Variation in State-Specific Infant Mortality Risks

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Synopsis

Data from the National Infant Mortality Surveillance project were used to examine the State-specific variations in infant, neonatal, and postneonatal mortality and to examine some of the factors affecting the risks of death.

The infant mortality risk, defined as the risk of death before 1 year of age to an infant born in the 1980 birth cohort, in the highest risk State was nearly three times that in the lowest risk State. Mortality risk ratios of two or greater were found when comparing high and low States for overall black infant mortality risks, overall neonatal mortality, neonatal mortality risks for black and white infants examined separately, neonatal mortality risks for low birth weight infants regardless of race, and overall postneonatal mortality and postneonatal mortality for white infants. The lowest State-specific black mortality risks were higher than the highest white risks for overall infant mortality and neonatal mortality. The differences between State extremes in mortality risks are greater than the differences between the United States and the Scandinavian countries with the lowest infant mortality.

THE INFANT MORTALITY RATE FOR THE UNITED States compares unfavorably with the rates found in the countries of Western and Northern Europe (*1*). The fact that the United States ranks 18th in the world in infant mortality has been viewed with embarrassment because of what this ranking implies regarding the health and services for low socioeconomic groups in U.S. society. Infants born in Sweden or Finland have mortality rates approximately 70 percent lower than do infants born in the United States (*1*). These comparisons provide a powerful incentive for increased efforts to improve infant survival.

Similarly, States can use their relative rankings in the United States to highlight program needs and to develop broad support for maternal and child health programs. For example, the high rates of infant mortality among Southern States led the Southern Governors Association to identify infant mortality as an area for increased effort (*2*). In this paper we examine the State-specific variation in infant and neonatal mortality and discuss implications of this variation for State program evaluation and priorities.

Even though comparisons of crude infant mortality are powerful incentives for increased program efforts to improve infant survival, researchers and public health practitioners are aware that simplistic comparisons of crude rates can mask large differences in baseline population risk and prevalence of low birth weight. For example, the twofold higher risk of mortality among black infants compared with white infants is a national problem that we highlight throughout this report. Using data from the National Infant Mortality Surveillance (NIMS) project, we will

show that even when racial differences are taken into account and birth weight groups are examined separately, large differences in infant mortality risks persist among the States. These differences, in fact, remain larger than those found between the United States and the countries of Europe with the lowest infant mortality rates.

Methods

The methods of the NIMS project, including data collection and evaluation, are described in detail elsewhere (*3–5*). In brief, 53 vital statistics reporting areas participated in the project: 50 States, New York City, the District of Columbia, and Puerto Rico. These national level tabulations do not include Puerto Rico. All reporting areas (subsequently referred to as "States") linked birth and death certificates for infants who were born alive in 1980 and who died within the first year of life in 1980 or 1981. The completeness of birth and death certificate linkage is estimated to be approximately 95 percent (*3–5*). States provided the Centers for Disease Control (CDC) with the number of infant deaths by birth weight, age at death, race, and other infant and maternal characteristics. CDC generated corresponding numbers of births from the computer tape of 1980 natality records produced by the National Center for Health Statistics (NCHS), with exceptions for Maine and New Mexico as previously described (*3*). State of residence was defined in State of mother's residence at the time her infant was born; race of infant was based on the race of both parents, using the NCHS algorithm (*6*). For logistic reasons, categories for race of infant were limited to white, black, and all races combined. Because the NIMS data are for a birth cohort, rather than for births and deaths occurring in a given year, we use the term mortality "risk" instead of "rate."

The neonatal mortality risk (NMR) was defined as the number of neonatal deaths (less than 28 days of age) per 1,000 live births, the postneonatal mortality risk (PNMR) as the number of postneonatal deaths (28 days to less than 1 year) per 1,000 neonatal survivors, and the infant mortality risk (IMR) as the number of infant deaths (less than 1 year) per 1,000 live births. For calculation of mortality risks, infants with unknown birth weight (0.2 percent of births and 3.3 percent of deaths) were assigned to birth weight categories according to the proportion of neonates and infants with known birth weights (*3*).

