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Indiana Infant Mortality Report: 1999
Period Linked Birth/ Infant Death Data Set

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Abstract

Objective - This report presents 1999 period infant mortality statistics in Indiana from the linked birth/infant death data set (linked file) by race, a variety of infant and maternal characteristics, and leading causes of death.

Methods - The numerator for the 1999 period linked file consists of all infant deaths (less than one year of age) occurring in 1999 that could be linked to their corresponding birth certificate, whether the birth occurred in 1999 or 1998. The denominator file for this data set is the 1999 natality file, that is, all births occurring in 1999. To be included in the linked file, the infant must have been a resident of Indiana at birth and at death. Descriptive tabulations of data from the linked file are presented for all infants and by race.

Results -The overall infant mortality rate (IMR) in Indiana in 1999 was 7.8 infant deaths per 1,000 live births, essentially unchanged from the rate in 1998. For infants born to black mothers, the IMR was 15.5 deaths per 1,000 live births, more than double the rate of 6.8 for infants born to white mothers. Among Hispanics, the IMR was 8.0 compared to 6.7 among the non-Hispanic whites and 15.5 among the non-Hispanic blacks. The IMR of male infants (9.0) was 38% higher than female infants (6.5) and IMR of plural births (34.4) was almost five times the rate for singleton births (6.9). In 1999, two-thirds of all infant deaths occurred to the 7.8% of infants born at low birthweight. The IMR for low birthweight infants (63.3) was more than 23 times the IMR of 2.7 among normal birthweight infants. Infant mortality rates were higher for infants whose mothers were teenagers, had 9-11 years of education, were unmarried, had no prenatal care, or smoked during pregnancy. Among the low birthweight or preterm infants, the IMR of infants born to black mothers was 36-51% higher than the IMR of those born to white mothers but the difference did not reach statistical significance. Among the normal birthweight or term infants, however, the IMR of black infants was 117-119% higher than the rate among whites. Racial disparity in IMR persisted regardless of maternal characteristics, but the racial gap grew wider among infants whose mothers were older, more educated, married, had early and adequate care, or did not smoke. In general, the effect of sociodemographic characteristics such as mother's age, education, or marital status on infant mortality was weaker among blacks compared to whites.

The three leading causes of infant death among all races and among whites were congenital anomalies, disorders related to low birthweight and short gestation and sudden infant death syndrome (SIDS), which all together accounted for 45-47% of infant deaths. Among blacks, the leading causes of death were disorders related to low birthweight and short gestation, followed by accidents and congenital anomalies.

Introduction

This report presents information on IMR from the Indiana 1999 period linked birth/infant death data set (linked file). In the linked file, death records of all infants who were Indiana residents and died under 1 year of age during 1999 are linked to their corresponding birth certificate. The purpose of linkage is to use the additional information available on the

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birth certificate for conducting a more in depth analysis of the pattern of infant mortality. The demographic and health variables included in the analysis of infant mortality are race, plurality, sex, birthweight, gestational age, maternal age, maternal education, live birth order, marital status, prenatal care, and smoking during pregnancy. Results are reported for all races combined and for whites and blacks separately. For the Hispanic population, due to relatively small number of births and infant deaths, only the overall IMR is reported.

The descriptive statistics presented here are useful in understanding the basic relationships between the individual risk factors and infant mortality. The IMRs reported are according to a specific maternal or infant characteristic and are unadjusted for the possible effects of other risk factors that are often present simultaneously. The preferred method for a better understanding of the interrelationship of multiple risk factors for infant mortality is multivariate analysis. The goal of this report, however, is to provide a basic understanding of the relationships of various risk factors and infant mortality.

Methods

Period linked file - To create the 1999 period linked file, death certificate numbers of infants under one year of age who died in Indiana in 1999 were matched and linked to their birth certificate number. The final linked data set included the infants who were resident of Indiana at time of birth (either in 1998 or 1999) and at time of death (in 1999). Accuracy of linking was determined by measuring consistency between various items common to both the birth and the death certificates such as date of birth, infant's first name, infant's last name, infant's sex, and mother's maiden name. This link created a single record containing information on the birth and death certificates from the two previously separate records. In 1999, of 671 infant deaths of Indiana residents, 99.3 percent (666 deaths) was successfully matched to their corresponding birth records (Table A). Of the matched births/infant death records, three were not Indiana residents at the time of birth.

Table A. Number and percent of infant death records linked and not linked to their corresponding birth record by age at death and residency status: Indiana, 1999 linked file

Link status of infant death records	Infant age at death		
	All	Neonatal	Post-neonatal
		Number	
Total infant deaths- Indiana resident at death	671	441	230
Linked to birth record	666	436	230
Indiana resident at birth	663	435	228
Not Indiana resident at birth	3	1	2
Unlinked	5	5	0
		Percent	
Linked records	99.3	98.9	100.0
Unlinked records	0.7	1.1	0.0

The remaining 663 matched infant deaths that were residents of Indiana at both birth and death comprised the final Indiana 1999 period linked file. All of the five unlinked infant death records were neonatal deaths (<28 days). As a result, the percent linked varied by age at death, from 98.9% for neonatal deaths to 100% for postneonatal deaths with an overall linkage of 99.3%. Due to the high percent of records linked, weighting of data was not considered necessary. Because the analysis is based on the linked birth/death records (663 infant deaths) and does not include the unlinked records (5 infant deaths), IMRs are understated by 0.7 percent on the average.

Infant mortality rates - Infant mortality rates are calculated by dividing the number of infant deaths in a period (numerator) by the number of live births in the same period (denominator), times 1,000 or 100,000. The 1999 period linked file contains a numerator file that includes all infant deaths in 1999 that have been linked to their corresponding birth certificate whether the birth occurred in 1999 or in 1998 and a denominator file that includes all live births during 1999.

The infant mortality rate is subject to random (or chance) variation in the number of births or deaths involved. Rates based on fewer than 20 deaths are considered unstable because their 95-percent confidence interval is about as wide as the rate itself[1]. Therefore in this report, IMRs based on less than 20 deaths are not reported. Additional explanation of random variation and stability of rates is presented in the Technical Notes.

