants of white, black, American Indian, and API mothers and in [table 3](#) for infants of Hispanic mothers and non-Hispanic white and black mothers.

Table A. Infant, neonatal, and postneonatal deaths and mortality rates by specified race or national origin of mother: United States, 1998 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	3,941,553	28,325	18,915	9,410	7.2	4.8	2.4
White	3,118,727	18,575	12,338	6,238	6.0	4.0	2.0
Black	609,902	8,418	5,708	2,710	13.8	9.4	4.4
American Indian ¹	40,272	376	200	175	9.3	5.0	4.3
Asian or Pacific Islander	172,652	956	669	287	5.5	3.9	1.7
Chinese	28,058	113	77	36	4.0	2.7	1.3
Japanese	8,893	31	22	8	3.5	2.5	*
Hawaiian	6,025	60	44	16	10.0	7.3	*
Filipino	31,170	193	142	51	6.2	4.6	1.6
Other Asian or Pacific Islander	98,506	560	383	176	5.7	3.9	1.8

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

¹ Includes Aleuts and Eskimos.

Table B. Infant, neonatal, and postneonatal deaths and mortality rates by race or national origin of mother: Total of 9 States, 1998 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	1,676,088	10,735	7,181	3,554	6.4	4.3	2.1
Total Asian or Pacific Islander	123,443	697	492	205	5.6	4.0	1.7
Chinese	22,453	97	64	34	4.3	2.9	1.5
Japanese	7,109	27	19	8	3.8	*	*
Filipino	25,813	162	122	40	6.3	4.7	1.5
Vietnamese	11,536	55	42	12	4.8	3.6	*
Asian Indian	19,772	110	86	24	5.6	4.3	1.2
Korean	8,241	35	21	14	4.2	2.5	*
Hawaiian	5,501	53	40	13	9.6	7.3	*
Samoan	1,718	18	9	8	*	*	*
Guamanian	492	5	2	3	*	*	*
Remaining Asian or Pacific Islander	20,808	135	86	49	6.5	4.1	2.4
White	1,326,064	7,154	4,803	2,350	5.4	3.6	1.8
Black	217,933	2,791	1,831	960	12.8	8.4	4.4
American Indian ¹	8,648	94	55	38	10.9	6.4	4.4

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

¹ Includes Aleuts and Eskimos.

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

Table C. Infant, neonatal, and postneonatal deaths and mortality rates by Hispanic origin of mother and by race of mother for mothers of non-Hispanic origin: Unites States, 1998 linked file

Hispanic origin and race of mother	Live births	Number of deaths			Mortality rate per 1,000 live births		
		Infant	Neonatal	Postneonatal	Infant	Neonatal	Postneonatal
All origins ¹	3,941,553	28,325	18,915	9,410	7.2	4.8	2.4
Total Hispanic	734,661	4,228	2,844	1,385	5.8	3.9	1.9
Mexican	516,011	2,891	1,934	957	5.6	3.7	1.9
Puerto Rican	57,349	446	297	149	7.8	5.2	2.6
Cuban	13,226	48	36	12	3.6	2.7	*
Central and South American	98,226	519	354	165	5.3	3.6	1.7
Other and unknown Hispanic	49,849	324	223	102	6.5	4.5	2.0
Non-Hispanic total ²	3,158,975	23,605	15,694	7,911	7.5	5.0	2.5
Non-Hispanic white	2,361,462	14,119	9,297	4,822	6.0	3.9	2.0
Non-Hispanic black	593,127	8,233	5,574	2,659	13.9	9.4	4.5
Not stated	47,917	492	377	115	...	...	...

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

... Category not applicable.

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

² Includes races other than white or black.

Sex of infant—In 1998 the IMR was 7.8 for male infants, 20 percent higher than the rate of 6.5 for female infants. Similar to previous years, IMRs were higher for male than for female infants for each race and Hispanic origin group, although differences were not statistically significant for infants of American Indian, API, and Central and South American mothers.

Multiple births—For plural births, the IMR was 33.9, more than five times the rate of 6.4 for single births (figure 2). IMRs for plural births were significantly higher than rates for single births for all race and Hispanic-origin groups. The number of triplet, quadruplet, quintuplet, and other higher order multiple births rose in 1998 (9) and the risk of infant death increases with the increasing number of infants in the pregnancy (10). From 1997–98, IMRs for plural births had nonstatistically significant increases for infants of black, American Indian, and Central and South American mothers. Higher order multiple birth rates have more than doubled from 1991–98 (from 81.4 per 100,000 live births in 1991 to 193.5 per 100,000 live births in 1998) (3). In 1998, the

IMR for triplet and higher order births (67.1) was more than double the rate for twin births (31.6), and more than 10 times the rate for single births (6.4) (tabular data not shown).

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) (10–12).

Birthweight and period of gestation—Birthweight and period of gestation are the two most important predictors of an infant's subsequent health and survival. In 1998, 65 percent of all infant deaths occurred to the 7.6 percent of infants born at low birthweight (less than 2,500 grams). Infants born too small or too soon have a much greater risk of death and both short-term and long-term disability than those born at term (37–41 weeks of gestation) or with birthweights of 2,500 grams or more (13–15). The percent of infants born at low birthweight ranged from a low of 5.4 percent for births to Chinese mothers to a high

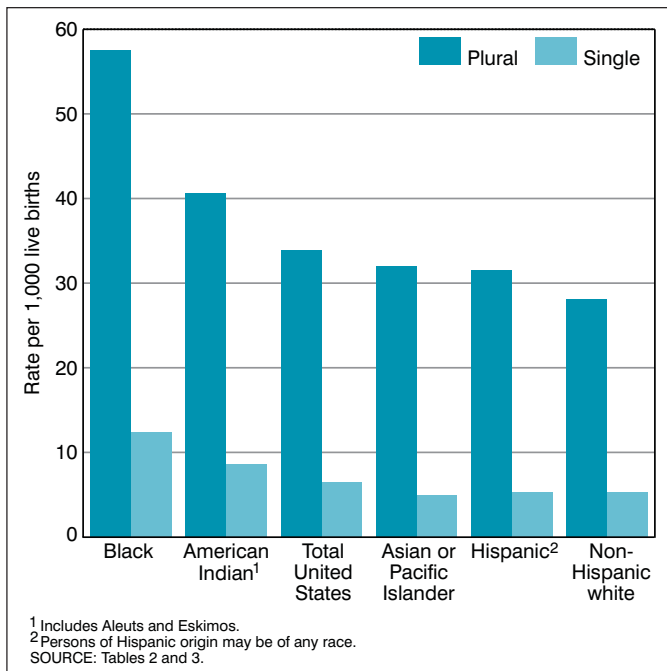


Figure 2. Infant mortality rates by plurality and race and ethnicity, 1998

of 13.1 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.

IMRs 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 IMR for very low birthweight infants (those with birthweights of less than 1,500 grams) was 250.0, over 90 times the rate of 2.6 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 16.5, more than six times the rate for infants with birthweights of 2,500 grams or more. Similarly, the IMR for very preterm infants (those born at less than 32 weeks of gestation) was 184.4, 66 times the rate of 2.8 for infants born at term (37–41 weeks of gestation). The IMR for moderately preterm infants (those born at 32–36 weeks of gestation) was 9.6, more than three times the rate for term births.

IMRs for more detailed birthweight categories are presented in table 6. Eighty-seven 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. IMRs are lowest at birthweights of 4,000–4,499 grams, with some increases observed among the heaviest infants. Although not statistically significant, IMRs appear lower for black than for white infants at individual birthweight categories under 1,500 grams, about equal at 2,000–2,499 grams, but are higher at birthweights of 2,500 grams or more.

From 1995 to 1998, infants weighing 1,000–1,249 grams had the largest decline, 16.4 percent, in the IMR by specified birthweight (from 85.5 to 71.5). Other significant declines include IMR's for birthweights of 500–749 grams, 750–999 grams, 1,500–1,999 grams, 2,500–2,999 grams, 3,000–3,499 grams, and 3,500–3,999 grams. For white mothers,

the largest significant decline was for infants weighing 1,000–1,249 grams (21.2 percent). There were no significant declines by specified birthweight for infants of black mothers.

