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Are reported preterm birth rates reliable? An analysis of interhospital differences in the calculation of the weeks of gestation at delivery and preterm birth rate

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We investigated the possibility of preterm birth misclassification as a determinant of variation in its reported rates. Using a database of 497,105 deliveries from 17 hospitals, the best estimate of gestational age made at delivery and entered into the database at that time was recalculated from the menstrual dates and mid-trimester ultrasound scan. The recalculated completed weeks of gestation at delivery was compared with that made at birth. Calculation of estimated gestational age varied between hospitals due to inconsistencies in 'rounding' and 'truncating' the weeks of gestation at delivery. This resulted in preterm birth misclassification rates of up to 10.1%.

INTRODUCTION

Trends in preterm birth reported in the literature in the developed world are contradictory. Some authors have reported an increase in the rate of preterm birth, while others have reported a decreased rate.[1,2] In the USA, the increase in the preterm birth rate has been mainly attributed to the increased proportion of multiple pregnancies in white women. In 1989, Goldenberg *et al.*[3] suggested that an apparent rise in the incidence of preterm birth in the United States was partly due to a reduced tendency to round off, and an increased tendency to truncate, the weeks of gestation at delivery. This change in the recording of the weeks of gestation was probably a response to the WHO definition of preterm birth in 1977, which is the delivery of an infant before 37 completed weeks of gestation or less than 259 days, from the first day of the last menstrual period.[4] No study has investigated whether or not preterm birth misclassification occurs elsewhere. The possibility of an error in calculating the weeks of gestation at delivery and, hence, preterm birth misclassification, should not be ignored as this may partly account for differences in reported preterm birth rates. This study aimed to investigate whether or not there is variation in calculating the weeks of gestation at delivery, and if so, the effect on the calculation of preterm birth rates in the hospitals of the North West of London.

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METHODS

Data for analysis were obtained from the St Mary's Maternity Information System (SMMIS). This is an online system which contains 497,105 routinely collected maternity records from 17 hospitals within the boundaries of the former North West Thames Regional Health Authority. Data were collected prospectively and entered into the SMMIS database from 1988 to 1998, making this the largest maternity database in the United Kingdom. In addition, the validity of data held on SMMIS has been formally assessed and reported to be highly accurate.[5,6] Direct patient identification was prevented and the use of this database for research was approved by the Local Research Ethics Committee. The Statistical Package for the Social Sciences (SPSS) release 10 was used for all analyses in this study.

The best estimate of gestational age at delivery was recorded in the database at the time of birth by the midwives as a two-digit number, representing the weeks of gestation at delivery. This was calculated as the duration of pregnancy from the first day of the last menstrual period, provided the women were certain of their menstrual dates and had regular menstrual cycles. When the above conditions were not fulfilled, the best estimate of gestational age was based on the mid-trimester ultrasound scan instead of the menstrual dates. The mid-trimester ultrasound scan estimate of gestational age was based on the first fetal biparietal diameter measured before 24 weeks of gestation. Where there was a disparity of 14 days or more between both the estimated dates of delivery, the estimated date of delivery based on mid-trimester ultrasound scan was used instead of the last menstrual period-based estimated date of delivery.

SMMIS does not allow users to enter values less than 16 or greater than 49 for the best estimate of gestational age at delivery. Due to technical errors, there were 2058 cases less than 16 weeks and two cases more than 49 weeks and these were excluded from analysis. When entering gestational age of less than 24 or greater than 42 weeks, a system query ('is this correct?') is automatically displayed. This query reduces the likelihood of input error but the user can override it if the entry is perceived to be valid. In addition, plausibility checks between the best estimate of gestational age, the estimated date of delivery by ultrasound scan and the estimated date of delivery by the last menstrual period are conducted automatically. When entering data from 24 to less than 43 weeks of gestation, crosschecks with the estimated dates of delivery based on both the last menstrual period and ultrasound scan are automatically made. Where there is a disparity of two weeks or more between the entered gestational age and the estimated gestational age based on either of the estimated dates of delivery, another system query is raised.

The medical and midwifery personnel responsible for overseeing the SMMIS data entry from two hospitals were interviewed. It was found that two different methods were used when calculating the weeks of gestation at delivery. For one hospital, the best estimate of gestational age at delivery was truncated to obtain the completed weeks of gestation, such that babies born between 36 weeks and 36 weeks plus six days of gestation inclusive, were recorded as 36 weeks of gestation at delivery. For another hospital, the best estimate of gestational age at delivery was rounded off to obtain the nearest week of gestation at delivery, such that babies born between 36 weeks plus four days and 37 weeks plus three days of gestation inclusive, were recorded as 37 weeks of gestation at delivery.

