Predicting Gestational Age of Fetus with the Reference of Humerus and Foot Length by Ultrasonography

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Abstract
Objective: The objective of the study is to predict the gestational age of fetus with the reference of humerus and foot length by ultrasonography.
Methodology: A cross sectional analytical study was perform in which 131 pregnant women with a singleton fetus were taken to get the required results. All data of the ultrasonographical reports has been collected from The Department of Radiology, Sheikh Zaid Hospital, Lahore. All pregnant women, from the second trimester to full term, are examined by ultrasound measurement of the full HL and FFL were taken by using a curve array transducer.
Results: 36 women (27.5%) out of 131 had gestational age by LMP was 17-20 weeks and only 2 women (1.5%) having gestational age by LMP of 37-40 weeks while out of 37 women (28.2%) out of 131 had gestational age by foot length was 17-20 weeks and 8 women(6.1%) having gestational age by foot length of 25-28 weeks. 41 women (31.3%) out of 131 had gestational age by humerus length was17-20 weeks and 3 women (2.3%) having gestational age by foot length of 37-40 weeks.GA was almost similar from these different parameters i.e. LMP, Foot Length and Humerus Length.
Conclusion: The fetal foot length and humerus length developed with gestational age in a healthily developing fetus. During the late second and third trimesters of pregnancy, the length of a fetus's foot and humerus length could be considered as an exploratory approach to determine the gestation of the fetus. When other parameters failed to reliably estimate gestational age, the length of the fetal foot and humerus length proved effective.
Keywords: Gestational age, Humerus Length, Foot length

1. Introduction
In obstetric care, an accurate measurement of gestational age is important. Making effective management decisions necessarily requires correct gestational age information. In addition to assisting obstetricians in correctly counselling women at high risk of preterm birth about possible perinatal outcomes, accurate awareness

of gestational age is also significant in the assessment of growth of fetus and the identification of intrauterine growth retardation. Although clinical data such as menstrual cycle or uterine size are often unreliable, the obstetrician can use ultrasound to assess the accurate parameter for pregnancy timing. Ultrasound is considered reliable and effective tool for determining gestational age in the first and second trimesters of pregnancy, and it can change obstetric performance and improve neonatal care when used as part of routine prenatal care[1]. Estimating GA can be done in a variety of ways. The first day of the last menstrual cycle (LMP) and ultrasonography are used to measure GA during the antenatal period. If the menstrual cycle is normal, LMP is a common way to measure GA. In the case of an irregular cycle, however, LMP may not be a reliable method of estimating the GA. Ultrasound (US) analysis is believed to be important for determining the age of fetus [2].Gestational age can be determined at any point during pregnancy, and there are many methods for doing so, each involving different equipment or abilities and varying degrees of accuracy[3, 4]. If a fetal size is appropriate for gestational age, accurate GA measurement is essential. LMP is a clinical test for GA that can be confusing or unreliable. The CRL is the most reliable parameter for assessing gestational age earlier in pregnancy during an ultrasound test in the first trimester. In the second trimester, BPD has the most precise association with gestational age, but FL can be used to assess GA if the head is abnormally shaped or if BPD cannot be imaged correctly, but its accuracy decreases as GA increases[5]. The difference between the first day of the last menstrual period (LMP) and the delivery date is used to calculate GA. Early pregnancy ultrasound is also believed to be important for determining GA [6, 7].Many methods have been identified in the last 30 years concerning the relation between different biometric parameters such as crown rump length, diameter of gestational sac, biparietal diameter (BPD), femur bone length (FL) and abdominal circumference (AC) and gestation. Early prenatal sonography has been shown to be a reliable and objective method of determining gestational age [1].The ability to determine gestational age (GA) early in pregnancy is helpful in identifying growth abnormalities later in the pregnancy. GA may be determined by keeping a detailed record of your last menstrual period (LMP) or using ultrasonographical measurements[8].In the management of obstetric patients, accurate prediction of gestational age (GA) is very useful for preparing a timely outcome. To determine gestational age in early pregnancy, sonographers may use mean sac diameter (MSD) at 0-7 weeks and crown-rump length (CRL) at 9-13 weeks. Sonographers use parameters such as biparietal diameter at 13-40 weeks, femur length at 24-40 w/g, head circumference, and abdominal circumference in the second and third trimesters. However, these biometric parameters have limitations. For example, conditions that affect the shape of the skull, such as cranial malformations, will affect biparietal diameter (BPD) and head circumference (HC). In these cases, we must rely on other parameters to provide a more accurate estimate of gestational age [9, 10].BPD measurements will overestimate or underestimate gestational age if a head is disproportionately rounded (brachycephalic) or unusually elongated (dolichocephalic). Similarly, variations in AC measurements were found in macrosomic and growth-retarded fetus due to differences in liver size and subcutaneous tissue width[11].It is possible to estimate the fetal length with a great accuracy because it is simple to locate and measure. To estimate the accurate GA, many antenatal assessment factors have been studied. While biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) are all considered reliable predictors and are used as typical parameters, using foot length along with humerus length to determine gestational age is more accurate. These parameters are useful in determining the fundal height of patients whose last menstrual period does not correspond to their fundal height on abdominal examination (LMP). The humerus length (HL) is determined using the same principles as the femur. After the forearm and shoulder regions have been identified, the beam of ultrasound is direct perpendicularly and the diaphysis alone is measured. From the tip of the longest toe (usually the second toe) to the tip of the heal, the fetal foot is measured [12].Several studies have shown that using the CRL and foot length, i.e. heel-toe length, and other extremity parameters in second and third-trimester fetuses improves age determination [13]. As a result, length of the fetus feet was positively correlated with gestational age[14].

