Extremely Low Birth Weight and Infant Mortality Rates in the United States

AUTHORS: Carissa Lau, Namasivayam Ambalavanan, MD, Hrishikesh Chakraborty, DrPH, Martha S. Wingate, DrPH, and Waldemar A. Carlo, MD

Objective: Infant mortality rates (IMR) and neonatal mortality rates (NMR) in the United States have not decreased noticeably during recent decades. The purpose of this study was to determine the contributions of birth weight and gestational age subgroups to the IMR and NMR in the United States.

Methods: We used the most recent (1983–2005) US linked birth and infant death data and simple regression analysis to determine the contributions of specific birth weight and gestational age subgroups to trends in IMR and NMR.

Results: IMR and NMR decreased between 1983 and 2005 for all birth weight and gestational age subgroups. There was an increase in births of very low birth weight infants from 1.2% to 1.5% (P < .001) over this period. The proportion of very low birth weight–infant deaths increased from 42.9% to 54.8%, resulting in recent nonsignificant declines in IMR and NMR. The proportion of live-born infants <500 g increased from 0.12% to 0.18% (P < .001). The adjusted IMR and NMR over time (excluding infants <500 g) have steeper declining trends than the ones including infants <500 g. The changes in overall IMR and NMR in recent years (2000–2005) are not statistically significant. However, the adjusted IMR and NMR trends during this time are highly significant.

Conclusions: The increased proportions of infants <500 g and other low birth weight infants contribute greatly to the lack of a decrease in IMR and NMR from 2000 to 2005, although birth weight– and gestational age–specific IMR and NMR continue to decrease. Pediatrics 2013;131:1–6
From 1915 to 2008, the reported infant mortality rates (IMR) in the United States decreased from 99.9 deaths to 6.6 deaths per 1000 live births.¹ Neonatal mortality rate (NMR) decreased from 20.5 deaths in 1950² to 4.3 deaths in 2008 per 1000 live births.¹ Although the IMR and NMR in some other high-income countries have continued to decrease,² IMR and NMR in the United States have not decreased notably from 2000 to the most recent data in 2008, ranging from 6.6–7.0 and 4.3–4.7 deaths per 1000 live births, respectively.¹,³ thereby leading to a worsening international rank.⁵

The recent plateau in infant mortality may be related to the increasing proportion of preterm (<37 weeks gestation) and low birth weight (<2500 g) deliveries. From 1983 to 2005, preterm birth rates increased from 9.0% to 12.7%.⁶ Additionally, the percentage of low birth weight infant births increased from 6.8% in 1983 to 8.2% in 2005.⁶ Preterm birth and low birth weight are among the most frequent causes of infant and neonatal death in the United States.⁷ Between 2000 and 2005, total preterm births increased by 9%, which accounted for a large percentage of infant deaths.⁸ Increases in the Alabama and Delaware IMR have been attributed to a rise in very low birth weight infant mortality.⁹ In 1993, a similar study in Canada noted that increased reporting of live infants born weighing <500 g had negatively affected its IMR.¹⁰ An increase in preterm births may in part account for the lack of improvement in IMR and NMR, and thus analysis of nationwide data would be useful.

The purpose of this study was to examine the contribution of narrow birth weight categories (250-g and 500-g intervals) to the IMR and NMR of the United States. Specifically, we evaluated the effect of birth weight on the overall United States IMR and NMR. By examining narrow ranges of birth weights, it would be possible to determine their proportional contributions to IMR and NMR. We hypothesized that the increased number of infants born weighing <500 g has disproportionately influenced IMR and NMR.

**METHODS**

We obtained data from the National Center for Health Statistics linked birth and infant death cohort data files² for all the years available during the period 1983–2005. Years 1992–1994 were unavailable and were therefore excluded. To determine the birth weight–specific neonatal and infant mortality rates, data were analyzed by the following weight subgroups used in the database: ≥3500 g, 3000 to 3499 g, 2500 to 2999 g, 2000 to 2499 g, 1500 to 1999 g, 1250 to 1499 g, 1000 to 1249 g, 750 to 999 g, 500 to 749 g, and <500 g. Infants with unknown birth weight were excluded. For each year, the following calculations were performed for each weight subgroup: percentage of live births, percentage of infant deaths, percentage of neonatal deaths, IMR, and NMR. The same analysis was done for gestational age subgroups in the database: <28 weeks, 28 to 31 weeks, 32 to 35 weeks, 36 weeks, 37 to 39 weeks, 40 weeks, 41 weeks, and 42 weeks. By determining the percentages of births and deaths, we were able to observe how each subgroup’s contribution has changed over time.