Race and Hispanic origin - The racial and ethnic designation used in this report is that of the mother from the birth certificate. The linked file provides more accurate data for computing the IMRs by race and Hispanic origin compared to that reported in the general mortality report[2]. In the linked file, the race of the mother from the birth certificate is used both in the numerator and the denominator of IMR. In contrast, in the general mortality report, the race information in the denominator is that of the mother from the birth certificate while the race information in the numerator is the race of the decedent recorded on the death certificate reported by an informant or on observation. As a result of this difference in the method of reporting race data in the linked file and general mortality file, race-specific IMRs from these two data files can be different.

Birthweight and gestational age edits - Birthweight and gestational age edits were performed according to National Center for Health Statistics (NCHS) guidelines[3]. Birthweights below 227 and above 8,650 grams were considered as unknown. Birthweights within the acceptable range of 227 to 8,650 grams were checked for consistency with gestational age. Gestational age in completed weeks was calculated from the date of last normal menstrual period to the date of birth. The clinical estimate was used for 2.9% of the records in which the date of last menses was missing (1.8%), or when the computed gestational age was either out of the acceptable range of 17 to 47 weeks (0.9%) or inconsistent with the birthweight (0.2%).

Cause of death - Cause of death coding in this report is according to the Tenth Revision, International Classification of Diseases (ICD-10)[4].

Statistical significance - Throughout the text, any statement that a given IMR is higher or lower than another rate implies a statistically significant difference. Detailed information about the statistical tests used in this report is presented in the Technical Notes.

Results

Infant mortality by race and Hispanic origin of mother

The overall 1999 Indiana IMR from the linked file was 7.8 infant deaths per 1,000 live births. There was a wide racial disparity in IMR as indicated by a rate of 6.8 for whites and 15.5 for blacks. Among Hispanics, the IMR of 8.0 was not significantly higher compared to non-Hispanic whites (6.7) but was significantly lower compared to blacks (Table 1).

Among all races, two thirds of infant deaths occurred during the neonatal period (<28 days of age). Among Hispanics, however, neonatal deaths accounted for 80% of all deaths. The racial disparity in the mortality rate was evident for both the neonatal and post-neonatal periods. Compared to non-Hispanic whites, the neonatal mortality rate was higher by 140% among blacks and by 49% among Hispanics. The postneonatal mortality rate was higher by 117% among blacks compared to non-Hispanic whites. The number of postneonatal deaths among Hispanics was not large enough to give a stable rate (Table 1).

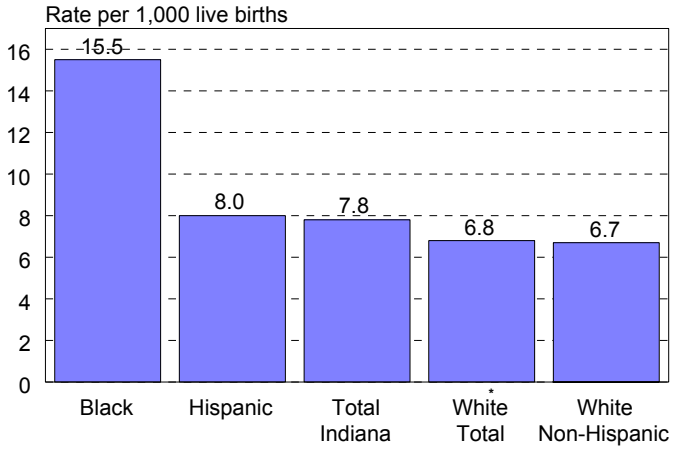


Figure 1. Infant mortality rates by race and Hispanic origin: Indiana, 1999 linked file

Infant mortality by selected infant and maternal characteristics

Infant mortality rates by various infant and maternal characteristics are shown in Table 2 for all infants and for infants of white and black mothers. The number of live births and infant deaths in corresponding categories are shown in Table 3. Among Hispanics, breakdowns of infant deaths by various infant and maternal characteristics resulted in small numbers of deaths and unstable IMR in most categories and therefore are not reported. Combining several years of data in future reports would provide enough numbers of infant deaths among Hispanics to yield stable IMRs in different categories.

Table 1. Infant, neonatal, and postneonatal deaths and mortality rates by race and Hispanic origin of mother: Indiana, 1999 linked file

Race and Hispanic origin of mother	Live births	Number of deaths[1]			Mortality rate per 1,000 live births		
		Infant	Neonatal	Post-neonatal	Infant	Neonatal	Post-neonatal
Total	85,489	663	435	228	7.8	5.1	2.7
Race							
White	74,787	508	331	177	6.8	4.4	2.4
Black	9,244	143	95	48	15.5	10.3	5.2
Other	1,331	7	7	0	*	*	*
Unknown	127	10	7	3	*	*	*
Hispanic origin							
Hispanic	4,383	35	28	7	8.0	6.4	*
Non-Hispanic total	80,467	624	404	220	7.8	5.0	2.7
Non-Hispanic white	69,973	471	301	170	6.7	4.3	2.4
Non-Hispanic black	9,200	143	95	48	15.5	10.3	5.2
Non-Hispanic Other/Unknown	1,294	10	8	2	*	*	*
Unknown	639	9	8	1	*	*	*

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

[1]Linked birth/infant death file includes 663 infant deaths who were Indiana resident at time of birth and death.

Sex of infant - The mortality rate of male infants (9.0) was 38% higher than the mortality rate of female infants (6.5). Blacks had higher IMRs for both males and females compared to whites (Table 2, Figure 2). Compared to female infants, the IMR of male infants was higher by 50% among white infants and by 17% among black infants. This indicates that being a male infant increased the risk of infant death significantly among whites but not among blacks.

Table 2. Infant mortality rates by selected characteristics and race of mother: Indiana, 1999 linked file

Characteristics	Race of mother		
	All races[1]	White	Black
	Infant mortality rates per 1,000 live births		
Total	7.8	6.8	15.5
Age at death			
Total neonatal (0-27 days)	5.1	4.4	10.3
Early neonatal (<7 days)	4.0	3.4	8.3
Late neonatal (7-27 days)	1.1	1.0	*
Postneonatal (28-364 days)	2.7	2.4	5.2
Sex			
Male	9.0	8.1	16.6
Female	6.5	5.4	14.2
Plurality			
Single births	6.9	6.0	13.4
Multiple births	34.4	29.4	75.4
Birthweight			
Less than 2,500 grams (LBW)	63.6	59.5	81.2
Less than 1,500 grams (VLBW)	261.7	251.6	290.9
1,500-2,499 grams (MLBW)	19.0	19.2	*
2,500 grams or more (NBW)	2.7	2.4	5.2
Gestational age			
Less than 37 weeks (Preterm)	43.6	40.1	60.6
Less than 32 weeks	228.4	220.1	252.3
32-36 weeks	11.6	11.7	*
37-41 weeks (Term)	3.0	2.7	5.9
42 weeks or more	3.0	*	*
Age of mother			
Under 20 years	10.7	9.8	14.4
Under 18 years	11.1	9.7	*
18-19 years	10.5	9.9	*
20 years and over	7.3	6.4	15.8
20-24 years	8.7	7.5	15.4
25-29 years	6.0	5.2	14.7
30-34 years	6.8	5.9	18.6
35 years and over	8.1	7.5	*

Table 2. Infant mortality rates and mortality rate ratios by selected characteristics and race of mother: Indiana, 1999 linked file--Cont.