Prenatal care—Although difficult to measure, the timing and quality of prenatal care received by the mother during pregnancy can be important to the infant's subsequent health and survival (16–18). Early comprehensive prenatal care can promote healthier pregnancies by providing health behavior advice and early detection and treatment of maternal complications that may influence the infant's subsequent health and survival (19–21). Infants of mothers who began prenatal care after the first trimester of pregnancy or not at all had an IMR of 9.4, which was 49 percent higher than the rate for those who began care in the first trimester (6.3). For each race and Hispanic-origin group, IMRs were higher for mothers who began prenatal care after the first trimester or not at all, although differences were not statistically significant for infants of American Indian, Puerto Rican, and Central and South American mothers (tables 3 and 4).

For the past few years, the IMR for mothers who began prenatal care in the first trimester has declined. The rate in 1998 (6.3) was the same as the rate in 1997 but still 4.5 percent lower than in 1995 (6.6). The IMR for after first trimester or no care was the same as in 1997 (9.4).

Maternal age—Infant mortality exhibits a curvilinear relationship with maternal age with rates being 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.

For all infants, non-Hispanic white, and infants of API mothers, IMRs were higher for teenage mothers than for mothers 40–54 years of age. For infants of API mothers, this difference was not statistically significant. For infants of black, Mexican, and Central and South American mothers, IMRs were higher for mothers 40–54 years of age than for teenagers, although the difference was not statistically significant for any of these populations. For American Indian, Puerto Rican, and Cuban mothers, there were not enough infant deaths for mothers 40–54 years of age to be able to compute reliable rates.

Except for infants of Central and South American mothers, IMRs were higher for infants of teenaged mothers than for infants of mothers 25–29 years of age for all race and Hispanic origin groups, although differences were only statistically significant for infants of non-Hispanic white, Mexican, and API mothers. IMRs were higher for infants of women 40–54 years of age than for women 25–29 years of age, although differences by race and Hispanic origin were only statistically significant for non-Hispanic white, Mexican, and API mothers. Recent 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 (22–26).

Maternal education—The percent of births to mothers who had completed high school or more ranged from a low of 45 percent for Mexican mothers to a high of 98 percent for Japanese mothers (tables 4 and 5). IMRs generally decreased with increasing educational level (tables 2 and 3). This pattern may reflect in part socioeconomic differences because women with more education tend to have higher family income levels (27).

Among infants of non-Hispanic white, black, American Indian, and Puerto Rican mothers, IMRs 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

American Indian mothers only). In contrast, for API and Mexican mothers, mortality rates were lower but not statistically significant for infants of mothers with 0–8 years of education than for infants of mothers with 9–11 years of education. 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 (28). In general, infants of women born outside the 50 States and the District of Columbia have lower IMRs than infants of women born in the 50 States and the District of Columbia (see the section on Nativity).

Live birth order—Overall, IMRs were slightly higher for first births than for second births, and thereafter increased with increasing birth order. Compared with the IMR for second births (6.4), the rate for first births was 9 percent higher (7.0), while the rate for fifth and higher order births (10.9) was 70 percent higher.

Marital status—Marital status interacts with a wide variety of other factors, such as the degree of economic and social support for the mother and child; whether or not the pregnancy was wanted; as well as maternal age, educational level, and the quantity and quality of prenatal care (29–31). The IMR for infants of married mothers was 5.7 in 1998 compared with 5.6 in 1997. The rate for infants of unmarried mothers decreased 3 percent from 10.5 in 1997 to 10.2 in 1998, which is 1.8 times the rate for married mothers. For each race and Hispanic-origin group studied, IMRs were higher for unmarried mothers than for married mothers, although differences were not significant for American Indian and Central and South American mothers.

Nativity—In 1998 the IMR for mothers born in the 50 States and the District of Columbia (7.4) was 35 percent higher than the rate for mothers born outside of the 50 States and the District of Columbia (5.5). For each race and Hispanic origin group, IMRs 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 Puerto Rican, Cuban, and Central and South American mothers. The percent of births to mothers born in the 50 States and the District of Columbia ranged from a low of 10 percent for Central and South American and Chinese mothers to a high of 96–98 percent for American Indian and Hawaiian mothers (tables 4 and 5).

A variety of different hypotheses has been advanced to account for the lower IMR 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 (32–34). 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 (34–35).

Maternal smoking—The IMR for infants of smokers was 10.9 in 1998, 60 percent higher than the rate of 6.8 for nonsmokers. The percentage of women who smoked during pregnancy ranged from a low of 0.8 percent for Chinese mothers to a high of 20.2 percent for American Indian mothers. For each race and Hispanic-origin group, the IMR for smokers was higher than for nonsmokers, although the difference was not statistically significant for American Indian mothers.

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 (36–39).

Leading causes of infant death

IMRs for the five leading causes of infant death are presented in table 7 by race and Hispanic origin of mother. The three leading causes of infant death—Congenital anomalies, Disorders relating to short gestation and unspecified low birthweight (low birthweight), and Sudden infant death syndrome (SIDS) taken together accounted for 46 percent of all infant deaths in the United States in 1998. The fourth and fifth leading causes—Newborn affected by maternal complications of pregnancy (maternal complications) and Respiratory distress syndrome (RDS), each accounted for about 5 percent of all infant deaths in 1998. Rankings of leading causes of infant death varied substantially by race and Hispanic origin of the mother, although Congenital anomalies was the leading cause for all groups except black women.

When changes in cause-specific infant mortality rates from 1997–98 were examined, SIDS rates declined by 7 percent for the total population, continuing the rapid decline in SIDS during the 1990's. For infants of APIs, IMRs increased by 57 percent from 1997–98 for low birthweight (from 51.8 to 81.1 infant deaths per 100,000 live births), and more than doubled for maternal complications (from 13.5 to 29.0). The increases for these causes of death may relate in part to a 10 percent increase from 1997–98 in the percent of multiple births to API mothers (from 2.0 to 2.2 of all API births). With these increases, the 1998 IMR for low birthweight was higher for infants of API mothers than for non-Hispanic white mothers. Other changes in cause-specific mortality rates from 1997–98 were not statistically significant.

Except for SIDS, which was highest among American Indian mothers, infants of black mothers had the highest mortality rates among any race or ethnic group studied for four of the five leading causes of infant death. For infants of black mothers, mortality rates from Congenital anomalies were 17 percent higher than for infants of non-Hispanic white mothers. For low birthweight, the mortality rate was 277.6 for infants of black mothers, four times the rate of 69.2 for infants of non-Hispanic white mothers. For SIDS, RDS and maternal complications, rates were 2.1–2.8 times higher for infants of black than for infants of non-Hispanic white mothers.

For infants of American Indian mothers, the SIDS rate was 151.5, 2.3 times that for infants of non-Hispanic white mothers, and the highest among all race and ethnic groups. As most SIDS deaths occur during the postneonatal period, the high SIDS rate for infants of American Indian mothers accounts for much of their elevated risk of postneonatal mortality. For infants of API mothers the SIDS rate of 39.4 was about 40 percent lower than the non-Hispanic white rate of 66.4.

For infants of Mexican mothers, the SIDS rate of 38.0 was 43 percent lower than the rate of 66.4 for non-Hispanic white mothers. The rate for RDS was 38 percent lower for Mexican than for infants of non-Hispanic white mothers.

For infants of Puerto Rican mothers, the most notable finding was the much higher IMR for low birthweight. The rate of 115.1 was 66 percent higher than the rate of 69.2 for non-Hispanic white mothers. However, the rate for Congenital anomalies was 23 percent lower for infants of Puerto Rican than for non-Hispanic white mothers. For infants of Central and South American mothers, the most notable finding was their much lower SIDS rate.

