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ORIGINAL PAPER

Problems with gestational age estimation by last menstrual period and ultrasound among late antenatal care attendant women in a low-resource setting in Africa, Sudan

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Abstract

Introduction Accurate estimation of gestational age is essential to interpret and manage several maternal and perinatal indicators. Last menstrual period (LMP) and ultrasound are the two most common methods used for estimating gestational age. There are few published studies comparing the use of LMP and ultrasound in Sub-Saharan Africa to estimate gestational age and no studies on this topic in Sudan.

Material and Methods A cross-sectional study was conducted in Gadarif Maternity Hospital in Sudan during November through December 2022. Sociodemographic information was collected, and the date of the first day of each participant's LMP was recorded. Ultrasound examinations were performed (measuring crown-rump length in early pregnancy and biparietal diameter and femur length in late pregnancy) using a 3.5-MHz electronic convex sector probe. Bland–Altman analysis was performed.

Results Four-hundred seventy-six pregnant women were enrolled. The median (interquartile range [IQR]) age and gravidity was 24.0 (20.0−29.0) years and 2 (1−4), respectively. There was a strong positive correlation between gestational age determined by LMP and ultrasound ($r = 0.921$, $P < 0.001$). The mean gestational age estimate according to LMP was higher than that determined by ultrasound, with a difference, on average, of 0.01 week (95% confidence interval [CI]: − 0.05, 0.07). Bland–Altman analysis showed the limits of agreement varied from − 1.36 to 1.38 weeks. A linear regression analysis showed proportional bias. The coefficient of difference of the mean was equal to 0.26 (95% CI: 0.01, 0.03, $P < 0.001$).

Conclusion Based on our results, there was a bias in LMP-based gestational age estimates when compared with the reproducible method (ultrasound).

Keywords Gestational age · Last menstrual period · Pregnancy · Ultrasound

Introduction

Gestational age is of paramount importance to interpret and manage several maternal and perinatal indicators [1, 2]. During pregnancy, several clinical factors, such as weight gain, preterm birth, postdate, and cesarean preplanning, require accurate determination of gestational age to ensure optimum interventions for the management of these conditions and associated outcomes [1, 2].

Last menstrual period (LMP) and ultrasound are the two most common methods used for estimating gestational age [3]. Although LMP is a simple and cost-free method of estimation, it may not always be accurate due to various factors, such as cycle irregularities, early pregnancy vaginal bleeding unrelated to menses, and delayed ovulation [3]. Ultrasound is an operator dependent technique, and may not be available in all health care settings, especially in resource-poor countries [3]. Ultrasound may also show bias, especially when fetuses are large or small. Moreover, ultrasound reference values during pregnancy are based upon estimated dates first determined using LMP [3]. Studies have shown that early pregnancy ultrasound using a combination of fetal biometric variables is superior to LMP or other clinical methods in determining gestational age [4, 5].

Discrepancies in gestational age estimation have implications for pregnancy management and perinatal outcomes in the presence of high-risk conditions, such as hypertension and diabetes [6]. This issue is particularly critical in resource-poor environments, such as most countries in

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Sub-Saharan Africa [6]. Disease (e.g., malaria), which is endemic in many Sub-Saharan countries, including Sudan, may also lead to inaccurate estimations of gestational age, as disease can affect fetal growth [7].

There are few published studies in Africa comparing ultrasound with other methods of gestational age estimation [7–10]. The results of these studies are also not conclusive [7–13]. The health system infrastructure in Sudan, which is the third largest country in Africa, is limited, and maternal and neonatal outcomes are poor [14, 15]. More studies need to be conducted in low-resource settings to compare the detection of gestational age according to the LMP and ultrasound as standard. The aim of the current study was to compare the use of LMP with the reproducible method (ultrasound) in estimating gestational age in eastern Sudan.

Methods

A cross-sectional study was conducted in antenatal care of Gadarif Maternity Hospital, Sudan during November through December 2022.

Inclusion criteria Women who had spontaneous pregnancies, certain LMP dates, regular cycles, not used oral contraceptive pills in the 6 months prior to the current pregnancy, and a single cephalic fetus, alive, without congenital malformations were enrolled. The exclusion criteria were smokers, women with a recent miscarriage/abortion or delivery before 6 months from conception, pregnancies as a result of induction or assisted reproductive technology, multiple pregnancies, intrauterine fetal death, and breach births.

