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Prediction of an estimated delivery date should take into account both the length of a previous pregnancy and the interpregnancy interval

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ABSTRACT

Objective: To assess the relationship between gestational lengths of the first and second pregnancies in the same women.
Study design: Observational study.
Methods: We used information from a dataset of over 500,000 pregnancies from 15 maternity units in the North West Thames, London. Data on the gestational length in days of the first pregnancy and the gestational length in days of the second pregnancy were correlated using regression models. First and second pregnancies were ascribed to the same women by identical maternal date of birth, ethnicity and maternal height (to within ±3 cm).
Results: There is a statistically significant cubic relationship between the gestational lengths of the first birth and the second birth (R 0.102, $p < 0.001$). The gestational length of the second pregnancy is likely to be closer to 280 days than the first pregnancy. In the 20% of women who had an interpregnancy interval of less than one year, the next pregnancy was one day shorter for every three months less than 12.
Conclusions: Although the gestation of second pregnancies exhibits regression towards the mean of 280 days, there is still a clinically important tendency for both preterm and postdates pregnancies to recur. Prediction of an estimated delivery date for second pregnancies should take into account both the length of the first pregnancy and the interpregnancy interval if it is less than 12 months.

Introduction

The estimation of pregnancy due dates is important both for the expectant mother, who wants be able to prepare for the birth of her baby, and for health care providers in order to schedule appropriate screening tests and assessments [1]. Pregnant women were traditionally assigned an estimated delivery date (EDD) of 280 days after the first day of their last menstrual period (LMP), although currently in the UK the recommendation is to estimate it from ultrasound measurements taken between 10 and 13 weeks gestation. However, only 4% of women deliver precisely at 280 days and only 70% of women deliver within 10 days of their EDD, even when their EDD is estimated from first trimester ultrasound [2]. A recent study conducted by the US National Institute of Environmental Health Sciences concluded that the variation in the length of pregnancy spanned 37 days, even when excluding preterm births [3].

Pre-term birth is a well-recognised cause of perinatal mortality and morbidity [4–6]. Similarly, prolonged (>42 weeks gestation) pregnancies have also been associated with adverse maternal and neonatal outcomes [7–9]. Factors shown to affect the length of a pregnancy include socio-demographic characteristics, medical complications, previous pre-term delivery, cigarette smoking and maternal age [10,11]. There is also evidence to suggest a difference in normal gestational lengths for different racial groups; Black African and South Asian women have a shorter gestational length [12] compared to White European women. Older mothers and women with a higher body mass index have longer gestational lengths [3,12,13]. However, although there have been many studies looking at the recurrence of preterm birth (i.e. before 37 weeks) [14–18], there are no published large scale studies that have assessed the influence of previous pregnancy length on the proportion of subsequent births before or after the due date, within the period designated as 'term'. Rather, there has been an assumption that preterm birth is pathologic, and that if the next pregnancy is not pathologic, its duration will on average be the same as the rest of the population, i.e. 280 days. Despite this, there is a common belief amongst mothers that the length of a previous

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pregnancy is a useful guide for predicting the EDD and that this may be a useful measure of the woman's 'natural' length of pregnancy – a woman with a longer gestational duration in a previous pregnancy being more likely to have a longer pregnancy, and vice versa. The data to evaluate this belief are surprisingly sparse. A study of only 130 births published in 2013 demonstrated that if women had longer pregnancies previously, the subsequent pregnancy was likely to be longer even though still within the range of 'term'; a one week above average duration of a previous pregnancy was associated with about a 2.5 day increase in the length of the subsequent pregnancy [3]. This is consistent with our hypothesis that there is likely to be regression to the mean, but that despite this tendency, women who gave birth early or late within the period designated 'term' are more likely to do so again than would occur by chance. The existence of a large and well validated dataset with detailed information on the duration of pregnancy gave us the opportunity to test this hypothesis.

We also took the opportunity to investigate the additional effect of the interpregnancy interval (IPI). It has been known for many years that an interval of less than 12 months between the birth of the first child and the conception of the next is associated with a higher preterm birth rate in the second pregnancy [19–21]. We assessed the relationship between the length of the IPI and duration of the subsequent pregnancy in our population.

