National Center for Health Statistics

Supplemental Analyses of Recent Trends in Infant Mortality

by Kenneth D. Kochanek, M.A., and Joyce A. Martin, M.P.H.

Overview

Preliminary data for 2002 indicate an increase in the infant mortality rate (IMR) to 7.0 deaths per 1,000 live births from 6.8 in 2001 (1) (Table 1). To better understand the increase in the IMR for 2002, the Centers for Disease Control and Prevention?s National Center for Health Statistics (NCHS) reviewed additional partially edited mortality records processed after the close of the preliminary data file as well as partially edited fetal death data for 2002 (processed as of January 2004). These data indicate that the increase in the 2002 IMR observed for preliminary data will be confirmed by final data, and that while the IMR increased, the perinatal mortality rate (late fetal deaths plus early neonatal deaths per 1,000 live births plus fetal deaths) remained stable. (Final statistics will be available later this year.)

The rise in the IMR is concentrated in the neonatal period (0-27 days), particularly in the early neonatal period (0-6 days) (Tables 1 and 2). The rate of late fetal mortality (fetal deaths of 28 or more weeks of gestation per 1,000 live births plus fetal deaths) shows a 3 percent decline for 2002 (slightly greater than the average annual decline for 1990-2001). As a result, the perinatal mortality rate, which more fully describes the risk of death at late stages of pregnancy and shortly after birth, appears unchanged for 2002 (Table 2 and Figure 1). The perinatal mortality rate had declined fairly consistently for more than half of a century.

Cause of Death

One way to better understand the increase in the IMR is to examine changes by cause using final 2001 and preliminary 2002 data. When examined by cause of infant death, 3 causes among the 10 leading causes of infant death appear to account for most of the current year increase: Congenital malformations, deformations and chromosomal abnormalities; Disorders related to short gestation and low birth weight, not elsewhere classified; and Newborn affected by maternal complications of pregnancy (Table 3). Historically, the majority of these deaths have been among infants born low birthweight (weight at delivery of less than 2,500 grams or 5 and one-half pounds). Despite steady increases in preterm and low birthweight rates between 1990 and 2002, trends over this time period for these three causes do not indicate a consistent pattern of increase or decrease (2-14). However, the interpretation of the cause of death trends is complicated by the change in the ICD revision in 1999 that created breaks in the comparability of cause of death statistics (5).

Historical Trends in Infant Mortality

The death registration area was completed in 1933 when all States were included in the collection of death statistics (15). Since then, with the exception of 1957-58, when a significant increase in the IMR was observed, the historical trend of the IMR has been one of steady, sometimes rapid decline. Through the 1930s and 1940s, the IMR declined by an average of 4

percent per year. The rate of decline slowed markedly to 1 percent per year for 1950 to 1964. Thereafter, until the early 1980s, infant mortality declined rapidly, by an average of almost 5 percent per year (16). From 1981 to 1989 the rate of decline again slowed to an average of 2 percent per year (3).

Recent Trends in Fetal and Infant Mortality

Over the more recent period, 1990 to 2001, the IMR declined 26 percent (from 9.2 to 6.8 per 1,000) for an average decrease of 3 percent per year (3) (Table 1 and Figure 2). Between 1990 and 2001 the neonatal mortality rate declined from 5.8 to 4.5 per 1,000 (down 22 percent) and the postneonatal mortality rate from 3.4 to 2.3 (down 32 percent) (3). Between 1990 and 2001, the late fetal mortality rate declined fairly steadily, by 23 percent, from 4.3 to 3.3 per 1,000 (17) (Table 2). The perinatal mortality rate also declined steadily between 1990 and 2001, from 9.1 to 6.9 for a total of 24 percent (Table 2 and Figure 2). Although the pace of decline has slowed somewhat since the mid-1990s, significant declines in late fetal mortality and infant mortality have been observed through 2001 despite substantial increases in preterm and low birthweight risk, two important predictors of perinatal health.

As discussed above, preliminary data for 2002 indicate a 3 percent rise in the IMR from 2001. The increase was observed for neonatal deaths only; a 4-percent increase in the neonatal mortality rate was reported, whereas the postneonatal rate remained constant. The increase in neonatal mortality was accompanied by a 3-percent decline in the late fetal mortality rate and, as a result, the perinatal mortality rate was unchanged for 2002.

