Secular Trends in Preterm Birth
A Hospital-Based Cohort Study

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Context.—Canada and the United States have reported a recent increase in the incidence of preterm birth, but the reasons for this increase are unknown.

Objective.—To assess secular trends in preterm birth and its potential determinants.

Design.—Hospital-based cohort study.


Participants.—A total of 65,574 nonreferred live births and stillbirths.

Main Outcome Measures.—Changes in occurrence of preterm birth, before and after adjustment for changes in method of gestational age assessment, obstetric intervention, registration of births weighing less than 500 g, and sociodemographic, behavioral, and clinical determinants.

Results.—A crude secular increase in preterm births was seen for births less than 37, 34, and 32 completed weeks and attenuated the trend for births before 34 and 32 weeks and attenuated the trend for births before 37 weeks. Nearly half of the remaining trend for births before 37 weeks was accounted for by the increasing use of early ultrasound dating. The residual trend was eliminated after controlling for secular increases in unmarred status and the proportion of women aged 35 years or older. These factors, combined with a decrease in alcohol consumption and increases in histological chorioamnionitis and cocaine use, appear to have counteracted a reduction in preterm birth since the mid-1980s that otherwise would have been observed.

Conclusions.—This hospital’s increase in preterm births since 1978 parallels increases reported in population-based national studies from the United States and Canada. This trend appears largely attributable to the increasing use of early ultrasound dating, preterm induction and preterm cesarean delivery without labor, and changes in sociodemographic and behavioral factors.

PRETERM BIRTH is arguably the most important maternal and child health problem in developed societies. It is the leading cause of infant mortality and is associated with major long-term neurocognitive, respiratory, and ophthalmologic morbidity. Moreover, provision of intensive care for extremely preterm newborns is expensive and giving birth to an infant requiring such care is traumatic for parents and families. Dramatic reductions in perinatal and infant mortality have occurred during the last several decades, virtually all of which are attributable to improved access to and quality of high-risk obstetric and neonatal care. The major consequence has been a reduction in mortality of preterm newborns, rather than prevention of preterm birth.

With the exception of France and Finland, no country (to our knowledge) has reported a reduction in incidence of preterm birth. In fact, the United States has experienced a small but steady increase since the early 1980s and recent Canadian data also suggest an increase. Does this disappointing secular trend reflect a total failure to prevent preterm delivery, or is it due to the countervailing effects of increased use of early ultrasound estimation of gestational age, early delivery for extreme fetal growth retardation or severe preeclampsia, multiple gestation (due to infertility treatment), registration of fetuses and newborns near the borderline of viability, or changes in sociodemographic or behavioral determinants of preterm birth? The answer to this question is important for both clinical practice and public health policy. In this article, we attempt to provide such an answer by analyzing the secular trend in preterm birth from 1978 to 1996 and the potential determinants of that trend, using a computerized hospital database.

METHODS

Our analysis is based on all 65,574 inborn infants (whether live-born or stillborn, but excluding antenatal referrals) delivered at the Royal Victoria Hospital, a tertiary care general and maternity hospital affiliated with McGill University, Montreal, Quebec. Data on these births are recorded in the McGill Obstetric and Neonatal Database, which has been in its current version since 1978. The principal outcomes under study are delivery prior to 37, 34, or 32 completed weeks of gestation (259, 238, and 224 days, respectively). Gestational age was assessed in 3 ways: (1) time since the first day of the last normal menstrual period (LNMP), (2) early (usually 16-18 weeks) ultrasound estimate used in all other cases.

Independent variables considered as either potential determinants or confounders of the secular trend in preterm birth ...
included stillbirth vs live birth; singleton vs multiple gestation; preterm induction of labor; preterm cesarean delivery without labor; birth weight less than 500 g or 500 to 749 g; maternal age, parity, education, and marital status; cigarette smoking; any alcohol, cannabis, or cocaine use during pregnancy; prepregnancy hypertension; severe pregnancy-induced hypertension (PIH); and histological chorioamnionitis. Data on smoking, alcohol, cannabis, cocaine, education, and marital status were obtained by maternal self-report. No information was collected on the family income or racial-ethnic origin of the mother. Women were classified as “unmarried” if they were legally single, widowed, or divorced. Severe PIH was defined as the specific mention of “severe preeclampsia” on the discharge sheet completed by the attending obstetrician or on documented evidence of frank eclampsia. We restricted our analysis of PIH to severe cases to minimize the effects of misclassification and temporal variations in diagnosis of milder cases. Chorioamnionitis was considered present if the perinatal pathologist noted definite or severe leukocytic infiltration of the placental membranes or umbilical cord.