After signing an informed consent form, two female medical officers interviewed the participants and recorded the participants' sociodemographic information, namely, age, parity, education, occupation, and place of residence. They asked each participant about the date of the first day of her LMP and recorded the data. The number of weeks between the first day of the participant's LMP and the day of enrolment provided a gestational age estimate.

One of the authors (GKA), a fetal medicine consultant with 9 years' experience in obstetric sonography, performed the sonographic examinations using 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). Reliable landmarks and planes/parameters were measured and these were; crown-rump length which was used in early pregnancy while biparietal diameter and femur length were used in the second and third trimesters, and gestation age was estimated according to these measures [16, 17].

Statistical analysis

The data were analyzed using SPSS version 25. Spearman's correlation and coefficient (r) was between gestational age according to the LMP, and ultrasound was performed. The mean difference (95% confidence interval [CI] and mean ± 1.96 × standard deviation [SD]) were calculated according to the Bland and Altman method [18]. The limits of agreement (Bland–Altman analysis) between the two methods was judged by linear regression, with the difference in the gestational age between the two methods a dependent variable and the average of gestational by two methods an independent variable, and the coefficient (95% CI) and P value were calculated. A two-sided P value of < 0.05 was considered statistically significant.

Sample size calculation

The sample size was calculated by assuming a difference of one week and a SD of 5.6 between the two methods of measuring gestational age (LMP and ultrasound). According to this calculation, a sample size of 476 was needed to ensure a significant minimum difference in the correlation ($r = 0.12$) between gestational age measured by LMP or ultrasound (80% power and a difference of 5% at $\alpha = 0.05$) [19].

Results

Of 643 pregnant women who were initially screened, 167 (25.9%) were excluded due to uncertainty surrounding the date of their LMP (14.3%), multiple pregnancies (4.9%), and other reasons. Four-hundred seventy-six (74.01%) pregnant women fulfilled the inclusion criteria, had complete data, and were enrolled (Fig. 1). The median (interquartile range [IQR]) age was 24.0 (20.0−29.0) years, and the median gravidity was 2 (1−4). Of the 476 participants in the study, 28.6% were educated to ≥ secondary level, and 93.5% were housewives (Table 1). The distribution of the gestational age is shown in Fig. 2. Details on gestational age variables according to the LMP and ultrasound methods are shown in Table 2 The median value according to LMP was 40 weeks (IQR: 39–40; range: 31–43 weeks), whereas it was 39 weeks (IQR: 38–40; range: 32–42 weeks) according to ultrasound (Table 2). Thirty -three (6.9%) women were in early pregnancy (gestational age < 24 weeks) as shown in Fig. 2.

There was a strong correlation between gestational age detected by the LMP and ultrasound methods ($r = 0.921$, $P < 0.001$). The mean gestational estimates defined by the LMP method were higher than those defined by ultrasound (on average, a difference of 0.01-week, 95% CI: – 0.05, 0.07). The Bland – Altman analysis showed that the limits

