OBSTETRICS

Decreased term and postterm birthweight in the United States: impact of labor induction

Xun Zhang, PhD; K. S. Joseph, MD, PhD; Michael S. Kramer, MD

OBJECTIVE: We sought to assess recent trends in falling mean birthweight (BW) and gestational age (GA) among US non-Hispanic white singleton live births ≥37 weeks of gestation and the contribution of increased rates of induction to these trends.

STUDY DESIGN: This was an ecological study based on US vital statistics from 1992 through 2003.

RESULTS: From 1992 through 2003, mean BW fell by 37 g, mean GA by 3 days, and macrosomia rates by 25%. Rates of induction nearly doubled from 14% to 27%. Our ecological state-level analysis showed that the increased rate of induction was significantly associated with reduced mean BW (r = −0.54; 95% confidence interval [CI], −0.71 to −0.29), mean GA (r = −0.44; 95% CI, −0.65 to −0.17), and rate of macrosomia (r = −0.55; 95% CI, −0.74 to −0.32).

CONCLUSION: Increasing use of induction is a likely cause of the observed recent declines in BW and GA. The impact of these trends on infant and long-term health warrants attention and investigation.

Key words: birthweight, cesarean section, ecological analysis, gestational age, labor induction, vital statistics


From the Departments of Pediatrics (Drs Zhang and Kramer) and Epidemiology, Biostatistics, and Occupational Health (Dr Kramer), McGill University Faculty of Medicine, Montreal, Quebec, and the Department of Obstetrics and Gynecology and the School of Population and Public Health, University of British Columbia and British Columbia’s Women’s Hospital and Health Center (Dr Joseph), Vancouver, British Columbia, Canada.

Presented at the 21st Annual Meeting of the Society for Pediatric and Perinatal Epidemiologic Research, Chicago, IL, June 19-21, 2008.

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REFERENCES


2. From the Departments of Pediatrics (Drs Zhang and Kramer) and Epidemiology, Biostatistics, and Occupational Health (Dr Kramer), McGill University Faculty of Medicine, Montreal, Quebec, and the Department of Obstetrics and Gynecology and the School of Population and Public Health, University of British Columbia and British Columbia’s Women’s Hospital and Health Center (Dr Joseph), Vancouver, British Columbia, Canada.

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Birthweight (BW) and gestational age (GA) are key measures of maternal and infant health both for individuals and populations. \(^1,2\) In industrialized countries, preterm birth (GA < 37 completed weeks) is the leading cause of infant mortality, and survivors are at risk for major neurocognitive, pulmonary, and ophthalmologic morbidity. \(^3,4\) Even more recently, however, rates of macrosomia have begun to fall in the United States. \(^18\) Moreover, rates of labor induction have doubled since the early 1990s, \(^19-21\) largely due to a rise in elective induction. \(^19,22-24\) In examining recent trends in BW in US vital statistics, we noticed a recent decline and wondered whether the decline was entirely attributable to the well-recognized temporal increase in preterm (<37 weeks) birth, and if not, whether increased rates of induction and cesarean delivery might be contributing to the decline. To explore these hypotheses, we examined temporal trends in BW, GA, labor induction, and cesarean delivery among singleton live births born at term (37-41 weeks) or postterm (≥42 weeks) gestation and the association between the rising rates of labor induction and cesarean delivery and temporal changes in BW and GA. To avoid confounding by the medical indication for labor induction (ie, the pregnancy complications that affect BW and GA independently affect the risk of labor induction), we based our analysis on an ecological (state-level) approach. \(^25,26\)

MATERIALS AND METHODS

Our study was based on US live birth cohorts for the years from 1992 through 2003. Natality data files, compiled by the National Vital Statistics System of the National Center for Health Statistics, provide demographic and health data for births occurring during the calendar year. The data are based on information abstracted from birth certificates filed in vital statistics offices of each state and the District of Columbia. Demographic data include variables such as date of birth, age and educational attainment of the parents, marital status, live-birth order, race, sex, and geographic area. Health data include items such as BW, gestation, prenatal care, attendant at birth, mode of delivery, and labor management (in-
cluding induction). For cesarean deliveries, the timing, ie, prelabor (elective) vs after onset of labor, is not recorded.

In the United States, GA is usually calculated from the first day of the mother’s last menstrual period (LMP). It has been shown that GA derived from the LMP estimate is prone to error, especially for postterm dates.

The clinical estimate of gestation is also recorded, although prior to the 2003 revision, no instructions were provided for specifying the basis of the estimate.

