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Predicting date of birth: the best time to date a pregnancy?

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ABSTRACT

Objective: To compare the estimated date of birth (DOB) calculations from last menstrual period (LMP) and ultrasound examinations at varying gestations (<7^{0}, 7^{0}-10^{6}, 11^{0}-14^{0}, 14^{1}-19^{6} and 20^{0}-27^{6}) against the actual DOB.

Methods: This cohort study in a single local health district, Australia included 18,708 women with spontaneous labor who gave birth to a single live born infant without major anomalies between 2007 and 2011. Data were sourced from a computerized population birth database. The outcome of interest was duration of pregnancy expressed as total days, and the difference between actual DOB and estimated DOB by dating method.

Results: Only 5% of births occurred on the estimated DOB regardless of the method or timing of the estimate. Approximately 66% of births occurred +/-7 days of the estimated DOB, and there was little difference between the ultrasound examinations performed at varying gestational weeks. The 11^{0}-14^{0} weeks of gestation ultrasound examination performed as well if not better than ultrasound examinations conducted at other gestations.

Conclusion: An early dating scan (10 weeks or earlier) is unnecessary if LMP is reliable.

INTRODUCTION

Determination of the expected date of birth (DOB) has a direct effect on determination of gestational age, which in turn has a critical impact on the timing of prenatal tests, diagnosis of preterm labor and post-term pregnancies, interventions for poor fetal growth, induction of labor and tocolytic treatment [1]. Prediction of the delivery date also has social and personal ramifications for the pregnant woman and her family as they prepare for the arrival of their newborn child, including household preparations, timing of cultural rituals, travel arrangements for family visitors from afar and initiation of parental leave.

Current methods for determining the length of human gestation are based on last menstrual period (LMP) and/or ultrasound examination. Using LMP, length of gestation is calculated as 280 days from the first day of the LMP or 266 days from ovulation to delivery, assuming that the woman has a 28 day cycle and ovulates on the 14th day [2]. Limitations of LMP include recall bias, irregular menstrual cycles, oral contraceptive use and bleeding in early pregnancy [3]. Ultrasound dating relies on a variety of fetal size measurements such as crown-rump length (CRL), biparietal diameter, head circumference, abdominal circumference, femur length and transverse cerebellar diameter [3]. A criticism of ultrasound dating is that fetal measurements are compared with fetal size references which do not account for normal variability [4]. An implicit assumption in ultrasound examination is that all fetal size variability is due only to gestational age below a certain gestational age, which may systematically result in the assignment of incorrect lower gestational age estimates for smaller infants [4].

Compared to menstrual dating, ultrasonography before 20 weeks' gestation is generally viewed as a more accurate method of estimating gestational age [5-8]. In practice, the use of both methods is intertwined. LMP estimates are used as a benchmark for booking the timing of the ultrasound examination; therefore, influencing the calibration and acceptance of the gestational age resulting from ultrasound information. When LMP is uncertain, gestational age estimates are based on early ultrasound examination (<20 weeks) or other factors [9]. When there is disagreement between the two methods non-standardised or universal rules are used to decide whether to substitute ultrasound-based gestational age estimates for LMP-based estimates [7].

While there is a prevailing belief that the earlier in pregnancy an ultrasound examination is conducted the greater accuracy it has,[9] there are no studies to support this claim. The obstetric literature strongly suggests CRL measurement between 6.5–10 weeks of gestation is the single most accurate method of pregnancy dating [10, 11]. However, Gezer and colleagues found that CRL measurements changed the gestational age estimation in a great proportion of cases [11]. As more pregnancies undergo nuchal translucency screening, it remains to be seen whether such ultrasound examinations, commonly done at 11-13 weeks of gestation, will provide adequate dating. The aim of the present study was to compare the estimated DOB calculations from LMP and ultrasound examinations at varying gestations against the actual DOB.

MATERIALS AND METHODS

The study population included all women with spontaneous labor who gave birth to a singleton infant without major anomalies in the Northern Sydney Central Coast

Health Area between 1 January 2007 and 31 October 2011. These births represent 51.7% of all births during the study period (n=37,089). Within this population there is a high uptake of nuchal translucency screening and fetal anomaly ultrasound examinations. Other ultrasound examinations are performed at the discretion of the caregiver according to clinical circumstances. Women undergo ultrasound examinations in dedicated public or private obstetric ultrasound services staffed with accredited obstetric sonographers, obstetricians with ultrasound sub-speciality training or maternal-fetal medicine specialists using accredited equipment. Generally women book into hospital in the first 16 weeks and have available ultrasound examination results recorded at that time such that ultrasound examinations after this booking visit may not be captured.