An examination of cause-specific differences in infant mortality rates between race and Hispanic origin groups can help researchers understand overall differences in infant mortality rates between these groups. For example, 27 percent of the elevated infant mortality rate for infants of black mothers, when compared with non-Hispanic white mothers, can be accounted for by their higher infant mortality rate due to low birthweight and a further 9 percent can be accounted for by differences in SIDS. In other words, if black IMRs for low birthweight and SIDS could be reduced to non-Hispanic white levels, the difference in the IMR between black and white mothers would be reduced by 36 percent. For infants of American Indian mothers, 25 percent of their elevated IMR, when compared with non-Hispanic white mothers, can be accounted for by their higher SIDS rates. If American Indian SIDS mortality could be reduced to non-Hispanic white levels, the difference in the IMR between American Indian and non-Hispanic white mothers would be reduced by one-fourth. In addition to helping to explain differences in IMRs 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, the Virgin Islands, and Guam, 1996-98 linked files

[By place of residence]

State	Total ¹	Race and Hispanic origin of mother						
		Race				Hispanic origin		
		White	Black	American Indian ²	Asian/Pacific Islander	Hispanic	Non-Hispanic White	Non-Hispanic Black
United States ³	7.2	6.0	13.9	9.3	5.2	5.9	6.0	13.9
Alabama	10.0	7.8	14.7	*	*	8.4	7.7	14.7
Alaska	6.9	5.6	*	9.8	*	*	5.4	*
Arizona	7.4	7.1	14.1	9.0	5.2	7.4	6.9	14.0
Arkansas	9.0	7.8	13.7	*	*	8.3	7.8	13.5
California	5.9	5.4	12.2	8.4	5.1	5.4	5.3	12.2
Colorado	6.8	6.5	14.2	*	5.7	7.3	6.2	13.9
Connecticut	6.8	5.7	15.5	*	*	9.0	4.9	15.0
Delaware	8.4	6.3	15.0	*	*	*	6.7	15.1
District of Columbia	13.8	4.3	17.2	*	*	*	*	17.2
Florida	7.3	5.8	12.4	*	4.9	4.9	6.1	12.4
Georgia	8.7	6.3	13.7	*	4.4	5.6	6.3	13.7
Hawaii	6.5	5.3	*	*	6.8	6.9	5.5	*
Idaho	7.0	6.8	*	*	*	7.3	6.6	*
Illinois	8.5	6.4	17.1	*	5.9	6.9	6.3	17.1
Indiana	8.1	7.3	15.3	*	8.0	7.5	7.2	15.2
Iowa	6.5	6.2	15.4	*	*	5.2	6.2	16.3
Kansas	7.6	7.1	14.4	*	*	6.2	7.1	14.4
Kentucky	7.3	6.8	12.4	*	*	*	6.8	12.4
Louisiana	9.2	6.5	13.0	*	6.7	*	6.6	13.1
Maine	5.3	5.3	*	*	*	*	5.2	*
Maryland	8.6	5.7	14.4	*	6.3	5.7	5.7	14.4
Massachusetts	5.1	4.7	10.1	*	3.1	6.4	4.4	10.6
Michigan	8.2	6.4	16.0	10.4	4.9	6.8	6.2	15.8
Minnesota	5.9	5.3	12.2	15.3	6.7	6.2	5.4	12.3
Mississippi	10.5	7.0	14.7	*	*	*	7.0	14.7
Missouri	7.6	6.2	15.5	*	*	5.5	6.2	15.5
Montana	7.1	6.7	*	10.1	*	*	6.5	*
Nebraska	7.8	7.2	17.1	*	*	8.6	7.2	17.0
Nevada	6.6	6.1	13.2	*	5.3	5.0	6.7	12.9
New Hampshire	4.5	4.4	*	*	*	*	4.2	*
New Jersey	6.5	4.9	13.7	*	4.7	6.7	4.3	14.1
New Mexico	6.6	6.5	*	7.2	*	6.6	6.4	*
New York	6.6	5.2	12.3	*	4.1	6.0	4.5	12.6
North Carolina	9.2	6.9	15.8	13.3	5.1	6.0	7.0	15.7
North Dakota	6.8	6.4	*	11.0	*	*	6.4	*
Ohio	7.8	6.7	14.4	*	5.9	7.9	6.6	14.5
Oklahoma	8.1	7.5	14.2	8.0	*	5.8	7.6	14.3
Oregon	5.5	5.4	10.4	*	5.1	6.1	5.3	10.2
Pennsylvania	7.5	6.2	15.8	*	5.0	8.7	6.0	15.7
Rhode Island	6.5	5.9	11.9	*	*	9.4	4.8	9.8
South Carolina	9.2	6.1	14.9	*	*	8.2	6.0	14.9
South Dakota	7.4	6.1	*	14.3	*	*	6.1	*
Tennessee	8.4	6.6	15.1	*	*	6.8	6.6	15.1
Texas	6.3	5.8	10.7	*	4.9	5.6	6.0	10.7
Utah	5.9	5.7	*	*	7.6	6.5	5.6	*
Vermont	6.7	6.6	*	*	*	*	6.3	*
Virginia	7.7	5.9	13.6	*	5.2	5.9	6.0	13.5
Washington	5.7	5.4	11.7	9.1	5.3	4.9	5.3	11.3
West Virginia	8.3	8.0	14.7	*	*	*	8.0	14.7
Wisconsin	7.0	6.0	16.6	9.6	5.9	10.3	5.7	16.6
Wyoming	6.6	6.3	*	*	*	*	6.0	*
Puerto Rico	10.7	10.7	9.7	---	---	---	---	---
Virgin Islands ⁴	10.8	*	11.6	*	*	*	*	10.5
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.

¹ Includes non-Hispanic births of other races and births with origin not stated; not shown separately.² Includes Aleuts and Eskimos.³ Excludes data for Puerto Rico, the Virgin Islands, and Guam.⁴ The infant mortality rate for the Virgin Islands may be slightly underestimated due to a low percentage of record linkage (89.5 %).

Table 2. Infant mortality rates, live births, and infant deaths by selected characteristics and specified race of mother: United States, 1998 linked file

Characteristics	All races	Race of mother			
		White	Black	American Indian ¹	Asian/ Pacific Islander
Infant mortality rates per 1,000 live births in specified group					
Total	7.2	6.0	13.8	9.3	5.5
Age at death:					
Total neonatal	4.8	4.0	9.4	5.0	3.9
Early neonatal (< 7 days)	3.8	3.1	7.6	3.8	3.1
Late neonatal (7-27 days)	1.0	0.8	1.7	1.1	0.8
Postneonatal	2.4	2.0	4.4	4.3	1.7
Sex:					
Male	7.8	6.5	15.1	10.2	5.9
Female	6.5	5.4	12.5	8.5	5.2
Plurality:					
Single births	6.4	5.2	12.4	8.6	4.9
Plural births	33.9	29.0	57.5	40.6	32.0
Birthweight:					
Less than 1,500 grams	250.0	239.4	270.9	263.8	239.7
1,500-2,499 grams	16.5	16.4	16.8	22.7	14.5
2,500 grams or more	2.6	2.4	4.0	4.9	2.0
Period of gestation:					
Less than 32 weeks	184.4	174.5	204.2	174.5	183.4
32-36 weeks	9.6	9.0	11.8	12.1	8.8
37-41 weeks	2.8	2.5	4.2	4.9	2.1
42 weeks or more	3.3	2.9	5.0	5.3	2.5
Trimester of pregnancy prenatal care began:					
First trimester	6.3	5.3	12.5	8.1	5.1
After first trimester or no care	9.4	7.6	14.8	10.3	6.8
Second trimester	7.7	6.6	11.5	8.9	5.9
Third trimester	6.1	5.5	7.7	10.1	4.8
No prenatal care	35.2	27.2	50.3	28.3	27.5
Age of mother:					
Under 20 years	10.2	8.6	14.3	11.0	9.5
20-24 years	7.8	6.4	13.4	9.0	6.3
25-29 years	6.3	5.3	13.3	8.0	4.5
30-34 years	6.0	4.9	14.3	9.9	5.3
35-39 years	6.8	5.9	14.4	9.7	5.1
40-54 years	8.4	7.3	15.9	*	8.7
Educational attainment of mother:					
0-8 years	7.5	6.9	15.4	12.6	6.3
9-11 years	9.6	8.1	14.5	10.0	7.1
12 years	7.7	6.2	14.1	9.4	6.2
13-15 years	6.1	5.1	11.5	7.2	4.4
16 years and over	4.6	4.1	10.1	*	4.7
Live-birth order:					
1	7.0	5.9	13.5	8.5	5.2
2	6.4	5.4	12.4	8.5	5.4
3	7.1	5.8	13.6	10.0	5.5
4	8.8	7.2	15.1	10.6	7.9
5 or more	10.9	8.3	18.2	10.8	8.0
Marital status:					
Married	5.7	5.2	11.7	7.9	5.0
Unmarried	10.2	8.0	14.8	10.3	8.7
Mother's place of birth:					
Born in the 50 States and D.C.	7.4	6.0	13.8	9.4	7.2
Born elsewhere	5.5	5.1	10.0	*	5.1
Maternal smoking during pregnancy: ²					
Smoker	10.9	9.6	19.3	10.2	12.3
Nonsmoker	6.8	5.4	13.1	8.1	5.2