The aim of this research is to discover other parameters that can be used to assess gestational age more accurately or in situations where the previous parameters are inaccurate, such as foot length, which can also be used as a replacement in the diagnosis of many karyotypic defects and syndromes. We use the fetal foot length along with the humerus length to find the gestational age of the fetus. Our study is based on the fetal foot length as an accurate estimate of the gestational age in early pregnancy. This study clarify the role of HL and foot length in determining the gestational age. In some cases when other parameters are not reliable then HL or foot length is of great interest in obstetric practice.

1.1 Materials and Methods

This is cross sectional analytical study, included normal pregnant women with a singleton fetus in the second and third trimesters, with the aim of determining the accuracy of HL and FFL in determining gestational age. This was an institutional base study conducted between January 2021 and March 2021 in department of radiology, Sheikh Zaid Hospital, Lahore. The study duration is 4 months. These pregnant women, from the

second trimester to full term, are examined by ultrasound while lying comfortably on their backs (supine); apply gel to the lower abdomen and measure full HL and FFL using a 3.5 MHz transducer. The inclusion criteria is Pregnant women with singleton fetus GA verified clinically in 2nd and 3rd trimester Pregnant women with accurate LMP.The exclusion criteria is Pregnant women before 2nd trimester. Patients with unknown date of last menstrual period. Women having gestational diabetes, skeletal dysplasia, Oligo-hydramnios, Poly-hydramnios, Pre-eclampsia.Women with more than single gestations. Ultrasound machine convex array transducer with frequency range of 2-7 MHz

2. Results

In our study total number of 131(100%) women and the maximum number of cases were reported in age of 30 years .The total number of cases in age of 30 years were 15 (11.5%).36 women (27.5%), 37 women (28.2%) and 41 women (31.3%) out of 131(100%) women had gestational age by LMP, foot and humerus length were between the 17-20 weeks respectively.

3. Discussion

Molly S. Chatterjee et al, demonstrated a significant linear association between fetal foot length and gestational age (R2= 0.89, p0.0001) in a study that was published in 2010. They used sonography to measure the length of the foot from 15 to 36 weeks of pregnancy. According to their findings, the foot length of the fetus could be detected by ultrasonography at 15 weeks of pregnancy, with a mean of foot length (17.51.29), and at 36 weeks of gestation, with a mean sonographic length of foot of 64.43.28. [15].