Characteristics	Race of mother		
	All races[1]	White	Black
	Infant mortality rates per 1,000 live births		
Educational attainment of mother			
Less than12 years	11.6	10.8	16.4
0-8 years	8.0	7.0	*
9-11 years	12.6	11.9	15.9
12 years	8.3	7.4	14.5
More than 12 years	5.0	4.4	13.4
13-15 years	5.7	4.7	14.7
16 years and over	4.3	4.1	*
Live-birth order			
First	8.3	7.5	15.7
Second	6.4	5.7	13.1
Third	7.7	6.5	16.8
Fourth+	9.6	8.0	17.2
Marital status			
Married	5.9	5.5	14.6
Unmarried	11.2	9.7	15.7
Trimester prenatal care began			
First trimester	6.9	6.2	13.4
After first trimester	8.4	7.6	12.3
Second trimester	8.5	8.0	11.8
Third trimester	7.6	*	*
No care	36.9	*	*
Prenatal care index[2]			
Adequate plus	11.4	10.6	17.8
Adequate	3.3	3.0	7.2
Intermediate	3.9	3.9	*
Inadequate	7.6	6.9	11.2
No care	36.9	*	*
Maternal smoking			
Smoking	10.8	10.0	19.9
Not smoking	6.9	5.8	14.7

[1]Includes races other than black or white and unknown race.

*Figure does not meet standard of reliability or precision.

[2]Based on APNCU index (Kotelchuck, M. Am J Public Health 1994;84:1

Note: LBW = Low Birthweight, VLBW = Very Low Birthweight, MLBW=Moderately Low Birthweight, NBW = Normal Birthweight

Table 3. Infant deaths and live births by selected characteristics and race of mother: Indiana, 1999 linked file

Characteristics	Infant deaths			Live births		
	All races[1]	White	Black	All races[1]	White	Black
Total	663	508	143	85,489	74,787	9,244
Age at death						
Total neonatal (0-27 days)	435	331	95	--	--	--
Early neonatal (<7 days)	340	255	77	--	--	--
Late neonatal (7-27 days)	95	76	18	--	--	--
Postneonatal (28-364 days)	228	177	48	--	--	--
Sex						
Male	394	312	79	43,794	38,284	4,747
Female	269	196	64	41,694	36,502	4,497
Plurality						
Single births	567	436	120	82,702	72,339	8,939
Multiple births	96	72	23	2,787	2,448	305
Birthweight						
Less than 2,500 grams (LBW)	423	319	96	6,655	5,357	1,182
Less than 1,500 grams (VLBW)	320	234	80	1,223	930	275
1,500-2,499 grams (MLBW)	103	85	16	5,432	4,427	907
2,500 grams or more (NBW)	213	168	42	78,454	69,101	8,019
Unknown	27	21	5	380	329	43
Gestational age						
Less than 37 weeks (Preterm)	434	328	98	9,955	8,182	1,617
Less than 32 weeks (Very Preterm)	336	245	84	1,471	1,113	333
32-36 weeks	98	83	14	8,484	7,069	1,284
37 weeks or more	228	179	45	75,203	66,327	7,581
37-41 weeks	206	162	40	68,756	60,682	6,864
42 weeks or more	22	17	5	6,447	5,645	717
Unknown	1	1	0	331	278	46
Age of mother						
Under 20 years	121	88	32	11,301	8,945	2,221
Under 18 years	41	27	14	3,693	2,772	872
18-19 years	80	61	18	7,608	6,173	1,349
20 years and over	541	420	111	74,158	65,816	7,020
20-24 years	212	156	51	24,264	20,707	3,303
25-29 years	148	117	30	24,833	22,315	2,034
30-34 years	114	91	20	16,794	15,313	1,075
35 years and over	67	56	10	8,267	7,481	608
Unknown	1	0	0	30	26	3

Table 3. Infant deaths and live births by selected characteristics and race of mother: Indiana, 1999 linked file--Cont.

Characteristics	Infant deaths			Live births		
	All races[1]	White	Black	All races[1]	White	Black
Educational attainment of mother						
Less than 12 years	202	157	43	17,352	14,520	2,626
0-8 years	28	23	4	3,501	3,272	173
9-11 years	174	134	39	13,851	11,248	2,453
12 years	249	193	53	30,000	25,999	3,647
More than 12 years	188	148	38	37,328	33,655	2,828
13-15 years	110	79	31	19,156	16,785	2,103
16 years and over	78	69	7	18,172	16,870	725
Unknown	24	10	9	809	613	143
Live-birth order						
First	275	218	52	32,974	28,980	3,306
Second	181	144	35	28,299	25,160	2,673
Third	115	85	29	14,955	13,029	1,728
Fourth+	87	60	26	9,089	7,487	1,509
Unknown	5	1	1	172	131	28
Marital status						
Married	330	292	31	55,889	52,625	2,122
Unmarried	332	216	112	29,596	22,159	7,122
Unknown	1	0	0	4	3	0
Trimester prenatal care began						
First trimester	467	379	81	67,982	60,810	6,056
After first trimester	134	98	35	16004	12870	2836
Second trimester	113	86	27	13,229	10,703	2,287
Third trimester	21	12	8	2,775	2,167	549
No care	24	13	11	650	454	186
Unknown	38	18	16	853	653	166
Prenatal care index[2]						
Adequate plus	291	239	48	25,605	22,530	2,694
Adequate	122	99	20	36,431	33,057	2,772
Intermediate	40	35	5	10,186	8,893	1,097
Inadequate	73	52	21	9,614	7,556	1,870
No care	24	13	11	650	454	186
Unknown	113	70	38	3,003	2,292	625
Maternal smoking						
Smoking	193	163	29	17,852	16,269	1,460
Not smoking	466	341	114	67,398	58,309	7,759
Unknown	4	4	0	239	209	25

-- Category not applicable.