De-identified population health data were sourced from ObstetriX, a computerized birth database, which includes all births of at least 400 grams birth weight or ≥20 weeks of gestation. Information on maternal characteristics, pregnancy, labor and delivery and infant outcomes were entered into the electronic database by the attending midwife or doctor as they occurred during pregnancy and birth. Validation studies show ObstetriX has low rates of missing data and generally high levels of agreement when compared with information obtained directly from the medical record [12]. The study received ethics approval from the Human Research Ethics Committee (HREC) of Northern Sydney Central Coast Health, Australia. Obtaining individual informed consent was not required because the research involves no more than minimal risk, uses secondary data without any identifiers provided to researchers and would have impractical and possibly more harmful depending on the obstetrical outcome to contact large numbers of participants.

The outcome of interest was duration of pregnancy expressed as both the total number of days and the difference between the actual and the estimated DOB, by type of dating method. Outcomes were calculated using the following variables: date of LMP, cycle length, the dates and gestational age estimates for individual ultrasound examinations taken during pregnancy and the actual DOB. Duration of pregnancy is reported in days and calculated as: 280+ (actual DOB- estimated DOB). Estimated DOB values were calculated using available information on LMP (LMP date+280+ (cycle length-28) and ultrasound examination (ultrasound examination date - days gestation at ultrasound examination +280). LMP dates were only recorded when 'reliable' (including a reliable date, regular menstrual cycle prior to pregnancy and cycle length between 21 and 35 days). Ultrasound examinations were categorized into five gestational bands: $<7^0$ weeks, 7^0-10^6 weeks, 11^0-14^0 weeks, 14^1-19^6 weeks and 20^0-27^6 weeks. There are no standard international guidelines for the number of recommended ultrasound examinations during routine prenatal care, thus categories were based on the most common medical indications for performing ultrasound examinations in most industrialized countries [13, 14]. In broad terms, these include early first trimester ultrasound examinations ($<7^0$ or 7^0-10^6 weeks gestation) to confirm heartbeat, viable, molar or ectopic pregnancies, measure CRL and assess gestational age; the 11^0-14^0 week ultrasound examination to assess risk of trisomy, the mid-pregnancy ultrasound examination (14^1-19^6 weeks gestation) for systematic investigation of fetal morphology and the 20^0-27^6 week ultrasound examination to identify placental location, observe fetal presentation and movements, identify uterine or pelvic abnormalities of the mother or confirm intrauterine death.

For women with more than one ultrasound examination in a specific gestational band (n=928), estimates from the earliest ultrasound examination in the band were used. Explanatory variables included: maternal age, parity, pre-pregnancy body mass index (BMI), smoking during pregnancy, hypertension (pre-existing, gestational and pre-eclampsia), diabetes (pre-existing and gestational) and model of care (including midwife, hospital-based or private obstetrician). Using international standards, BMI measurements were used to categorise women as underweight (BMI < 18.5 kg/m^2), normal weight (BMI 18.5 to 24.9 kg/m^2), overweight (BMI 25.0 to 29.9 kg/m^2), or obese (BMI ≥ 30 kg/m^2) [15]. Age was categorised as <20, 20-24, 25-29, 30-34, 35-39 and 40 years or more.

The paired difference between actual DOB and estimated DOB (actual DOB minus estimated DOB) was calculated for each non-missing LMP/ultrasound examination band for each woman. Descriptive analyses using frequency tables for categorical outcomes and means (standard deviations), medians (25th and 75th percentile ranges) and modes for continuous variables were performed to examine general characteristics of the study population and to describe the distributional spread of duration of pregnancy in days and the paired actual DOB- estimated DOB differences by method of estimated DOB. Frequency tables were used to examine the proportion of births where the estimated DOB was within 0 (same day), ±3, ±7, ±14 and ±21 days of the actual DOB using different sources of dating measurements. Analyses were conducted using SAS, version 9.2 (SAS Institute, Cary, NC, USA).