The clinical estimate is based on the managing clinician’s best estimate, including menstrual history, physical findings, laboratory values, and (if available) sonography.

Recent evidence suggests that the clinical estimate provides rates of preterm birth, postterm birth, and GA-specific rates and relative risks of adverse pregnancy outcomes that are more consistent with those reported in other countries.

In this study, therefore, our analyses were based on the clinical estimate of GA.

We restricted our principal analysis to singleton non-Hispanic white live births delivered at \( \geq 37 \) completed weeks of gestation. The restriction by race was intended to control for potential confounding due to differences in induction and cesarean rates by race and the changing racial composition over time.

To assess the generalizability of our findings, however, we repeated the analysis in non-Hispanic blacks. Restriction to live births avoided the reverse causality inherent in the fact that induction is often used to deliver stillborn fetuses. Restriction to term and postterm singleton births ensured that our findings would not be driven by increases in multiple births and/or indicated preterm deliveries. California was excluded from the analyses because no data were available on clinical estimate of GA.

We first calculated the mean BW from 1972 through 2003 for all white singleton live births delivered at term or postterm gestations based on the LMP estimate. (No data on Hispanic origin or clinical estimate of GA were available in the 1970s and the early 1980s.) The US birth certificate was revised in 1989 to include, among other data items, the clinical estimate of GA and use of induction. A substantial number of states did not report these data items in 1989 through 1991, however. We therefore began with 1992 and examined temporal trends in BW, GA, labor induction, and cesarean delivery for non-Hispanic whites from 1992 through 2003.

Mean BW, mean GA, distributions of GA, and rates of macrosomia, labor induction, and cesarean delivery were calculated for each calendar year. Macrosomia was defined as a BW >4500 g. Gender-specific mean BW-for-GA z-scores were calculated based on an internal reference, ie, the difference between the observed BW and mean BW divided by SD for each gender at each completed week of gestation; small for GA (SGA) was defined using the customary cutoff as <10th percentile, large for GA (LGA) as >90th percentile, and appropriate size for GA (AGA) as between the 10th and 90th percentiles.

Our study sample consisted of 23,549,360 non-Hispanic white live births born at \( \geq 37 \) weeks of gestation from 1992 through 2003. Missing values for induction and cesarean delivery were negligible (0.84% and 0.88%, respectively) and individuals with missing values were excluded from estimation of nationwide rates for these procedures.

The association between labor induction and BW or GA is likely to be confounded by the medical indication for labor induction. In other words, maternal or fetal conditions or complications leading to induction are likely to be responsible for lower BW or GA independently of the effects of induction.

Although some adverse maternal and fetal conditions are reported on the US birth certificate, specific indications for induction are not, and thus cannot be controlled adequately at the individual level.

To reduce confounding by medical indication, we therefore designed an ecological analysis.

The analysis was based on 48 ecological units: 47 states plus the District of Columbia. As noted earlier, California was excluded because no data are available on the clinical estimate of GA. Previous studies suggest that labor induction rates in Wisconsin and New York were unexpectedly high due to faulty reporting. These 2 states were therefore also excluded from the analysis. We also conducted a sensitivity analysis with all the states (including California, New York, and Wisconsin), based on the LMP estimate of gestation.

In the ecological analysis, we used data for 1992 (n = 1,881,358) and 2003 (n = 1,739,197). It has been reported that the rate of induction in US vital statistics data is likely to be an overestimate of the true rate. However, differences of induction rates between the 2 time points (1992 and 2003) are less likely to be affected by any systematic underreporting or overreporting within states. We calculated rates of induction and cesarean, mean BW, mean GA, rate of macrosomia, and mean BW-for-GA z-score for each of the 48 ecological units in the years 1992 and 2003, respectively. The z-score was based on an internal standard: non-Hispanic white singleton live births from 1992 through 2003. We then calculated the changes in these means or rates for each of the 48 ecological units between 1992 and 2003, ie, the differences from the year 2003 vs the year 1992. Using these state-level aggregated data (ie, the differences between the 2 years for the 48 units), we then assessed the association between the change in rates of labor induction and changes in mean BW, mean GA, rates of macrosomia, and mean z-score and rates of SGA, LGA, and AGA between 1992 and 2003.

