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Discordant dating of pregnancy by LMP and ultrasound and its implications in perinatal statistics

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Abstract

Context: High perinatal mortality in India may be caused by inaccurate dating of pregnancy resulting from suboptimal uptake of antenatal care and ultrasound services during pregnancy. **Aim:** To determine the discrepancy in the last menstrual period (LMP) assigned expected date of delivery (EDD) and ultrasound assigned EDD in pregnant women in a rural district of central India. **Methods:** Data from an ongoing cross-sectional screening program providing fetal radiology imaging in Guna district of Madhya Pradesh from 2012–2019 was analyzed for recall of LMP and discordance between LMP and ultrasound assigned EDD. The discrepancy was present when EDD assigned by ultrasound differed by 3 or more days at gestational ages less than 8^{+6} weeks, 5–7 days at gestational ages 8^{+6} weeks till 14 weeks, and 7–10 days at gestational ages 14–20 weeks. **Results:** The program screened 14,701 pregnant women of which 4,683 (31.86%, 95% CI: 31.11, 32.61) could not recall LMP. EDD assigned by LMP and ultrasound matched in 7,035 (70.22%, 95% CI: 69.32, 71.12) of the remaining 10,018 pregnant women. EDD was overestimated by LMP for 26.06% (95% CI: 25.21, 26.93) women; these foetuses were at risk of being misclassified as a term fetus. In 2018, the project had no maternal deaths, infant mortality rate of 24.7, low birth weight rate of 9.69%, and 100% antenatal coverage. **Conclusion:** Accurate dating of pregnancy and systematic follow-up integrating radiology imaging and obstetrics care for appropriate risk-based management of pregnant women can significantly improve perinatal statistics of India.

Key words: Antenatal care; dating; gestational age; pregnancy outcomes; preterm births; ultrasound

The determination of an accurate gestational age and expected date of delivery (EDD) is very important from a clinical perspective for the appropriate management of a pregnant woman.[1] Accurate gestational age is important as several laboratory and screening tests are gestational age-specific for optimal results.[2,3] Predictors of risk for major comorbidities in pregnancy are specific for a range of gestational ages, incorporate gestational age, and inter-pregnancy intervals in the calculations.[4-8] An accurate

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estimation of gestational age is important to chart fetal growth, to determine the timing of delivery or induction of labour,[8] for interventions including amniocentesis or antenatal corticosteroids, and to plan deliveries in pregnancies with medical comorbidities like preeclampsia.[9]

India has a high perinatal mortality rate, 36 per 1000 pregnancies, as reported by the national representative of National Family Health Survey-4 (NFHS-4).[10] In addition, NFHS-4 reported a neonatal mortality rate of 30 per 1000 live births in India and a birth weight <2500 g in 18.2% of live births.[10] Preterm births and low birth weight are the major causes (41.77%) of neonatal deaths in India.[11] In 2014-16, the maternal mortality ratio in India was reported as 130 per 100,000 live births.[12] Approximately one-tenth of all maternal deaths in Asia is associated with hypertensive disorders of pregnancy.[13] Moreover, the incidence of preeclampsia is reported to be 8–10% among pregnant women in India.[13] The NFHS-4 reported an increasing utilization of antenatal care (ANC) with 82.7% pregnant women reporting at least one antenatal care visit including 58.6% women visiting in the 1st trimester of pregnancy.[10] An estimated 79% of all deliveries were institutional deliveries and 61% of all pregnancies had received at least one ultrasound examination during pregnancy.[10] The Indian Radiological and Imaging Association (IRIA) has recently initiated a national program, Samrakshan, to reduce perinatal mortality in India.

Accurate dating of pregnancy is very important in the context of foeto-maternal care in India for several reasons. Perinatal indicators of mortality are declining slowly in India despite increasing uptake of antenatal care services, ultrasound services, and institutional deliveries.[10] The management of major contributors of foeto-maternal morbidity and mortality in India, preeclampsia and foetal growth restriction; need an accurate dating for risk prediction and planning of delivery. In this manuscript, we report on the lack of agreement in dating of pregnancy using the last menstrual period (LMP) and ultrasound in a rural area of Guna district of Madhya Pradesh in central India and discuss the potential implications of these findings.