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, 1998 linked file--Con.

Characteristics	All races	Race of mother			
		White	Black	American Indian ¹	Asian/ Pacific Islander
		Infant deaths			
Total	28,325	18,575	8,418	376	956
Age at death:					
Total neonatal	18,915	12,338	5,708	200	669
Early neonatal (< 7 days)	15,061	9,727	4,646	155	533
Late neonatal (7-27 days)	3,853	2,611	1,062	45	136
Postneonatal	9,410	6,238	2,710	175	287
Sex:					
Male	15,738	10,326	4,679	209	524
Female	12,588	8,249	3,740	167	432
Plurality:					
Single births	24,319	15,849	7,296	340	833
Plural births	4,007	2,726	1,122	36	123
Birthweight:					
Less than 1,500 grams	14,434	8,689	5,153	134	458
1,500-2,499 grams	3,976	2,749	1,018	51	158
2,500 grams or more	9,551	6,934	2,121	183	313
Not stated	364	204	126	7	26
Period of gestation:					
Less than 32 weeks	14,114	8,453	5,081	138	442
32-36 weeks	3,624	2,489	954	49	132
37-41 weeks	8,698	6,360	1,890	152	296
42 weeks or more	952	690	218	20	25
Not stated	937	585	275	16	62
Trimester of pregnancy prenatal care began:					
First trimester	20,006	13,757	5,335	216	697
After first trimester or no care	6,162	3,534	2,313	125	190
Second trimester	3,903	2,375	1,322	78	129
Third trimester	634	394	191	26	22
No prenatal care	1,624	766	800	21	38
Not stated	2,158	1,284	770	34	69
Age of mother:					
Under 20 years	5,022	2,970	1,873	92	88
20-24 years	7,543	4,733	2,528	117	166
25-29 years	6,840	4,672	1,851	76	242
30-34 years	5,318	3,642	1,339	59	277
35-39 years	2,889	2,060	671	27	132
40-54 years	712	499	157	5	51
Educational attainment of mother:					
0-8 years	1,658	1,332	253	21	52
9-11 years	6,019	3,713	2,098	112	96
12 years	9,773	6,054	3,303	146	269
13-15 years	5,267	3,473	1,577	59	159
16 years and over	4,157	3,166	663	13	314
Not stated	1,453	838	525	23	67
Live-birth order:					
1	11,097	7,445	3,119	119	412
2	8,197	5,571	2,225	92	308
3	4,608	2,983	1,433	71	122
4	2,185	1,352	735	40	58
5 or more	1,782	937	754	43	47
Not stated	457	287	152	10	9
Marital status:					
Married	15,068	12,017	2,199	129	723
Unmarried	13,257	6,558	6,219	246	233

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, 1998 linked file--Con.

Characteristics	All races	Race of mother			
		White	Black	American Indian ¹	Asian/ Pacific Islander
Infant deaths					
Mother's place of birth:					
Born in the 50 States and D.C.	23,408	15,375	7,466	362	204
Born elsewhere	4,206	2,798	660	12	735
Not stated	712	402	292	1	17
Maternal smoking during pregnancy: ²					
Smoker	4,393	3,293	991	68	42
Nonsmoker	18,641	11,471	6,406	213	551
Not stated	731	474	209	24	23

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

¹ Includes Aleuts and Eskimos.

² Excludes data for California, Indiana, New York State (but includes New York City), 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, 1998 linked file

Characteristics	All origins ¹	Hispanic						Non-Hispanic			Not stated
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total ²	White	Black	
Infant mortality rates per 1,000 live births in specified group											
Total	7.2	5.8	5.6	7.8	3.6	5.3	6.5	7.5	6.0	13.9	...
Age at death:											
Total neonatal	4.8	3.9	3.7	5.2	2.7	3.6	4.5	5.0	3.9	9.4	...
Early neonatal (< 7 days)	3.8	3.1	3.0	4.1	2.0	2.9	3.7	3.9	3.1	7.6	...
Late neonatal (7-27 days)	1.0	0.8	0.8	1.1	*	0.7	0.8	1.0	0.9	1.8	...
Postneonatal	2.4	1.9	1.9	2.6	*	1.7	2.0	2.5	2.0	4.5	...
Sex:											
Male	7.8	6.3	6.0	9.3	4.9	5.7	6.9	8.1	6.5	15.2	...
Female	6.5	5.2	5.2	6.2	*	4.9	6.2	6.8	5.4	12.5	...
Plurality:											
Single births	6.4	5.2	5.1	7.1	2.7	4.5	5.9	6.6	5.2	12.4	...
Plural births	33.9	31.5	29.9	32.3	*	37.9	32.0	33.9	28.1	57.7	...
Birthweight:											
Less than 1,500 grams	250.0	241.4	249.1	250.2	175.1	225.5	214.0	249.7	236.1	270.1	...
1,500-2,499 grams	16.5	16.4	17.9	11.4	*	14.0	16.4	16.5	16.4	16.8	...
2,500 grams or more	2.6	2.2	2.2	2.3	*	1.9	2.5	2.7	2.4	4.0	...
Period of gestation:											
Less than 32 weeks	184.4	158.8	157.7	183.8	127.2	151.8	150.2	187.9	177.7	203.6	...
32-36 weeks	9.6	8.4	8.4	8.3	*	7.9	9.9	9.9	9.2	11.9	...
37-41 weeks	2.8	2.3	2.4	2.3	*	1.9	2.4	2.9	2.6	4.2	...
42 weeks or more	3.3	2.5	2.5	*	*	*	*	3.4	3.1	5.0	...
Trimester of pregnancy prenatal care began:											
First trimester	6.3	5.3	5.2	7.3	3.7	4.7	5.2	6.5	5.3	12.5	...
After first trimester or no care	9.4	6.3	6.1	8.7	*	5.6	8.0	10.5	8.5	15.0	...
Second trimester	7.7	5.3	5.2	6.8	*	5.0	6.0	8.5	7.3	11.6	...
Third trimester	6.1	4.3	4.1	*	*	*	*	6.9	6.4	7.8	...
No prenatal care	35.2	22.2	19.9	42.3	*	24.0	31.3	40.0	31.0	50.4	...
Age of mother:											
Under 20 years	10.2	7.1	6.9	10.4	*	5.3	7.0	11.1	9.4	14.3	...
20-24 years	7.8	5.3	5.1	6.5	*	5.0	6.7	8.5	6.9	13.5	...
25-29 years	6.3	5.2	5.0	7.2	*	5.4	4.6	6.5	5.3	13.4	...
30-34 years	6.0	5.4	5.3	7.6	*	4.5	6.7	6.0	4.8	14.4	...
35-39 years	6.8	7.0	6.9	8.5	*	6.4	10.1	6.7	5.6	14.4	...
40-54 years	8.4	8.3	9.0	*	*	8.8	*	8.3	6.9	16.2	...
Educational attainment of mother:											
0-8 years	7.5	5.7	5.6	10.5	*	5.5	7.4	11.7	11.1	16.0	...
9-11 years	9.6	6.1	5.8	9.1	*	5.5	6.7	11.3	9.7	14.7	...
12 years	7.7	5.5	5.3	7.2	*	5.6	6.2	8.2	6.4	14.3	...
13-15 years	6.1	5.2	5.5	6.0	*	4.8	3.7	6.3	5.1	11.5	...
16 years and over	4.6	3.7	3.8	5.1	*	3.0	3.8	4.6	4.1	10.2	...
Live-birth order:											
1	7.0	5.7	5.6	8.9	3.5	4.8	5.8	7.3	6.0	13.6	...
2	6.4	5.4	5.3	6.5	4.4	5.3	5.9	6.6	5.4	12.4	...
3	7.1	5.4	5.2	6.9	*	5.5	6.5	7.5	5.9	13.8	...
4	8.8	6.3	6.1	7.2	*	6.1	8.1	9.6	7.6	15.2	...
5 or more	10.9	7.6	7.5	9.8	*	5.9	10.4	11.9	8.6	18.2	...
Marital status:											
Married	5.7	5.1	5.1	6.1	3.6	4.8	6.0	5.8	5.2	11.8	...
Unmarried	10.2	6.6	6.4	8.9	*	6.0	7.1	11.3	8.7	14.8	...
Mother's place of birth:											
Born in the 50 States and D.C.	7.4	6.4	6.3	7.9	3.8	5.6	6.3	7.5	5.9	13.8	...
Born elsewhere	5.5	5.2	5.0	7.5	3.5	5.3	4.8	5.9	4.7	10.4	...
Maternal smoking during pregnancy: ³											
Smoker	10.9	11.8	12.5	13.2	*	*	9.2	10.8	9.5	19.2	...
Nonsmoker	6.8	5.7	5.6	6.9	3.6	5.3	6.4	7.0	5.3	13.1	...

