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Dating gestational age by last menstrual period, symphysis-fundal height, and ultrasound in urban Pakistan

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Abstract

Objective—To compare the accuracy of the reported date of the last menstrual period (LMP) with that of symphysis-fundal height (SFH) in the estimation of gestational age (GA), using an ultrasound (US) scan as reference.

Methods—Gestational age was concurrently assessed by the 3 methods in this prospective, population-based, pregnancy-outcome study conducted in Hyderabad, Pakistan, from June 18, 2003, through August 31, 2005, with 1128 women between 20 and 26 weeks of a singleton pregnancy.

Results—The mean GA was less by ultrasound than by SFH measurement or the reported LMP, and the mean differences with the US result were statistically significant ($P < 0.001$ for both). At delivery, about 75% of the GA values estimated by SFH measurement were within 7 days and almost 91% were within 14 days of the estimation by ultrasound, compared with 65% and 82% for the GA estimated by the reported LMP. Moreover, using the US as reference, the SFH correctly classified 84% of the term, 68% of the preterm, and 86% of the post-term deliveries (weighted $\kappa = 0.58$) compared with the corresponding 79%, 61%, and 55% predicted by the reported LMP (weighted $\kappa = 0.44$).

Conclusion—The SFH measurement was found to be more accurate than the reported LMP as a tool to estimate GA and therefore date of delivery, but neither were as accurate as a US scan.

Keywords

Gestational age; Last menstrual period; Pakistan; Symphysis-fundal height; Ultrasound

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Conflict of interest

The authors declare that they have no conflict of interest.

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1. Introduction

Knowing gestational age (GA) accurately is essential for optimal prenatal, delivery, and postnatal care. The expected date of delivery, correct diagnosis of preterm or post-term labor, and differentiation between premature birth and intrauterine growth restriction rest on the estimated GA, as do prenatal counseling and interventions for poor fetal growth as well as the avoidance of unnecessary hospitalization, testing, and interventions such as induction of labor and tocolytic treatment [1,2,3]. Furthermore, a close estimation of GA informs research toward improving maternal and neonatal outcomes. And an accurately predicted delivery date (PDD) is obviously useful to the pregnant woman and her family.

As a fetal ultrasound (US) scan is based on biometric measurements of the fetus, it is considered the gold standard for establishing GA when done before 20 weeks of gestation, when the biologic variations in fetal size and the effects of growth restriction are still small. The accuracy is less if the scan is performed during the third trimester [3,4,5]. In many high-resource countries, a first-trimester US scan and a second scan between 18 and 22 weeks are essential parts of obstetric practice because they establish GA and screen for fetal anomalies [3,6].

However, US equipment is often unavailable in low-resource countries, especially in rural and peri-urban areas. And where available, the equipment is expensive to use, often of poor quality, and operated by undertrained technicians. In addition, women often seek prenatal care late in pregnancy, which further limits the use of ultrasound to assess GA [1,3]. Alternate methods of assessing GA are therefore necessary in such settings.

Dating the last menstrual period (LMP) and measuring the symphysis-fundal height (SFH) are alternate means of assessing GA, but each has limitations. Dating the LMP may be difficult because of poor recollection, irregular menstrual cycles of varying duration, lactational amenorrhea, bleeding in early pregnancy, or hormonal contraceptive use prior to conception [1,2,3,4,7,8]. The SFH may be used after 12 weeks of gestation but its accuracy may be diminished by a multiple pregnancy, maternal size, intrauterine growth restriction, fetal position, and other maternal or fetal characteristics [9,10,11,12]. Moreover, due to the observed variations in SFH across populations, local standards are required for optimal pregnancy dating using SFH [13,14,15,16,17].

Using the US scan as the gold standard, we evaluated LMP dating and SFH measurement as alternate tools for estimating GA between 20 and 26 weeks of pregnancy, and thus for predicting the date of delivery and estimating GA at delivery. The study was reviewed and approved by the Ethical and Review Committee of Aga Khan University and the Review Boards of the University of Alabama and Research Triangle Institute.