In addition to releasing preliminary and final mortality and natality statistics, NCHS also releases monthly provisional counts of vital events (as differentiated from records of vital events) and corresponding rates along with cumulative provisional information for the past 12 months and for all months to date in the calendar year. The provisional series is subject to reporting inconsistencies with considerable variation in the resulting estimates (18). However, the provisional series can be used to get early information on more recent trends with the understanding that the findings may change when more complete data are available. NCHS currently has provisional counts of infant deaths for the first 9 months of 2003. These counts suggest an improvement in the IMR between 2002 and 2003; however, the provisional data are not stable enough to determine if the magnitude of that improvement is large enough to bring the rate down to or below the historically low level reached in 2001.

Potential Explanatory Factors for the Changes in the Infant Mortality Rate

Changes in the characteristics of births and changes in birthweight and gestation-specific infant mortality rates (i.e., the death rate for infants at a given weight or gestational age) may be related to changes in the IMR. Final birth data for 2002 indicate that the two key predictors of infant health, the percent of births born preterm (less than 37 completed weeks of gestation) and low birthweight (LBW), continued to climb, rising 1 to 2 percent for 2002 (2) (Table 2 and Figure 2). Increases in preterm and LBW rates of 3 and 1 percent respectively, were also noted between 2000 and 2001. Since 1990 preterm and LBW rates have risen fairly steadily, preterm by 14 percent (from 10.6 to 12.1 percent) and LBW by 11 percent (from 7.0 to 7.8 percent).

The bulk of the increase has been among moderately preterm (32-36 weeks of gestation) and moderately low birthweight (1,500-2,499 grams) infants. Between 1990 and 2002, the moderately preterm rate rose from 8.7 to 10.1 percent and the moderately low birthweight (MLBW) rate from 5.7 to 6.4 percent, whereas the very preterm rate (less than 32 weeks of gestation) rose from 1.92 to 1.96 percent and the very low birthweight rate (VLBW) (less than 1,500 grams) from 1.27 to 1.46 percent. Although still at increased risk compared with term or normal birthweight infants, infants born moderately preterm and MLBW, are at substantially lower risk than their very preterm and VLBW counterparts for early death. For 2001, 18 percent of infants born very preterm did not survive the first year of life compared with less than 1 percent of infants born moderately preterm (19).

Multiple births, more than half of which are born preterm and/or low birthweight, have contributed importantly to recent increases in preterm and LBW rates. Between 1990 and 2002 the multiple birth rate climbed 42 percent (a 3-percent rise was reported between 2001 and 2002) (2, 20); in 2002 nearly one-fourth of all LBW infants were born in a multiple

delivery (2). Multiple births do not account for all of the preterm/LBW rise; however, the preterm rate for singletons alone increased 7 percent over this period (2). (While the rate of moderately preterm singleton births rose from 8.01 to 8.87 percent between 1990 and 2002, the very preterm rate for singletons declined slightly, from 1.69 to 1.57 percent.)

The increased use of assisted reproductive therapies (ART) such as in-vitro fertilization has been strongly associated with the growth in multiple gestation pregnancies (21) and may also be associated with an increased risk of LBW among singletons (22,23). One percent of all 2001 births were the result of ART procedures (24).

Changes in the management of labor and delivery influenced at least in part by the increased use of medical technologies (e.g., ultrasound) (25), and more aggressive management of premature rupture of the membranes (PROM) (26,27) may also be related to the trends in preterm/LBW births as induction of labor and cesarean delivery occur more often at earlier gestational ages; the use of induction of labor and of cesarean delivery among births delivered preterm has risen substantially in recent years (28-30).

Recent declines in infant mortality have been attributed to improvement in birthweight and gestation-specific infant mortality rates, not to the prevention of preterm or LBW births (31). The decline in birthweight and gestation-specific mortality has been attributed primarily to improvements in obstetric and neonatal care such as pulmonary surfactants for preterm infants. Data from the 2002 linked birth and infant death file, to be available in the summer of 2004, will allow us to assess whether changes in birthweight and gestation-specific mortality rates have contributed to the current year rise in the IMR.

