Original Article

Discrepancy Rate and Associated Factors of Gestational Age Determination by Last Menstrual Period Compared with First-Trimester Ultrasound in Certain Menstrual Period Pregnant Women

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Objective: To assess discrepancy rate and associated factors of gestational age (GA) determination by last menstrual period (LMP) compared with first-trimester ultrasound in certain menstrual period pregnant women.

Materials and Methods: The present study was a cross-sectional study that was conducted at Srinagarind Hospital, Khon Kaen University, Thailand between May 2020 and January 2021. Participants were singleton pregnant women who reported certain LMP dates. GA was estimated using Naegele's rule and crown-rump length (CRL) measurement. Differences of GA more than five days at GA of 8 or fewer$^{6/7}$ weeks and more than seven days at GA of nine$^{0/7}$ to twelve$^{6/7}$ weeks were considered discrepant. Factors associated with discrepancy were determined by calculating an odds ratio (OR) with a 95% confidence interval (CI).

Results: Of the 220 participants, 67 had discrepant GA obtained from LMP and CRL measures, accounting for a rate of 30.5% (95% CI 24.4% to 36.9%). Factors associated with increased risk of discrepant GA consisted of low household income (adjusted OR 2.76; 95% CI 1.43 to 5.31) and long intervals of the menstrual cycle (adjusted OR 3.85; 95% CI 1.85 to 8.02).

Conclusion: Approximately one-third of participants in the present study had a discrepancy of LMP and early ultrasound-based GA measures. Factors influencing the risk of discrepant GA between these two methods included household income and interval of menstruation.

Keywords: Gestational age; Last menstrual period; First-trimester ultrasound; Discrepancy

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Accurate estimation of gestational age (GA) is of paramount importance, especially in assigning precise timing of delivery for high-risk pregnant women[1-3]. Calculating GA and the estimated due date (EDD) are done by determining the first day of the last menstrual period (LMP). The EDD is 280 days or 40 weeks after the first day of the LMP, known as Naegele's rule. This estimation assumes a 28-day menstrual cycle with ovulation occurring on the fourteenth day after the LMP which, nevertheless, remains a biologically questionable assumption[4].

In real-world practice, the LMP is often uncertain. In previous studies[5,6], 25% to 50% of women could not accurately recall their LMP date. In addition, time of ovulation, variability of menstrual cycle length, and factors including ethnicity, maternal body composition, and parity characteristics have significantly influence on the estimation of GA and EDD[4,7]. The American College of Obstetricians and Gynecologists (ACOG) together with the American Institute of Ultrasound in Medicine and the Society for Maternal-Fetal Medicine recommend that GA should be determined by comparing the results obtained from LMP and first-trimester ultrasound measurement of fetal crown-rump length (CRL)[7-10].

In Thailand, first-trimester ultrasound for determining GA and EDD among pregnant women who can recall their LMP have not been routinely performed. A discrepancy between EDD estimated by

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LMP and by ultrasound in pregnant women may then be left unnoticed. The present study was conducted to assess discrepancy of LMP and first trimester ultrasound-based GA and associated factors.

Materials and Methods

The authors conducted a cross-sectional study at Srinagarind Hospital, Khon Kaen University, Thailand between May 2020 and January 2021. The study protocol was approved by the Khon Kaen University Ethics Committee in Human Research (HE631137). The present study was reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement[11]. Written informed consents were obtained from all women before participating in the study.

The present study recruited Thai singleton pregnant women ages 18 years or older, GA between eight$^{0/7}$ and twelve$^{6/7}$ weeks, who reported having certain LMP dates and regular menstruation cycle. Pregnant women who underwent assisted reproductive technology and those who had a history of hormonal contraceptive use within three months before the LMP dates were excluded. Participants were withdrawn if they were found to have multiple gestations, ectopic pregnancy, or non-viable pregnancy during the first-trimester ultrasound.

After enrollment, the CRL was measured using a GE Voluson E8 and Samsung-Medison SonoAce R7 ultrasound machine with a 2.5 to 5 MHz convex transabdominal probe. This first-trimester ultrasound was performed by second-and third-year obstetrics and gynecology trainees and maternal-fetal medicine fellows under staff supervision. All persons who performed CRL measurement had been trained on basic and advanced obstetrics ultrasound courses, which were annually conducted by the Department of Obstetrics and Gynecology, Faculty of Medicine, Khon Kaen University.