2. Material and methods

This prospective, population-based cohort study was conducted in 4 administrative units in Hyderabad, Pakistan. The study area comprised a low- to middle-income population of about 90 000 residents. The pregnant women were identified by government lady health workers (LHW), who are each responsible for providing basic maternal and child care to 100 households. The LHWs visit each household under their care once per month and maintain logs of all pregnancies and birth outcomes. We worked with 90 LHWs after training them in the research protocol, study recruitment, and confidentiality. The study nurse supervised the LHWs in their study-related field work.

The LHWs explained the study to the pregnant women and screened them for eligibility. The criteria were being 16 years or older and between 20 and 26 weeks of pregnancy;

having no serious medical condition; and being a resident of the area planning to be delivered in the area. The eligible women were scheduled for a visit at the research clinic closest to their homes. During the visit GA was determined by ultrasound to confirm eligibility, and other data were collected on pretested forms by trained research staff that included 2 women physicians, 2 LHWs, and 1 midwife. The LHWs regularly visited all enrolled women until delivery. Within the 48 hours that followed delivery the study physician and a nurse visited the woman to collect information concerning the delivery and other maternal and neonatal particulars. All women gave informed consent prior to participating in the study.

The 3 methods of determining GA were used at enrollment. The woman was asked to provide the date of the first day of her LMP as she recalled it, and the solar date was recorded using a combination lunar/solar calendar. The number of weeks between the first day of her LMP and her day of enrollment provided a GA estimate. A US scan was then performed by means of a portable, real-time, high-performance convex-linear SSD-500 ultrasound machine fitted with a 3.5-MHz electronic convex sector probe (Aloka, Tokyo, Japan). The fetal biparietal diameter, femur length, abdominal circumference, and head circumference were measured using reliable landmarks and planes [18] and GA was estimated by the Hadlock method [19]. All US measurements were made by one of the study physicians, who had both received standardized training from a consultant sonologist (S.Z.). Finally, after the woman had emptied her bladder and resumed the supine position, her SFH was measured as described by Westin [20]. A nonelastic tape was used with the graduation in centimeters facing the abdomen to reduce bias. The number of centimeters was considered to correspond to GA in weeks [17,21]. The GA assessor by each method was blinded to the other 2 measurements.

The PDD and the GA at birth were calculated for each of the methods using the 3 GA results obtained at enrollment. The calculations of PDD were based on the assumption of a term delivery at 40 weeks. A preterm delivery was defined as a delivery occurring before the 37th week and a term delivery as a delivery occurring between the beginning of the 37th week and the end of the 40th week. A post-term delivery occurred in the 41st week or later. Because, by the US method, there were only 56 [5%] of these deliveries, they were grouped together as post-term/postdate.

Data were entered and checked at our center, with consistency verified within and across forms. Further checking and editing was then performed by an independent data center. The relevant data were analyzed using the SAS software program, version 9.1 (SAS, Cary, North Carolina, USA) and descriptive statistics were produced. Paired *t* tests were used to evaluate the mean differences between the GA values obtained by US (the reference values) and by each of the other 2 methods, and χ^2 tests were used to assess homogeneity in the delivery classification according to GA by each of the 3 methods. *P* < 0.05 was considered significant. The levels of agreement between GA estimates by the US method and the 2 tested methods were assessed using κ statistics. A Maxwell symmetry analysis assessed the overall disagreement between the 3 methods of estimating GA.

3. Results

Of 1369 women screened between 20 and 26 weeks of pregnancy from June 18, 2003 through August 31, 2005, 1196 had singleton pregnancies. Of these 1196 women, 1128 (94%) had GA estimated by all 3 methods and were included in the analyses. Their mean $\pm$ SD age was 26.7 ± 5.15 years, mean height was 152 ± 5.6 cm, and mean weight was 55.7 ± 11.14 kg; 82% reported at least 1 birth prior to the present pregnancy; 66% had some formal

education; and 88% were not employed outside the home. The mean birth weight was 2784 ± 573.4 g, and 48% of the newborns were male (Table 1).