Methods

Data collection

Between 1988 and 2000 inclusive, data were collected on over 500,000 pregnancies in 15 maternity units in the North West Thames region of London. Trained clerks and/or midwives entered the data on 301 variables for each pregnancy from the first antenatal visit up to 28 days postpartum. Computer entry of the data using a system with online validation, prompting, and standard definitions for clinical measurements, produced reliable high quality data. The data have been extensively validated in many previously published studies [22,23]. Local Research Ethics committee approval was obtained for the use of the dataset for epidemiological studies using pseudo-anonymised data reported in aggregate. Because the data were anonymised, it was not possible to identify consecutive pregnancies by name or hospital number. Instead, first (parity entered as 0) and second pregnancies (parity entered as 1) to the same women were matched using the mother's date of birth, the hospital in which they gave birth, their ethnic group, and their height (to within ±3 cm to allow for small differences in conversions from feet and inches (the mother's usual descriptive preference) to cm). Importantly, the data on each pregnancy were collected in equal detail and with equal accuracy.

Estimation of gestational age

The gestational length of a women's first and second pregnancies was calculated as the duration of pregnancy from the first day of the LMP in women who were certain of their dates and had a regular 28 day cycle. In women who were not certain of their menstrual dates and/or had irregular cycles, the gestational age was determined from the fetal biparietal diameter on a fetal ultrasonography measurement made before 24 weeks gestation. Where there was a discrepancy of more than 14 days between the EDD by the LMP and ultrasonography, the EDD based on the mid-trimester ultrasound scans was used. Any gestational ages at birth less than 16 weeks or greater than 49 weeks were considered to be implausible and were excluded from the analysis. Additional plausibility checks between the best estimate of gestational age at birth made by the delivering midwife, the EDD by ultrasound and the EDD by the LMP were conducted using an algorithm reported in detail previously [1]. Where there was a discrepancy of greater than two weeks between the best estimate of gestational age at birth and the gestational age based on either the LMP or ultrasound findings, a further system enquiry was raised and implausible cases removed.

Although there are many factors that influence gestational length at birth, such as maternal age and racial group, and medical complications such as hypertension and diabetes, because we wanted an analysis relevant to the total population, we did not correct for them. Most potential confounders relating to the length of pregnancy are automatically allowed for because the first and second pregnancies were in the same women (i.e. each woman acted as her own control). However, to see if factors leading to elective early delivery changed the relationship significantly, we performed a secondary analysis including only women with a spontaneous onset of labour in both pregnancies.

Estimation of interpregnancy interval

The interpregnancy interval was assessed by calculating the number of weeks between the date of birth of the first baby and the date of birth of the second, and then subtracting the duration of the second pregnancy in weeks minus two (to allow for conception occurring on average at day 14 of pregnancy as traditionally calculated).

Data analysis

Regression models (linear, quadratic and cubic) were used to analyse the relationship between the gestational length of the first pregnancy (pregnancy 1) and the gestational length of the subsequent pregnancy (pregnancy 2), and between the inter-pregnancy interval and the gestational length of the subsequent pregnancy (pregnancy 2). All analyses were performed using SPSS version 21.

Results

A total of 40,861 women who had matched first and second pregnancies were included in the study. Subject characteristics, including maternal age, ethnic group, diabetes status in pregnancy, smoking status, onset of labour for pregnancy 1 and 2 (spontaneous onset or induced), body mass index (BMI) and sex of the fetus are shown in Table 1.

The association between the mean length of gestation of pregnancy 1 and gestation of pregnancy 2 is illustrated in Fig. 1. When the length of pregnancy 1 is between 256 and 298 days, the confidence intervals for pregnancy 2 are narrow. We performed regression analysis in all 40,861 cases to determine the association between the length of pregnancy 1 and pregnancy 2. Fig. 2 shows a scatter plot of the gestational lengths of first and second pregnancies in the same women. Linear, quadratic and cubic regression models with parameter estimates are shown in Table 2. We used the cubic regression model to estimate the relationship between the gestational lengths of the first and second pregnancies because it gave the best fit (R^2 0.102, $p < 0.001$, constant 269.621, $b1$ −0.119, $b2$ 0.000, $b3$ 0.00000192).

Where the length of pregnancy 1 is x and the length of pregnancy 2 is y, the derived cubic equation for the model is $y = 269.621 - (0.11935^{*}x) + (0^{*}x^2) + (0.00000192^{*}x^3)$.

The analysis including only women with spontaneous onset of labour in first and second pregnancies, including 25,871 cases, shows the same cubic relationship of gestational lengths of pregnancy 1 and pregnancy 2 (Fig. 3). Table 3 shows the cubic regression model with parameter estimates.