Statistical techniques included ordinary \( \chi^2 \) tests and \( \chi^2 \) tests for linear trend for bivariate analyses and multiple logistic regression. All statistical analyses were carried out using SAS-PC for Windows (SAS Institute Inc, Cary, NC). Because linear time trends are expressed on a per-year basis, which reflect small yearly changes during the study period, all odds ratios (ORs) are reported to 3 decimal places.

RESULTS

Figure 1 shows the secular trend in preterm birth by 2-year intervals using all 3 definitions of gestational age. Three levels (cutoffs) for gestational age are shown in Figure 1: all preterm births (<37 completed weeks), earlier preterm births (<34 completed weeks), and extremely preterm births (<32 completed weeks). Based on the algorithm-derived gestational age estimates, rates increased from 6.6% to 9.8% for births before 37 weeks, 1.7% to 2.3% before 34 weeks, and 1.0% to 1.2% before 32 weeks. After the first 2 intervals, the curves corresponding to the 3 gestational age definitions are reasonably parallel, with the highest rates using the early ultrasound estimate, the lowest rates using the LNMP definition, and intermediate rates for the algorithm. Complementing the rise in preterm birth rates was a marked reduction in postterm birth (>42 completed weeks); algorithm-based rates of postterm birth decreased from 5.8% in 1978-1979 to 1.6% in 1994-1996.

Figure 2 shows the change in distribution of gestational age assessment information during the study period. The proportion of births missing both LNMP and ultrasound estimates decreased substantially, as did the proportion of births missing ultrasound estimates only. The proportion missing only LNMP estimates was low and remained low during the study period, whereas the proportions of births with concordant (within 7 days) and discordant (and hence ultrasound-derived) estimates both increased.

Table 1 shows the corresponding secular trends in other potential determinants. Unlike Canadian population-based
Table 1.—Secular Trends in Potential Determinants of Preterm Births, 1978-1996