Bivariate correlations between the change in induction and changes in mean BW, mean GA, rates of macrosomia, mean z-score, and SGA, LGA, and AGA rates were calculated, with each state weighted by its total number of births. Ecological multiple linear regression analysis was used to estimate the independent effect of change in labor induction on changes in mean BW, mean GA, rate of macrosomia, and mean z-score after adjustment for changes in parity, maternal age, and maternal education. Although the data file contained a substantial number of missing values for maternal education (4.7%), this state-level variable was calculated based on available data. Finally, we carried out similar analyses to assess the effects of changes in cesarean delivery rates and of changes in a composite of labor induction and/or cesarean delivery. All data
were analyzed using the software SAS v. 9.1 (SAS Institute, Cary, NC).

**Results**

As shown in Figure 1, the mean BW of white singleton live births at term and postterm gestations increased in the 1970s and 1980s by >60 g but began to fall in the early 1990s. Table 1 shows trends from 1992 through 2003 in mean GA, BW, and BW-for-GA z-score and rates of macrosomia, labor induction, and cesarean delivery among non-Hispanic white term and postterm singleton live births. Mean GA declined steadily from 1992 through 2003, with infants delivered about 1 day earlier per 4-year period. Mean BW fell by 37 g from 1992 through 2003, and the rate of macrosomia declined by 0.6%, ie, a 25% relative reduction over the 12-year study period. Rates of labor induction nearly doubled over the 12-year study period, rising from 14% to 27%, with similar increases at every term and postterm GA and the trends were similar at every term and postterm GA (Figure 2). Rates of cesarean delivery declined from 21% in 1992 to 19% in 1996 but then increased to 25% in 2003.

As shown in Table 2, a progressively larger proportion of infants were born at 37 and 38 weeks, up from 5.8% and 13.5%, respectively, in 1992 to 8.5% and 20.9% in 2003, while a lower proportion were born at late term (41 weeks) and postterm (≥42 weeks) GA, down from 13.2% and 3.8%, respectively, in 1992 to 9.1% and 0.9% in 2003.

Mean BW increased from 1992 through 2003 at every GA except at 41 weeks (mean BW at 41 weeks remained stable). As shown in Table 3, mean BW increased most at 37-38 weeks, by >30 g. Mean z-score increased by 3.6% of SD. SGA rates declined from 9.9% to 8.2%, while the LGA rate remained relatively stable and the AGA rate increased by 1.8% (since approximately 0.5% of BWs

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>GA, d</th>
<th>BW, g</th>
<th>Macrosomia, %</th>
<th>Induction, %</th>
<th>Cesarean, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>2,074,590</td>
<td>276.8 ± 8.2</td>
<td>3492.3 ± 480.7</td>
<td>2.2</td>
<td>14.3</td>
<td>21.3</td>
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<tr>
<td>1993</td>
<td>2,037,837</td>
<td>276.7 ± 8.2</td>
<td>3485.9 ± 479.8</td>
<td>2.1</td>
<td>17.0</td>
<td>20.6</td>
</tr>
<tr>
<td>1994</td>
<td>2,017,882</td>
<td>276.5 ± 8.2</td>
<td>3485.1 ± 479.9</td>
<td>2.1</td>
<td>18.6</td>
<td>19.8</td>
</tr>
<tr>
<td>1995</td>
<td>1,971,588</td>
<td>276.3 ± 8.2</td>
<td>3481.4 ± 478.6</td>
<td>2.1</td>
<td>20.1</td>
<td>19.2</td>
</tr>
<tr>
<td>1996</td>
<td>1,949,898</td>
<td>275.8 ± 8.1</td>
<td>3482.1 ± 477.2</td>
<td>2.1</td>
<td>21.2</td>
<td>18.9</td>
</tr>
<tr>
<td>1997</td>
<td>1,933,469</td>
<td>275.7 ± 8.1</td>
<td>3478.1 ± 475.4</td>
<td>2.0</td>
<td>23.1</td>
<td>18.9</td>
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<tr>
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<td>3479.4 ± 474.8</td>
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<td>3476.9 ± 472.7</td>
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<td>24.9</td>
<td>19.9</td>
</tr>
<tr>
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<td>3479.7 ± 471.8</td>
<td>2.0</td>
<td>25.3</td>
<td>20.8</td>
</tr>
<tr>
<td>2001</td>
<td>1,922,422</td>
<td>274.5 ± 8.0</td>
<td>3467.8 ± 468.5</td>
<td>1.8</td>
<td>26.4</td>
<td>22.2</td>
</tr>
<tr>
<td>2002</td>
<td>1,894,497</td>
<td>274.2 ± 8.0</td>
<td>3462.3 ± 466.5</td>
<td>1.7</td>
<td>26.9</td>
<td>23.7</td>
</tr>
<tr>
<td>2003</td>
<td>1,906,184</td>
<td>273.9 ± 7.9</td>
<td>3455.3 ± 464.4</td>
<td>1.6</td>
<td>27.0</td>
<td>25.0</td>
</tr>
</tbody>
</table>

BW, birthweight; GA, gestational age; MBW, mean birthweight. California was not included because data on clinical estimate of gestation were not available. 