Summary

Preliminary data for 2002 show a significant increase in the IMR to 7.0 infant deaths per 1,000 live births, the first rise in the U.S. IMR since 1958 (1,15). Review of additional partially edited 2002 mortality data indicate that the increase in the IMR will be confirmed by final data. The 2002 increase in infant mortality was concentrated in the neonatal period, particularly in deaths occurring within 7 days of birth. Partially edited fetal death data suggest that the increase in neonatal mortality was accompanied by a decline in the late fetal mortality rate for 2002, and thus it appears that the 2002 perinatal mortality rate will remain level.

Data from the 2002 linked birth and infant death file, which are expected to be available by the summer of 2004, will allow us to assess the contribution of maternal and infant factors such as multiple births and management of labor and delivery. With this file, it will also be possible to investigate whether changes in birthweight and gestation-specific neonatal mortality rates relate to the increase in infant mortality.

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Definition of terms

Infant mortality rate – Deaths of infants aged under 1 year per 1,000 or 100,000 live births. The infant mortality rate is the sum of the neonatal and postneonatal mortality rates.

Neonatal mortality rate – Deaths of infants aged 0-27 days per 1,000 live births. The neonatal mortality rate is the sum of the early neonatal and late neonatal mortality rates.

Early neonatal mortality rate – Deaths of infants aged 0-6 days per 1,000 live births.

Late neonatal mortality rate – Deaths of infants aged 7-27 days per 1,000 live births.

Postneonatal mortality rate – Deaths to infants aged 28 days-1 year per 1,000 live births.

Late fetal mortality rate – Fetal deaths of 28 or more weeks of gestation per 1,000 live births plus fetal deaths.

Perinatal mortality rate – Late fetal deaths plus early neonatal deaths per 1,000 live births plus fetal deaths.

Low birthweight rate – Births with weight at delivery of less than 2,500 grams per 100 live births. The low birthweight rate is the sum of the moderately low and very low birthweight rates.

Moderately low birthweight rate – Births with weight at delivery of 1,500-2,499 grams per 100 live births.

Very low birthweight rate – Births with weight at delivery of less than 1,500 grams per 100 live births.

Term – Births at 37-41 weeks of gestation.

Preterm rate – Births at less than 37 completed weeks of gestation per 100 live births. The preterm rate is the sum of the moderately and very preterm rates.

Moderately preterm rate – Births at 32-36 weeks of gestation per 100 live births.

Very preterm rate – Births at less than 32 weeks of gestation per 100 live births.