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stillbirths</strong></td>
<td>0.54</td>
<td>0.56</td>
<td>0.59</td>
<td>0.49</td>
<td>0.40</td>
<td>0.42</td>
<td>0.36</td>
<td>0.29</td>
<td>0.41</td>
<td>.001 61 949</td>
</tr>
<tr>
<td>Birth weight &lt; 500 g</td>
<td>0.00</td>
<td>0.02</td>
<td>0.00</td>
<td>0.00</td>
<td>0.06</td>
<td>0.04</td>
<td>0.14</td>
<td>0.04</td>
<td>0.05</td>
<td>.001 65 574</td>
</tr>
<tr>
<td>Birth weight 500-750 g</td>
<td>0.3</td>
<td>0.2</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.2</td>
<td>.02 65 574</td>
</tr>
<tr>
<td>Preterm induction</td>
<td>1.0</td>
<td>1.0</td>
<td>0.8</td>
<td>1.4</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.3</td>
<td>.003 63 354</td>
</tr>
<tr>
<td>Preterm cesarean delivery without labor</td>
<td>0.6</td>
<td>1.0</td>
<td>0.3</td>
<td>1.0</td>
<td>0.9</td>
<td>1.1</td>
<td>1.6</td>
<td>1.5</td>
<td>1.8</td>
<td>&lt;.001 61 949</td>
</tr>
<tr>
<td>Maternal age, y</td>
<td></td>
<td></td>
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<tr>
<td>&lt; 20</td>
<td>4.7</td>
<td>3.9</td>
<td>2.3</td>
<td>1.8</td>
<td>1.8</td>
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<td>1.3</td>
<td>1.2</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>20-34</td>
<td>87.5</td>
<td>87.2</td>
<td>87.2</td>
<td>84.3</td>
<td>82.2</td>
<td>80.4</td>
<td>82.0</td>
<td>79.4</td>
<td>76.9</td>
<td>&lt;.001† 65 561</td>
</tr>
<tr>
<td>≥ 35</td>
<td>7.8</td>
<td>8.9</td>
<td>10.5</td>
<td>13.9</td>
<td>16.1</td>
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<td>16.8</td>
<td>19.3</td>
<td>20.1</td>
<td></td>
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<tr>
<td>Primiparity</td>
<td>47.5</td>
<td>46.5</td>
<td>47.4</td>
<td>47.0</td>
<td>46.5</td>
<td>47.1</td>
<td>48.0</td>
<td>46.9</td>
<td>46.3</td>
<td>.64 65 559</td>
</tr>
<tr>
<td>Maternal education ≤ 12 y</td>
<td>‡</td>
<td>‡</td>
<td>‡</td>
<td>54.3</td>
<td>50.1</td>
<td>44.9</td>
<td>40.3</td>
<td>38.4</td>
<td>34.0</td>
<td>&lt;.001 46 202</td>
</tr>
<tr>
<td>Unmarried status</td>
<td>4.8</td>
<td>8.5</td>
<td>11.9</td>
<td>14.8</td>
<td>16.4</td>
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<td>18.3</td>
<td>18.5</td>
<td>18.1</td>
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<tr>
<td>Multiple birth</td>
<td>2.3</td>
<td>2.3</td>
<td>2.0</td>
<td>1.9</td>
<td>2.0</td>
<td>2.3</td>
<td>2.7</td>
<td>2.3</td>
<td>2.3</td>
<td>17 65 574</td>
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<tr>
<td>Prepregnancy hypertension</td>
<td>0.49</td>
<td>0.50</td>
<td>0.26</td>
<td>0.43</td>
<td>0.33</td>
<td>0.23</td>
<td>0.13</td>
<td>0.27</td>
<td>0.17</td>
<td>&lt;.001 64 840</td>
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<tr>
<td>Severe pregnancy-induced hypertension</td>
<td>0.60</td>
<td>1.59</td>
<td>0.90</td>
<td>0.65</td>
<td>0.50</td>
<td>0.62</td>
<td>0.64</td>
<td>0.55</td>
<td>0.65</td>
<td>&lt;.001 65 574</td>
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<tr>
<td>Smoking, cigarettes per day</td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>None</td>
<td>78.4</td>
<td>77.6</td>
<td>79.4</td>
<td>77.4</td>
<td>77.5</td>
<td>81.0</td>
<td>83.0</td>
<td>84.9</td>
<td>87.9</td>
<td>&lt;.001† 63 124</td>
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<td>1-10</td>
<td>8.6</td>
<td>9.5</td>
<td>8.6</td>
<td>8.8</td>
<td>8.3</td>
<td>7.8</td>
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<td>7.7</td>
<td>6.4</td>
<td></td>
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<tr>
<td>≥ 10</td>
<td>13.0</td>
<td>12.9</td>
<td>12.1</td>
<td>13.8</td>
<td>14.2</td>
<td>11.2</td>
<td>9.3</td>
<td>7.4</td>
<td>5.8</td>
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<tr>
<td>Alcohol use</td>
<td>‡</td>
<td>‡</td>
<td>29.3</td>
<td>34.1</td>
<td>32.2</td>
<td>24.8</td>
<td>15.7</td>
<td>12.6</td>
<td>10.9</td>
<td>&lt;.001 53 342</td>
</tr>
<tr>
<td>Cannabis use</td>
<td>‡</td>
<td>‡</td>
<td>0.2</td>
<td>0.3</td>
<td>0.5</td>
<td>0.4</td>
<td>0.2</td>
<td>0.3</td>
<td>0.3</td>
<td>.98 50 616</td>
</tr>
<tr>
<td>Cocaine use</td>
<td>‡</td>
<td>‡</td>
<td>0.5</td>
<td>0.0</td>
<td>0.3</td>
<td>0.6</td>
<td>0.5</td>
<td>0.4</td>
<td>0.2</td>
<td>&lt;.001 50 616</td>
</tr>
</tbody>
</table>
| Histological chorioamnionitis         | ‡        | ‡        | 2.5      | 3.5      | 1.6      | 2.4      | 3.9      | 4.4      | 4.4      | <.001 43 262          

*P values are based on χ² test for linear trend.†These P values are based on the overall linear trend for the 3 categories of age and cigarette smoking.‡Large proportions of values are missing for these years.
Figure 3.—Secular trends in births before 37, 34, and 32 completed weeks (based on the algorithm) after eliminating births weighing less than 500 g and inductions and preterm cesarean deliveries without labor before those corresponding gestational ages.