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, 1998 linked file--Con.

Characteristics	All origins ¹	Hispanic						Non-Hispanic			Not stated
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total ²	White	Black	
Live births											
Total	3,941,553	734,661	516,011	57,349	13,226	98,226	49,849	3,158,975	2,361,462	593,127	47,917
Sex:											
Male	2,016,205	374,516	262,642	29,287	6,944	50,112	25,531	1,617,147	1,210,605	301,507	24,542
Female	1,925,348	360,145	253,369	28,062	6,282	48,114	24,318	1,541,828	1,150,857	291,620	23,375
Plurality:											
Single births	3,823,258	719,093	505,847	55,740	12,800	95,983	48,723	3,057,857	2,283,986	574,020	46,308
Plural births	118,295	15,568	10,164	1,609	426	2,243	1,126	101,118	77,476	19,107	1,609
Birthweight:											
Less than 1,500 grams	57,733	8,525	5,340	1,083	177	1,224	701	48,444	27,468	18,680	764
1,500-2,499 grams	241,476	38,924	25,512	4,481	683	5,146	3,102	199,875	127,628	59,616	2,677
2,500 grams or more	3,640,324	686,963	485,059	51,750	12,361	91,847	45,946	2,909,209	2,205,650	514,556	44,152
Not stated	2,020	249	100	35	5	9	100	1,447	716	275	324
Period of gestation:											
Less than 32 weeks	76,523	12,384	7,978	1,453	228	1,733	992	63,218	35,742	24,425	921
32-36 weeks	375,752	69,898	47,657	6,488	1,272	9,523	4,958	301,938	204,558	79,163	3,916
37-41 weeks	3,156,116	580,496	407,451	44,710	10,829	78,235	39,271	2,537,578	1,930,558	442,230	38,042
42 weeks or more	292,766	56,900	40,418	4,388	840	7,275	3,979	232,457	176,615	42,606	3,409
Not stated	40,396	14,983	12,507	310	57	1,460	649	23,784	13,989	4,703	1,629
Trimester of pregnancy prenatal care began:											
First trimester	3,174,194	526,798	366,174	41,281	11,987	72,256	35,100	2,611,084	2,035,753	416,966	36,312
After first trimester or no care	658,018	182,338	136,672	12,371	1,070	20,369	11,856	468,950	279,028	151,763	6,730
Second trimester	508,373	137,846	102,358	9,658	907	15,871	9,052	365,512	223,984	112,080	5,015
Third trimester	103,482	31,944	24,360	1,980	110	3,457	2,037	70,445	39,644	24,081	1,093
No prenatal care	46,163	12,548	9,954	733	53	1,041	767	32,993	15,400	15,602	622
Not stated	109,341	25,525	13,165	3,697	169	5,601	2,893	78,941	46,681	24,398	4,875
Age of mother:											
Under 20 years	494,357	124,104	90,458	12,553	911	10,096	10,086	365,698	221,301	128,280	4,555
20-24 years	965,122	223,113	163,691	17,930	2,536	24,430	14,526	732,440	511,101	184,263	9,569
25-29 years	1,083,010	196,012	139,091	13,643	3,761	27,200	12,317	874,227	678,227	135,158	12,771
30-34 years	889,365	125,702	82,140	8,801	3,771	22,627	8,363	750,955	603,639	90,827	12,708
35-39 years	424,890	54,195	33,484	3,662	1,926	11,361	3,762	363,941	291,202	45,096	6,754
40-54 years	84,809	11,535	7,147	760	321	2,512	795	71,714	55,992	9,503	1,560
Educational attainment of mother:											
0-8 years	220,175	152,984	127,064	3,137	241	18,601	3,941	66,220	41,601	15,218	971
9-11 years	627,981	201,439	152,260	17,118	1,475	18,327	12,259	421,600	258,189	140,374	4,942
12 years	1,266,102	215,440	144,620	18,720	4,330	30,582	17,188	1,038,202	753,356	228,391	12,460
13-15 years	859,688	98,754	57,690	12,072	3,361	16,382	9,249	752,044	575,079	134,525	8,890
16 years and over	907,220	50,546	23,942	5,340	3,762	11,978	5,524	844,586	712,350	64,117	12,088
Not stated	60,387	15,498	10,435	962	57	2,356	1,688	36,323	20,887	10,502	8,566
Live-birth order:											
1	1,576,478	272,024	185,738	22,526	5,739	37,714	20,307	1,286,516	972,642	224,263	17,938
2	1,280,805	223,025	153,762	17,443	4,794	31,603	15,423	1,042,683	802,093	174,821	15,097
3	646,539	134,336	96,818	9,715	1,920	17,613	8,270	504,882	374,714	102,228	7,321
4	247,955	59,119	44,289	4,151	517	6,832	3,330	186,119	128,132	47,480	2,717
5 or more	163,585	40,216	30,981	2,845	230	4,054	2,106	121,199	71,150	40,662	2,170
Not stated	26,191	5,941	4,423	669	26	410	413	17,576	12,731	3,673	2,674
Marital status:											
Married	2,647,986	429,219	311,743	23,255	9,940	57,000	27,281	2,183,958	1,844,309	182,150	34,809
Unmarried	1,293,567	305,442	204,268	34,094	3,286	41,226	22,568	975,017	517,153	410,977	13,108
Mother's place of birth:											
Born in the 50 States and D.C.	3,166,642	292,302	204,608	36,488	5,253	9,883	36,070	2,832,289	2,237,596	533,544	42,051
Born elsewhere	764,764	440,594	310,623	20,735	7,965	88,161	13,110	319,485	120,013	57,077	4,685
Not stated	10,147	1,765	780	126	8	182	669	7,201	3,853	2,506	1,181
Maternal smoking during pregnancy: ³											
Smoker	404,520	18,395	8,210	5,533	453	1,041	3,158	381,797	321,934	50,454	4,328
Nonsmoker	2,732,416	446,111	284,890	46,040	11,774	67,052	36,355	2,264,752	1,660,891	477,421	21,553
Not stated	49,250	5,766	3,075	1,042	53	695	901	39,838	30,631	6,108	3,646

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, 1998 linked file--Con.