Methods

The Guna Maternal and Child Health project started in 2012, provided systematic foetal imaging services to pregnant women in Guna district of Madhya Pradesh. The project covered approximately 60,000 people of low socioeconomic status in 38 Anganwadi centers of Guna town, Tehsil and district headquarters at Guna. All pregnant women residing in the project area were considered for inclusion and there were no exclusion criteria other than residence outside of the project area. The Anganwadi worker registered the pregnancy and brought pregnant women, every Wednesday and the first Thursday of each month on a prefixed area-specific schedule, to the project center located near the district hospital. Each pregnant woman who visited the project center was assigned a unique project identification number and had a detailed evaluation including current and past obstetric history, LMP, details of prior birth, if any, and current and past comorbidities. Pregnant women underwent trimester-specific ultrasound examinations including determination of gestational age, fetal growth, and presence of congenital abnormalities. All ultrasound assessments were done by a single, experienced radiologist with training in foetal measurements using a GE Voluson S6 machine.

The duration of pregnancy or gestational age was estimated and assigned at the first registry visit for each pregnant woman. LMP was determined by a recall from the woman and the gestational age was further assessed using an ultrasound exam. Ultrasound dating was done using a transabdominal approach with a 3 to 6 MHz convex probe or transvaginal approach using a 5 to 12 MHz 4D convex probe. Ultrasound dating includes crown-rump length (CRL) in the 1st trimester and bi-parietal diameter, head circumference, abdominal circumference, and femur length in the 2nd trimester.[1,9,14,15] Fetal biometric measures were considered if the CRL exceeded 84 mm in the 1st trimester.[1,9,14,15] Ultrasound dating was performed even if the first visit of the pregnant woman was beyond 28 weeks, for documentation, and the EDD was assigned with variability of +/- 21 days.[1,9,14,15]

Expected date of delivery (EDD) was assigned and documented in the first visit and was not changed thereafter. A discrepancy of LMP and ultrasound dating was considered when the assigned EDD by ultrasound was different than that assigned by LMP. A significant discrepancy was defined as a difference of 3 days or more if the gestational age was less than 8^{+6} weeks, a difference of 5–7 days at gestational ages 8^{+6} weeks till 14 weeks, and a difference of 7–10 days at gestational ages 14–20 weeks.[14,15] The ultrasound assigned EDD was used for further follow-up of the pregnant woman, to chart the growth of the foetus, and to plan the delivery of the child.[1,9]

Every pregnant woman was provided multivitamin supplements, calcium, and iron and folic acid tablets from 12th week of pregnancy till delivery. In addition, pregnant women were provided hematinics and other medications including antihypertensive medications as necessary and provided dietary and general preventative counselling. Pregnant women were referred to the obstetrics and gynecology unit of the district hospital for obstetric follow-up as per government guidelines. Pregnant women were free to choose consultation with obstetricians in private sector. Post-delivery vaccinations were provided by the auxiliary nurse midwife (ANM) at the respective Anganwadi centers. Each child delivered through the project was followed up to 5 years of age. The project was a combined team effort of the Guna district administration, the woman and child department, and the administration and doctors of the district hospital at Guna, under the guidance of a radiologist.

The actual gestational age at delivery was dependent on obstetricians and the obstetric management protocols at the various obstetric practices in the various hospitals. Data from the project were transcribed from paper records into an MS Excel spreadsheet for analysis and data storage. The discrepancy between EDD assigned by LMP and USG was expressed as proportions and 95% confidence intervals (CI) around the point estimates. Data on perinatal indices were compared with baseline data reported in the Annual Health Survey, India of 2012–13.