Table 2.—Multiple Logistic Regression Analysis for Secular Trend in Preterm Birth, 1978-1996*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interval, y</td>
<td></td>
</tr>
<tr>
<td>1978-1983</td>
<td>1.000 (Reference)</td>
</tr>
<tr>
<td>1984-1989</td>
<td>1.057 (0.966-1.157)</td>
</tr>
<tr>
<td>1990-1996</td>
<td>1.004 (0.918-1.098)</td>
</tr>
<tr>
<td>Ultrasound-based gestational age assessment</td>
<td>1.736 (1.612-1.870)</td>
</tr>
<tr>
<td>Maternal age, y</td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>1.156 (0.921-1.452)</td>
</tr>
<tr>
<td>20-34</td>
<td>1.000 (Reference)</td>
</tr>
<tr>
<td>≥35</td>
<td>1.285 (1.169-1.413)</td>
</tr>
<tr>
<td>Primiparity</td>
<td>1.081 (1.006-1.161)</td>
</tr>
<tr>
<td>Unmarried status</td>
<td>1.570 (1.432-1.721)</td>
</tr>
<tr>
<td>Multiple birth</td>
<td>13.699 (12.060-15.561)</td>
</tr>
<tr>
<td>Smoking, cigarettes per day</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>1.000 (Reference)</td>
</tr>
<tr>
<td>&gt;1-10</td>
<td>1.030 (0.907-1.170)</td>
</tr>
<tr>
<td>&gt;10</td>
<td>1.191 (1.069-1.325)</td>
</tr>
<tr>
<td>Prepregnancy hypertension</td>
<td>1.895 (1.188-3.212)</td>
</tr>
<tr>
<td>Severe PIH</td>
<td>2.573 (1.811-3.657)</td>
</tr>
</tbody>
</table>

Crude and Sequentially Adjusted Year and Interval Effects for Births <37 Weeks

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Crude OR (95% CI)</td>
<td>1.015 (1.008-1.021)</td>
<td>1.153 (1.061-1.253)</td>
<td>1.165 (1.074-1.264)</td>
</tr>
<tr>
<td>Adjusted for ultrasound</td>
<td>1.009 (1.003-1.016)</td>
<td>1.084 (0.997-1.179)</td>
<td>1.092 (1.006-1.186)</td>
</tr>
<tr>
<td>Plus preterm induction, multiple births</td>
<td>1.010 (1.003-1.017)</td>
<td>1.126 (1.031-1.216)</td>
<td>1.093 (1.001-1.193)</td>
</tr>
<tr>
<td>Plus smoking, prepregnancy hypertension, and severe PIH</td>
<td>1.009 (1.003-1.015)</td>
<td>1.019 (1.017-1.209)</td>
<td>1.078 (0.989-1.174)</td>
</tr>
<tr>
<td>Plus maternal age, or smoking, prepregnancy hypertension</td>
<td>1.008 (1.003-1.015)</td>
<td>1.102 (1.017-1.216)</td>
<td>1.075 (0.985-1.175)</td>
</tr>
<tr>
<td>Plus primiparity</td>
<td>1.008 (1.003-1.016)</td>
<td>1.110 (1.015-1.214)</td>
<td>1.072 (0.981-1.172)</td>
</tr>
<tr>
<td>Plus unmarried status</td>
<td>1.003 (0.996-1.010)</td>
<td>1.057 (0.966-1.157)</td>
<td>1.004 (0.918-1.098)</td>
</tr>
</tbody>
</table>

*After eliminating preterm inductions, preterm cesarean deliveries without labor, and births weighing less than 500 g, OR indicates odds ratio; CI, confidence interval; and PIH, pregnancy-induced hypertension.