TABLE 2
Gestational age distribution

<table>
<thead>
<tr>
<th>Year</th>
<th>37 wk</th>
<th>38 wk</th>
<th>39 wk</th>
<th>40 wk</th>
<th>41 wk</th>
<th>≥42 wk</th>
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</thead>
<tbody>
<tr>
<td>1992</td>
<td>5.8</td>
<td>13.5</td>
<td>22.4</td>
<td>41.3</td>
<td>13.2</td>
<td>3.8</td>
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<tr>
<td>1993</td>
<td>5.9</td>
<td>13.6</td>
<td>22.8</td>
<td>40.6</td>
<td>13.5</td>
<td>3.6</td>
</tr>
<tr>
<td>1994</td>
<td>6.0</td>
<td>14.1</td>
<td>23.4</td>
<td>39.7</td>
<td>13.5</td>
<td>3.2</td>
</tr>
<tr>
<td>1995</td>
<td>6.3</td>
<td>14.6</td>
<td>24.2</td>
<td>38.8</td>
<td>13.3</td>
<td>2.8</td>
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<tr>
<td>1996</td>
<td>6.7</td>
<td>15.6</td>
<td>25.5</td>
<td>37.5</td>
<td>12.3</td>
<td>2.3</td>
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<tr>
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<td>6.8</td>
<td>15.8</td>
<td>25.9</td>
<td>36.8</td>
<td>12.5</td>
<td>2.2</td>
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<tr>
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<td>7.1</td>
<td>16.6</td>
<td>26.7</td>
<td>35.7</td>
<td>11.9</td>
<td>2.0</td>
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<tr>
<td>1999</td>
<td>7.3</td>
<td>17.4</td>
<td>27.6</td>
<td>34.5</td>
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<td>1.7</td>
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<td>2000</td>
<td>7.8</td>
<td>18.7</td>
<td>28.9</td>
<td>32.8</td>
<td>10.3</td>
<td>1.4</td>
</tr>
<tr>
<td>2001</td>
<td>7.9</td>
<td>19.1</td>
<td>29.7</td>
<td>32.0</td>
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<td>1.2</td>
</tr>
<tr>
<td>2002</td>
<td>8.2</td>
<td>19.9</td>
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<td>30.5</td>
<td>9.7</td>
<td>1.1</td>
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<tr>
<td>2003</td>
<td>8.5</td>
<td>20.9</td>
<td>31.5</td>
<td>29.1</td>
<td>9.1</td>
<td>0.9</td>
</tr>
</tbody>
</table>
similar in magnitude and statistical significance to those for labor induction alone (data available on request).

The temporal trend in mean BW among singleton term or postterm non-Hispanic black live births was different from that seen in non-Hispanic whites, with a continued increase through the 1990s, from 3266 g in 1992 to 3278 g in 2000, followed by a decrease to 3257 g in 2003. Temporal trends in mean GA, macrosomia rate, and mean z-scores were similar to those observed in non-Hispanic whites. Although the rate of labor induction was much lower among non-Hispanic blacks than among whites, the temporal trend was similar, with rates rising from 8% in 1992 to 19% in 2003. The rate and temporal trend for cesarean delivery were both also very similar to those observed among non-Hispanic whites. Our ecological analysis in non-Hispanic blacks showed no significant association between the change in rate of labor induction or cesarean delivery and changes in mean GA, BW, rate of macrosomia, or BW-for-GA z-score.