RESULTS

During the study period, there were 19,191 women with spontaneous labor who gave birth to a singleton infant. After excluding women that were missing dating information for both LMP- and ultrasound examination-based methods (n=483, 2.5%), the study population consisted of 18,708 births. The mean (±SD) maternal age was 30.3 (± 5.5) years and 23.2% were aged 35 years of more, while 26.2% were overweight or obese (**Table 1**). As women with planned births (labor induction and prelabor cesarean section) were excluded, the rates of hypertension and diabetes are low. Of the 10, 243 (55%) women with a reliable LMP, 88.3% had a cycle of 26-30 days, 3.3% a cycle of 21-25 days and 8.4% had 31-35 day cycles. Smokers were less likely to report a reliable LMP than non-smokers (31.1% vs 56.5%). The subgroup of Asian-born women had a shorter pregnancy duration at all ultrasound bands; for the 11^0-14^0 weeks ultrasound their median DOB-EDB difference was -2 days.

Ninety-five percent of women had at least one ultrasound examination and 1.7% had four or more. The most frequently reported ultrasound examination (65.1%) was performed at 11^0-14^0 weeks (**Table 2**). Based on calculations using the aDOB, the mean (±SD) duration of pregnancy based on LMP-estimates was 277.7 (±13.1) days (**Table 2**). Duration of pregnancy based on estimates from different ultrasound examination bands showed mean estimates ranging from 275.7 to 278.7 days and medians from 278 to 281 days. Calculations for estimated DOB based on ultrasound examinations performed at 11^0-14^0 weeks of gestation showed the least amount of dispersion around the mean (standard deviation (SD)=11.2 days) compared to greater dispersion or variability when using the LMP-based estimate (SD=13.1) or the commonly preferred dating ultrasound examination between 7^0 and 10^6 weeks (SD=12.8). The difference between the overall mean estimated DOB's for the 7^0-10^6 and 11^0-14^0 ultrasound examinations was small (2.0 days) compared to the natural variability around the estimated DOB (≥10 days between the 25th and 75th percentile).

Across all methods for estimated DOB, approximately 5% (range 4.9-5.5%) of estimated DOBs correctly predicted the actual DOB and approximately 66% (range 60.8-67.9%) occurred within a week (± 7 days) of the eDOB (**Table 2**). Estimated DOB using the LMP and the 20^0-27^6 ultrasound examinations led to a higher proportion of post-term births (1.6% and 1.8%, respectively) in comparison to the other ultrasound examination bands. Estimated DOB based on the 11^0-14^0 and 14^1-19^6 ultrasound examination bands led to the lowest proportion of preterm births (3.8 and 4.3%, respectively) compared to the other methods. Ultrasound examinations performed at $<7^0$ weeks had more births occur before the estimated DOB (58.9%), which is visually represented by a left shift in the histogram showing the distribution in the difference in days between the actual and estimated DOB (**Figure 1**). In contrast, the 11^0-14^0 ultrasound examination showed a slight shift to the right, suggesting more births occurred after the estimated DOB. For all gestational bands, the distribution of actual DOB- estimated DOB differences necessarily had a longer tail to the left (skewness = -3.8) due to the occurrence of very preterm births.

DISCUSSION

Key findings from this comparison of estimated DOB calculations from LMP and ultrasound examinations at varying gestations are as follows: few births occur on the expected due date and the difference between estimated DOB and actual DOB are similar regardless of which method is used to calculate estimated DOB.

While it has been suggested that a very small proportion of births occur on the estimated DOB [8, 16], this study uses a population-based sample and data on actual DOB to support this claim. Results show that 1 in 20 births occur on the estimated DOB and approximately 66% of births occur within a week (+/- 7 days) of the estimated DOB. Most clinical decisions during pregnancy are influenced by the presumed gestational age of the fetus at the time that decisions are made. Therefore, better prediction of the timing of birth will improve monitoring of fetal growth and assist in providing optimal management for preterm and postterm deliveries [17].

Results of this study also found that compared to the large natural variability around DOB, there was little practical difference at the individual patient level between the various dating examinations. The small amount of difference between dating methods suggests that revisions to estimated DOB during pregnancy are unwarranted. Older studies have claimed that estimated DOB using "early" ultrasound examination (before 20 weeks) instead of LMP has contributed to higher rates of preterm delivery rate (<37 completed weeks) [18, 19]. The present study found that reliance on a dating examination before 11 weeks would have resulted in a higher apparent preterm rate for the cohort (5.1% based upon the 7^0-10^6 scan) compared to reliance upon later scans (3.8% at 11^0-14^0, 4.3% at 14^1-19^6). These rates are lower than for the entire Health Area (6.3%)[20], which is unsurprising given the cohort only includes women who spontaneously laboured and does not include high risk transfers from rural areas.