for births before 37 weeks, though still evident, is considerably attenuated and less regular. No increase is evident for births before 34 or 32 weeks. Data (not shown) based on the ultrasound or LMP definitions of gestational age show an identical pattern for all 3 preterm cutoffs. These results suggest that the crude trends shown in Figure 1 are largely attributable to an increasing tendency toward preterm inductions and preterm cesarean deliveries without labor. The crude yearly OR (and 95% confidence interval) for the increase in algorithm-based births before 37 weeks before eliminating preterm inductions, preterm cesarean deliveries without labor, and births of newborns weighing less than 500 g was 1.023 (1.017-1.029), indicating an average increase of 2.3% per year in the rate of preterm birth. When the overall study period was divided into three 6-year intervals (1978-1983, 1984-1989, and 1990-1996), the crude ORs for the latter 2 intervals (relative to the first interval) were 1.211 (1.125-1.303) and 1.336 (1.245-1.434), respectively, ie, a significant increase in both the second and third intervals. After eliminating preterm inductions, preterm cesarean deliveries without labor, and births weighing less than 500 g, the yearly OR decreased to 1.015 (1.008-1.021), while the interval ORs decreased to 1.153 (1.061-1.253) for 1984-1989 and 1.165 (1.074-1.264) for 1990-1996, indicating that the eliminated factors were responsible for about one third of the crude overall increase before 37 weeks and most of the increase since 1990. When gestational age assessment method (ultrasound-based vs LMP-based) was added to these logistic models, the association between an ultrasound-based method and preterm birth was substantial (OR, 1.645 [1.535-1.763] in the yearly model), and the yearly OR decreased to 1.009 (1.003-1.016), while the interval ORs decreased to 1.084 (0.997-1.179) for 1984-1989 and 1.092 (1.006-1.186) for 1990-1996. These results indicate that the secular trend toward ultrasound-based estimates of gestational age accounted for nearly half of the apparent residual increase in births before 37 weeks during the study period. As shown in the top part of Table 2, when maternal age, parity, unmarried status, multiple births, smoking, prepregnancy hypertension, and severe PIH were added to the logistic regression model, the secular increase in algorithm-derived births before 37 weeks was markedly reduced and statistically nonsignificant (OR, 1.057 [0.996-1.157] for 1984-1989 and OR, 1.004 [0.918-1.098] for 1990-1996). Including maternal education in the model resulted in virtually identical effects for the secular trend and the other covariates but reduced the sample size because of missing values for maternal education. A similar reduction was noted in the average yearly trend (OR, 1.003 [0.996-1.010]). As shown in the bottom of Table 2, most of the additional reduction was due to unmarried status and maternal age. These results suggest that the secular increases in unmarried status and older maternal age over the study period were responsible for most of the residual (ie, after controlling for ultrasound-based gestational age estimates) increase in births before 37 weeks. Multiple birth was strongly associated with preterm birth (adjusted OR, 13.413 [11.824-15.215]) but had little effect on the yearly or interval changes because multiple birth rates did not increase significantly during the study period (Table 1).
Because the majority of study subjects had missing values for cocaine and alcohol use from 1978-1981, and for histological chorioamnionitis for 1978-1983, analyses for the effects of these potential determinants were restricted to the years 1984-1996. After eliminating preterm inductions, preterm cesarean deliveries without labor, and births weighing less than 500 g, no significant interval (OR, 1.010 [0.935-1.091] for 1990-1996 vs 1984-1989) or yearly (OR, 1.006 [0.995-1.017] for yearly trend) was observed during these study years. These trend effects remained essentially unchanged after controlling for gestational age assessment method (OR, 1.008 [0.983-1.038] for 1990-1996 vs 1984-1989 and OR, 1.006 [0.995-1.017] for yearly trend). After controlling for maternal age, parity, unmarried status, multiple birth, cigarette smoking, alcohol and cocaine use, prepregnancy hypertension, severe PIH, and histological chorioamnionitis, however, the secular trend was actually reversed (top of Table 3). The corresponding yearly trend was also reversed (OR, 0.986 [0.973-0.999]). As shown in the bottom of Table 3, sequential logistic regression models indicated that a decrease in alcohol consumption and increase in chorioamnionitis were responsible for about half this reversal for both the yearly and interval effects: increases in unmarried status and cocaine use also accounted for a sizeable portion.

Inclusion of low maternal education in these models resulted in nearly identical confidence intervals (data not shown), because of the large number of missing values for maternal education. These results suggest that the secular decrease in alcohol use and the secular increase in histological chorioamnionitis, unmarried status, and cocaine use since 1984 may have actually prevented a reduction in preterm birth, ie, a reduction would have been observed if those changes had not occurred.