[1] Includes races other than black or white and unknown race.

[2] Based on APNCU index (Kotelchuck, M., Am J Public Health 1994;84:1414-1420).

Note: LBW = Low Birthweight, VLBW = Very Low Birthweight, NBW = Normal Birthweight

Plurality - In 1999, the IMR was 34.4 for multiple births, five times the IMR of 6.9 for singletons. For both multiple and singleton births, IMRs were more than two times higher for infants of black mothers compared to infants of white mothers (Table 2, Figure 3).

Birthweight and gestational age - Low birthweight and short gestational age are the two most important risk factors for infant health and survival. In 1999, low birthweight (<2,500 grams) and very low birthweight (<1,500 grams) infants comprised 7.8% and 1.4% of the live births and 66.5% and 50.3% of the infant deaths, respectively (Table 4). Therefore, the majority of infant deaths occurred to a small proportion of live births weighing less than 2,500 grams at birth (Figure 4). A similar pattern was observed for gestational age. Racial differences were evident in the distribution of birthweight and gestational age. Among black infants, 12.8% of live births were low birthweight and 17.6% were preterm compared to 7.2% and 11.0% among whites, respectively (Figure 5).

Infants who are born with low birthweight are at significantly higher risk of death than infants born at normal weight. The IMR of 63.6 among the low birthweights was more than 23 times the rate of 2.7 for normal birthweight infants (Table 2). The IMR for infants of very low birthweight (<1,500 grams) was 261.7 deaths per 1,000 live births, more than 90 times the rate for normal weight infants. Similarly, the IMR for infants born prematurely (<37 weeks) was 43.6, almost 15 times the rate of 3.0 among term infants (Table 2). Among very preterm infants (<32 weeks), the IMR was 228.4, 76 times the rate for term infants, and for moderately preterm infants (32-36 weeks of gestation), the rate was 11.6, almost four times the rate for term births.

Among black infants, the IMR of normal birthweight infants was 5.2, 117% higher than the IMR of 2.4 among whites (Table 2). However, among the very low birthweight infants who are at high risk of death, the black IMR of 290.9 was only 16% higher (not statistically significant) than the corresponding IMR of 251.6 for whites indicating that at lower birthweights, racial disparity in infant mortality rate is diminished (Figure 6). A similar pattern of racial disparity in infant mortality was observed among the preterm and term infants. Among term infants (37-41 weeks), the IMR of blacks was 119% higher than IMR of whites whereas among the very preterm infants (less than 32 weeks), blacks had a 15% higher IMR (not statistically significant) compared to whites (Table 2, Figure 7). A protective effect of black race for survival at lower gestational age has been reported in U.S.[5].

Maternal age - Infant mortality rate decreased as mother's age increased from below 20 years of age to 25-29 years (Table 2). Among all races, the IMR rate for teen mothers (less than 20 years of age) was 10.7 deaths per 1,000 live births, which was 47% higher than the rate of 7.3 for adult mothers (20 years of age and older). Among blacks, however, the IMR of teen mothers (14.4) was only slightly lower than the IMR of adult mothers (15.8) and the difference was not statistically significant. At all age intervals, black mothers were more likely to experience infant deaths compared to white mothers. Racial disparity in IMR grew wider as mother's age increased. Among teen mothers, the IMR of black infants was 47% higher compared to white infants whereas among adult mothers, black IMR was 147% higher than white IMR (Table 2, Figure 8).

Maternal education - The percent of births to mothers who had not finished high school was 20.5% among all races, 19.6% among whites, and 28.9% among blacks (Table 4). Overall, the IMR decreased as mother's education increased (Table 2). For mothers with less than 12 years of education, the IMR was 11.6, 40% higher than the rate of 8.3 for high school graduates and 132% higher than the rate of 5.0 for those with some college education.

White mothers followed a similar pattern of IMR along the various educational categories as all races combined (Table 2). Among white mothers, the IMR of those who did not finish high school (10.8) was 145% higher than the IMR of those who had more than high school education (4.4). Among blacks, however, the IMR for mothers with less than 12 years of education (16.4) was only 22% higher than the rate for those with some college education (13.4). Racial disparity in IMR persisted along various educational categories but the gap widened with increasing educational level. Among mothers with less than 12 years of education, black IMR was 52% higher than white IMR (not statistically significant), whereas among those with a high school diploma and those with some college education, black IMR was two times and three times the white IMR, respectively (Table 2, Figure 9). Similar findings have been reported from North Carolina indicating that higher education magnifies racial differences in infant mortality on a multiplicative scale[6]. The possible reasons included greater stress, fewer economic resources, and poorer quality of prenatal care among blacks.

Live-birth order - IMR was lowest for the second live birth order (6.4) compared to the first (8.3), third (7.7), and fourth/higher (9.6) birth orders among all races as well as among whites and blacks. IMRs of first live births and fourth/higher live births were higher by 30% and 50% compared to second live births, respectively (Table 2). The IMR among blacks was more than two times the rate among whites across all live birth orders.