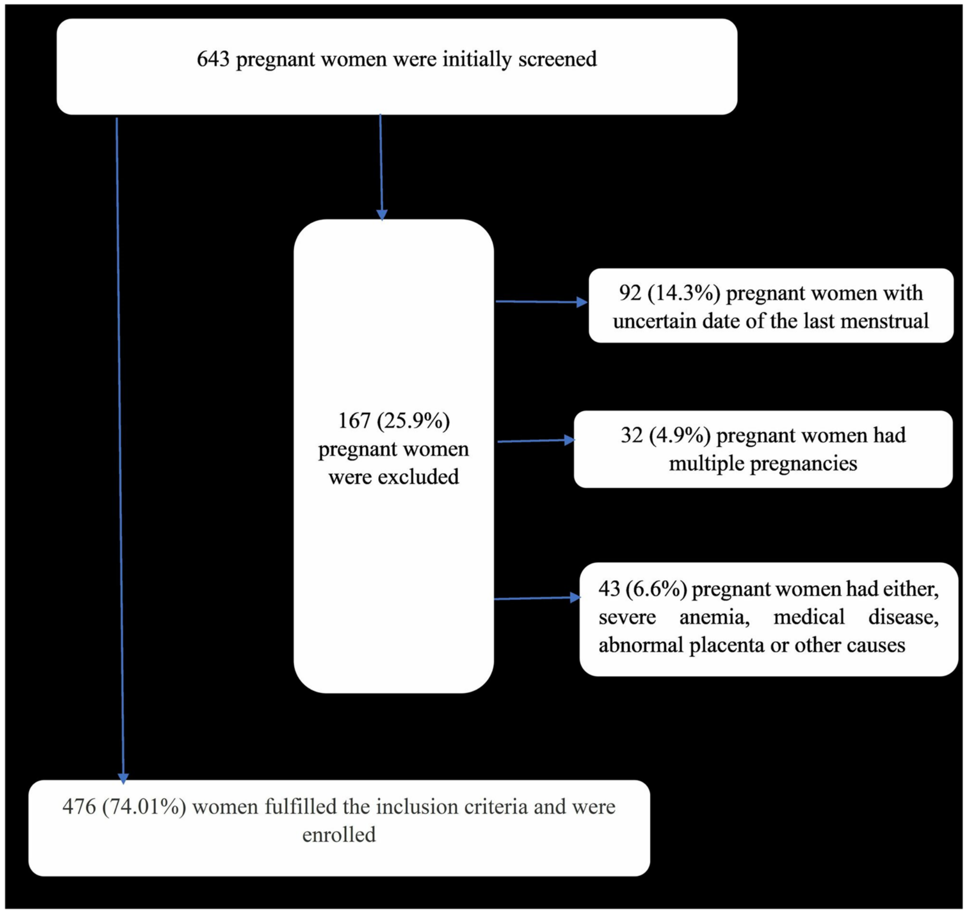

Fig. 1 Flow diagram for eligibility of pregnant women in eastern Sudan in accessing gestational age, 2022

Table 1 Characteristics of the pregnant women in eastern Sudan, 2022 ($N=476$)

Variable	Frequency	Proportion
Residence		
Urban	152	31.9
Rural	324	68.1
Educational status		
≥ Secondary	136	28.6
< Secondary	340	71.4
Employment status		
Unemployed	445	93.5
Employed	31	6.5

of agreement varied from − 1.36 to 1.38 weeks (Fig. 3). The linear regression analysis revealed proportional bias with the mean coefficient of difference equal to 0.26 (95% CI: 0.01, 0.03, $P<0.001$).

Discussion

The main findings of the current study were as follows: The mean gestational age estimates using LMP were higher than those using ultrasound, and there was proportional bias when estimation of gestational age when compared with the reproducible method (ultrasound). Our findings are in accordance with those of a previous study, which reported a poor correlation between LMP and ultrasound in estimating gestational age in 1630 women in four African countries with *P. falciparum* infection and in their third trimester (gestational age: > 24 weeks) [7]. In a study in Zambia, the authors reported discrepancy and bias in the gestational ages of 942 pregnant women assessed by LMP and ultrasound [9]. A study performed in Pakistan found a significant difference in mean gestational age when LMP was compared with ultrasound as a reproducible methods in 1,128 women whose gestational ages ranged between 20 and 26 weeks [11]. Low agreement between LMP and ultrasound was also reported in a study on women in their second and third trimesters in Tanzania [10]. Moreover, a larger difference was reported when LMP was investigated as a potential method to determine gestational age and eligibility for a medical abortion [13]. According to a previous study, LMP