**COMMENT**

The results of this large, hospital-based cohort study confirm recent Canadian population-based data indicating an increase in preterm birth during the last 2 decades. The availability of separate gestational age estimates based on early ultrasound, LNMP, and an algorithmic combination of the 2 permit a quantitative estimate of the extent to which the increasing use of early ultrasound dating explains the observed trend, at least at the study hospital. Our results indicate that the overall secular increase is partly an artifact of changing methods of gestational age estimation. Nonetheless, our results also demonstrate that early ultrasound dating cannot explain all of the observed increase during the study period.

We deliberately excluded antenatal referrals so as not to bias our results by secular changes in referral patterns. Nonetheless, we were surprised to observe that in contrast to recently reported national trends from Canada, the United States, and Denmark, the study hospital saw no increase in the rate of multiple births during the study period (approximately 2.3% of births in 1990-1996 vs 1984-1989). As in Canada overall, the study hospital had a slight increase in births weighing less than 500 g, which were recorded in the database only for newborns admitted to the hospital’s neonatal intensive care unit. Such admissions have increased somewhat in recent years, probably because physicians are aware that newborns weighing less than 500 g are more likely to survive than in the past. Nonetheless, this increase had a very small impact on the overall secular trend in preterm birth.

A major factor contributing to the secular increase in preterm birth at this hospital was the increasing use of preterm induction and preterm cesarean delivery without labor, which appear to account for all of the secular increase in births before 34 and 32 weeks and a major portion of the trend before 37 weeks. The fact that this trend was accompanied by a decline in the hospital’s stillbirth rate and in-hospital neonatal death rate suggests that the increased obstetric intervention may well be justified. Earlier obstetric intervention for pregnancies complicated by severe pre-eclampsia, fetal growth retardation, prolonged prelabor rupture of membranes, and other indications has been well documented in several settings. In the study by Goldenberg et al, the secular increases in these interventions accounted for only a small fraction of the observed increase in preterm delivery. In the study by Bréart et al, increasing trends toward preterm inductions and preterm cesarean deliveries in France were observed despite a secular trend of decreasing preterm birth rates in France. The latter pattern suggests that recent trends toward early obstetric intervention in pathologic pregnancies may have resulted primarily in a shift toward earlier preterm delivery of infants who would nevertheless have been born before 37 weeks.

After eliminating preterm inductions and preterm cesarean deliveries without labor, we observed a persistent, albeit at-

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**Table 3.—Multiple Logistic Regression Analysis for Secular Trend in Preterm Birth, 1984-1996**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full Logistic Regression Model for Births &lt;37 Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interval</td>
<td>Adjusted OR (95% CI)</td>
</tr>
<tr>
<td>1990-1996 (vs 1984-1989)</td>
<td>0.883 (0.807-0.965)</td>
</tr>
<tr>
<td>Ultrasound-based gestational age assessment</td>
<td>1.790 (1.638-1.957)</td>
</tr>
<tr>
<td>Maternal age, y</td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>0.989 (0.702-1.395)</td>
</tr>
<tr>
<td>≥35</td>
<td>1.324 (1.186-1.479)</td>
</tr>
<tr>
<td>Primaparity</td>
<td>1.038 (0.994-1.135)</td>
</tr>
<tr>
<td>Unmarried status</td>
<td>1.510 (1.355-1.683)</td>
</tr>
<tr>
<td>Multiple birth</td>
<td>14.782 (12.517-17.458)</td>
</tr>
</tbody>
</table>

| Smoking, cigarettes per day | | |
| None | 1.000 (Reference) | 1.000 (Reference) |
| 1-10 | 0.982 (0.834-1.156) | 0.982 (0.834-1.156) |
| >10 | 1.174 (1.020-1.350) | 1.174 (1.020-1.350) |

| Alcohol use | Plus maternal age | 1.008 (0.933-1.088) | 0.991 (0.979-1.012) |
| Cocaine use | 2.526 (1.497-4.262) | 2.526 (1.497-4.262) |
| Prepregnancy hypertension | 2.163 (1.084-4.318) | 2.163 (1.084-4.318) |
| Severe PIH | 2.397 (1.383-4.154) | 2.397 (1.383-4.154) |
| Histological chorioamnionitis | 4.402 (3.762-5.150) | 4.402 (3.762-5.150) |