GA by LMP date was estimated using Naegele's rule[7]. CRL measurement was performed in triplicate and mean value was recorded to lessen measurement variation. GA was then auto-generated by the ultrasound machine using the Hadlock formula. According to the ACOG 2017 guideline, differences of more than five days at GA of 8$^{6/7}$ or less weeks and more than seven days at GA of nine $^{0/7}$ to thirteen$^{6/7}$ weeks of GA estimated by LMP date and CRL measurement were considered discrepant, and GA should be redefined according to ultrasound-based dating[8].

The sample size was calculated based on a previous study[6] that found a 37% discrepancy rate of GA assessed by LMP date and first-trimester ultrasound. Given a 95% level of confidence and 6.5% of precision error. The present study required 212 participants. The sample size was adjusted for anticipated withdrawal by adding 10% of the total number of participants required. Finally, the present study aimed to recruit 233 participants.

Statistical analysis was performed using Stata/SE, version 10.0 (StataCorp LP, College Station, TX, USA). Descriptive statistics were used to present baseline demographic characteristics. Logistic regression analysis was used to determine the factors associated with the discrepancy results. Variables assessed in the logistic regression model consisted of maternal age, parity characteristics, maternal body mass index (BMI), socioeconomic status, and length of the menstrual interval. BMI was classified using the cutoff values for the Asian population[12]. Household income was used as an indicator of socioeconomic status[13]. An odds ratio (OR), with a 95% confidence interval (CI) that did not include unity, was considered statistically significant.

Results

Of the 245 pregnant women who agreed and gave consent to participate in the study, twenty-five were withdrawn after first-trimester ultrasound performed due to non-viable pregnancy (23), tubal pregnancy (1), and multiple gestations (1), thus, leaving 220 pregnant women for the analysis.

Table 1 displays the demographic characteristics of the participants. The median age of participants was 30 years with an interquartile range (IQR) of 27 to 34 years. Fifty-five (25.0%) women were 35 years of age or older. Eighty-one (36.8%) women were noted to have a pre-pregnancy BMI of 23.0 kg/m^2 or higher. Unintended pregnancy was reported in ten (4.5%) women.

GA obtained from LMP and first-trimester ultrasonography-based dating methods were discrepant in 67 women, which accounted for a discrepancy rate of 30.5% (95% CI 24.4 to 36.9).

Table 2 shows the results of logistic regression analysis. Of five covariates assessed, the odds of the discrepant GA between LMP and first-trimester ultrasound-based methods were significantly increased in pregnant women with low household income (adjusted OR 2.76; 95% CI 1.43 to 5.31) and women whose length of the interval of menstrual cycle were longer than 28 days (adjusted OR 3.85, 95% CI 1.85 to 8.02).

Table 1. Baseline characteristics of the participants

Characteristics	Participants with discrepant GA (n=67)	Participants without discrepant GA (n=153)	All participants (n=220)
Age (years); n (%)			
<35	51 (76.1)	114 (74.5)	165 (75.0)
≥35	16 (23.9)	39 (25.5)	55 (25.0)
Pre-pregnancy BMI (kg/m^2); n (%)			
<18.5	6 (9.0)	19 (12.4)	25 (11.4)
18.5 to 22.9	36 (53.7)	78 (51.0)	114 (51.8)
23.0 to 24.9	10 (14.9)	22 (14.4)	32 (14.5)
25.0 to 29.9	10 (14.9)	29 (18.9)	39 (17.7)
≥30	5 (7.4)	5 (3.3)	10 (4.5)
Education attainment; n (%)			
Primary school	1 (1.5)	2 (1.3)	3 (1.4)
Secondary school	16 (23.9)	35 (22.9)	51 (23.2)
College/university or above	50 (74.6)	116 (75.8)	166 (75.4)
Household income (Baht/month); n (%)			
<10,000	1 (1.5)	5 (3.3)	6 (2.7)
10,000 to 30,000	46 (68.7)	68 (44.4)	114 (51.8)
>30,000	20 (29.8)	80 (52.3)	100 (45.5)
Pregnancy intention; n (%)			
Planned pregnancy	63 (94.0)	147 (96.1)	210 (95.5)
Unplanned pregnancy	4 (6.0)	6 (3.9)	10 (4.5)
Gravidity; n (%)			
Primigravida	32 (47.8)	60 (39.2)	92 (41.8)
Multigravida	35 (52.2)	93 (60.8)	128 (58.2)
Menstruation pattern; median (IQR)			
Interval (days)	30 (30 to 33)	30 (28 to 30)	30 (28 to 30)
Duration (days)	4 (4 to 5)	4 (4 to 5)	4 (4 to 5)
Amount (pads/day)	3 (3 to 4)	3 (2 to 4)	3 (3 to 4)