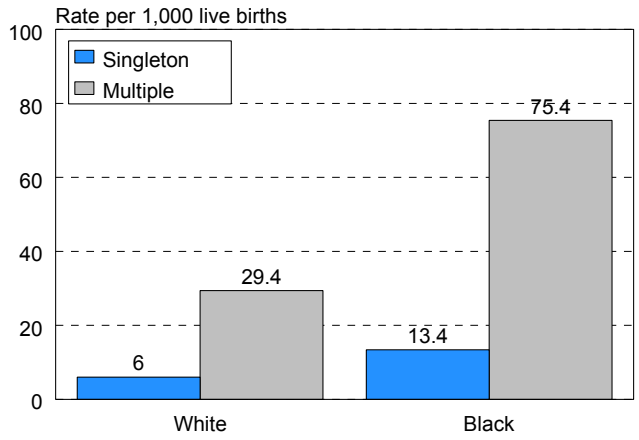


Figure 2. Infant mortality rates by sex and race: Indiana, 1999 linked file

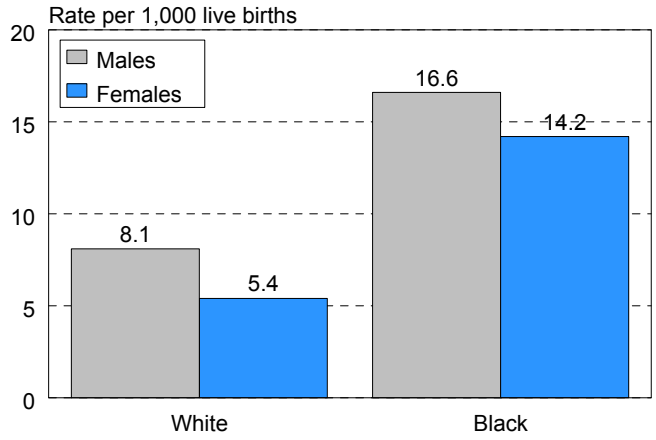


Figure 3. Infant mortality rates by plurality and race: Indiana, 1999 linked file

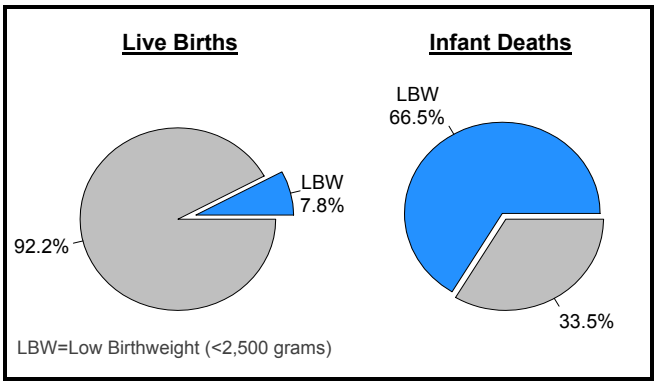


Figure 4. Prevalence of low birthweight: Indiana, 1999 linked file

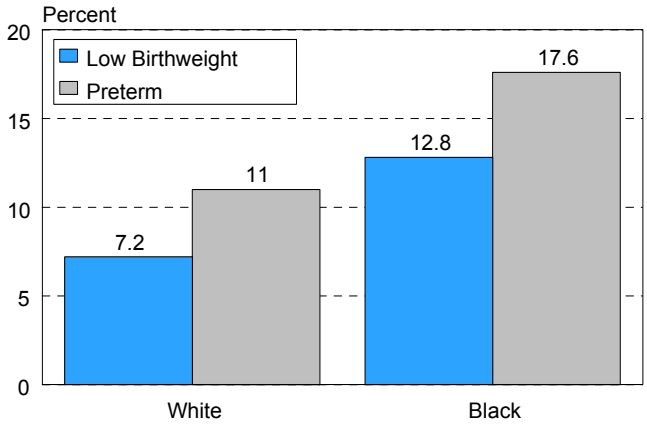
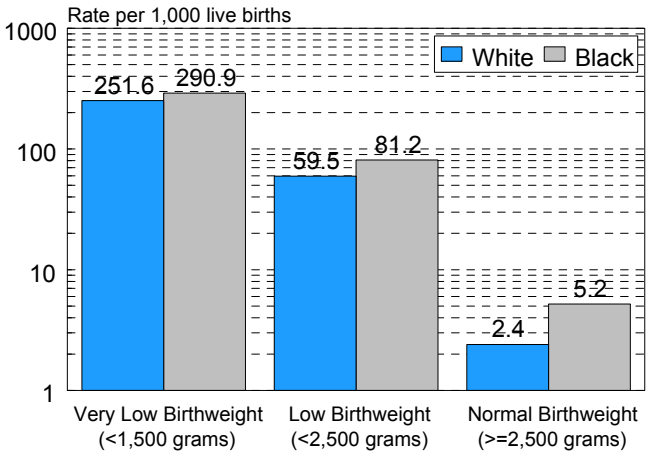
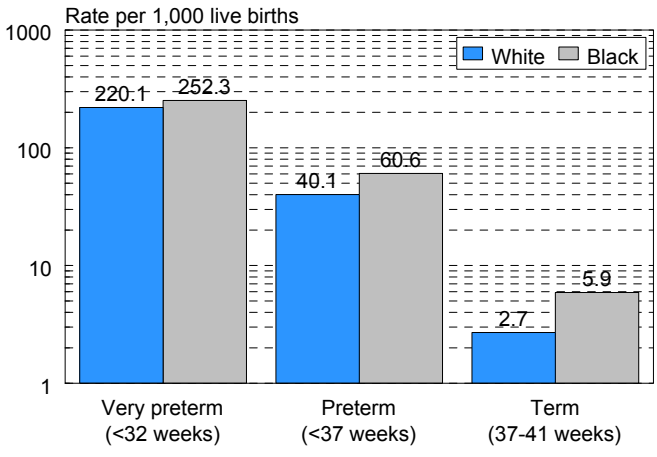


Figure 5. Prevalence of low birthweight and preterm birth by race: Indiana, 1999 live births



NOTE: Y axis is based on log scale.

Figure 6. Infant mortality rates by birthweight and race: Indiana, 1999 linked file



NOTE: Y axis is based on log scale.

Figure 7. Infant mortality rates by gestational age and race: Indiana, 1999 linked file

Marital status - Among all races combined, the IMR for unmarried mothers was 11.2, 90% higher than the rate of 5.9 for married mothers (Table 2). Among the white population, the IMR of 5.5 for married mothers was significantly lower than the rate of 9.7 for unmarried mothers whereas among blacks, the IMR of married and unmarried mothers were not significantly different (Figure 10). The racial gap in IMR was wider among married mothers (165% higher for blacks) than among unmarried mothers (62% higher for blacks). The proportion of unmarried mothers differed substantially between the white and black populations. Among whites, 29.6% of the live births and 42.5% of the infant deaths were to unmarried mothers in contrast to 77.0% and 78.3% among black mothers, respectively (Table 4).

Prenatal care - Infants of mothers who began prenatal care after the first trimester had an IMR of 8.4 which was 22% higher than the rate for those who began prenatal care in the first trimester (6.9). The mortality rate for infants of mothers with no prenatal care was 36.9, more than five times the rate for those infants whose mothers received care during the first trimester (Table 2).