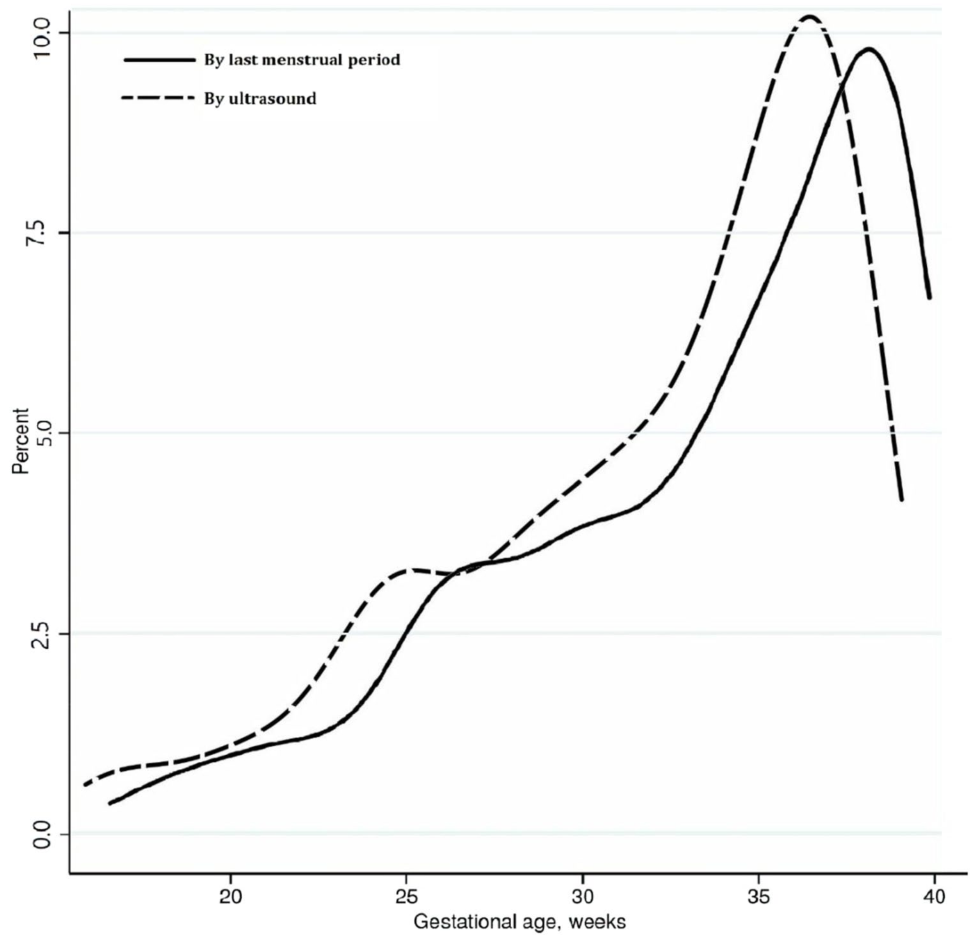

Fig. 2 Distribution of gestational age estimated by last menstrual period and ultrasound among pregnant women in eastern Sudan, 2022

Table 2 Comparison of gestational age using last menstrual period and ultrasound

Variable	Gestational age according to last menstrual period	Gestational age according to ultrasound
Number	476	476
Range	16.5−39.8	17.5−40.0
Mean	33.3	33.3
Standard deviation	5.6	5.4
95% confidence interval	32.8, 33.8	32.8, 33.8
Median	35.1	35.2
Interquartile range	29.6−38.1	29.5−38.0

is a reliable alternative in estimating gestational age during early pregnancy [20].

The differences of fetal biometric measurements between expected and observed values are not always due to differences in gestational age, they may be due to differences of embryonic and fetal growth as it occurs in in-vitro fertilization/intracytoplasmic sperm injection (IVF/ICSI) fetuses, in which gestational age is certain. In fact, IVF/ICSI conceptions present greater extent of small crown rump length (below the 5th centile) and larger extent of fetuses small for gestational age or growth restriction (particularly when conceived with fresh blastocyst transfers as compared to frozen-thawed blastocyst transfers [21, 22].

The majority of the pregnant women in our study were late gestational stage. This could explain the discrepancy between the gestational ages estimated by LMP and those estimated by ultrasound. Estimation of gestational age in the third trimester has the major limitation that does not take into account the extent of fetal growth restriction and small for gestational age fetuses (growth abnormalities) [23].

Compared with ultrasound measurements obtained in early pregnancy, those in late pregnancy may be suboptimal in terms of gestational age estimation [23]. Moreover, clinicians are facing problems in finding a reliable method to diagnose post-term pregnancies and make optimum decisions for operative deliveries and inducing labor [20]. In countries with insufficient resources, less than one-quarter of women (24.0%) attend antenatal clinic during early pregnancy [24].