Previous studies have reported lower rates of post-term births for women with estimated DOB based on first trimester ultrasound assessments compared to second trimester ultrasound assessments[21] and compared to LMP [22, 23]; however, these studies were unable to distinguish between first and second trimester ultrasound examinations at varying gestations. In this study, there were fewer post-term births for earlier ultrasound examinations performed at $<7^{0}$ -10^{6} weeks compared to ultrasound examinations at 11^{0}-14^{0} or 14^{1}-19^{6} weeks. Both the 11^{0}-14^{0} and 14^{1}-19^{6} ultrasound examination showed a slight shift to the right in the actual DOB- estimated DOB difference (post-term advanced by 1-2 days). Except for the 20^{0}-27^{6} ultrasound examination, all of the other ultrasound examinations resulted in fewer or equivalent post-term births compared to LMP.

While no single gestational ultrasound examination band stands out as the best, the nuchal translucency and anomaly ultrasound examinations which are already routinely performed appear to have the least amount of dispersion around the mean. Our results lend support to international guidelines that recommend [13] using either ultrasound examination (11^{0}-14^{0} or 14^{1}-19^{6}) for dating purposes, which would lead to reduced costs (if 7^{0}-10^{6} week dating scans are in widespread use) and greater consistency in gestational age assessment. While ultrasound examinations prior to 10 weeks gestation may provide the opportunity for early detection of nonviable and ectopic pregnancies, our results suggest that their use for dating purposes could be limited to when LMP is unknown or unreliable and determination of gestational age is required for accurate booking of a nuchal tranclucency ultrasound examination.

In terms of implications, expectant mothers should be informed that there is only a 35% chance that they will actually go into labor during the week of their estimated DOB (+/-3 days). While the practice of supplying women with a single day on which to expect their birth has long been the norm, it has been suggested that anxiety may be alleviated if a range of dates (for example 38-42 weeks) was substituted for a specific date of delivery [24]. However, information on women's preferences for how the timing of their birth is communicated is lacking.

The strengths of this study include the use of reliable measures of maternal characteristics, LMP dates are only used when reported to be reliable, and pregnancies with prelabor interventions (induction or prelabor cesarean section) were excluded to eliminate the introduction of bias from the artificial shortening of the biological span of pregnancy. Furthermore, this study used a population-based cohort with data on actual DOB and was able to express duration of pregnancy in days and not just weeks. Estimated DOBs were determined prior to, and unbiased by, the actual DOB. Consequently, these data also describe the natural duration of singleton pregnancies. Study limitations include the possibility that the study sample is not generalizable to all pregnant women including those with multiple pregnancies. Our study population has a greater proportion of older and more educated women compared to national estimates [25]. Another possible limitation is that many of the women did not have a record of estimated DOB assessment in all gestational bands. If those not attending for a particular estimated DOB were systematically different from those who did, this could introduce bias into comparisons of estimated DOB at different gestational bands. However, the differences between the estimated DOB by ultrasound examination band were relatively small, suggesting a limited effect to any such potential bias. The lack of complete data on ultrasound examination results from the 14-19 week morphology ultrasound examination is because this examination usually occurs after the antenatal booking appointment and dating results may not always be sent to the attending midwife or doctor who enters medical information into the electronic database. Finally, data were not available on which fetal measurements were used at various ultrasound examinations nor on details relating to providers, training and equipment, and it is not possible to determine whether the LMP estimation of gestational age based on women's self-reported dates influenced ultrasound measurements or results.

In summary, regardless of which dating method is used, current methods used in clinical settings for estimating the duration of pregnancy from conception to spontaneous birth are only able to predict actual DOB for 1 in 20 births. While no single dating method stands out, our results support use of an ultrasound examination between 11-14 weeks for determining gestational age [13].

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CONFLICTS OF INTEREST

The authors did not report any potential conflicts of interest.

REFERENCES

1. Von der Pool B: **Preterm labor: Diagnosis and treatment**. *Am Fam Physician* 1998, **15**:2457-2464.

2. Mittendorf R, Williams, MA., Berkey, CS., Cotter, PF.: **The length of uncomplicated human gestation**. *Obstet Gynecol* 1990, **75**:929-932.