**Comment**

Although the rise in preterm birth in the United States and other industrialized countries has been highly publicized, the more recent fall in mean BW has not received wide attention. Chauhan et al.\(^1^8\) reported a decline in macrosomia in the United States from 1996 through 2002 but focused on management and out-

<table>
<thead>
<tr>
<th>TABLE 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gestational age-specific birthweight</strong></td>
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<table>
<thead>
<tr>
<th>Year</th>
<th>37 wk</th>
<th>38 wk</th>
<th>39 wk</th>
<th>40 wk</th>
<th>41 wk</th>
<th>≥42 wk</th>
<th>z-Score</th>
<th>SGA, %</th>
<th>LGA, %</th>
<th>AGA, %</th>
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<tr>
<td>1992</td>
<td>3072</td>
<td>3286</td>
<td>3446</td>
<td>3558</td>
<td>3687</td>
<td>3748</td>
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<td>9.9</td>
<td>9.5</td>
<td>80.7</td>
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<tr>
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<td>3286</td>
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<td>3557</td>
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<td>3744</td>
<td>−0.0230</td>
<td>9.8</td>
<td>9.4</td>
<td>80.9</td>
</tr>
<tr>
<td>1996</td>
<td>3084</td>
<td>3300</td>
<td>3454</td>
<td>3564</td>
<td>3687</td>
<td>3743</td>
<td>−0.0025</td>
<td>9.4</td>
<td>9.6</td>
<td>81.0</td>
</tr>
<tr>
<td>1997</td>
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<td>3297</td>
<td>3450</td>
<td>3563</td>
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<td>−0.0091</td>
<td>9.4</td>
<td>9.4</td>
<td>81.2</td>
</tr>
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<td>3090</td>
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<td>3458</td>
<td>3568</td>
<td>3689</td>
<td>3751</td>
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<td>9.0</td>
<td>9.6</td>
<td>81.4</td>
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<td>0.0130</td>
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<td>3114</td>
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<td>81.9</td>
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<tr>
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<td>3567</td>
<td>3687</td>
<td>3757</td>
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<td>8.4</td>
<td>9.5</td>
<td>82.2</td>
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<tr>
<td>2003</td>
<td>3104</td>
<td>3322</td>
<td>3462</td>
<td>3566</td>
<td>3684</td>
<td>3753</td>
<td>0.0164</td>
<td>8.2</td>
<td>9.3</td>
<td>82.5</td>
</tr>
</tbody>
</table>

AGA, appropriate size for gestational age; GA, gestational age; LGA, large for gestational age; MBW, mean birthweight; SGA, small for gestational age. California was not included because data on clinical estimate of gestation were not available.

**TABLE 4**

<table>
<thead>
<tr>
<th>Infant characteristic</th>
<th>Unadjusted correlations (95% CI)</th>
<th>Regression coefficient (95% CI)</th>
<th>Model adjusted R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in mean BW, g</td>
<td>−0.54 (−0.71 to −0.29)</td>
<td>−2.24 (−3.23 to −1.26)</td>
<td>0.53</td>
</tr>
<tr>
<td>Change in mean GA, d</td>
<td>−0.44 (−0.65 to −0.17)</td>
<td>−0.07 (−0.11 to −0.03)</td>
<td>0.51</td>
</tr>
<tr>
<td>Change in % macrosomia</td>
<td>−0.55 (−0.74 to −0.32)</td>
<td>−0.03 (−0.04 to −0.01)</td>
<td>0.44</td>
</tr>
<tr>
<td>Change in mean z-score</td>
<td>−0.35 (−0.58 to −0.07)</td>
<td>−0.0021 (−0.0037 to −0.0005)</td>
<td>0.24</td>
</tr>
<tr>
<td>Change in % LGA</td>
<td>−0.46 (−0.66 to −0.20)</td>
<td>−0.06 (−0.06 to −0.03)</td>
<td>0.37</td>
</tr>
<tr>
<td>Change in % SGA</td>
<td>+0.03 (0.02 to 0.03)</td>
<td>+0.00 (−0.03 to 0.04)</td>
<td>0.16</td>
</tr>
<tr>
<td>Change in % AGA</td>
<td>+0.33 (0.05 to 0.56)</td>
<td>+0.06 (0.02 to 0.10)</td>
<td>0.32</td>
</tr>
</tbody>
</table>

AGA, appropriate size for gestational age; BW, birthweight; CI, confidence interval; GA, gestational age; LGA, large for gestational age; SGA, small for gestational age. California was not included because data on clinical estimate of gestation were not available; New York and Wisconsin were excluded due to faulty reporting on induction.

*Weighted by total number of births of each state; †Weighted by total number of births of each state and adjusted for changes in parity, maternal age, and maternal education.

ome of macrosomia, rather than temporal trends. Davidoff et al\(^7\) reported that the GA distribution among US singleton births from 1992 through 2002 shifted to the left (lower GAs) and attributed this shift to rising rates in late preterm births. In our study, the decline in BW and GA was evident even among term and postterm births and thus cannot be simply attributed to the rise in preterm birth. A reduction of 40 g in BW or 3 days in GA may not matter for an individual infant, but represents a substantial change for a population. For example, the macrosomia rate fell by 25%, with important effects likely on duration of labor, cesarean and instrumental delivery, and birth injury. Similar effects are likely associated with the change in GA.