For this analysis we limited our comparisons to single-delivery infants. We ranked States according to their overall infant mortality risks and neonatal and postneonatal mortality risks. Because the major predictor for neonatal mortality is birth weight, we examined whether risks for low birth weight infants (500–2,499 grams (g)) showed substantially lower variation than overall risk. We excluded births and deaths of infants weighing less than 500 g because we were focusing on mortality differences as a reflection of infant care.

State comparisons of mortality risks were carried out separately for both white and black births. Because many States have too few births and deaths in some subgroups to have statistically stable estimates of birth weight-specific mortality risks, we limited our comparisons to States with at least 25 deaths in each category or a minimum of 2,500 births or neonatal survivors in the category regardless of the number of deaths. In addition, we excluded from the comparison of high and low extremes States in which total reported infant deaths differed by more than 10 percent from the estimated expected number of deaths using NCHS mortality records (*3,4*). We also excluded one State in which there was uncertainty regarding birth weight distribution. These exclusions served to remove outliers whose extreme risks were possibly due to small numbers or data problems.

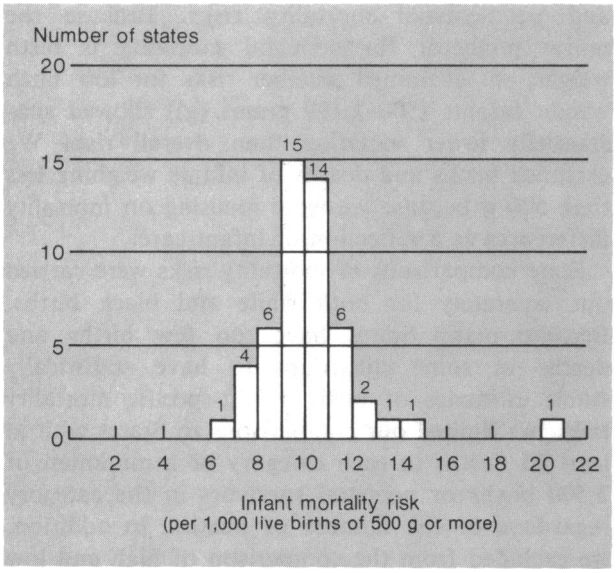
We compared the mortality risk ratio in the State having the highest risk with that in the State having the lowest risk. High risk ratios indicate large variation between States. Statistical significance is not shown for these ratios, although in every instance the risk in the highest risk State was significantly higher than the risk in the lowest risk State.

To examine the relationship between very low birth weight (VLBW, 500–1,499 g) and neonatal mortality according to the method of Lee and coworkers, we included all States unless the number of deaths (at least 25) or births (at least 2,500) was too few (*7*). This method correlates the frequency of very low birth weight with the neonatal mortality risk to identify crudely the relative contribution of birth weight-specific mortality compared with birth weight distribution to their neonatal mortality rank. Each State was weighted equally rather than weighted according to the number of births.

Results

Overall infant mortality. Figure 1 shows the distribution of State-specific infant mortality risks

Figure 1. Distribution of State infant mortality risks, National Infant Mortality Surveillance, 1980 U.S. birth cohort



for all States. After applying the exclusionary criteria for data completeness and small numbers, the risk in the highest risk State was still nearly three times higher than in the State with the lowest risk (table 1). Because race is such a powerful predictor of overall infant mortality risk, comparisons within racial groups showed decreased variation between the high and low States. Nevertheless, among white infants the risk for the highest risk State compared with the lowest risk State was 60 percent greater, and among blacks the highest State risk was 100 percent greater.

Nationally, black infants with birth weights of 500 g or more were approximately twice as likely to die as white infants (16.5 compared with 8.7 per 1,000 live births). This same risk ratio holds true when comparing the lowest and highest State black risks with the corresponding white risks. In fact, the highest State white infant mortality risk (10.1) was still lower than the lowest black infant mortality risk (12.5).