| Crude and Sequentially Adjusted Year and Interval Effects for Births <37 Weeks |
|---|---|
| Variable | Per Year | 1990-1996 Interval vs 1984-1989 |
| Crude OR (95% CI) | 1.006 (0.995-1.016) | 1.010 (0.995-1.021) |
| Adjusted ultrasound | 1.006 (0.995-1.017) | 1.008 (0.933-1.088) |
| Plus pregnancy hypertension, severe PIH, and smoking | 1.002 (0.999-1.013) | 0.975 (0.900-1.057) |
| Plus multiple births | 1.001 (0.989-1.013) | 0.973 (0.896-1.057) |
| Plus maternal age | 1.000 (0.998-1.012) | 0.970 (0.893-1.053) |
| Plus primaparity | 1.000 (0.998-1.012) | 0.969 (0.892-1.052) |
| Plus unmarried status | 0.997 (0.985-1.009) | 0.951 (0.876-1.033) |
| Plus alcohol use | 0.991 (0.979-1.004) | 0.913 (0.838-0.993) |
| Plus cocaine use | 0.990 (0.978-1.002) | 0.950 (0.831-0.986) |
| Plus histological chorioamnionitis | 0.986 (0.973-0.999) | 0.883 (0.807-0.965) |

*After eliminating preterm inductions, preterm cesarean deliveries without labor, and births weighing less than 500 g. OR indicates odds ratio; CI, confidence interval; and PIH, pregnancy-induced hypertension.*

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tenuated, secular increase in births before 37 weeks. Nearly half this residual increase can be attributed to the increasing use of ultrasound dating of gestational age. This is consistent with previous reports, indicating that early ultrasound dating shifts the overall gestational age distribution to the left and systematically increases the proportion of births classified as preterm. This shift probably reflects a correction for delayed ovulation (and hence delayed conception) and missed spontaneous abortion (with ultrasound-based gestational age reflecting the second, ie, nonaborted conception), rather than systematic underestimates in women’s recollection of the date of their LMP. It could, however, reflect an error in the ultrasound-based gestational age error estimates, since even a small systematic bias in the formula (based on the biparietal diameter) could lead to a substantial increase in apparent preterm birth rates.

Even after accounting for the artificial increase in births before 37 weeks due to early ultrasound dating, a significant secular increase remained. Much of the residual increase appears attributable to a secular increase in the proportions of deliveries to unmarried women and women aged 35 years or older, because these proportions were substantial and increased 4-fold and 2.5-fold, respectively, during the study period. In addition, since 1984, the decreased use of (any) alcohol and increases in the prevalence of histological chorioamnionitis (which presumably reflects colonization and/or infection of the upper genital tract during pregnancy) and in cocaine use may have prevented a secular decrease in rate of preterm delivery that would have otherwise been apparent. Thus, overall, our results suggest that observed crude increases in delivery before 32 and 34 completed weeks are largely attributable to changes in obstetric practice, while sociodemographic and behavioral changes may have been responsible for a substantial part of the remaining true (ie, not due to gestational age assessment method) increase and for a failure to observe a decrease in deliveries between 34 and 36 weeks of gestation.

Caution is advised in interpreting our findings concerning several of the potential determinants we investigated. Although women delivering at the study hospital did not have routine vaginal or cervical cultures, and although the results of those who did have such cultures are not contained in the computerized database, genital tract colonization does not necessarily denote infection. We were fortunate to have pathological examination of placenta (as of 1984), which provides histological evidence about the presence of chorioamnionitis, although placental infarction can have causes other than gestational tract infection. Ascertainment of cigarette smoking and use of alcohol, cannabis, and cocaine during pregnancy were all based on the mother’s self report. In the absence of biomarker measurements of these exposures, it is probably safe to assume that all were underreported. We have no reason to suspect different degrees of underreporting over time among mothers who delivered preterm vs at term, however, and such nondifferential underreporting would therefore reduce the effects of secular trends in these exposures on the corresponding trends in preterm birth.