One source of confounding could be a random error ('typo') in the entry of the best estimate of gestational age at delivery. Random errors of entry can be detected by plausibility checks against birthweight. However, such errors we anticipate would be random and not systematic. In this study, we were searching for systematic differences between hospitals which by definition would not be generated by random error. In addition, the exclusion rules for birthweight–gestational age discrepancy have never been formulated for such a large data set, as even apparently unlikely combinations will sometimes occur. Accordingly, we have not adjusted for such discrepancies.

The interhospital differences in the calculation of the weeks of gestation at delivery from 1988 to 1998 were investigated. The SMMIS variables used in this study were the midwives' recorded best estimate of gestational age at delivery (weeks), the estimated date of delivery based on the last menstrual period, the estimated date of delivery based on the mid-trimester ultrasound scan, the infant's date of birth, certainty of the last menstrual period and regularity of menstrual cycle. Certainty of the last menstrual period refers to a woman's ability to recall the date of the first day of the last menstrual period. This was categorised into 'certain', 'uncertain' and 'no idea'. A regular menstrual cycle is duration of 28 ± 5 days between the first days of consecutive periods, for at least three cycles. The variable for the regularity of menstrual cycle refers to menstrual cycles prior to the pregnancy, and was categorised into 'regular', 'irregular' and 'amenorrhoea'. The estimated date of delivery based on the last menstrual period is 280 days from the first day of the last menstrual period. This method assumes a 28-day cycle with ovulation on day 14. The estimated date of delivery based on the mid-trimester ultrasound scan is as described above.

Cases with unrecorded best estimate of gestational age at delivery or with gestational age of less than 24 weeks (as recorded by the midwives) were excluded from this study. The midwives' recording of the best estimate of gestational age at delivery was recalculated to obtain the gestational length in days. To do this, the infant's date of birth and both the estimated dates of delivery were computed in calendar days. For example, the 2nd of February was coded as day 33 of the calendar year. The difference in days between the estimated date of delivery and the infant's date of birth was calculated. The difference in days was then subtracted or added as appropriate to 280 to give the gestational length in days. Because many births occur in the year before or the year after that of the estimated date of delivery (e.g. where the infant's date of birth was 30th of December 1997 and the estimated date of delivery was 2nd of February 1988), the formula below was used.

$$280 + (\text{year of birth} - \text{year of estimated date of delivery}) \times 365 + (\text{calendar day of birth} - \text{calendar day of estimated date of delivery})$$

Corrections were made for leap years. SPSS automatically computes a leap year as a 366-day year. Where the infant's date of birth was at the end of a leap year and the estimated date of delivery was at the beginning of the following year, one day was deducted from the gestational age. Where the estimated date of delivery was at the end of a leap year and the infant's date of birth was at the beginning of the following year, one day was added to the gestational age. As with the midwives' calculation for the gestational age, the estimated date of delivery was based on the ultrasound scan instead of the menstrual dates if the last menstrual period was unrecorded, uncertain or unknown; or if the menstrual cycles were not regular; or if there was at least 14 days disparity between the two estimated dates of delivery.

Two sets of gestational age at delivery were created. For the first gestation set, we truncated the gestational age to calculate the completed weeks of gestation at delivery. For the second gestation set, we rounded off the gestational age to calculate the nearest week of gestation at delivery. The preterm birth rates for each hospital was calculated from the midwives' recording of the best estimate of gestational age at delivery, as the number of births at or greater than 24 and less than 37 weeks of gestation, divided by the total births at or greater than 24 weeks of gestation, over the period of 1988 to 1998. Preterm birth rates for gestation sets one and two were also calculated so that comparisons could be made. The absolute percentage difference of the preterm birth rates for the gestation sets one and two, from the midwives' preterm birth rate, was calculated for each hospital. The preterm birth misclassification rate (R) for each hospital is the difference in the number of preterm births between the recalculated preterm births in completed weeks of gestation at delivery and the midwives' preterm births, divided by the number of recalculated preterm births. The 95% confidence intervals (CI) were calculated around the preterm birth misclassification rate assuming a binomial distribution and a standard error of square root $(p(1 - p)/n)$ where p is the misclassification rate and n is the number of recalculated preterm births.

RESULTS

The proportion of recalculated best estimate of gestational age at delivery which was based on ultrasound scan alone was 17.6%. This proportion varied from 13% to 26.8% by hospital; however, this did not correlate with the proportion of preterm births by hospital (Kendall's tau-*b* correlation coefficient 0.158, $P = 0.345$). There was no relationship between completed weeks of gestation and the accuracy with which gestational age was estimated.

For each hospital, the preterm birth rate calculated from the midwives' recorded best estimate of gestational age at delivery should mirror the preterm birth rate for gestation set one if the completed week of gestation was used, or mirror the preterm birth rate for gestation set two if the nearest week of gestation was used. Figure 1 demonstrates that all hospitals during this study period have used a combination of truncating and rounding off the gestational age to calculate the week of gestation at delivery. In all hospitals, the midwives' preterm birth rates were closer to the actual preterm birth rate for gestation set one than that for gestation set two.