Moawia Gameraddin et al, conducted a study in Dream Specialized Hospital in Khartoum State from August to October 2015, which was a descriptive cross-sectional study. The researchers came to the conclusion that HL was a reliable method of estimating the GA. In their study, there was a significant positive connection between HL and GA. The HL is a fundamental fetal bone biometry test used in the assessment of gestational age, and it can be used in conjunction with the FL to discover anomalies in the fetal bone. [16]

Our research was carried out on 131(100%) women who had normal singleton pregnancies, regular menstrual cycles, and known LMP in order to measure the accuracy of ultrasound in determining the weeks of gestation by humeral length and foot length, respectively. The length of the femur is already a well-established ultrasonography measure for estimating the gestational age of a fetus. Despite the fact that the fetal humerus and foot length are not currently used to determine gestational age, we noticed that the humerus and foot length were associated with gestational age in a similar manner to the gestational age associated with the other parameters. In our study we measure the gestational age by LMP and 36 women out of 131 having gestational age between the 17-20 weeks having percentage and standard deviation 27.5% and 1.805 respectively. We also measure the fetal humerus length in 131 pregnant women to estimate the gestational age. 41 out of 131 women having gestational age between the 17 to 20 weeks having percentage 31.0 % and standard deviation 1.799. We also measure the fetal foot length in 131 pregnant women to estimate the gestational age.37 out of 131 women having gestational age between the 17 to 20 weeks having percentage 31.3 % and standard deviation 1.935. The lengths of the fetal foot and humerus were measured using ultrasound, and the weeks of gestation was determined by using abdominal sonography that measured the femur length, biparietal diameter and abdominal circumference. Biparietal diameter, head and abdominal circumference and femur length are reliable predictors of gestational age. Due to the fact that the humerus length and foot length are not usually taken as biometric parameters for calculating GA, the study was conducted in order to assess fetal gestational age by measuring humerus length and foot length in 2nd and 3rd trimester.

Few studies are present in which the determination of GA by foot length and HL were predict. We predicted gestational age by foot length and humerus length which were very close to that gestational ages which were predict by LMP. Our results were much similar to their result in which it was found that foot length and humerus length were considered useful parameters for determining the GA.

Conclusion

The fetal foot length and humerus length are used to calculate the correct gestational age. The fetal foot length develops with gestational age in a healthily developing fetus. Fetal foot length is an excellent predictor of gestational age, particularly in situations with femur achondroplasia, dolichocephaly, or brachycephaly. During the late second and third trimesters of pregnancy, the length of a fetus's foot can be used as exploratory tool to determine the weeks of gestation of the developing fetus. When other parameters failed to reliably estimate gestational age, the length of the fetal foot proved to be particularly effective. The HL was the most precise variable, especially in the third trimester of pregnancy. HL would contribute to the highest level of accuracy across all parameters.

Conflict of Interest

There is no conflict of interest in this research.

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Table No: 1 table showing the frequency of patient age

		Age(Years)			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	19	1	.8	.8	.8
	20	2	1.5	1.5	2.3
	21	2	1.5	1.5	3.8
	22	8	6.1	6.1	9.9
	23	9	6.9	6.9	16.8
	24	5	3.8	3.8	20.6
	25	14	10.7	10.7	31.3
	26	6	4.6	4.6	35.9
	27	11	8.4	8.4	44.3
	28	10	7.6	7.6	51.9
	29	10	7.6	7.6	59.5
	30	15	11.5	11.5	71.0
	31	6	4.6	4.6	75.6
	32	4	3.1	3.1	78.6
	33	7	5.3	5.3	84.0
	34	6	4.6	4.6	88.5
	35	8	6.1	6.1	94.7
	36	2	1.5	1.5	96.2
	38	1	.8	.8	96.9
	39	1	.8	.8	97.7
	40	1	.8	.8	98.5
	42	2	1.5	1.5	100.0
	Total	131	100.0	100.0	