In 1999 in Indiana, prenatal care was initiated during the first trimester for 80.3% of the mothers. Racial disparity was apparent in the initiation of prenatal care. Among live births, 33.3% of black mothers did not receive prenatal care during the first trimester compared to 18% of white mothers (Table 4). The mortality rate was significantly higher among black infants compared to whites even when the prenatal care was initiated during the first trimester (Figure 11). Mortality rates of black or white infants whose mothers had no prenatal care or began care in the third trimester could not be estimated because the numbers of births and deaths in these high-risk categories were not large enough to establish reliable mortality rates.

In addition to the initiation of the prenatal care as a measure of prenatal care, different prenatal care indices have been developed as alternative measures based on the timing of the prenatal care, as well as the number of prenatal visits, and the gestational age of the infant at birth. Among these indices are the Kessner/Institute of Medicine (IOM) index which defines care as "adequate", "intermediate", and "inadequate"[7]. In this report, the Kotelchuck Adequacy of Prenatal Care Utilization (APNCU) index[8] is used. This index also includes the adequate plus care category for those women with unexpectedly large number of prenatal visits given the gestational age at delivery and the month prenatal care began. This index does not assess the quality of the prenatal care, but simply its utilization. The prenatal care utilization is considered inadequate if care is initiated after the fourth month of pregnancy regardless of the number of visits. Once prenatal care is initiated during the first four months of pregnancy, then the index is classified into inadequate, intermediate, adequate, or adequate plus if the ratio of actual-to-expected number of visits is less than 50%, 50%-79%, 80%-109%, or 110% and more, respectively. The prenatal care index is considered unknown for mothers who have missing information on the initiation of prenatal care, the number of visits, or gestational age, for mothers with duration of gestation below 20 weeks and above 44 weeks (unacceptable values), and for mothers with inconsistent values of initiation of care, number of visits, and duration of gestation.

For mothers who received prenatal care, the infant mortality rate was highest in the adequate plus category and lowest in the adequate category for all races combined as well as for whites and for blacks (Table 2). The infant mortality rate increased by more than three fold for adequate plus care and by two fold for inadequate care compared to those who received adequate prenatal care. Adequate plus category mainly includes women who are considered at high risk and receive extra prenatal services and have a disproportionately high share of low birthweight infants compared to other categories[9].

The mortality rate of infants with unknown information on adequacy of prenatal care was 37.6 deaths per 1,000 live births (extrapolated from Table 3), a rate close to those with no prenatal care (Figure 12). Therefore, the population of mothers with missing information on adequacy of prenatal care must have mainly included those with no care at all who are at high risk of infant mortality and indicates a possible underestimation of IMR among infants whose mothers had no prenatal care. The proportion of infant deaths with an unknown prenatal care utilization index ranged from 14% among whites to as high as 27% among blacks which indicates the need for improving data quality in Indiana vital records.

Racial difference between the two major races was manifested by a higher proportion of inadequate care among blacks compared to whites in both the live birth and the infant death populations (Table 4). Infant mortality rates were significantly higher among blacks compared to whites among all care categories. Racial disparity in infant mortality was more noticeable among mothers who received adequate care compared to those who had inadequate care.

Maternal smoking - Significant increases in the risks of fetal and infant mortality has been demonstrated among infants born to smoking mothers[10]. In 1999 in Indiana, 20.9% of all live births were to mothers who smoked during their pregnancy (Table 4). Smoking during pregnancy was more prevalent among white mothers (15.8%) than among black mothers (21.8%). The mortality rate of infants whose mothers smoked was 10.8, 57% higher than the rate of 6.9 among births to non-smokers. Blacks had significantly higher infant mortality rates relative to whites regardless of the mother's smoking status. The racial gap in IMR, however, was wider among non-smoking mothers than among the smoking ones (Table 2, Figure 13).

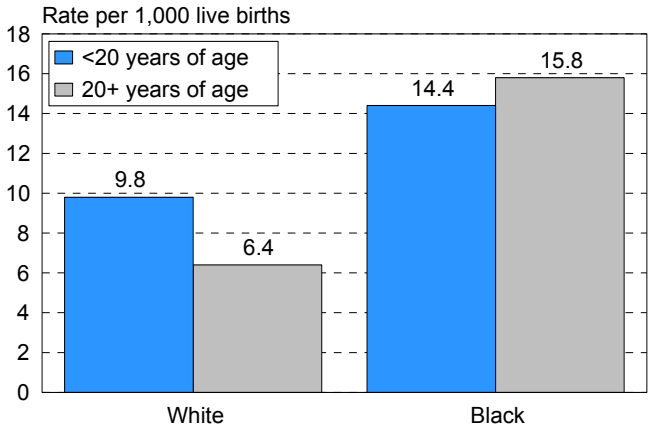


Figure 8. Infant mortality rates by mother's age and race: Indiana, 1999 linked file

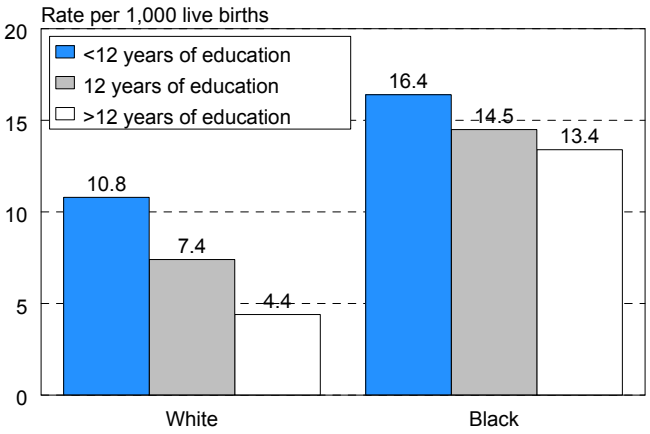


Figure 9. Infant mortality rates by mother's education and race: Indiana, 1999 linked file

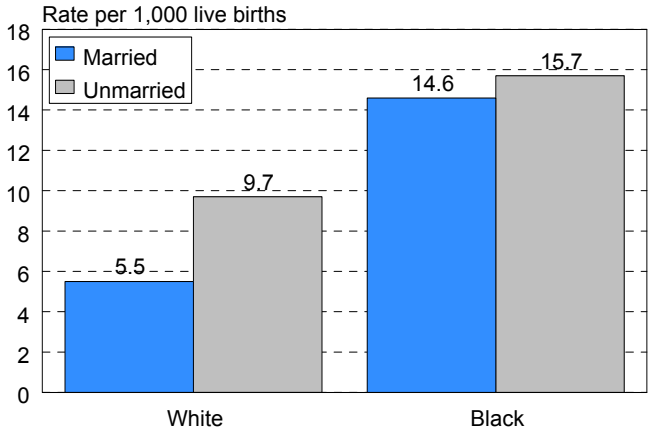


Figure 10. Infant mortality rates by mother's marital status and race: Indiana, 1999 linked file