GA=gestational age; BMI=body mass index; IQR=interquartile range

Table 2. Results of logistic regression analysis

Variables	Category	Crude OR (95% CI)	Adjusted OR (95% CI)
Age	<35 years	Reference	Reference
	≥35 years	0.92 (0.47 to 1.79)	1.49 (0.70 to 3.18)
Gravida	Primigravida	Reference	Reference
	Multigravida	0.71 (0.40 to 1.26)	0.60 (0.31 to 1.15)
Pre-pregnancy BMI	≥23 kg/m^2	Reference	Reference
	<23 kg/m^2	0.97 (0.54 to 1.76)	1.04 (0.54 to 2.00)
Household income per month	>30,000 Baht	Reference	Reference
	≤30000 Baht	2.57 (1.40 to 4.75)	2.76 (1.43 to 5.31)
Interval of menstruation cycle	≤28 days	Reference	Reference
	>28 days	3.57 (1.77 to 7.20)	3.85 (1.85 to 8.02)

OR=odds ratio; CI=confidence interval; BMI=body mass index

Discussion

Main findings

The present study conducted among Thai pregnant women who reported certain LMP dates noted that GA obtained from LMP and first-trimester ultrasound-based methods was discrepant in 67 women, accounting for a discrepancy rate of 30.5% (95% CI 24.4 to 36.9). Factors associated with

increased risk of discrepant GA consisted of low socioeconomic status (adjusted OR 2.76; 95% CI 1.43 to 5.31) and long intervals of the menstrual cycle (adjusted OR 3.85; 95% CI 1.85 to 8.02).

Interpretations

The rate of discrepant GA noted between LMP- and ultrasound-based methods can vary from 8% to 38%[6,14-18]. The wide variation of discrepancy of LMP- and ultrasound-based GA reported in the literature are secondary to the differences in the characteristics of the population assessed such as ethnicity, maternal age, and socioeconomic status, the proportion of women with unknown or uncertain LMP, and timing of GA measures[6,14-18]. Direct comparisons of the results across the studies, therefore, should be done with caution. In the study of Macaulay et al[6] in which 67.2% of participants reported certain LMP dates, discrepant GA estimates by LMP- and ultrasound-based methods were noted in 37.3% of participants. Even in the present study that solely recruited participants who were able to recall their LMP dates and ultrasound for assessing GA were performed during the first trimester, the discrepancy rate between the two methods remained high at 30.5%. These findings indicated that discrepant GA estimated by LMP- and ultrasound-based methods were common and might suggest the role of routine first-trimester ultrasound to ascertain the accuracy of GA estimation.

Maternal characteristics have been reported to alter the magnitude of the discrepancy between the GA estimates including maternal age, gravidity, socioeconomic status, maternal body composition, maternal ethnicity, and pregnancy intention[6,14-18]. Women from economically disadvantaged backgrounds are at increased risk of having discrepant GA estimates and are thought, in general, to be due to difficulty in recalling LMP[6,15-18]. The association between level of socioeconomic status and risk of discrepant GA was also noted in the present study. Pregnant women participating in the present study who had low household income, a proxy of low socioeconomic status, were 2.8-time more likely to have discrepant estimates (adjusted OR 2.76; 95% CI 1.43 to 5.31). The present study, therefore, reaffirmed that socioeconomically disadvantaged women were more likely to encounter an inconsistency between LMP and ultrasound-based estimates of GA even among those who felt certain of their LMP dates.