Characteristics	All origins ¹	Hispanic						Non-Hispanic			Not stated
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total ²	White	Black	
Infant deaths											
Total	28,325	4,228	2,891	446	48	519	324	23,604	14,119	8,233	492
Age at death:											
Total neonatal	18,915	2,844	1,934	297	36	354	223	15,694	9,297	5,574	377
Early neonatal (< 7 days)	15,061	2,258	1,524	236	26	288	184	12,464	7,279	4,530	339
Late neonatal (7-27 days)	3,853	586	410	61	10	66	39	3,231	2,019	1,044	38
Postneonatal	9,410	1,385	957	149	12	165	102	7,910	4,822	2,659	115
Sex:											
Male	15,738	2,347	1,581	271	34	286	175	13,131	7,865	4,574	260
Female	12,588	1,882	1,310	174	14	234	150	10,473	6,254	3,659	232
Plurality:											
Single births	24,319	3,738	2,586	394	35	434	289	20,175	11,943	7,131	405
Plural births	4,007	490	304	52	13	85	36	3,430	2,176	1,103	87
Birthweight:											
Less than 1,500 grams	14,434	2,058	1,330	271	31	276	150	12,096	6,485	5,045	280
1,500-2,499 grams	3,976	637	457	51	6	72	51	3,289	2,093	1,003	52
2,500 grams or more	9,551	1,494	1,082	119	9	171	113	7,923	5,392	2,068	134
Not stated	364	41	23	6	2	-	10	297	149	117	25
Period of gestation:											
Less than 32 weeks	14,114	1,966	1,258	267	29	263	149	11,880	6,353	4,972	269
32-36 weeks	3,624	585	402	54	5	75	49	3,000	1,892	940	40
37-41 weeks	8,698	1,327	977	101	7	146	96	7,248	4,981	1,847	123
42 weeks or more	952	145	101	14	3	17	10	796	540	214	11
Not stated	937	206	153	10	4	18	21	682	353	261	49
Trimester of pregnancy prenatal care began:											
First trimester	20,006	2,768	1,898	301	44	343	182	16,982	10,889	5,228	255
After first trimester or no care	6,162	1,148	830	108	1	114	95	4,924	2,359	2,272	91
Second trimester	3,903	733	532	66	1	80	54	3,120	1,627	1,298	51
Third trimester	634	137	100	11	-	9	17	485	255	187	11
No prenatal care	1,624	278	198	31	-	25	24	1,320	477	787	29
Not stated	2,158	313	163	38	3	62	47	1,698	871	733	146
Age of mother:											
Under 20 years	5,022	879	623	130	1	54	71	4,077	2,083	1,837	67
20-24 years	7,543	1,176	833	116	9	121	97	6,257	3,512	2,480	110
25-29 years	6,840	1,020	702	98	15	148	57	5,707	3,598	1,807	113
30-34 years	5,318	676	438	67	14	101	56	4,528	2,898	1,305	113
35-39 years	2,889	380	230	31	8	73	38	2,440	1,639	651	69
40-54 years	712	96	64	4	1	22	5	596	389	154	19
Educational attainment of mother:											
0-8 years	1,658	871	706	33	1	102	29	772	463	243	13
9-11 years	6,019	1,223	881	155	5	100	82	4,745	2,499	2,058	52
12 years	9,773	1,189	762	134	17	170	106	8,474	4,823	3,256	109
13-15 years	5,267	510	315	72	10	79	34	4,710	2,954	1,547	46
16 years and over	4,157	188	92	27	12	36	21	3,917	2,941	656	51
Not stated	1,453	245	134	23	3	32	53	987	440	473	221
Live-birth order:											
1	11,097	1,556	1,037	201	20	181	117	9,376	5,820	3,056	163
2	8,197	1,204	811	114	21	167	91	6,864	4,319	2,169	129
3	4,608	725	502	67	5	97	54	3,808	2,214	1,409	76
4	2,185	370	269	30	2	42	27	1,782	971	721	34
5 or more	1,782	306	232	28	-	24	22	1,443	615	742	33
Not stated	457	66	40	5	-	7	14	334	182	136	58
Marital status:											
Married	15,068	2,201	1,587	143	36	271	164	12,585	9,612	2,149	282
Unmarried	13,257	2,028	1,304	303	12	248	161	11,020	4,508	6,084	210

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, 1998 linked file--Con.

Characteristics	All origins ¹	Hispanic						Non-Hispanic			Not stated
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total ²	White	Black	
Infant deaths											
Mother's place of birth:											
Born in the 50 States and D.C.	23,408	1,872	1,282	289	20	55	226	21,204	13,311	7,388	331
Born elsewhere	4,206	2,279	1,568	156	28	464	63	1,894	565	595	33
Not stated	712	77	41	1	-	-	35	507	244	250	128
Maternal smoking during pregnancy: ³											
Smoker	4,393	217	103	73	1	11	29	4,107	3,043	971	70
Nonsmoker	18,641	2,547	1,598	316	42	358	233	15,877	8,879	6,275	218
Not stated	731	74	40	15	-	7	12	573	337	195	82

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

- Quantity zero.

... Category not applicable.

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

² Includes races other than black or white.

³ Excludes data for California, Indiana, New York State (but includes New York City), 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, 1998 linked file

Characteristic	All races	White	Black	American Indian ¹	Asian or Pacific Islander					
					Total	Chinese	Japanese	Hawaiian	Filipino	Other
Birthweight:										
Less than 1,500 grams	1.5	1.2	3.1	1.3	1.1	0.8	0.8	1.5	1.4	1.1
Less than 2,500 grams	7.6	6.5	13.1	6.9	7.4	5.4	7.5	7.2	8.2	7.8
Preterm births ²	11.6	10.5	17.5	12.2	10.4	7.6	8.7	12.0	11.8	10.7
Prenatal care beginning in the first trimester	82.8	84.8	73.3	68.8	83.1	88.5	90.2	78.8	84.2	80.9
Births to mothers under 20 years	12.5	11.1	21.5	20.9	5.4	0.9	2.4	18.8	6.2	5.8
Fourth and higher order births	10.5	9.7	14.9	19.5	7.7	2.4	4.3	14.7	7.2	9.2
Births to unmarried mothers	32.8	26.3	69.1	59.3	15.6	6.4	9.7	51.1	19.7	15.2
Mothers completing 12 or more years of school ...	78.1	78.8	73.1	67.3	87.1	88.6	97.6	81.5	93.1	84.1
Mothers born in the 50 States and D.C.	80.5	82.2	89.1	95.8	16.6	9.8	43.7	97.9	19.4	10.2
Mother smoked during pregnancy ³	12.9	14.0	9.5	20.2	3.1	0.8	4.8	16.8	3.3	2.4

¹ Includes births to Aleuts and Eskimos.

² Born prior to 37 completed weeks of gestation.

³ Excludes data for California, Indiana, New York State (but includes New York City), 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, 1998 linked file

Characteristic	All origins ¹	Hispanic						Non-Hispanic		
		Total	Mexican	Puerto Rican	Cuban	Central and South American	Other and unknown Hispanic	Total ²	White	Black
Birthweight:										
Less than 1,500 grams	1.5	1.2	1.0	1.9	1.3	1.2	1.4	1.5	1.2	3.2
Less than 2,500 grams	7.6	6.5	6.0	9.7	6.5	6.5	7.6	7.9	6.6	13.2
Preterm births ³	11.6	11.4	11.0	13.9	11.4	11.6	12.1	11.6	10.2	17.6
Prenatal care beginning in the first trimester	82.8	74.3	72.8	76.9	91.8	78.0	74.8	84.8	87.9	73.3
Births to mothers under 20 years	12.5	16.9	17.5	21.9	6.9	10.3	20.2	11.6	9.4	21.6
Fourth and higher order births	10.5	13.6	14.7	12.3	5.7	11.1	11.0	9.8	8.5	15.0
Births to unmarried mothers	32.8	41.6	39.6	59.5	24.8	42.0	45.3	30.9	21.9	69.3
Mothers completing 12 or more years of school ...	78.1	50.7	44.8	64.1	87.0	61.5	66.4	84.4	87.2	73.3
Mothers born in the 50 States and D.C.	80.5	39.9	39.7	63.8	39.7	10.1	73.3	89.9	94.9	90.3
Mother smoked during pregnancy ⁴	12.9	4.0	2.8	10.7	3.7	1.5	8.0	14.4	16.2	9.6

¹ Includes origin not stated.