The causes of the rise in labor induction are complex. The rise in medically indicated inductions has been slower than the overall increase in induction and it appears that labor induction is increasingly used for the convenience of mothers, families, and caregivers. Based on our results these increases in elective induction seem likely to have led to the recent decline in mean GA and BW. The large decline in macrosomia may reflect the increase in postterm labor induction due to concerns about the higher risks of shoulder dystocia and related complications.\(^3\)

The trend in cesarean delivery was different among singleton live births: a decline from 1989 through 1996, followed by an increase since 1997.\(^7,37,38\) We did not observe any association between changes in cesarean delivery and the changes in mean BW, GA, or BW-for-GA z-score or in the rate of macrosomia. Cesarean deliveries performed after labor onset would make only a few hours’ difference in GA and should therefore not have a large impact on GA. Bettegowda et al\(^19\) linked a rise in preterm birth from 1996 through 2004 to increased cesarean delivery but did not carry out a formal statistical analysis, nor did they account for medical indications for cesarean delivery. Elective (prelabor) cesarean delivery would be expected to have a larger impact but is probably used far less frequently than induction, although reliable estimates of that frequency are not available on a population-wide basis.

In spite of the fall in mean BW from 1992 through 2003, mean BW for GA increased as a result of the shift in the GA distribution. More than 60% of live births were delivered <40 weeks in 2003, an increase of 20% from 1992. Mean BW increased at every GA except 41 weeks and especially at 37-38 weeks. Although the LGA rate did not decline over the study period, the decline in the rate of macrosomia suggests that labor inductions were being carried out to prevent the complications of macrosomia. Nevertheless, the magnitude of the negative association observed between the changes in LGA and induction rates was very similar to that between macrosomia and induction, suggesting that inductions were increasingly performed on potentially macrosomic infants. States with larger increase in rates of induction had smaller increases in z-scores. The observed increase in mean z-score and the negative association between this increase and the change in induction rates reflect earlier induction and the consequent reduction in macrosomia. Given the reciprocal relationship among LGA, SGA, and AGA (they must sum up 100%), the positive association we observed between induction and AGA rates is not surprising.

One limitation of our study was the lack of information on medical indications for labor induction. Any observational analysis that examines associations between labor induction and BW, GA, or rate of macrosomia is prone to confounding by the clinical indications that lead both to induction, and independently of induction, to lower BW and GA. Ecological analysis is less likely to be biased, however, because the large variations in induction rates observed across states are likely driven largely by practice style, rather than by state-level differences in medical indication. Differences in practice style create a quasi experiment across states in the use of labor induction and therefore permit an assessment of the effects of the increasing use of labor induction.\(^4\) A further limitation of our study was our use of a nationwide vital statistics database in which coding errors are known to occur. In particular, inaccurate estimation of GA and misreporting of labor induction have been widely reported and discussed.\(^19,21,23,27-29\) It is unlikely, however, that such misreporting of labor induction would be differential with respect to BW or GA, and thus the associations we observed are likely to be conservative (biased toward the null). In addition, basing our analysis on changes in induction rates over time should have reduced systematic differences among states in underlying maternal risks, as well as in the completeness of recording of labor induction.

Recent systematic reviews and meta-analyses of randomized controlled trials comparing routine induction with expectant management in term and postterm pregnancies concluded that labor induction may reduce perinatal mortality but without increasing the risk of cesarean delivery. As observed in this study, increasing and earlier use of labor induction appears to have shortened the duration of gestation and thus reduced both mean BW and rates of macrosomia.

Although several studies have reported increased risks of some causes of neonatal morbidity and maternal complications with increasing GA at term, more and more infants are being delivered at early term gestation (37-38 weeks), up from 19% in 1992 to 29% in 2003. Earlier term birth is associated with increased risk of sudden infant death syndrome,\(^4\) and we have recently documented increases in several adverse birth outcomes among early term births, including increased risks of infant mortality and some types of neonatal morbidity.\(^4\) Thus the impact of these recent trends requires further investigation, including large randomized trials, to ensure that the rise in induction is doing more good than harm.

**REFERENCES**