Neonatal mortality. State variation in the overall risk of neonatal mortality was the largest of any of the comparisons made, with a mortality risk ratio of 3.6 from the highest to the lowest State (table 2). Even when comparisons were made within racial groups, the risks of neonatal death for both whites and blacks in the highest States were more than two times their risks in the lowest. Thus, risk ratios remained high even when we accounted for race.

Table 1. State extremes in infant mortality risks (deaths per 1,000 live births) by race, National Infant Mortality Surveillance, 1980

Race	Highest	Lowest	Mortality ratio
All races[1]	20.6	7.4	2.8
White[1]	10.1	6.5	1.6
Black[1]	24.6	12.5	2.0
Black to white mortality ratio[1]	2.4	1.9	. . .

[1]All races includes 42 States; white, 41 States; and black, 26 States.
NOTE: For exclusion criteria see text.

Table 2. State extremes in neonatal mortality risks (deaths per 1,000 live births) by race, National Infant Mortality Surveillance, 1980

Race	Highest	Lowest	Mortality ratio
All races[1]	15.8	4.4	3.6
White[1]	6.9	3.2	2.1
Black[1]	18.9	8.0	2.4
Black to white mortality ratio[1]	2.7	2.5	. . .

[1]All races includes 42 States; whites, 41 States; and blacks 25 States.
NOTE: See text for exclusion criteria.

We also found large State-to-State variation in risk of neonatal death for low birth weight infants (500–2,499 g) (table 3). In States with the highest risks, low birth weight infants were more than twice as likely to die in the neonatal period as similar infants in States with the lowest risks. There was little change in the risk ratios of the States with extreme risks when the races were examined separately.

Because survival probabilities among low birth weight infants change rapidly with small increases in birth weight, we also examined State differences in survival for VLBW infants (500–1,499 g). Although these mortality ratios were somewhat smaller, the highest mortality risks were still approximately twice those risks in the lower States (data not shown).

The black to white neonatal mortality risk ratios show the same twofold excess among blacks as is found for overall infant mortality, with the lowest black risk being twice as high as the lowest white risk (table 2). However, when low birth weight infants are examined separately, the lowest State risks for blacks and whites are comparable.

Postneonatal mortality. The mortality ratios for postneonatal mortality between highest and lowest States were more than two for risk for all races combined and for whites (table 4). The black to

Table 3. State extremes in neonatal mortality risk (deaths per 1,000 live births) for low birth weight infants (500–2,499 g), National Infant Mortality Surveillance, 1980

Race	Highest	Lowest	Mortality ratio
All races[1]	118.1	50.0	2.4
White[1]	108.6	49.8	2.2
Black[1]	125.9	54.4	2.3
Black to white mortality ratio[1]	1.2	1.1	...

[1]All races includes 42 States; white, 40 States; and black, 24 States.
NOTE: See text for exclusion criteria.

Table 4. State extremes in postneonatal mortality risk (deaths per 1,000 live births), National Infant Mortality Surveillance, 1980

Race	Highest	Lowest	Mortality ratio
All races[1]	5.4	2.3	2.3
White[1]	4.8	2.0	2.3
Black[1]	8.2	4.5	1.8
Black to white mortality ratio[1]	1.7	2.2	...

[1]All races includes 42 States; white, 41 States; and black, 24 States.
NOTE: See text for exclusion criteria.