Our results showed a growth discrepancy (due to LMP) in the third trimester. Given the association of small for gestational age and fetal growth restriction to stillbirth,

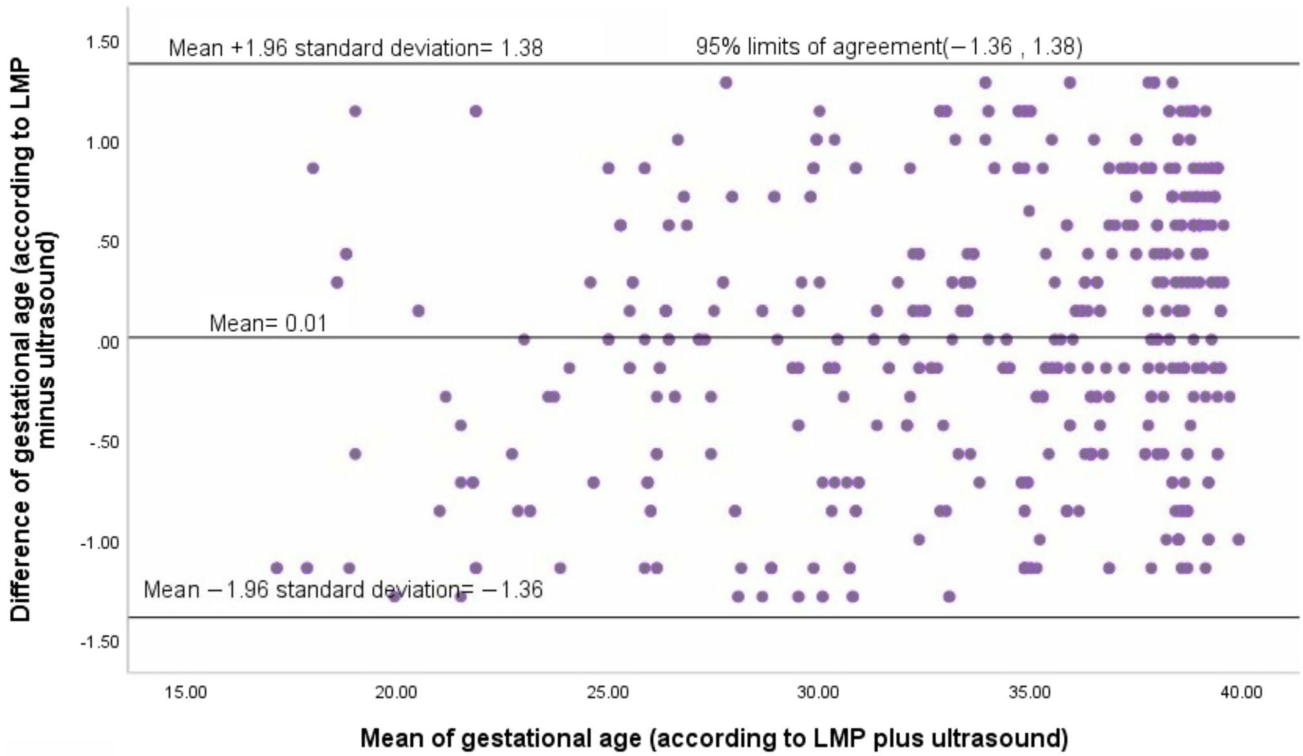

Fig. 3 Bland–Altman analysis of gestational age estimated by last menstrual period and ultrasound among pregnant women in eastern Sudan, 2022

preeclampsia and fetal compromise in labour. We would recommend and suggest for obstetricians in Sudan a growth reassessment each time they intercept a delta of growth of at least 2 weeks between actual biometry and LMP (mainly for smaller fetuses, but also for larger fetuses) to intercept growth abnormalities and propose appropriate birth timing. Moreover, for smaller fetuses doppler studies of umbilical circulation should be carried out to detect and could prevent unrecognized fetal hypoxia due to placental insufficiently.

There are some limitations to this study. We did not perform a quantitative evaluation of the ultrasound images, and we performed all the ultrasound examinations only once to avoid intra- and inter-observer variations. In addition, this study was conducted in a single hospital. Larger studies at several hospital sites are needed.

Conclusions

Based on our results, when ultrasonography was taken as a standard, there was bias in LMP-based gestational age estimates.

Declarations

Funding None received.

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

Ethical approval The study received ethical approval from the Research Board at the Faculty of Medicine, University of Gadarif, Sudan. The reference number is # 11, 2022. This study was conducted in accordance with the Declaration of Helsinki.

Consent to participate A signed informed consent was taken from each woman. Patient data were analysed anonymously and used only for research purposes.

Consent to publish Not applicable.

Author contributions AA, GKA and IA designed the study. GKA, NA the data. AA, NA and IA conducted the statistical analysis. All authors contributed to the writing of the manuscript and approved the final version for publication.

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