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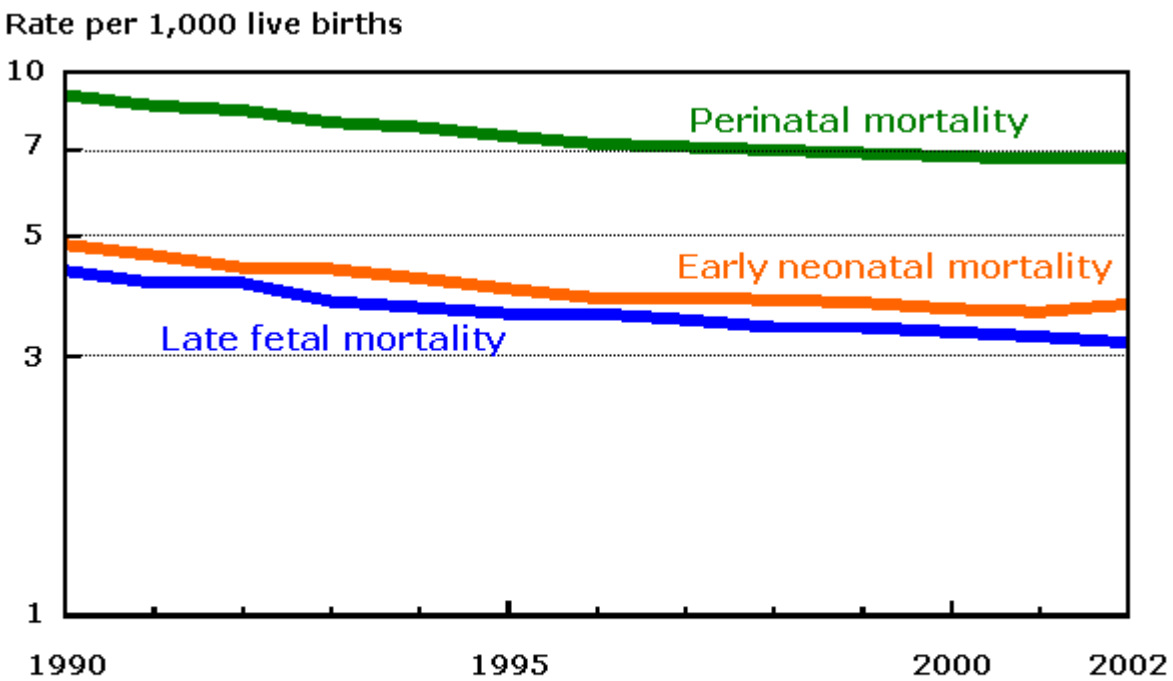
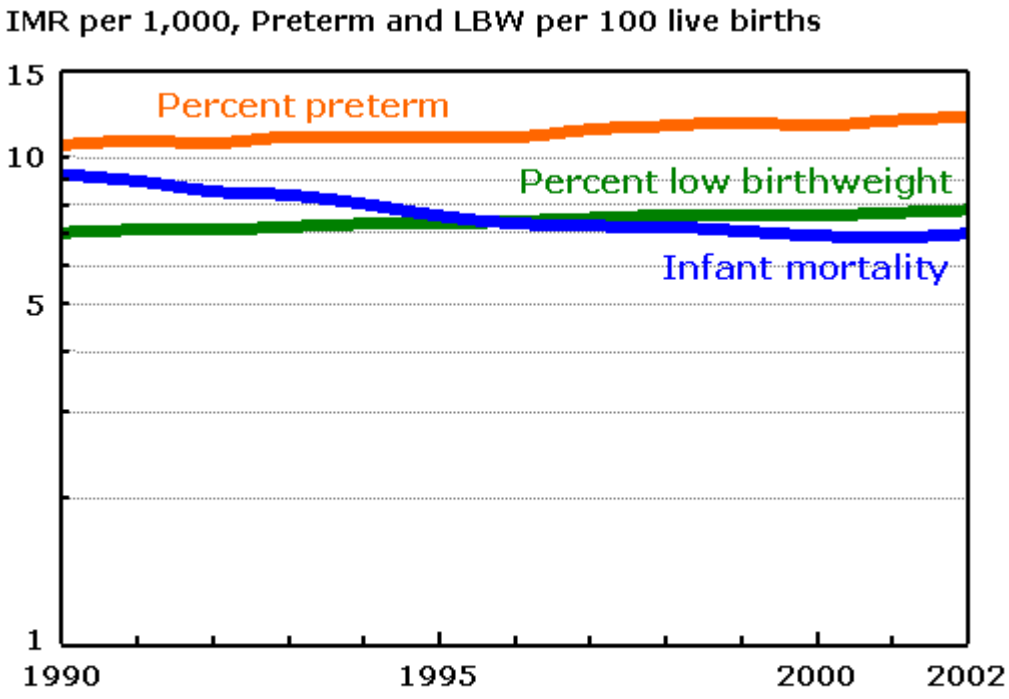
Figures

Figure 1. Perinatal, late fetal, and early neonatal mortality rates, 1990-2002



NOTE: Rates plotted on a log scale. Rates for 2002 are based on unedited data processed as of January 2004. Perinatal mortality rate = late fetal deaths plus infant deaths less than 7 days per 1,000 live births plus late fetal deaths. Early neonatal mortality rate = deaths to infants less than 7 days per 1,000 live births. Late fetal mortality rate = fetal deaths with stated or presumed gestational ages of 28 weeks or more per 1,000 live births plus late featal deaths.
SOURCE: National Vital Statistics System, NCHS, CDC.