3. Nakling J, Buhaug, H., Backe, B. : **The biologic error in gestational length related to the use of the first day of last menstrual period as a proxy for the start of pregnancy**. *Early Hum Dev* 2005, **81**:833-839.

4. Henriksen T, Wilcox, AJ., Hedegaard, M., Secher, NJ. : **Bias in studies of preterm and postterm delivery due to ultrasound assessment of gestational age**. *Epidemiology* 1995, **6**:533– 537.

5. Backe B, Nakling, J. : **Term prediction in routine ultrasound practice**. *Acta Obstet Gynecol Scund* 1994, **73**:113-118.

6. Barr W, Pecci, CC.: **Last menstrual period versus ultrasound for pregnancy dating**. *International Journal of Gynecology and Obstetrics* 2004, **87**:38-39.

7. Dietz P, Englanda, LJ., Callaghana, WM., Pearlb, M., Wierb, ML., Kharrazic, M.: **A comparison of LMP-based and ultrasound-based estimates of gestational age using linked California livebirth and prenatal screening records**. *Paediatric and Perinatal Epidemiology* 2007, **21**:62– 71.

8. Mongelli M, Wilcox, M., Gardosi, J.: **Estimating the date of confinement: ultrasonographic biometry versus certain menstrual dates.** *Am J Obstet Gynecol* 1996, **174**:278-281.

9. Hoffman C, Messerd, LC., Mendolad, P., Savitze, DA., Herring, AH., Hartmannf, KE.: **Comparison of gestational age at birth based on last menstrual period and ultrasound during the first trimester**. *Paediatric and Perinatal Epidemiology* 2008, **22**:587– 596.

10. Levi C, Dashefsky, SM., Lyons, EA. : **First trimester ultrasound: a practical approach. In: McMahan JM, Porto M (eds) Diagnostic obstetrical ultrasound**. *Lippincott Philadelphia* 1994:p 1.

11. Gezer A, Esen, F., Erdem, B., Mutlu, H., Kahraman, N., Ocak, V.: **Early first trimester ultrasound examination: Is it really efficient in the clinical management of the pregnancy?** *Arch Gynecol Obstet* 2002, **267**:76– 80.

12. Roberts CL, Bell JC, Ford JB, Morris JM: **Monitoring the quality of maternity care: how well are labour and delivery events reported in population health data?** *Paediatr Perinat Epidemiol* 2009, **23**(2) :144-152.

13. NICE: **National Collaborating Centre for Women Antenatal Care – routine care for the healthy pregnant woman. NICE/RCOG Press.** 2008.

14. Filly R, Crane, JP. : **Routine obstetric sonography**. *Journal of Ultrasound in Medicine* 2002, **21**:713-718.

15. NIH: **National Institutes of Health. Clinical guidelines on the identification,**
s and Children
evaluation, and treatment of overweight and obesity in adults: The evidence report. *Obes Res* 1998, **6** 51S– 209S.
s Health.

16. Katz V, Farmer, R., Tufariello, J., Carpenter, M.: **Why we should eliminate the due date: A truth in jest.** *American College of Obstetrics and Gynecologists* 2001, **98**:1127-1129.

17. Gjessing H, Grottum, P., Eiknes, SH.: **A direct method for ultrasound prediction of day of delivery: a new, population-based approach**. *Ultrasound Obstet Gynecol* 2007, **30**:19– 27.

18. Yang H, Kramer, MS., Platt, RW., Blondel, B., Bréart, G., Morin, I., Wilkins, R., Usher, R.: **How does early ultrasound estimation of gestational age lead to higher rates of preterm birth?** *Am J Obstet Gynecol* 2002, **186**:433 – 437.

19. Joseph K, Kramer, MS., Marcoux S., Ohlsson, A., Wen, SW., Allen, A., Platt, R. : **Determinants of preterm birth rates in Canada from 1981 through 1983 and from 1992 through 1994**. *N Engl J Med* 1998, **339**:1434– 1439.

20. NSW Department of Health: **NSW Mothers and Babies Reports 2009**. In *NSW Public Health Bulletin*. http://www.health.nsw.gov.au/pubs/a-z/n.asp (Accessed August 2012) .