Table 2 presents the mean GA at enrollment by the 3 methods, and the mean differences between the GAs obtained by the US method (the reference method) and those obtained by the LMP and SFH methods (the tested methods). The lowest GA values were those estimated by the US method, and the differences with the 2 other methods were significant ($P < 0.001$ for both).

The differences between actual and predicted delivery dates by each method, (with the actual dates classified as occurring within 1 week, between 1 and 2 weeks, and before or after more than 2 weeks of the predicted date), are shown in Table 3. Less than one-third of the deliveries occurred within 1 week of the predicted delivery date by any of the methods. The greatest accuracy (31.6%), defined as the highest percentage of deliveries occurring within 1 week of the predicted date, was obtained by the US method. The US method also produced the lowest percentage of deliveries occurring 2 or more weeks earlier than the predicted date ($P < 0.001$). Delivery occurred 1 week after the predicted date or later in 56.3% of cases by the LMP method, 59.7% by the SFH method, and 61.2% by the US method; and it occurred 1 week before the predicted date or earlier in 15.0% of cases by the LMP method, 13.0% by the SFH method, and 7.3% by the US method.

The GAs at delivery estimated by each of the tested methods were compared with those estimated by the US. The distribution of deviations of GAs by the tested methods occurring within the 7 days, between 7 and 14 days, and greater than 14 days of those of the US method are shown and compared in Table 4 ($P < 0.001$ by the χ^2 homogeneity test). In almost 75% of cases the GAs by the SFH were within 7 days, and in almost 91% of cases they were within 14 days, of those estimated by the US method, compared with 65% and 82% for the LMP method. And in 13.5% of cases by the LMP method, and 6.7% of cases by the SFH method, the difference in GAs with the US method was classified as being greater than 14 days.

Table 5 presents the estimated GAs at delivery classified as preterm, term, and post-term/postdate by the 3 methods. Statistically significant differences were found only for the post-term/postdate numbers of deliveries ($P < 0.001$). Table 6 compares the numbers of preterm, term, and post-term/postdate deliveries by the methods tested with the numbers by the US method. For example, of the 199 deliveries classified as preterm according to the US method, 73 (36.6%) were classified as term deliveries by the LMP method and 63 (31.7%) by the SFH method. And of the 873 deliveries classified as term deliveries according to the US method, 51 (5.9%) were classified as preterm and 134 (15.1%) as post-term/postdate by the LMP method, and 39 (4.5%) as preterm and 98 (11.8%) as post-term/postdate by the SFH method. Also, 25 (45.5%) of the 56 deliveries classified as post-term/postdate by the US method were classified as term deliveries by the LMP method and 8 (20.0%) by the SFH method.

The SFH method classified as term deliveries a slightly higher percentage of deliveries also classified as term deliveries by the US method than the LMP method (84.3% vs 79.0%). Overall, there was more agreement in classification between the US and SFH methods ($\kappa = 0.55$) than between the US and LMP methods ($\kappa = 0.40$). However, disagreement in classification with the US method was significant for the SFH ($S = 83.06$, $P < 0.001$) as well as the LMP ($S = 82.63$, $P < 0.001$) method, suggesting that the 2 tested methods tend to misclassify when the US method is taken as reference. In particular, the SFH and the LMP methods misclassified as term deliveries 32% and 37%, respectively, of the deliveries classified as preterm by the US method.

4. Discussion

Ultrasound equipment is not always available in low-resource countries and alternate methods such as LMP and SFH are used to determine GA and predict the date of delivery. Our study compared these 2 methods with the US method, which is considered the gold standard.

We found significant differences in the mean GA estimates obtained by the 3 methods for Pakistani women between 20 and 26 weeks of pregnancy. Moreover, the LMP and SFH methods produced larger mean and median GA values, and a wider range of values, than the US method.