Figure 2. Rates of infant mortality, low birthweight, and preterm birth, 1990-2002



NOTE: Rates plotted on a log scale. Preterm is less than 37 completed weeks of gestation. Low birthweight is less than 2,500 grams.
SOURCE: National Vital Statistics System, NCHS, CDC.

Tables

Table 1. Infant deaths and infant, neonatal, and postneonatal mortality rates: United States, 1933, 1940, 1950, 1960, 1970, and 1975-2001 final, and 2002 (preliminary and latest processed)

[Rates per 1,000 live births]

		Infant mortality rate				
			Neonatal (under 28 days)			
Year	Infant deaths	Total	Total	Under 7 days	7-27 days	Postneonatal (28 days – 11 months)
2002[1]	28,042	7.0	4.7	3.7	0.9	2.3
2002[2]	27,977	7.0	4.7	?	?	2.3
2001	27,568	6.8	4.5	3.6	0.9	2.3
2000	28,035	6.9	4.6	3.7	1.0	2.3
1999	27,937	7.1	4.7	3.8	1.0	2.3
1998	28,371	7.2	4.8	3.8	1.0	2.4

		Infant mortality rate				
			Neonatal (under 28 days)			
Year	Infant deaths	Total	Total	Under 7 days	7-27 days	Postneonatal (28 days – 11 months)
1997	28,045	7.2	4.8	3.8	0.9	2.5
1996	28,487	7.3	4.8	3.8	0.9	2.5
1995	29,583	7.6	4.9	4.0	0.9	2.7
1994	31,710	8.0	5.1	4.2	0.9	2.9
1993	33,466	8.4	5.3	4.3	0.9	3.1
1992	34,628	8.5	5.4	4.4	1.0	3.1
1991	36,766	8.9	5.6	4.6	1.0	3.4
1990	38,351	9.2	5.8	4.8	1.0	3.4
1989	39,655	9.8	6.2	5.1	1.1	3.6
1988	38,910	10.0	6.3	5.2	1.1	3.6
1987	38,408	10.1	6.5	5.4	1.1	3.6
1986	38,891	10.4	6.7	5.6	1.1	3.6
1985	40,030	10.6	7.0	5.8	1.2	3.7
1984	39,580	10.8	7.0	5.9	1.1	3.8
1983	40,627	11.2	7.3	6.1	1.2	3.9
1982	42,401	11.5	7.7	6.4	1.3	3.8
1981	43,305	11.9	8.0	6.7	1.3	3.9
1980	45,526	12.6	8.5	7.1	1.4	4.1
1979	45,665	13.1	8.9	7.5	1.4	4.2
1978	45,945	13.8	9.5	8.0	1.5	4.3
1977	46,975	14.1	9.9	8.4	1.5	4.2
1976	48,265	15.2	10.9	9.3	1.6	4.3
1975	50,525	16.1	11.6	10.0	1.6	4.5
1970	74,667	20.0	15.1	13.6	1.5	4.9
1960	110,873	26.0	18.7	16.7	2.0	7.3
1950	103,825	29.2	20.5	17.8	2.7	8.7
1940	110,984	47.0	28.8	23.3	5.5	18.3
1933[3]	120,887	58.1	34.0	26.3	7.7	24.1

? Data not available.

[1] Partially edited data processed through January 2004.

[2] Preliminary data processed though July 10, 2003.

[3] First year in which all States were included in the collection of death statistics.

SOURCE: Various CDC/NCHS publications; see text.

Table 2a. Trends in measures of perinatal health: United States, 1990-2002

	Preterm[1]			
		Percent		
Year	Number	Total	Very preterm[1]	Moderately perterm[1]
2002	480,812	12.1	2.0	10.1
2001	476,250	11.9	1.9	10.0
2000	467,201	11.6	1.9	9.7
1999	460,853	11.8	2.0	9.8
1998	452,275	11.6	2.0	9.6
1997	436,600	11.4	1.9	9.4
1996	423,107	11.0	1.9	9.1
1995	424,455	11.0	1.9	9.1
1994	431,613	11.0	1.9	9.1
1993	435,625	11.0	1.9	9.1
1992	430,239	10.7	1.9	8.8
1991	440,082	10.8	1.9	8.9
1990	436,590	10.6	1.9	8.7

See footnotes at end of Table 2c.