Results

The project covered 14,701 pregnant women from 2012 till August, 2019. Around 4,683 (31.86%, 95% CI: 31.11, 32.61) of these 14,701 pregnant women could not recall their LMP although there has been an increasing trend for recall over the years [Table 1]. There was an agreement in the EDD assigned by LMP and ultrasound in 7,035 (70.22%, 95% CI: 69.32, 71.12) among the remaining 10,018 pregnant women with a recall of LMP. The ultrasound assigned EDD was earlier than the LMP assigned EDD in 2,611 (87.53%, 95%CI: 86.29, 88.31) and later than the LMP assigned EDD in 372 (12.47%, 95% CI: 11.32, 13.69) of the 2,983 pregnant women with the discrepancy between LMP and ultrasound assigned EDD. There was no significant difference (Chi-square test $P = 0.64$) in the trend of agreement or discrepancy between LMP assigned and ultrasound assigned EDD over the years of the project. [Table 2]

Indices of maternal mortality, infant mortality, uptake of antenatal care services, and low birth weight have shown significant improvement in the project area [Table 3] compared to baseline data for Guna district and Madhya Pradesh obtained from the Annual Health Survey, India (2012–13).

Discussion

Gestational age is usually determined based on LMP and adjusted using ultrasound estimates only if there is a large variation.[16-18] After excluding women without recall of LMP, there was an agreement between LMP assigned EDD and ultrasound assigned EDD in 70.22% women with 1 in 3 women showing a discrepancy. The EDD was overestimated by LMP for 26.06% (95% CI: 25.21, 26.93) of the 10,018 pregnant women with a recall of LMP screened in the project. These foetuses may actually be preterm but instead, get categorized as term or closer to term growth-restricted foetuses based on the LMP assigned EDD. A single experienced radiologist performing all ultrasound assessments using a single machine probe combination is a strength of the study limiting variations in study measurements although a systematic bias can persist. Childbirth occurred at several obstetric practices with varied management protocols. The lack of standardization of obstetric practices may be considered a limitation, however, the project achieved significant improvement in perinatal statistics.

Table 1: Recall of Last Menstrual Period (LMP) in the study population (2012-August 2019)

Year	Number of women screened	Number of women with a recall of LMP
2012	3001	1535 (51.15%)
2013	2219	1560 (70.30%)
2014	1818	1272 (69.97%)
2015	2106	1428 (67.81%)
2016	1880	1284 (68.30%)
2017	1463	1164 (79.56%)
2018	1266	1023 (80.81%)
Up to August 2019	948	752 (79.32%)

Table 2: Agreement between Last Menstrual Period (LMP) assigned expected date of delivery (EDD) and ultrasound assigned EDD

Year	Number of women with a recall of LMP	Ultrasound and LMP EDD matches	Discrepancy in EDD
2012	1535	1103 (71.86%)	432 (28.14%)
2013	1560	1038 (66.54%)	522 (33.46%)
2014	1272	899 (70.68%)	373 (29.32%)
2015	1428	970 (67.93%)	458 (32.07%)
2016	1284	889 (69.24%)	395 (30.16%)
2017	1164	848 (72.85%)	316 (27.15%)
2018	1023	763 (74.58%)	260 (25.42%)
2019 till August	752	525 (69.81%)	227 (30.19%)
Total	10018	7035 (70.22%)	2983 (29.78%)

Table 3: Perinatal indices in the project area compared to baseline data from the Annual Health Survey, India (2012-13)

	Madhya Pradesh (2012-13)	Guna (2012-13)	Project area (2018)
Maternal mortality rate	227	181	0
Infant mortality rate	62	75	24.7
Birth weight <2500	26.5%	30.1%	9.69%
Antenatal coverage	16.2%	10.1%	100%

There are several reasons why LMP may not be a reliable indicator in this population. Recall and the inability to remember the exact LMP is a known limitation. However, the potential for errors exists even when the LMP is known as the estimation of LMP assumes a uniform 28-day cycle with ovulation on day 14 of that cycle, both of which may not necessarily be true, especially if contraceptives have been used before conception.[1] The potential lack of agreement on the definition of LMP between the doctor and pregnant woman is also to be considered. In the study area and neighbouring districts, women estimate the LMP as the last day of the menstrual period, which can lead to errors and discrepancies. Lactational amenorrhoea can also affect the determination of LMP and inter-pregnancy intervals.