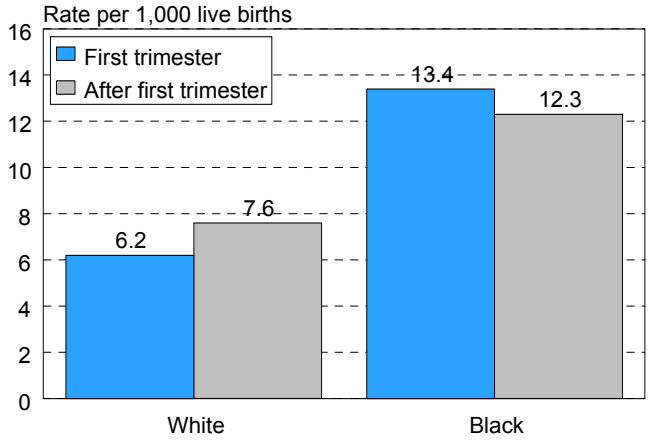


Figure 11. Infant mortality rates by trimester prenatal care began and race: Indiana, 1999 linked file

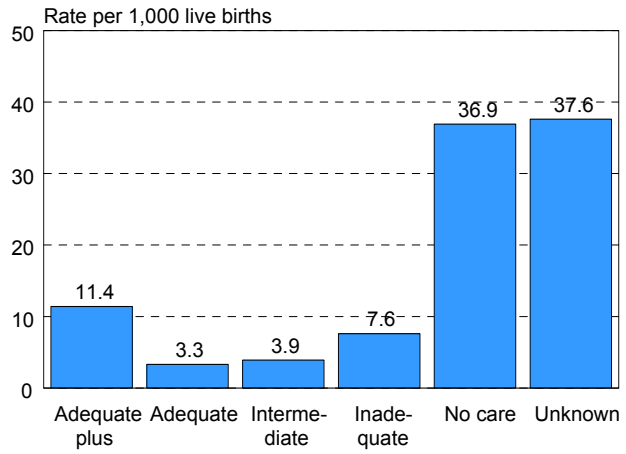


Figure 12. Infant mortality rates by adequacy of prenatal care: Indiana, 1999 linked file

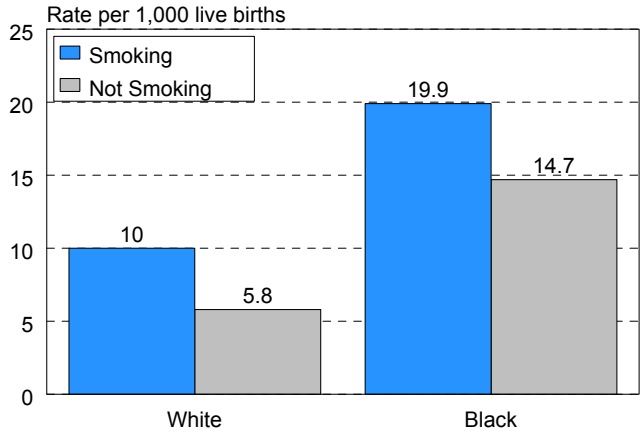


Figure 13. Infant mortality rates by maternal smoking and race: Indiana, 1999 linked file

Table 4. Percent of live births and infant deaths with selected maternal and infant characteristics by race of mother: Indiana, 1998 linked file

Characteristics	Live births			Infant deaths		
	All[1]	White	Black	All	White	Black
Infant						
Male	51.2	51.2	51.4	59.4	61.4	55.2
Multiple birth	3.3	3.3	3.3	14.5	14.2	16.1
LBW (<2,500g)	7.8	7.2	12.8	66.5	65.5	69.6
VLBW (<1,500g)	1.4	1.2	3.0	50.3	48.0	58.0
Preterm (<37 weeks)	11.7	11.0	17.6	65.6	64.7	68.5
Very preterm (<28 weeks)	1.7	1.5	3.6	50.8	48.3	58.7
Mother						
Less than 20 years of age	13.2	12.0	24.0	18.3	17.3	22.4
Less than 12 years of education	20.5	19.6	28.9	31.6	31.5	32.1
Fourth and higher order births	10.7	10.0	16.4	13.2	11.8	18.3
Unmarried	34.6	29.6	77.0	50.2	42.5	78.3
Prenatal care-Not in first trimester	18.9	17.4	31.2	21.4	20.0	27.6
Prenatal care-Inadequate[2]	11.7	10.4	21.7	13.3	11.9	20.0
Smoked during pregnancy	20.9	21.8	15.8	29.3	32.3	20.3

[1]Includes races other than black or white.

[2]Based on APNCU index (Kotelchuck, M. Am J Public Health 1994;84:1414-1420).

Note. LBW=Low Birth Weight, VLBW=Very Low Birth Weight

Table 5. Infant deaths and mortality rates for the 5 leading causes of death by race of mother: Indiana, 1999 linked file

(Rates per 100,000 live births in specified group)

Cause of Death	All races			White			Black		
(ICD-9 code)	Rank	Number	rate	Rank	Number	rate	Rank	Number	rate
All causes	---	663	775.5	---	508	679.3	---	143	1546.9
Congenital anomalies	1	141	164.9	1	125	167.1	3	13	*
Disorders related to short gestation & low birth weight	2	105	122.8	2	73	97.6	1	32	346.2
Sudden infant death syndrome	3	53	62.0	3	44	58.8	4	9	*
Accidents	4	41	48.0		24	32.1	2	17	*
Bacterial sepsis of newborn	5	36	42.1	4	31	41.5		5	*
Newborn affected by maternal complications of pregnancy		32	37.4	5	25	33.4		6	*
Respiratory distress of newborn		28	32.8		19	*	5	8	*

*Figure does not meet standard of reliability or precision

---Category not applicable

Leading causes of infant death

Infant mortality rates for the five leading causes of death in Indiana by race are presented in table 5. The three leading causes of infant deaths in 1999 for all races and for whites were congenital anomalies followed by disorders related to short gestation and low birthweight, and sudden infant syndrome (SIDS). These three causes accounted for 45.1% of all infant deaths and 47.6% of infant deaths among whites. Among blacks, the three leading causes of death had a different ranking compared to whites and included disorders related to short gestation and low birthweight as the leading cause followed by accidents and congenital anomalies. These three causes accounted for 43% of infant deaths among blacks. Among whites, the fourth and fifth leading causes of infant death were bacterial sepsis of newborns and newborns affected by maternal complications of pregnancy accounting for 5.5% of all deaths whereas among blacks SIDS and respiratory distress syndrome, respectively, accounted for 11.9% of deaths.