Table 2b. Trends in measures of perinatal health: United States, 1990-2002

	Low birthweight[2]			
		Percent		
Year	Number	Total	Very low birthweigth[2]	Moderately low birthweight[2]
2002	314,077	7.8	1.5	6.4
2001	308,747	7.7	1.4	6.2
2000	307,030	7.6	1.4	6.1
1999	301,183	7.6	1.5	6.2
1998	298,208	7.6	1.4	6.1
1997	291,154	7.5	1.4	6.1
1996	287,230	7.4	1.4	6.0
1995	285,152	7.3	1.3	6.0
1994	287,607	7.3	1.3	6.0
1993	288,482	7.2	1.3	5.9
1992	287,493	7.1	1.3	5.8
1991	292,230	7.1	1.3	5.8
1990	289,418	7.0	1.3	5.7

See footnotes at end of Table 2c.

Table 2c. Trends in measures of perinatal health: United States, 1990-2002

	Late fetal mortality[3]		Early neonatal mortality[4]		Perinatal mortality[5]	
Year	Number	Rate	Number	Rate	Number	Rate
2002[6]	12,871	3.2(3.19)	15,003	3.7	27,874	6.9
2001	13,251	3.3(3.28)	14,611	3.6	27,862	6.9
2000	13,506	3.3	14,913	3.7	28,419	7.0
1999	13,427	3.4	14,889	3.8	28,316	7.1
1998	13,474	3.4	15,073	3.8	28,547	7.2
1997	13,686	3.5	14,859	3.8	28,545	7.3
1996	14,078	3.6	14,968	3.8	29,046	7.4
1995	14,251	3.6	15,515	4.0	29,766	7.6
1994	14,781	3.7	16,523	4.2	31,304	7.9
1993	15,297	3.8	17,395	4.3	32,692	8.1
1992	16,782	4.1	17,798	4.4	34,580	8.5
1991	17,010	4.1	18,916	4.6	35,926	8.7
1990	17,959	4.3	20,020	4.8	37,979	9.1

[1] Less than 37 completed weeks of gestation. Very preterm is less than 32 completed weeks of gestation. Moderately preterm is 32-36 completed weeks of gestation.

[2] Less than 2,500 grams. Very low birthweight is less than 1,500 grams. Moderately low birthweight is 1,500-2,499 grams.

[3] The late fetal mortality rate = fetal deaths with stated or presumed gestational ages of 28 weeks or more per 1,000 live births plus late fetal deaths.

[4] Deaths to infants less than 7 days per 1,000 live births.

[5] Late fetal deaths plus infant deaths less than 7 days per 1,000 live births plus late fetal deaths.

[6] Partially edited data processed as of January 2004.

SOURCE: Various CDC/NCHS publications; see text.

Table 3a. Infant deaths and infant mortality rates for all causes and infant mortality rates by leading causes: United States, preliminary 2002, and final 1990-2001

[Rates per 100,000 live births]

	ICD-10[1]			
Cause of death (Based on the International Classification of Diseases, Tenth Revision, 1992)	2002[4]	2001	2000	1999
All causes (deaths)	27,977	27,568	28,035	27,937
All causes (rates)	696.1	684.8	690.7	705.6

See footnotes at end of Table 3d.

Table 3b. Infant deaths and infant mortality rates for all causes and infant mortality rates by leading causes: United States, preliminary 2002, and final 1990-2001

[Rates per 100,000 live births]

	ICD-9[2,3]								
Cause of death (Based on the International Classification of Diseases, Tenth Revision, 1992)	**1998**	**1997**	**1996**	**1995**	**1994**	**1993**	**1992**	**1991**	**1990**
All causes (deaths)	28,371	28,045	28,487	29,583	31,710	33,466	34,628	36,766	38,351
All causes (rates)	719.8	722.6	732.0	758.6	802.2	836.6	851.9	894.4	922.3

See footnotes at end of Table 3d.