Simple regression analysis was used to analyze the trends of IMR and NMR over time. We computed adjusted rates, which did not include infants born <500 g, as well as the actual rate, which included all birth weight subgroups. We evaluated and compared the trends over 2 time periods: 1983–1999 and 2000–2005. These periods were selected on the basis of recent analyses that support a lack of decrease in IMR during this the last decade.¹¹ Analysis of this cut off allowed us to observe whether the mortality rates had changed significantly over time. We also analyzed the proportion of infants born <500 g to total births over the same 2 periods and over the entire period and their effect on IMR and NMR. This analysis allowed us to determine the contribution of these births to IMR and NMR. A P value of <.05 was considered significant.

**RESULTS**

Over the study years, there was an increasing trend (P < .001) in the number of infants in the lower birth weight subgroups (<1500 g) with a corresponding decreasing trend (P < .001) in infants ≥3500 g (Fig 1). From 1983 to 2005, the contribution of very low birth weight infants (VLBW, <1500 g) to the total number of infant births increased from 1.2% to 1.5% (43 284–63 030), and the proportion of live births infants <500 g increased from 0.12% to 0.18% (4444–7274), both P < .001, while the contribution of those >3500 g decreased from 40.1% to 35.1%. The contribution of VLBW infants to deaths increased from 42.9% to 54.8% during this period. Similarly, there was an increased proportion of preterm infants born, with a corresponding decrease in postterm and term infants (Fig 2). The various subgroups of VLBW infants and infants born at <28 weeks increasingly contributed to infant deaths (Figs 3 and 4).

Both the IMR and NMR showed a significant decline from 1983 to 1999 and showed a nonsignificant declining trend from 2000 to 2005 (Fig 5). IMR and NMR decreased between 1983 and 2005 for all birth weight and gestational age subgroups. The analysis showed that during the period 1983–1999, the total IMR was declining significantly (P < .001), but during 2000–2005 it had no significant declining trend (P = .28). The gap between the IMR and NMR became smaller, as neonatal deaths
contributed more to the IMR. When the IMR was adjusted so that it did not include births or deaths of infants <500 g, there was an improvement in the United States IMR and NMR (Fig 5). The adjusted IMR decrease declined during 2000–2005 ($P = .006$). The difference between the adjusted and unadjusted IMR widened in the recent years as more infants <500 g were being registered. NMR decreased significantly during 1983–1999 ($P < .001$) but not during 2000–2005 ($P = .26$). The adjusted NMR, however, decreased throughout both the first ($P < .001$) and the second ($P = .002$) analyzed time periods (Fig 4). Infants <500 g had a bigger impact on the NMR than infants in other weight subgroups.

**DISCUSSION**

This study shows that IMR and NMR in the United States have not decreased recently, but this is due to increases in live birth registrations of smaller and more immature infants, particularly infants with birth weights <500 g. IMR and NMR have continued to decrease when birth weight– and gestational age–specific analyses are done. The narrowing gap between IMR and NMR is due to the increased proportion of extremely low birth weight and preterm infants.

This study has some intrinsic limitations. The data are retrospective and only published through 2005. Data collection of selected variables at the state level varied over this time period. There is possible misclassification between early infant deaths and fetal deaths but this is difficult to ascertain from the database. The unavailable cohort data from 1992 to 1994 could affect the statistical analysis of that time period. The effect of VLBW infants on IMR has been reported individually for Delaware and Alabama as well as in Canada. In the Delaware study, investigators reported that the increased IMR was due to an increase in VLBW infant mortality, while...
in the Alabama study it was concluded that the increase in infant mortality was due to infants <500 g. In Canada, an increase in IMR noted from 1992 to 1993 was reported to be due to increased registration of infants <500 g.10

A previous national study in the United States identified preterm birth as the most frequent cause of infant death.13 The current analysis focused on birth weight, but birth weight and gestational age are highly correlated.14 The increasing proportion of low birth weight infant births and deaths suggests an increasing contribution of preterm births to IMR and NMR. In an in-depth analysis of causes of infant mortality, preterm birth was found to be the most frequent cause in the United States, accounting for at least 34% of the deaths in 2002 and twice as many as that determined using standard coding procedures.13 The current study suggests that the contribution of prematurity to IMR and NMR has been increasing in recent years, particularly due to the most preterm infants, and accounts for the significant declining trends in IMR and NMR in recent years.