Table No 2: Total of 131 patients having the average age of 28.4 the table below showing mean of gestational age by LMP (3.40), mean of gestational age by foot length (3.52) and mean of gestational age by humerus length (3.37).
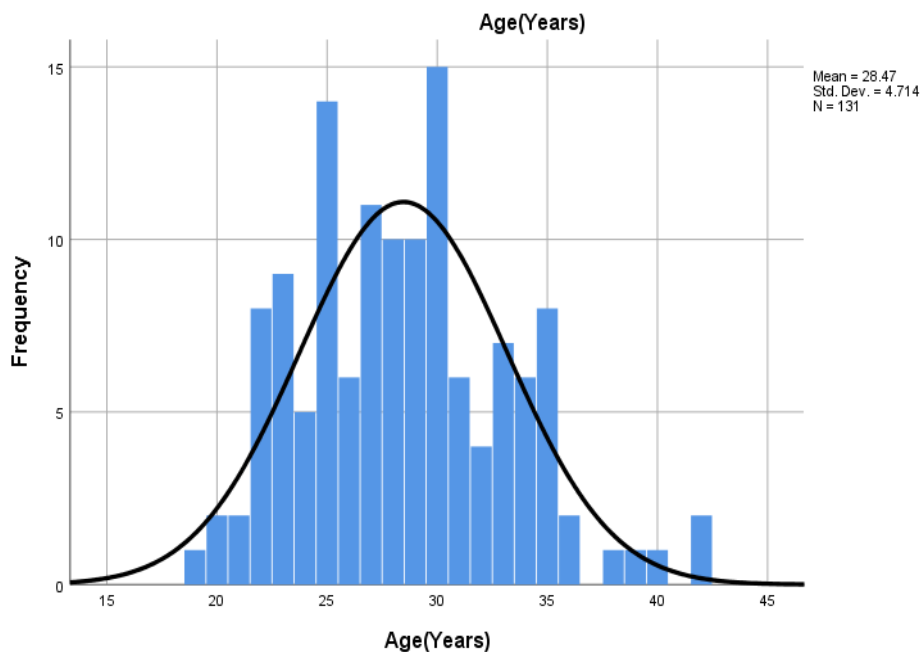
Table No: 3 the table below showing mean of gestational age by LMP, mean of gestational age by foot length and mean of gestational age by humerus length.

		Age(Years)	Gestational Age by LMP(weeks)	Gestational Age by foot length(weeks)	Gestational Age humerus length(weeks)
N	Valid	131	131	131	131
	Missing	0	0	0	0
Mean		28.47	3.40	3.52	3.37
Minimum		19	1	1	1
Maximum		42	7	7	7

Table No 4: 36 (27.5%) women out of 131(100%) had gestational age by LMP is 17-20 weeks and only 2 (1.5%) women having gestational age by LMP of 37-40 weeks. Table shows the frequency of total women having different gestational ages.

Gestational Age by LMP(weeks)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	13-16	18	13.7	13.7	13.7
	17-20	36	27.5	27.5	41.2
	21-24	26	19.8	19.8	61.1
	25-28	7	5.3	5.3	66.4
	29-32	16	12.2	12.2	78.6
	33-36	26	19.8	19.8	98.5
	37-40	2	1.5	1.5	100.0
	Total	131	100.0	100.0	

Table No: 5 frequency and the percent of women having different gestational ages from LMP.

Gestational Age by LMP(weeks)
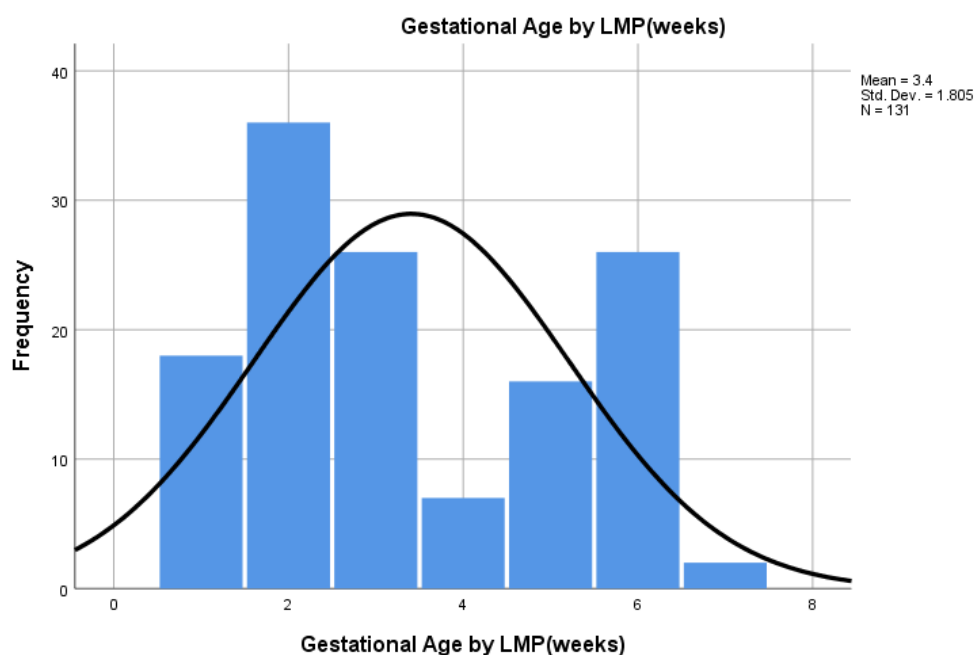
Mean = 3.4
Std. Dev. = 1.805
N = 131