21. Bennett K, Crane, JMG., O'Shea, P., Lacelle, J., Hutchens, D., Copel, JA.: **First trimester ultrasound screening is effective in reducing postterm labor induction rates: A randomized controlled trial**. *AJOG* 2004, **190**:1077-1081.

22. Kallen K: **Mid-trimester ultrasound prediction of gestational age: advantages and systematic errors**. *Ultrasound Obstet Gynecol* 2002, **20**:558– 563.

23. Tun M, Tuohy, J.: **Rate of postdates induction using first-trimester ultrasound to determine estimated due date: Wellington Regional Hospital audit**. *Australian and New Zealand Journal of Obstetrics and Gynaecology* 2011, **51**:216– 219.

24. Saunders N, Paterson, C.: **Can we abandon Naegele's rule?** *Lancet* 1991, **337**:600-601.

25. ABS: **Australian Bureau of Statistics**. *Website* *http://wwwabsgovau/ausstats/abs@nsf/Lookup/41020Chapter3202008*, **Accessed May 4, 2012**.

Table 1 Maternal characteristics by method of estimated date of birth (DOB) assessment (Last menstrual period and timing of ultrasound examination).

	Entire Study Population N=18,708 n (%)	Reliable Last Menstrual Period n=10,243 n (%)	Ultrasound Bands (Weeks of Gestation)				
			$<7^0$ n=1,999 n (%)	7^0-10^6 n=521 n (%)	11^0-14^0 n=12,184 n (%)	14^1-19^6 n=6,919 n (%)	20^0-27^6 n=2,234 n (%)
Maternal age, years							
Younger than 20	61 (3.3)	148 (1.4)	73 (3.7)	164 (3.6)	273 (2.2)	206 (3.0)	121 (5.4)
20-24	2 315 (12.4)	903 (8.8)	287 (14.4)	628 (13.9)	1218 (10.0)	851 (12.3)	334 (15.0)
25-29	5 073 (27.1)	2644 (25.8)	625 (31.3)	1265 (28.0)	3131 (25.7)	1841 (26.6)	617 (27.6)
30-34	6 376 (34.1)	3848 (37.6)	668 (33.4)	1470 (32.5)	4466 (36.7)	2431 (35.1)	699 (31.3)
35-39	3 684 (19.7)	2291 (22.4)	288 (14.4)	829 (18.3)	2666 (21.9)	1345 (19.4)	383 (17.1)
40 or older	649 (3.5)	409 (4.0)	58 (2.9)	165 (3.7)	430 (3.5)	245 (3.5)	80 (3.6)
Country of birth							
Australia	11 491 (61.7)	5734 (56.0)	1221 (61.5)	2874 (63.8)	7516 (61.7)	3947 (57.4)	1234 (55.5)
Asian region	3165 (17.0)	2042 (19.9)	380 (19.1)	747 (16.6)	1884 (15.5)	1498 (21.8)	510 (22.9)
Other	3972 (21.3)	2415 (23.6)	385 (19.4)	884 (19.6)	2727 (22.4)	1437 (20.9)	479 (21.6)
Nulliparous	8211 (43.9)	4549 (44.4)	1048 (52.4)	2106 (46.6)	5513 (45.3)	3147 (45.5)	1014 (45.4)
Body mass index (kg/m^2)							
Underweight	1 361 (7.5)	699 (7.0)	153 (7.8)	369 (8.4)	802 (6.8)	546 (8.1)	170 (7.9)
Normal weight	11 969 (66.3)	6733 (67.9)	1267 (64.4)	2824 (64.2)	7943 (67.2)	4513 (67.2)	1371 (63.9)