Less than one-third of the deliveries occurred within 1 week of the date of delivery predicted by each method, but the US method was the most accurate. The accuracy within 2 weeks of the actual delivery date was 51%, 54%, and 59%, respectively, by the LMP, SFH, and US methods. Over prediction, or a delivery occurring 1 week or more after the predicted date, was common with the 3 methods and was similar for the LMP and SFH methods. Under prediction, or a delivery occurring 1 week or more before the predicted date, occurred the most often with the US method and was also similar for the LMP and SFH methods. Other studies from low- and high-resource countries have reported similar results [1,15,22,23,24].

About 75% of the GAs at delivery estimated by the SFH method were within 7 days, and almost 91% were within 14 days, of those estimated by the US method, compared with 65% and 82% for the GAs estimated by the LMP method. This information suggests that SFH may be favored over LMP in the absence of US equipment.

Finally, we evaluated the percentages of deliveries predicted as preterm, term, and post-term by the SFH and LMP methods using as reference the values obtained by the US method. Overall, both tested methods under- predicted term deliveries and over-predicted post-term/postdate deliveries. The percentages of predicted preterm deliveries were similar by all 3 methods. Our findings are consistent with those of other studies [1,2,8,15,24], except that we found a higher percentage of deliveries classified as term deliveries by all 3 methods. We therefore speculate that, with a better training of health staff, more accurate GA estimates can be obtained by both the SFH and LMP methods. The study staff was trained to use a standardized protocol to record the SFH measurements and collect LMP information. As many women report dates according to the lunar calendar in Pakistan, calendars showing both lunar and solar dates were used for LMP dating. These measures proved to be useful.

The estimates obtained by the SFH method approximated the US estimates more closely than those obtained by the LMP method. About 84% of the deliveries predicted as term deliveries by the US method were also predicted as term by the SFH method, but only 79% were by the LMP method. Both methods were relatively poor at predicting preterm and post-term/postdate deliveries. About 68% of the deliveries predicted as preterm by the US method were misclassified as either term or post-term/postdate by the SFH method, compared with 63% by the LMP method. Moreover, 14% of the deliveries predicted as post-term/postdate by the US method were misclassified by the SFH method, compared with 44% by the LMP method. These observations warrant cautious interpretation of GA at delivery as predicted by the SFH or the LMP method, especially outside the range of term deliveries (37–40 weeks). In general, our findings favor the SFH over the LMP method, but neither is as accurate as the US method in predicting GA at delivery. Moreover, in keeping with the current practice in Pakistan, we considered that GA in weeks was equal to SFH in centimeters. A different scale or, preferably, a local SFH standard may give a more accurate GA estimate.

It is important to note that this work was conducted in a rigorous research context, with considerable efforts to standardize methods and measures. Two trained medical research officers alternatively recorded the US and SFH values and the same midwife recorded all maternal recalls of their LMP, using uniform protocols to reduce bias and inter observer variability [25]. Our findings therefore should not be used to decide whether the LMP or SFH method can accurately estimate GA in a non research health facility.

Synopsis

Symphysis-fundal height was found to be more accurate than the reported last menstrual period in the estimation of gestational age in the absence of ultrasound equipment.

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Table 1Characteristics of the 1128 study women^a

Characteristics	Value
Age, y	26.7 ± 5.2
No. of previous pregnancies ^b	3.6 ± 2.3
Maternal height, cm	152.4 ± 5.6
Maternal weight at booking	55.7 ± 11.1
No. of live births	1121
No. of male births	543.0 (48.0)
Birth weight, g ^c	2783.9 ± 573.4
Maternal education ^d	
None	370 (33)
Primary	188 (17)
Secondary	503 (45)
Higher	63 (6)
Maternal employment outside the home ^e	140 (12)
Monthly household income in rupees	3437 ± 5741

^aValues are given as mean ± SD, number, or number (percentage).^bFor the 923 women who were not nulliparous.^cFor all 1124 births.^dThere were 1066 answers.^eThere were 1126 answers.