Study mothers who consumed alcohol during pregnancy were at reduced risk for preterm birth. High alcohol consumption (≥2 drinks per day) is known to be associated with deficits in fetal growth but is not a recognized determinant of preterm birth.20 As previously reported from this study hospital, only about 0.3% of our study mothers report drinking even 1 or more drinks per day.21 Thus the high rates of any alcohol consumption observed in this study essentially reflect occasional alcohol use (<1 drink per day). Despite the known toxicologic effects of alcohol, our results do not necessarily indicate that this low level of consumption has a true, biological protective effect. We speculate that it may be a marker for low stress, high self-confidence, or other unmeasured behavioral traits that might reduce the risk of preterm birth, but the possibility of a true protective effect merits further study.

Our results require confirmation in other settings, both because of the numerous etiologic hypotheses we tested (ie, multiple comparisons) and because of the hospital-based provenance of the study. In particular, population-based studies have indicated a substantial secular increase in multiple births13,15,16 (caused largely by treatment for infertility). Multiple births may therefore play a larger role in the observed secular increase in preterm birth observed in large population-based studies. Apart from this difference relating to multiple births, the findings from this hospital are consistent with those from our recent population-based study of Canadian births from 1981 to 1994,20 even though obstetric intervention and ultrasound dating in the latter study were based on proxy ecological variables rather than individual-level measurement. Unfortunately, large population-based studies rarely contain detailed, individual-level information on the source of gestational age estimates (eg, the use of early ultrasound dating), obstetric interventions, substance abuse, and markers for genital tract infection, and other mother’s self data on maternal smoking. Thus, further study using large, computerized clinical databases from other settings would be useful in confirming our findings. Regardless of the results of future studies, however, the available evidence to date is clear in showing no observable secular reduction in preterm birth. However, the secular increase appears to be an artifact of the increasing use of early ultrasound-based estimates of gestational age, and part can be explained by clinically justified changes in obstetric intervention. Nonetheless, the failure to reduce (true) preterm delivery among those births without such intervention underlines the need for new etiologic hypotheses and further basic and epidemiologic research in advancing our understanding about the causes and prevention of preterm birth.

Dr Kramer is a Distinguished Scientist of the Medical Research Council of Canada.

References
Diagnosing Myocardial Infarction: Should Patients Carry a Copy of Their ECG?

To the Editor: While the article by Dr Panju and colleagues on diagnosing myocardial infarction (MI) was excellent, patients with cardiac conditions should be reminded to carry a copy of their electrocardiogram (ECG). In our splintered current health care system, this step would save much time and effort and permit appropriate therapy to be instituted more quickly.

Neil L. Kao, MD
Dayton, Ohio


In Reply: We thank Dr Kao for his thoughtful comments and agree that the ECG, and specifically the presence of new ST-segment elevation and new Q waves, plays an important role in aiding the diagnosis of MI. In particular in our review we found that the presence of a new ST-segment elevation was associated with likelihood ratios of 5.7 to 53.9, while the presence of any ST-segment elevation (which by definition includes ST-segment elevation that may have been present on a prior ECG) was associated with a likelihood ratio of only 11.2. Similarly, new Q waves, as opposed to any Q waves, also were associated with higher likelihood ratios and therefore more likely to occur in patients with, as opposed to those without, MI.

The clinical impact of a prior ECG on the triage of patients with acute chest pain also was studied by Lee et al.1 In this prospective study of 5673 patients who presented to the emergency department with acute chest pain, the availability of a prior ECG did not change the sensitivity of admission to the hospital or critical care unit in patients with MI. However, patients who did have MI but had prior ECGs available were less likely to be admitted to the critical care unit than were patients without MI who did not have prior ECGs. This increased diagnostic specificity was most marked in patients with current ECG changes consistent with ischemia or infarction, suggesting that prior ECG tracings may help avoid unnecessary admissions. Prior ECGs often are not available in the emergency department setting and Kao’s suggestion that patients assume the responsibility of carrying a copy of their ECG may be one approach to overcoming this obstacle.

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CORRECTION

Incorrect Figure: In the Original Contribution entitled “Secular Trends in Preterm Birth: A Hospital-Based Cohort Study,” published in the December 2, 1998, issue of The Journal, (1998;280:1848-1854), the interval 1992-1993 of Figure 2 on page 1851 was presented incorrectly. The correct figure appears below.

Secular trends in gestational age assessment information. LNMP indicates last normal menstrual period; US, ultrasound.

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