Overweight	3 283 (18.2)	1767 (17.8)	390 (19.8)	815 (18.5)	2178 (18.4)	1177 (17.5)	390 (18.2)
Obese	1 452 (8.0)	721 (7.3)	158 (8.0)	391 (8.9)	896 (7.6)	481 (7.2)	213 (9.9)
Model of prenatal care							
Midwife	14 554 (77.8)	7871 (77.8)	1571 (78.6)	3513 (77.7)	9677 (79.4)	5466 (79.0)	1708 (76.8)
Hospital-based medical	2 515 (13.4)	1280 (12.5)	278 (13.9)	658 (14.6)	1524 (12.5)	855 (12.4)	365 (16.4)
Shared	1 089 (5.8)	634 (6.2)	129 (6.5)	283 (6.3)	705 (5.8)	475 (6.9)	119 (5.4)
Private obstetrician	529 (2.8)	349 (3.4)	21 (1.1)	66 (1.5)	277 (2.3)	121 (1.8)	33 (1.5)
Smoked in pregnancy	1835 (9.8)	579 (5.7)	204 (10.2)	527 (11.7)	916 (7.5)	611 (8.8)	296 (13.3)
Diabetes							
None	17 889 (95.6)	9758 (95.6)	1895 (94.8)	4337 (96.3)	11 719 (96.2)	6562 (95.2)	2121 (95.7)
Pre-existing	16 (0.1)	11 (0.1)	2 (0.1)	4 (0.1)	9 (0.1)	6 (0.1)	4 (0.2)
Gestational	715 (3.8)	437 (4.3)	102 (5.1)	164 (3.6)	455 (3.7)	326 (4.7)	92 (4.2)
Hypertension							
None	18 341 (98.0)	10 052 (98.3)	1952 (97.8)	4435 (98.2)	11 947 (98.1)	6798 (98.3)	2197 (98.3)
Pre-existing	34 (0.2)	16 (0.2)	4 (0.2)	7 (0.2)	19 (0.2)	7 (0.1)	2 (0.1)
Pregnancy	307 (1.7)	162 (1.6)	39 (2.0)	75 (1.6)	208 (1.7)	106 (1.5)	31 (1.4)

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5 Reliable last menstural period defined as regular menstrual cycle prior to pregnancy and cycle length between 21 and 35 days.

6 Subgroup totals may be less than column total N because of missing data.

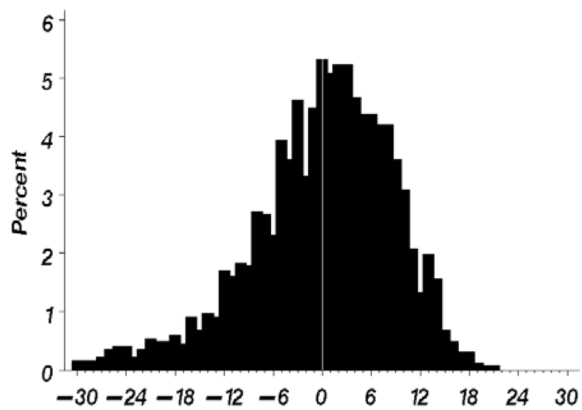
Table 2 Proportion of births where estimated date of birth (DOB) was the same as the actual DOB and within specified ranges by source of estimated DOB.

Duration of pregnancy		Reliable Last Menstrual Period	Gestation of Ultrasound Examination (Weeks)				
			<7⁰	7⁰-10⁶	11⁰-14⁰	14¹-19⁶	20⁰-27⁶
Total number of women		10,243	1,999	4,521	12,184	6,919	2,234
Proportion of women (%)		54.8	10.7	24.2	65.1	37.0	11.9
Mean duration (±SD) [2,3]		277.7 ± 13.1	275.7 ± 11.9	276.7 ± 12.8	278.7 ± 11.2	277.3 ± 12.5	277.8 ± 15.2
Median duration (interquartile range) [2,3]		280 (11)	278 (11)	279 (11)	281 (10)	279 (10)	281 (12)
Mode of duration (25th, 75th percentiles)[2,3]		280 (274, 285)	282 (272, 283)	279 (273, 284)	281 (275, 285)	281 (274, 284)	280 (274, 286)
Difference between aDOB and eDOB (days)							
	22 or more (preterm)	4.7	5.3	5.1	3.8	4.3	5.6
	15-21	4.6	6.6	5.0	3.5	4.9	3.8
aDOB before eDOB	**8-14**	12.1	15.2	13.0	10.7	12.4	10.9
	4-7	13.1	16.8	14.2	12.4	14.3	12.0
	1-3	13.9	15.0	14.8	14.2	14.6	11.9
aDOB on the eDOB	**0**	5.2	5.4	5.5	4.9	5.4	5.1
	1-3	14.4	14.8	15.5	16.3	15.5	14.9
aDOB after	**4-7**	18.0	14.1	17.5	20.1	17.2	16.9