Table 3c. Infant deaths and infant mortality rates for all causes and infant mortality rates by leading causes: United States, preliminary 2002, and final 1990-2001

[Rates per 100,000 live births]

	ICD-9[2,3]								
Cause of death (Based on the International Classification of Diseases, Tenth Revision, 1992)	**1998**	**1997**	**1996**	**1995**	**1994**	**1993**	**1992**	**1991**	**1990**
Congenital malformations, deformations and chromosomal abnormalities (Q00-Q99)	157.6	159.2	164.0	168.1	173.4	178.2	183.2	186.9	198.1
Disorders relating to short gestation and low birth weight, not elsewhere classified (P07)	104.0	101.1	100.3	100.9	107.6	107.7	99.3	100.7	96.5
Sudden infant death syndrome (R95)	71.6	77.1	78.4	87.1	103.0	116.7	120.3	130.1	130.3
Newborn affected by maternal complications of pregnancy (P01)	34.1	32.1	32.1	33.6	32.8	33.6	35.9	37.4	39.8
Newborn affected by complications of placenta, cord and membranes (P02)	24.4	24.7	24.4	24.7	24.0	24.8	24.4	23.4	23.4
Respiratory distress of newborn (P22)	32.9	33.5	35.0	37.3	39.6	45.4	50.8	62.5	68.5
Accidents (unintentional injuries) (V01-X59)	18.3	19.0	20.0	19.5	21.7	21.6	19.2	22.3	21.8
Bacterial sepsis of newborn (P36)	18.7	18.4	17.6	18.4	18.7	17.2	19.8	19.3	19.2
Diseases of the circulatory system (I00-I99)	25.2	24.7	24.3	24.8	24.1	23.6	23.2	22.8	24.5
Intrauterine hypoxia and birth asphyxia (P20-P21)	11.7	11.6	11.0	12.2	13.6	13.7	15.1	14.6	18.3

See footnotes at end of Table 3d.

Table 3d. Infant deaths and infant mortality rates for all causes and infant mortality rates by leading causes: United States, preliminary 2002, and final 1990-2001

[Rates per 100,000 live births]

	ICD-10[1]			
Cause of death (Based on the International Classification of Diseases, Tenth Revision, 1992)	**2002[4]**	**2001**	**2000**	**1999**
Congenital malformations, deformations and chromosomal abnormalities (Q00-Q99)	140.7	136.9	141.5	138.2
Disorders relating to short gestation and low birth weight, not elsewhere classified (P07)	114.4	109.5	108.3	110.9
Sudden infant death syndrome (R95)	50.6	55.5	62.2	66.9
Newborn affected by maternal complications of pregnancy (P01)	42.9	37.2	34.6	35.3

	ICD-10[1]			
Cause of death (Based on the International Classification of Diseases, Tenth Revision, 1992)	**2002[4]**	**2001**	**2000**	**1999**
Newborn affected by complications of placenta, cord and membranes (P02)	25.3	25.3	26.2	25.9
Respiratory distress of newborn (P22)	23.8	25.1	24.6	28.0
Accidents (unintentional injuries) (V01-X59)	22.2	24.2	21.7	21.3
Bacterial sepsis of newborn (P36)	18.3	17.3	18.9	17.5
Diseases of the circulatory system (I00-I99)	16.1	15.4	16.3	16.8
Intrauterine hypoxia and birth asphyxia (P20-P21)	14.4	13.3	15.5	15.5

[1] World Health Organization. International Statistical Classification of Diseases and Related Health Problems, Tenth Revision. Geneva: World Health Organization. 1992.

[2] World Health Organization. Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, based on the recommendations of the Ninth Revision Conference, 1975. Geneva: World Health Organization. 1977.

[3] Cause of death titles in ICD-9 differ in some cases from those in ICD-10. Breaks in the comparability of some causes listed have resulted in changes in category titles and from coding rules used to select the underlying cause of death. Comparisons between 1998 and 1999 infant mortality rates by cause of death in this table should not be made. The trends displayed should be interpreted separately as trends from 1990-1998 and 1999-2002. For a complete explanation of differences and measurement of the discontinuities between ICD-9 and ICD-10, see reference number 5 from the text section of this Health E-Stat.

[4] Preliminary data for 2002 processed through July 10, 2003.

SOURCE: Various CDC/NCHS publications; see text.

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