First-trimester ultrasound has high accuracy (+/- 5–7 days) to determine and confirm gestational age in pregnancy. The accuracy of ultrasound reduces with increasing gestational age with a reported accuracy of +/- 21–30 days after 28 gestation weeks and hence, later ultrasound estimates should not be used to correct the EDD if a first-trimester ultrasound dating has been performed.[1]

The use of ultrasound dating is not without limitations. Differences in estimated and true values of biometric measurements may reflect intraobserver as well as machine probe variations.[19] A study of 16 different obstetric machine probe combination, approved for use by the Royal College of Obstetrics and Gynaecology, found that differences attributed to different machine combinations were larger than expected in clinical practice with implications for dating pregnancy using fetal biometry.[19] Different machine probe combination led to a maximum difference of 2 days for CRL, 4 days for BPD, and 9 days for femur length.[19] At the larger measurements, the differences were attributed to machine probe combinations while the difference included intraobserver variation and machine probe combinations for smaller measures.[19]

Ultrasound dating uses fetal size to determine gestational age based on the assumption that foetuses grow at the same rate in early pregnancy,[20] and does not account for fetal growth changes by gender or early fetal growth restriction.[21,22] Imprecise measurements based on maternal factors like obesity may also influence the dating of pregnancy with the odds of postponing EDD increasing with increasing body mass index.[23-25]

The discrepancies between dating methods have several implications for clinical practice especially in relation to adverse perinatal outcomes.[26,27] Differences in the fetal size by gender can affect dating and impact on the relative risk estimates of pre and post-term births of female foetuses compared to males by 10–20%.[28] Several adverse perinatal events like stillbirth, neonatal mortality, low birth weight, and preterm birth are associated with a discrepancy of more than seven days between the estimates.[26] Small for gestational age (SGA) babies may be underestimated by 13% when ultrasound dating is done in cases of early fetal growth restriction and lead to misclassification of size at birth.[29] Underestimation of the gestational age can also lead to delayed delivery interventions like induction of labour or caesarean sections for pregnancies that have entered the post-term period and adversely affect perinatal mortality.[26,30] Misclassification of infants as a term by LMP assigned EDD when ultrasound assigned EDD or best estimate EDD indicated preterm resulted in higher risks of infant mortality.[31]

The 2nd-trimester ultrasound dating has a wide variation and can lead to greater misclassification of gestational age.[1] These may lead to adverse perinatal events especially in early fetal growth restriction or in foetuses with accelerated growth trajectory such as in diabetic pregnancies.[1] Gestational age misclassification may also influence the decision to administer corticosteroids for lung maturation before anticipated preterm birth.[1] The misclassification of gestational age gives two foetuses with otherwise similar actual gestational age very unequal opportunities in the case of extreme preterm delivery. A difference of a few days in EDD can determine viability and intensive life support versus deprivation of life support. Dating of pregnancy and gestational age is also an important component of Bayesian competing risk models to predict the risk for preterm preeclampsia and fetal growth restriction.[4-8] Inaccuracies in dating may change risk stratification with adverse consequences.

The accuracy of dating and lack thereof that we found in our study has several implications for the perinatal statistics of India. The contribution of dating to preterm birth rates, fetal growth assessments, risk prediction, delivery and induction decisions, and perinatal mortality in India has to be assessed in depth. Accurate dating integrated with radiology, obstetric care practice and existing government programs aimed at improving perinatal health has led to a significant improvement in the perinatal statistics of this rural area. India has an improving, but still sub-optimal, antenatal care uptake and ultrasound service uptake during pregnancy. First-trimester antenatal care uptake was only 58.6% and ultrasound uptake was only 61%.[10] Inaccuracies in dating that may be related to suboptimal 1st-trimester uptake of antenatal care and suboptimal ultrasound uptake may explain why perinatal statistics are still suboptimal despite institutional deliveries increasing to close to 80%. As ultrasound coverage increases for pregnant women, it is imperative that training programs on accurate dating and development of appropriate guidelines for dating are considered.

In conclusion, dating of pregnancy at the first visit and documenting an assigned EDD, gestational age at the assignment, and method on which the assignment is based is mandatory documentation for every pregnant woman. Programs addressing maternal and child health in India also have to consider the unreliability of LMP and focus on strategies for the early dating of pregnancy, preferably in the 1st trimester or early 2nd trimester.

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Conflicts of interest

There are no conflicts of interest.

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