² Includes races other than black or white.

³ Born prior to 37 completed weeks of gestation.

⁴ Excludes data for California, Indiana, New York State (but includes New York City), 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, 1998 linked file, and percent change in birthweight-specific infant mortality, 1995-98 linked file

Race and birthweight	Number				Mortality rate per 1,000 live births			Percent change in infant mortality rate 1995-98
	Live births	Infant deaths	Neonatal deaths	Postneonatal deaths	Infant	Neonatal	Postneonatal	
All races ¹	3,941,553	28,325	18,915	9,410	7.2	4.8	2.4	-5.3
Less than 2,500 grams	299,209	18,410	15,114	3,296	61.5	50.5	11.0	-4.8
Less than 1,500 grams	57,733	14,434	12,790	1,644	250.0	221.5	28.5	-6.9
Less than 500 grams	6,349	5,512	5,420	92	868.2	853.7	14.5	-3.9
500-749 grams	11,041	5,362	4,693	669	485.6	425.1	60.6	-8.0
750-999 grams	11,716	1,844	1,433	411	157.4	122.3	35.1	-13.6
1,000-1,249 grams	13,238	946	694	252	71.5	52.4	19.0	-16.4
1,250-1,499 grams	15,389	769	549	220	50.0	35.7	14.3	-8.4
1,500-1,999 grams	59,014	1,693	1,097	596	28.7	18.6	10.1	-13.6
2,000-2,499 grams	182,462	2,284	1,227	1,057	12.5	6.7	5.8	-7.4
2,500 grams or more	3,640,324	9,551	3,448	6,103	2.6	0.9	1.7	-13.3
2,500-2,999 grams	650,006	3,151	1,196	1,954	4.8	1.8	3.0	-11.1
3,000-3,499 grams	1,458,017	3,711	1,269	2,442	2.5	0.9	1.7	-13.8
3,500-3,999 grams	1,136,056	2,008	683	1,325	1.8	0.6	1.2	-10.0
4,000-4,499 grams	335,215	550	218	332	1.6	0.7	1.0	-11.1
4,500-4,999 grams	54,827	106	62	44	1.9	1.1	0.8	-13.6
5,000 grams or more	6,203	27	20	6	4.4	3.2	*	*
Not stated	2,020	364	352	11	...	...	...	...
White	3,118,727	18,575	12,338	6,238	6.0	4.0	2.0	-4.8
Less than 2,500 grams	203,886	11,438	9,501	1,937	56.1	46.6	9.5	-6.0
Less than 1,500 grams	36,294	8,689	7,780	909	239.4	214.4	25.0	-8.1
Less than 500 grams	3,502	3,062	3,015	48	874.4	860.9	13.7	-4.0
500-749 grams	6,510	3,265	2,905	361	501.5	446.2	55.5	-8.2
750-999 grams	7,360	1,220	990	230	165.8	134.5	31.3	-14.0
1,000-1,249 grams	8,670	621	485	136	71.6	55.9	15.7	-21.2
1,250-1,499 grams	10,252	520	385	135	50.7	37.6	13.2	-8.6
1,500-1,999 grams	40,802	1,153	799	354	28.3	19.6	8.7	-14.8
2,000-2,499 grams	126,790	1,597	922	674	12.6	7.3	5.3	-8.0
2,500 grams or more	2,913,643	6,934	2,642	4,292	2.4	0.9	1.5	-11.1
2,500-2,999 grams	465,494	2,162	869	1,294	4.6	1.9	2.8	-13.2
3,000-3,499 grams	1,140,741	2,691	971	1,721	2.4	0.9	1.5	-11.1
3,500-3,999 grams	958,968	1,546	560	986	1.6	0.6	1.0	-11.1
4,000-4,499 grams	294,403	436	182	253	1.5	0.6	0.9	-6.3
4,500-4,999 grams	48,687	77	45	32	1.6	0.9	0.7	-20.0
5,000 grams or more	5,350	21	15	6	3.9	*	*	-49.4
Not stated	1,198	204	195	9	...	...	...	...
Black	609,902	8,418	5,708	2,710	13.8	9.4	4.4	-5.5
Less than 2,500 grams	79,772	6,171	4,959	1,212	77.4	62.2	15.2	-2.3
Less than 1,500 grams	19,020	5,153	4,483	670	270.9	235.7	35.2	-5.1
Less than 500 grams	2,583	2,223	2,184	38	860.6	845.5	14.7	-3.8
500-749 grams	4,127	1,894	1,611	283	458.9	390.4	68.6	-8.1
750-999 grams	3,861	535	372	163	138.6	96.3	42.2	-15.0
1,000-1,249 grams	4,017	284	174	110	70.7	43.3	27.4	-5.1
1,250-1,499 grams	4,432	217	141	76	49.0	31.8	17.1	0.8
1,500-1,999 grams	15,383	446	234	212	29.0	15.2	13.8	-10.5
2,000-2,499 grams	45,369	572	243	329	12.6	5.4	7.3	-6.7
2,500 grams or more	529,816	2,121	624	1,498	4.0	1.2	2.8	-11.1
2,500-2,999 grams	141,146	815	250	565	5.8	1.8	4.0	-6.5
3,000-3,499 grams	230,937	824	235	589	3.6	1.0	2.6	-12.2
3,500-3,999 grams	125,007	371	94	277	3.0	0.8	2.2	-14.3
4,000-4,499 grams	27,972	83	25	58	3.0	0.9	2.1	-30.2
4,500-4,999 grams	4,170	22	14	8	5.3	*	*	*
5,000 grams or more	584	5	5	-	*	*	*	*
Not stated	314	126	125	1	...	...	...	...

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

- Quantity zero.

† Category not applicable.

¹ 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, 1998 linked file

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

Cause of death (Ninth Revision International Classification of Diseases, 1975)	All races			White			Black			American Indian ¹			Asian and Pacific Islander		
	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate
All causes .....	...	28,325	718.6	...	18,575	595.6	...	8,418	1380.0	...	376	933.7	...	956	553.7
Congenital anomalies (740-759)	1	6,241	158.3	1	4,810	154.2	2	1,099	180.2	1	69	171.3	1	263	152.3
Disorders related to short gestation and unspecified low birthweight (765)	2	4,093	103.8	2	2,223	71.3	1	1,693	277.6	3	37	91.9	2	140	81.1
Sudden infant death syndrome (798.0)	3	2,827	71.7	3	1,857	59.5	3	841	137.9	2	61	151.5	3	68	39.4
Newborn affected by maternal complications of pregnancy (761)	4	1,347	34.2	4	838	26.9	4	447	73.3	5	12	*	4	50	29.0
Respiratory distress syndrome (769)	5	1,306	33.1	5	821	26.3	5	438	71.8	7	11	*	5	36	20.9

Cause of death (Ninth Revision International Classification of Diseases, 1975)	Total Hispanic ²			Mexican			Puerto Rican			Central and South American			Non-Hispanic White		
	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate	Rank	Number	Rate
All causes .....	...	4,228	575.5	...	2,891	560.3	...	446	777.7	...	519	528.4	...	14,119	597.9
Congenital anomalies (740-759)	1	1,101	149.9	1	813	157.6	1	68	118.6	1	131	133.4	1	3,650	154.6
Disorders related to short gestation and unspecified low birthweight (765)	2	545	74.2	2	359	69.6	2	66	115.1	2	66	67.2	2	1,634	69.2
Sudden infant death syndrome (798.0)	3	275	37.4	3	196	38.0	4	24	41.8	4	20	20.4	3	1,569	66.4
Newborn affected by maternal complications of pregnancy (761)	5	144	19.6	6	90	17.4	3	25	43.6	6	16	*	4	659	27.9
Respiratory distress syndrome (769)	4	210	28.6	4	141	27.3	5	23	40.1	3	33	33.6	5	614	26.0

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

... Category not applicable.