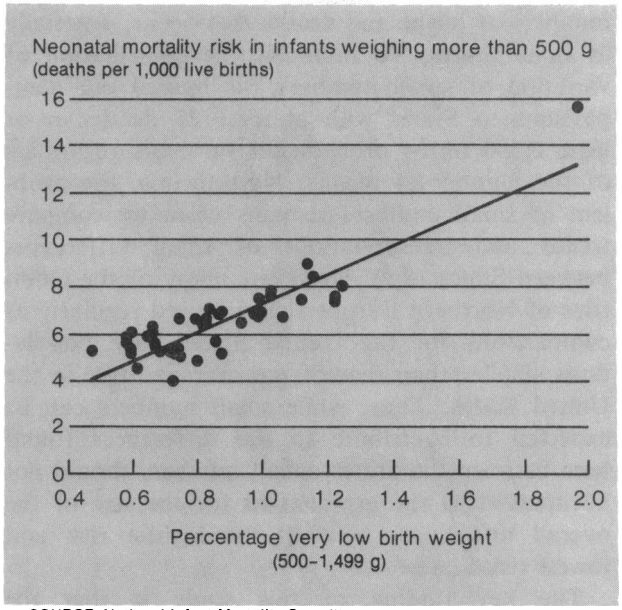
white mortality ratio was more than two for all States combined and was essentially consistent with comparisons of the lowest and highest States across races. The lowest State black risk (4.5 per 1,000) was nearly equal to the highest State white postneonatal mortality risks (4.8 per 1,000).

Comparison of State NMR with VLBW rate. We found a strong correlation (Pearson's $r = 0.88$) with the State neonatal mortality risk as the percentage of VLBW infants increased (fig. 2). The relationship for all races combined is substantially stronger than for either race examined separately (whites, $r = 0.37$; blacks, $r = 0.62$). This is largely because the birth weight distribution is so different between the races. The lowest prevalence of VLBW among blacks infants was 1.67 percent, whereas for whites the highest prevalence was 0.8 percent.

Discussion

It is not surprising to find that substantial variation exists between the extremes of State-specific infant mortality risks. States vary widely in population risk characteristics, prevalence of low birth weight, and geographic obstacles to delivery of care, especially neonatal intensive care. It is surprising, however, that the risk ratios found are

Figure 2. Neonatal mortality risk, all races, single deliveries, by percentage very low birth weight



SOURCE: National Infant Mortality Surveillance.

so large and that the risks remain more than twice as high in some States as in others, even within race and birth weight categories.

Infant mortality is generally considered a sensitive measure of the overall health of a population. It is for this reason that the unfavorable U.S. infant mortality position, relative to other developed countries, is viewed with such concern. Yet in this analysis we found that even larger differences in infant mortality exist between the States with highest and lowest risks than exist between the United States and other developed countries with the lowest risk. In 1980, Sweden had an infant mortality rate of 6.9 per 1,000 live births, compared with the U.S. rate of 12.5. Yet several States in the United States had infant mortality risks (8.4 or less) that would have placed them within the top five developed countries (*1*).

It is unlikely that problems with data quality explain many of the differences in infant mortality, although it is likely that State-to-State variations in the quality of vital records and record linkage may contribute to the apparent differences noted here (*3–5*). Further, it is also unlikely that differences in data quality and procedures vary more from State to State than they do between the United States and other countries. That is, there is probably less variation in definitions, reporting, and linkage between States of the United States than there is between the United States and other developed countries.

It is possible that some of the variation found here also reflects variation inherent in the small numbers of births and deaths that occur, especially in small States. To minimize the contribution of variation of small numbers, we limited our comparisons to States with at least 25 deaths or at least 2,500 births or neonatal survivors regardless of the number of deaths. Nevertheless, the problem of small numbers remains when we compare trends and interpretations of small differences between States (*8,9*). However, many of the countries of Northern Europe that are used regularly as comparisons for the United States have populations smaller than that of the average State in the United States. Thus, while small numbers can be expected to contribute to the differences found here between the States, small numbers should not be invoked as the explanation for the size of the overall differences between the highest risk and lowest risk States.

The key finding of this study is that the differences between the States in the United States in infant, neonatal, and postneonatal mortality are greater than those found between the United States and the countries of Scandinavia. Comparisons of the United States and other developed countries have been used for many years to help support national actions to reduce infant mortality. We suggest that differences considered intolerable between the United States and other developed countries must also be considered intolerable between the States of the United States.

Previous analyses of the source of the difference between infant mortality in the United States and that of Scandinavian countries have found that the high frequency of low birth weight infants in the United States is the major source of the excess U.S. infant mortality rate (*10,11*). That differences among States persist even when racial differences and birth weight, the most important mortality predictors, are considered, suggests that differences in access to care, quality of care, or both contribute to the mortality risk differences.