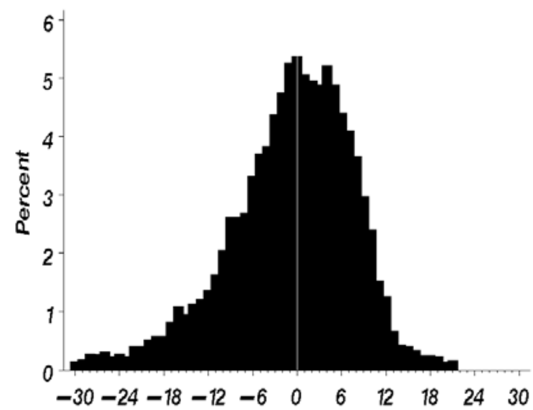
eDOB	**8-14**	12.4	6.8	9.1	13.7	11.0	17.0
	15 or more (postterm)	1.6	0.1	0.2	0.5	0.5	1.8

Figure 1.

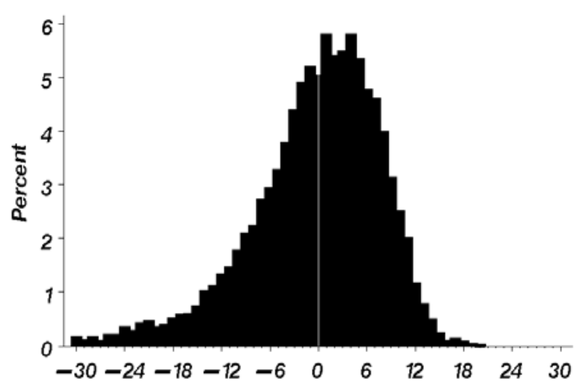
$<7^0$ weeks gestation



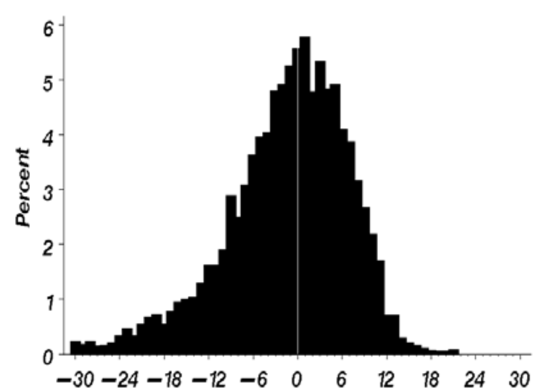
7^0 -10^6 weeks gestation



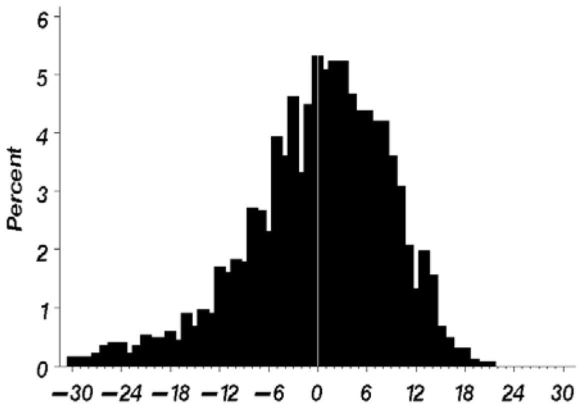
11^0 -14^0 weeks gestation



14^1 -19^6 weeks gestation



20^0 -27^6 weeks gestation



Last Menstrual Period (LMP)

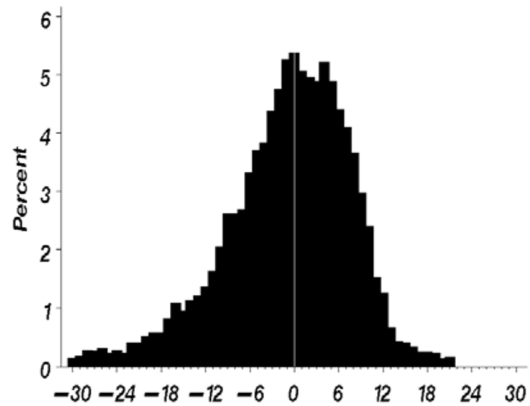


Figure Legend

Histogram of the difference in number of days between actual date of birth (DOB) and estimated DOB using last menstrual period (LMP) and ultrasonography estimates categorized by gestational age at ultrasonogram. A, less than 7 weeks of gestation; B, 7–10 6/7 weeks of gestation; C, 11–14 weeks of gestation; D, 14 1/7–19 6/7 weeks of gestation; E, 20–27 6/7; F, LMP.