The preterm birth rate calculated from the midwives' recorded estimated week of gestation at delivery for hospital 16 was closest to the actual preterm birth rate calculated from gestation set one, with a percentage difference of only 1.9. In contrast, the midwives' preterm birth rate for hospital six was the furthest from the actual preterm birth rate calculated from gestation set one, with a percentage difference of 11.3. The preterm birth misclassification rate was lowest in hospital 13, with a rate of 0.5% of preterm birth (95% CI 0.25–0.76) and was highest in hospital six, with a rate of 10.1% of preterm birth (95% CI 8.56–11.68). The overall preterm birth misclassification rate was 4.6% (95% CI 4.35–4.80).

For the period of 1988 to 1998 inclusive, the overall preterm birth rate calculated from the nearest week of gestation at delivery was 6.1% (95% CI 6.06–6.20). The overall preterm birth rate calculated from the completed week of gestation at delivery was 7.6% (95% CI 7.51–7.66), which is significantly higher than the preterm birth rate calculated from the midwives' best estimate of gestational age at delivery of 7.2% (95% CI 7.12–7.28).

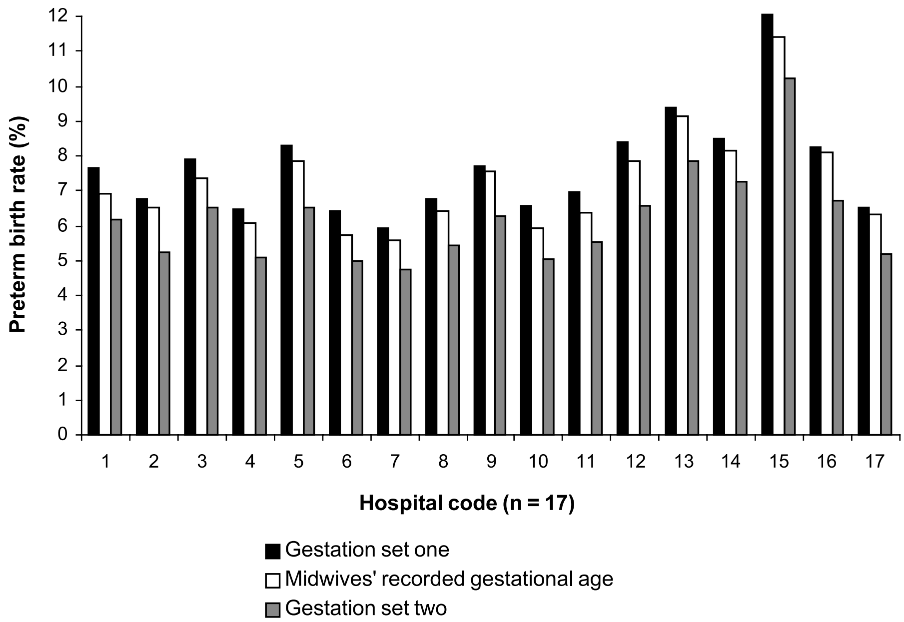

Fig. 1. Comparison of preterm birth rates for gestation set one, midwives' recorded gestational age and gestation set two, for each hospital.

DISCUSSION

After correcting for preterm birth misclassification, the preterm birth rate in the North West Thames region during the period of 1988 to 1998 has remained unchanged, with an overall rate of 7.6%. This was 5.3% higher than the preterm birth rate calculated from the midwives' recording of the best estimate of gestational age at delivery. Rounding the gestational age to the nearest week of gestation at delivery under-estimates the preterm birth rate, when compared with truncating to the completed week of gestation at delivery. This study shows that the preterm birth rate during this study period could have differed by up to 23.7%, by rounding off instead of truncating the weeks of gestation at delivery.

This study confirms the suggestion from Goldenberg's study that errors in recording the best estimate of gestational age at delivery do occur. Additionally, we have shown that this error persisted over time, and accounts for some of the variation of reported preterm birth rate between hospitals. This makes comparisons of preterm birth between hospitals or regions less reliable. Inconsistent methods of calculating the weeks of gestation at delivery will affect the accuracy of studies involving preterm, term and postterm birth. The under-estimation of preterm birth rate affects the antenatal and neonatal direct costs, as well as the long term cost of caring for handicapped infants born preterm. We recommend the retraining of all medical personnel and midwives so that the completed week of gestation is consistently used when recording data on the weeks of gestation at delivery. The use of an automated computation of the completed weeks of gestation at delivery would eliminate this human error.

Nearly 11% of cases within SMMIS had no best estimate of gestational age recorded. These cases were not included in this study but remain in the database. In these cases with missing best estimate of gestational age, the incidence of preterm birth estimated by other variables was higher. These data have been analysed and will be reported more fully elsewhere.

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Conflict of interest statement

None.

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