Our analysis also highlighted the great discrepancy between the survival of black and white infants. The most favorable mortality risks found for black infants were barely comparable to the worst mortality risks found for white infants. When examining the relationship between the VLBW rate and the neonatal mortality risk, we found that an important cause of the strength of the overall relationship was the very discrepant risks of having VLBW births when blacks were compared with whites. In fact, when we examined the relationships separately for each race, the correlation was substantially weaker.

Nevertheless, the comparison of VLBW rate and the risk of neonatal mortality remains highly valuable in its simplicity. States with neonatal mortality risks substantially below the regression line have birth weight-specific survival rates that are substantially better than average. These States are unlikely to improve neonatal mortality greatly through improvements in intensive care and even less likely to improve relative to other States, because similar improvements are likely to occur in all States. For States whose risk falls below the neonatal mortality risk regression line, efforts are best directed at prevention of low birth weight. Conversely, States that fall substantially above the regression line can expect to achieve further improvement through increasing access to quality of neonatal care as well as in addressing the problem of low birth weight. Thus, for the United States as a whole, excess prevalence of low birth weight appears to be the major reason that the U.S. infant mortality rate is so much higher than that of other developed countries. However, within the United States there still appear to be States in which improvements in quality of perinatal and neonatal care can be expected to pay dividends.

Of greatest importance is that the low risks of infant mortality achieved by several States, which are competitive with the lowest rates in Northern Europe, clearly should be attainable goals for other States.

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Birth Weight-Specific Infant Mortality, United States, 1960 and 1980

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Contributing to the research were the following persons from the Research and Statistics Branch: Jeanne C. Gilliland, J. Patrick Whitaker, and Evelyn L. Finch, who worked on systems design and assisted in computer programming, aggregating data from 53 vital statistics reporting areas; Sara W. Gill and Merrell Ramick, who assisted in preparing the data for processing; and Phyllis A. Wingo, who coordinated the data management. Patricia Knapp, Division of Analysis, National Center for Health Statistics, provided assistance in the use of data from the 1960 birth cohort study.

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Synopsis

National statistics on the risk of infant mortality by birth weight were collected most recently in 1980 and 1960. (Infant mortality risk is the number of deaths of infants under 1 year of age per 1,000 live births.) In this 20-year period, the infant mortality risk (IMR) for single-delivery infants declined 53 percent, from 23.3 deaths per 1,000 live births to 11.0; 91 percent of this decline was due to lower IMRs within birth weight categories, and 9 percent was due to reduced frequency of low birth weight. The greatest reduction in neonatal mortality (under 28 days)—73 percent—occurred among infants of 1,500-1,999 grams (g) birth weight, whereas the greatest reductions in postneonatal mortality (28 days to under 1 year)—51 percent to 54 percent—occurred among infants of 3,500 g or more birth weight.

Trends in IMR for black and white infants were similar, and the twofold gap between the races in IMR persisted from 1960 to 1980. For whites, reductions in the frequency of low birth weights contributed to the decline in the IMR. For blacks, the percentage of infants with birth weights of less than 1,500 g increased, and the total reduction in the IMR was attributable to lower birth weight-specific mortality risks. In some regions of the United States, failure to observe an increase in birth weight for blacks may be a reporting artifact, reflecting improved reporting of births of very small black infants in 1980.

Examination of changes in perinatal mortality risks (from 20 weeks gestation to less than 28 days of life) did not suggest that infant mortality trends were substantially affected by changes in the distinction between fetal and neonatal deaths over the 20-year period. Reducing the number of low birth weight infants remains the greatest potential for future reductions in infant mortality.

DECLINES IN INFANT MORTALITY may reflect the birth of fewer infants of low birth weight, improved survival among infants in different birth weight groups, or both. Using information from individual States or groups of States, researchers have demonstrated that recent mortality reductions