For infant deaths due to low birthweight and short gestation, the mortality rate was 346.2 per 100,000 live births for infants of black mothers, 3.5 times the rate of 97.6 for infants of white mothers. For other single causes of infant deaths, the number of deaths among infants of black mothers was not large enough to give a stable IMR.

References

[1]Kleinman, JC. *Infant Mortality*. Healthy People 2000 Statistical Notes. National Center for Health Statistics. 1991, Vol 1.1991.

[2]Rosenberg, HM, Maurer JD, Sorlie PD, et al. *Quality of death rates by race and Hispanic origin: A summary of current research, 1999.* National Center for Health Statistics. Vital Health Stat 2(128). 1999.

[3]National Center for Health Statistics/Centers for Disease Control and Prevention. *Instruction Manual. Part 12. Computer Edits for Natality Data, Effective 1996*. U.S. Department of Health and Human Services, 1995.

[4]World Health Organization. *International Statistical Classification of Diseases and Relad Health Problems*. Tenth Revision. Geneva: World Health Organization, 1992.

[5]Prager K. *Infant mortality by birthweight and other characteristics: United States, 1985 birth cohort*. National Center for Health Statistics. Vital Health Stat. 20(24).1994.

[6]Din-Dzietham R, Hertz-Picciotto I. *Infant mortality differences between whites and African Americans: The effect of maternal education.* Am. J.Public Health. 88:651-656. 1998.

[7]Kessner, DM, Singer J, Kalk CW, Schlesinger ER. *Infant death: an analysis by maternal risk and health care*. In: Contrasts in health status, Vol I. Washington DC: Institute of Medicine, National Academy of Sciences; 1973.

[8]Kotelchuck M. *An evaluation of the Kessner Adequacy of Prenatal Care Index and a proposed Adequacy of Prenatal Care Utilization Index*. Am J Public Health. 84:1414-1420. 1994.

[9]Kotelchuck M. *Adequacy of prenatal care utilization index: Its US distribution and association with low birthweight.* Am J Public Health. 84:1486-1489. 1994.

[10]Kleinman JC, Pierre M, Madans J, Land G, Schramm W. *The effects of maternal smoking in fetal and infant mortality*. Am J Epidemiol. 127:274-82. 1988.

[11]Chiang CL. *Standard error of the age-adjusted death rate*. Vital statistics-Special report. Vol 47, No 9. National Canter for Health Statistics. Washington: Public Health Service. 1961.

[12]Mathews TJ, Curtin SC, MacDorman MF. *Infant mortality statistics from the 1998 period linked birth/infant death data set*. National vital statistics reports; Vol. 48, no. 12. Hyattsville, Maryland: National Center for Health Statistics. 2000.

Technical Notes

Random variation and stability of rates

In this report, the number of infant births and deaths represent complete counts for the state of Indiana. Therefore, the reported infant mortality rates are not subject to sampling error. However, when rates are compared over time, between areas, or among various subgroups, the number of events and the corresponding rates are subject to random variation. That is, the rate that actually occurred may be considered as one of a large number of possible different outcomes (rates) that could have arisen under the same circumstances[11]. As a result, rates in a given population may tend to fluctuate from year to year even when the health of that population is unchanged. The simplest method for addressing the issue of random variation is the computation of 95% confidence interval. This interval indicates that it has 95% probability of including the true rate.

Random variation in rates based on a relatively small number of events tend to be larger than that for rates based on more frequently occurring events. A useful rule is that any rate based on fewer than 20 cases in the numerator (infant deaths in this report) will have a 95% confidence interval which is about as wide as the rate itself[1]. For example, in an area with 20 deaths out of 1,000 live births, it can be said that the true rate is within 20 +/- 10 per 1,000 , which is not a precise information. For this reason, in this report, infant mortality rates based on fewer than 20 deaths are not reported. One way to deal with the stability problem is to combine several years of data to increase the number of events, reduce the effect of random variation, and improve the reliability of the mortality rates.

When the number of events, in this case the number of infant deaths, is large, the relative standard error (RSE) is small and the binomial distribution is used to estimate the 95% confidence interval. When the number of events in the numerator (infant deaths) is less than 100, the confidence interval for the rate can be based on a Poisson distribution[12]. The formula for RSE of the IMR is:

$$RSE = 100 \times SQRT(1/D + 1/B),$$

where D is the number of deaths, B is the number of births, and SQRT denotes square root of the expression in parenthesis.

The formula for 95% confidence interval based on binomial distribution is:

Lower: $IMR - 1.96 \times IMR \times RSE/100$

Upper: $IMR + 1.96 \times IMR \times RSE/100$

The formula for 95% confidence interval based on Poisson distribution using Table I is:

Lower: $IMR \times L(D_{adj})$

Upper: $IMR \times U(D_{adj})$

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

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

$L(D_{adj})$ and $U(D_{adj})$ refer to the values in Table I corresponding to the value of D_{adj}.

Comparison of two infant mortality rates

If either of the two IMRs to be compared (R_1 or R_2) is based on less than 100 infant deaths, first compute the 95% confidence interval for each rate and then check to see if they overlap. If they do overlap, the difference is not statistically significant at the 0.05 level. If they do not overlap, the difference is considered statistically significant.

If both rates are based on 100 or more deaths, the following z-test is used to test for significance:

$$Z = \frac{R_1 - R_2}{SQRT\left[(R_1)^2 \times (RSE_1/100)^2 + (R_2)^2 \times (RSE_2/100)^2\right]}$$

If Z>=1.96, the difference is statistically significant at the 0.05 level and if the z is less than 1.96, the difference is not significant.

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

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