The risk of discrepancies between LMP- and early ultrasound-based GA appears to increase among young pregnant women, women with suboptimal pre-pregnancy BMI, and multigravida pregnant women[6,14-16]. In the present analysis, the rate of discrepant GA however did not alter significantly between pregnant women in a different group of maternal age, gravidity, and maternal pre-pregnancy BMI (Table 2).

In the previous studies conducted among US pregnant women, African American and Hispanic pregnant women were more like to have inconsistent GA estimates compared to women of other ethnicities[15,16]. Hoffman et al[16] found that the discordant result of GA estimation was higher among women with unintended pregnancy. In the present study, all participants were Thai women, additionally, the majority of participants (95.5%) reported that their pregnancies were planned. These two factors were therefore unable to reassess in the present analysis.

In a previous prospective study in women trying to conceive, GA distribution at delivery based on ovulation timing carried the narrowest frequency distribution for observed GA at delivery and the smallest mean difference compared to that obtained based on LMP and first-trimester ultrasound dating methods[19]. This finding indicated that the most accurate method of predicting gestational length is ovulation day[19]. As noted in the present study, which was undertaken among pregnant women who reported reliable recall of LMP, length of the interval of menstrual cycle was associated with discrepant GA. Pregnant women who had a length of menstruation interval of longer than 28 days had almost 4-time the risk of discrepant GA as compared to those with a shorter interval. This finding might highlight the potential impact of the variation of ovulation timing on the accuracy of GA estimated by the LMP dating method.

Strengths and limitations

Limitations in the present study should be acknowledged. Variability across the sonographers involved in the present study was not assessed. In addition, the authors have not collected perinatal outcomes and were thus unable to determine whether discrepant GA increased the risk of adverse perinatal outcomes. The participants recruited in the present study were Thai pregnant women, which limited the generalizability of findings to the population of different ethnicity. Despite these limitations, the present prospective study was pragmatic as it involved a large panel of the sonographer, undergoing quality control and in a real-life situation of low- and middle-

income settings.

Implication for practice

The authors' findings underlined that discrepancy of GA estimated by LMP- and first-trimester ultrasound-based methods was not uncommon even among those who reported certain LMP dates. Maternal characteristics were associated with the risk of discrepant results and might be used as a proxy for this condition. This information, thus, could have important implications on the routine assignment of GA by first-trimester ultrasound particularly among women who were potentially at an increased risk of inaccurate estimation of GA by LMP-based method.

Implication for research

A previous study suggested that differences in GA estimation between LMP and early ultrasound-based methods may be related to early fetal growth restriction[14]. The large-scale studies are required to precisely quantify the magnitude problem regarding an inaccurate GA estimated by the LMP-based method and to confirm the association between the discrepant GA between these two methods and early fetal growth restriction.

Conclusion

Approximately one-third of pregnant women who reported certain LMP dates were noted to have discrepancy of GA determined by LMP- and early ultrasound-based methods. This information might support the fact that the routine assignment of GA by first trimester ultrasound should be considered and performed particularly among women with low socioeconomic status and long intervals of menstrual cycle.

What is already known on this topic?

First trimester ultrasound for CRL is the most accurate method to determine GA. GA calculated from the first day of LMP may be uncertain.

What this study adds?

GA can be discrepant between LMP-based and ultrasound-based method even in certain date pregnant women. Factors that can influence accuracy in determining GA include household income and interval of menstruation.

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Data sharing statement

The datasets generated or analyzed during the current study are not publicly available but could be available from the corresponding author on reasonable request.

Authors' contributions

Conceptualization: AH, PS; Methodology: AH, PS; Resources: AH, PS, KK, SC, CD, RK, PK; Formal analysis: AH; Data Curation: AH, PS; Writing - Original Draft: AH; Writing - Review & Editing: PS, KK, SC, CD, RK, PK; Supervision: PS; Funding acquisition: AH, PS.

Conflicts of interest

The authors declare no conflicts of interest to report for this work.

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