¹ Includes Aleuts and Eskimos.

² Includes Cuban and other and unknown Hispanic.

NOTE: For American Indians, Pneumonia and influenza was the 4th leading cause of infant death, however, with only 16 deaths, a reliable infant mortality rate could not be computed. For American Indians, Accidents and adverse effects was tied for the 5th leading cause of death, however, with only 12 deaths, a reliable rate could not be computed. For Mexicans, Newborn affected by complications of placenta, cord, and membranes was the 5th leading cause of infant death with 91 deaths and a rate of 17.7. For Central and South Americans, Infections specific to the perinatal period was the 5th leading cause of infant death, however with only 18 deaths, a reliable infant mortality rate could not be computed. Reliable cause-specific infant mortality rates cannot be computed for Cubans because of the small number of infant deaths (48).

Technical notes

Differences between period and cohort data

From 1983–91, NCHS produced linked files in a birth cohort format. Beginning with 1995 data, linked files are produced first using a period format and then subsequently using a birth cohort format. Thus, the 1998-period linked file contains a numerator file that consists of all infant deaths occurring in 1998 that have been linked to their corresponding birth certificates, whether the birth occurred in 1998 or in 1997. This cross-sectional approach is used to improve timeliness of the file release. In contrast, the 1998 birth cohort-linked file will contain a numerator file that consists of all infant deaths to babies born in 1998 whether the death occurred in 1998 or 1999. In both the cohort and the period file, the denominator file is the 1998 natality file, which contains all births occurring in 1998. In practice, there is very little difference in rates from the period and cohort files.

The release of linked file data in two different formats allows NCHS to meet customer 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 1.6 percent (in 1998) 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 89.5–100.0 percent with all but six areas—California, Maine, New Mexico, Ohio, Oklahoma, and the Virgin Islands at 97 percent or higher) (table I). The percent linked also varied by age at death, from 98.0 percent for infants who died during the early neonatal period (within the first 7 days of life), to 99.1 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 (IMRs) by characteristics.

The 1998 linked file includes 27,883 unweighted infant death records. An additional 467 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 28,350 linked plus unlinked records. Since the data included in this report are tabulated by place of residence of the mother, 25 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 28,325 infant deaths.

Table I. Percent of infant death records which were linked to their corresponding birth records: United States and each State, Puerto Rico, Virgin Islands, and Guam, 1998 linked file

State	Percent linked by State of occurrence of death
United States ¹	98.4
Alabama	100.0
Alaska	98.1
Arizona	97.5
Arkansas	97.7
California	95.9
Colorado	100.0
Connecticut	100.0
Delaware	100.0
District of Columbia	98.3
Florida	99.7
Georgia	100.0
Hawaii	100.0
Idaho	100.0
Illinois	99.0
Indiana	98.7
Iowa	100.0
Kansas	100.0
Kentucky	99.4
Louisiana	98.7
Maine	96.3
Maryland	99.2
Massachusetts	97.2
Michigan	98.6
Minnesota	100.0
Mississippi	100.0
Missouri	97.5
Montana	98.6
Nebraska	100.0
Nevada	97.4
New Hampshire	100.0
New Jersey	98.3
New Mexico	96.1
New York	98.2
North Carolina	99.7
North Dakota	100.0
Ohio	94.6
Oklahoma	93.5
Oregon	100.0
Pennsylvania	98.0
Rhode Island	100.0
South Carolina	100.0
South Dakota	100.0
Tennessee	100.0
Texas	98.0
Utah	98.2
Vermont	100.0
Virginia	99.4
Washington	99.3
West Virginia	99.4
Wisconsin	100.0
Wyoming	100.0
Puerto Rico	99.2
Virgin Islands	89.5
Guam	100.0

¹ 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 IMR of 7.2 is the same from the 1998 period linked file and from the 1998 vital statistics mortality file. However, the number of infant deaths differs slightly (3). 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. In 1998, the mother's age is directly reported by five States (Kentucky, Nevada, North Dakota, Virginia, and Wyoming). From 1964–96, mother's age was edited for ages 10–49 years. 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 edited for ages 10–54 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 IMRs. These events have been included with births to women aged 40–49 years for computing age-specific IMRs.

In 1998, age of mother was not reported on 0.02 percent of birth records; for these records age of mother was imputed according to the last record with the same race and total birth order.

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. Nevada asks for the mother's marital status through the electronic birth registration process but this item is not included on certified or paper copies of the birth certificate. 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 1998, a birth is inferred as nonmarital if either of these factors 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 for Connecticut, see [Technical notes](#) in *Births: Final Data for 1998* (9).

The mother's marital status was not reported in 1998 on 0.04 percent of the birth records where this information is obtained by a direct question. Marital status was imputed as "married" for these records.

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 (39–41).

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 1998 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 1998 (9).

For the linked file not stated birthweight was imputed for 2,598 records or 0.07 percent of the birth records in 1998. If birthweight was not stated and the period of gestation was known, birthweight was assigned the value from the previous record with the same period of gestation, race, sex, and plurality. If birthweight and period of gestation were both unknown (2,020 records in 1998) the not stated value for birthweight was retained. This imputation was done to improve the accuracy of birthweight-specific IMRs, since the percent of records with not stated birthweight was higher for infant deaths (3.63 percent before imputation) than for live births (0.12 percent before imputation). The imputation reduced the percent of not stated records to 1.29 percent for infant deaths and 0.05 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 here were compiled in accordance with the World Health Organization (WHO) regulations, which specify that member nations classify causes of death by the current *Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death* (ICD)(2). Cause-of-death data presented in this publication were coded according to the Ninth Revision of the ICD by procedures outlined in annual issues of the *NCHS*

Instruction Manual (42). 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 that initiated the sequence of events leading directly to death or as the circumstances of the accident or violence that produced the fatal injury. 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. Generally, more medical information is reported on death certificates than is directly reflected in the underlying cause of death.

The cause-of-death ranking for infants in [table 7](#) is based on the List of 61 Selected Causes of Infant Death and HIV Infection (3). The group titles Certain conditions originating in the perinatal period and Symptoms, signs, and ill-defined conditions are not ranked from the List of 61 Selected Causes of Infant Death. In addition, 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, Pneumonia and influenza), its component parts are not ranked (in this case, Pneumonia and influenza).

Computation of rates

IMRs 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. IMRs 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 IMRs are not underestimated for those areas that did not successfully link all records. However, for Puerto Rico, 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. In general the percent of records linked has been very high (greater than 99 percent) for Puerto Rico, the Virgin Islands, and Guam and the effect of not weighting the data have been minimal. In 1998, however, the infant death rate for the Virgin Islands was probably underestimated because only 89.5 percent of their infant death records were successfully linked to their corresponding birth record. 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

(43). As a result, numbers of births, deaths, and IMRs 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:

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

where D is the number of deaths and

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

where B is the number of births.

For example, let us say that for group A the number of infant deaths was 104 while the number of live births was 27,380 yielding an IMR 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:

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

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

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:

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

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

Thus, for Group A:

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

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

Thus the chances are 95 out of 100 that the true IMR 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 II](#).

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

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

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

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

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

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

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

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

Lower: $5.3 \cdot 0.73476 = 3.9$

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:

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

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 Reports* through NCHS. Additional unpublished tabulations are available from NCHS or through our Internet site at <http://www.cdc.gov/nchs>. Selected variables from the linked file are also available for tabulation on CDC WONDER at <http://wonder.cdc.gov/lbdj.shtml>.

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

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

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