Table 2

Gestational age at enrollment (20–6 wk) by the 3 methods, and mean differences between the tested methods and the reference method

Method	No. of wk, mean $\pm$ SD	No. of wk, median (range)	Difference in No. of wk with the reference, mean $\pm$ SD	Test statistic ^a	P value
US (reference)	22.53 $\pm$ 1.5	22 (20–27)	--	--	--
SFH	22.97 $\pm$ 2.0	23 (1–30)	0.44 $\pm$ 1.7	8.74	<0.001
LMP	23.10 $\pm$ 1.7	23 (10–36)	0.57 $\pm$ 2.1	9.35	<0.001

Abbreviations: LMP, last menstrual period; SFH, symphysis–fundal height; US, ultrasound.

^a Comparisons were done by the paired *t* test.

Table 3

Precision of the predicted date of delivery by each method^a

Precision	LMP	SFH	US	Test statistic	P value
>2 wk earlier	98 (8.7)	70 (6.2)	21 (1.9)	48.44	<0.001
1–2 wk earlier	71 (6.3)	77 (6.8)	61 (5.4)	1.93	0.38
0–1 wk earlier	324 (28.7)	308 (27.3)	356 (31.6)	3.47	0.18
1–2 wk later	183 (16.2)	226 (20.0)	250 (22.2)	10.31	0.006
>2 wk later	452 (40.1)	447 (39.6)	440 (39.0)	0.20	0.90

Abbreviations: LMP, last menstrual period; SFH, symphysis–fundal height; US, ultrasound.

^aValues are given as number (percentage); the precision of the predicted date of delivery was defined as the difference between the actual date and the predicted date; comparisons were made by the χ^2 homogeneity test.

Table 4

Accuracy of the estimated gestational age at birth by the LMP and SFH methods compared with the age estimated by the US method^a

Precision	LMP	SFH
>14 d younger	50 (4.4)	22 (2.0)
7–14 d younger	63 (5.6)	46 (4.1)
0–7 d younger	176 (15.6)	169 (15.0)
0–7 d older	558 (49.5)	675 (59.8)
7–14 d older	129 (11.4)	141 (12.5)
>14 d older	152 (13.5)	75 (6.7)

Abbreviations: LMP, last menstrual period; SFH, symphysis–fundal height; US, ultrasound.

^aValues are given as number (percentage); the precision of estimated gestational age at birth by the tested methods was defined as the difference between the age estimated by these methods and the age estimated by the US method.

Table 5

Classification of preterm, term, and post-term/postdate deliveries by the 3 methods^a

Method	Gestational age at delivery			Test statistic	P value
	<37 wk (preterm)	37–40 wk (term)	≥41 wk (post-term/postdate)		
LMP	173 (15.3)	786 (69.7)	169 (14.9)	2.28	0.32
SFH	174 (15.4)	807 (71.5)	147 (13.0)	4.71	0.09
US	199 (17.6)	873 (77.4)	56 (4.9)	58.24,	<0.001

Abbreviations: LMP, last menstrual period; SFH, symphysis–fundal height; US, ultrasound.

^aValues are given as number (percentage); comparisons were made by the χ^2 homogeneity test.

Table 6

Comparison of the classification of preterm, term, and post-term/postdate deliveries by the LMP and SFH with US as reference^a

Classification by the US method (reference)	Classification by the SFH method ^b			Classification by the LMP method ^c		
	Preterm	Term	Post-term/postdate	Preterm	Term	Post-term/postdate
Preterm (n = 199)	135	63	1	122	73	4
Term (n = 873)	39	736	98	51	688	134
Post-term/postdate (n = 56)	0	8	48	0	25	31
Total (N = 1128)	174	807	147	173	786	169

Abbreviations: LMP, last menstrual period; SFH, symphysis-fundal height; US, ultrasound.

^aValues are given as number.

^bS = 83.06 ($P < 0.001$); simple $\kappa = 0.55$, weighted $\kappa = 0.58$.

^cS = 82.63 ($P < 0.001$); simple $\kappa = 0.40$, weighted $\kappa = 0.44$.