In the United States, there has been a rise in preterm birth rates due to induced preterm birth while spontaneous preterm births have declined,15 but these data are not likely to be due to the infants <500 g, as they constitute a minute proportion (currently about 0.15%) of the births (Fig 1). The rise in induced preterm births may indicate obstetrical successes,15 but the benefits for perinatal mortality and morbidity need to be demonstrated. Importantly, 23% of late-preterm infants do not have a recorded indication for delivery noted on the birth certificate.16 In addition to prematurity, the long-standing racial and ethnic disparities in infant outcomes also account for the lack of decrease in infant mortality in the United States.11 The continuing increase

FIGURE 3
Percentage contribution of infants in each birth weight subgroup to infant mortality for 1983–2005. The subgroups that contributed the most to infant mortality were the VLBW subgroups despite their relatively small contribution to births. Infants <500 g contributed the most (>20%) to deaths in recent years.

FIGURE 4
Percentage contribution of infants in gestational age subgroups to infant mortality for 1983–2005. Infants, 28 weeks contributed the most to infant mortality, and their contribution increased over the years.
in twin, triplet, and higher-order births in the United States accounts for some of the increase in lower birth weight and preterm infants. To our knowledge, this is the first birth weight–specific analysis that identifies the determinant contribution of infants <500 g to the IMR and NMR in the national data trends in the United States.

Although we focused the study on national linked birth and infant death cohort data, we also examined linked birth and infant death period data. The evaluations of the period linked set of data returned very similar results and verified that the changes in IMR and NMR from 1999 to 2005 were not significant unless infants <500 g were excluded.

It is possible that increased reporting accounts for the increased number of infants born weighing <500 g in the database. The World Health Organization defines live birth as the expelled product of conception showing evidence of life regardless of the duration of pregnancy. In contrast, in many countries, including many high-income countries, the definition of live birth requires a birth weight of 500 g or more.

In a study of live birth reporting in industrialized countries, the proportion of live births under 500 g varied from <1 per 10 000 live births in Belgium, Ireland, Latvia, Poland, and the Slovak Republic to >10 per 10 000 in Canada and the United States. These international differences compromise the validity of the rankings of neonatal and infant mortality. This also explains in part why the US IMR and NMR are higher than those of many other countries. The Born-Alive Infant Protection Act, which defines a live birth without regard to gestation, may have had a small impact after it became law in 2002, but the effect of the increased proportion of smaller and more immature infants occurred before.

A gestational age analysis indicates that the primary reason for the higher IMR in the United States appears to be the higher proportion of preterm births. A greater than 10-fold differential in the classification of fetal versus first 24-hour deaths has been reported between states in the United States. Twenty states had a specific tendency to classify these infants as either fetal deaths or live births/deaths. A trend for more births being classified as early neonatal deaths rather than fetal deaths could explain the increase in very low birth weight infants. The current study documents that there is an increase in the proportion of infants in the lower birth weight subgroups during the period of over 2 decades. Whether this is due to increased reporting or not cannot be determined by our study as it is difficult to ascertain from the national database. The 2009 US national data indicate that prematurity rates have decreased during the previous 3 years, and that overall low birth weight rates were not increasing.

**CONCLUSIONS**

The current study shows that IMR and NMR have continued to decrease during recent years in the United States when birth weight–specific analysis is done. The increasing proportion of infants in the lower birth weight groups is preventing larger decreases in IMR and NMR. The extent to which the increased proportion of lower birth weight infants is due to reporting, versus actual increased births, cannot be determined from our analysis.
REFERENCES

Extremely Low Birth Weight and Infant Mortality Rates in the United States
Carissa Lau, Namasivayam Ambalavanan, Hrishikesh Chakraborty, Martha S. Wingate and Waldemar A. Carlo
Pediatrics; originally published online April 1, 2013;
DOI: 10.1542/peds.2012-2471
Extremely Low Birth Weight and Infant Mortality Rates in the United States
Carissa Lau, Namasivayam Ambalavanan, Hrishikesh Chakraborty, Martha S. Wingate and Waldemar A. Carlo
Pediatrics; originally published online April 1, 2013;
DOI: 10.1542/peds.2012-2471

The online version of this article, along with updated information and services, is located on the World Wide Web at:
/content/early/2013/03/27/peds.2012-2471