Table No 6: 37 (28.2%) women out of 131(100%) had gestational age by foot length was 17-20 weeks 8 (6.1%) women having gestational age by foot length of 25-28 weeks. Table shows the frequency of total women of different gestational ages predicting from foot length.

Gestational Age by foot length(weeks)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	13-16	17	13.0	13.0	13.0
	17-20	37	28.2	28.2	41.2
	21-24	25	19.1	19.1	60.3
	25-28	8	6.1	6.1	66.4
	29-32	10	7.6	7.6	74.0
	33-36	25	19.1	19.1	93.1
	37-40	9	6.9	6.9	100.0
	Total	131	100.0	100.0	

Table No: 7 frequency and the percent of women having different gestational ages predicting from foot length.
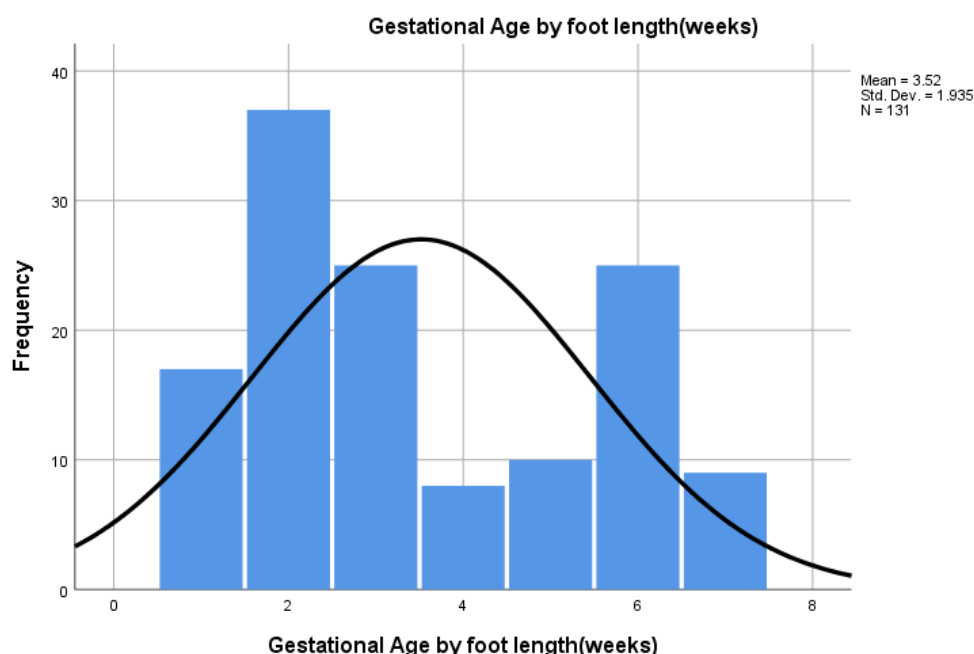

Table No 8: 41 (31.3%) women out of 131 (100%) had gestational age by humerus length was 17-20 weeks and 3 (2.3%) women having gestational age by foot length of 37-40 weeks. Table shows the frequency of total women of different gestational ages predicting from humerus length.

Gestational Age humerus length(weeks)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	13-16	16	12.2	12.2	12.2
	17-20	41	31.3	31.3	43.5
	21-24	24	18.3	18.3	61.8
	25-28	9	6.9	6.9	68.7
	29-32	13	9.9	9.9	78.6
	33-36	25	19.1	19.1	97.7
	37-40	3	2.3	2.3	100.0
	Total	131	100.0	100.0	

Table No: 9 frequency and the percent of women having different gestational ages predicting from humerus length.
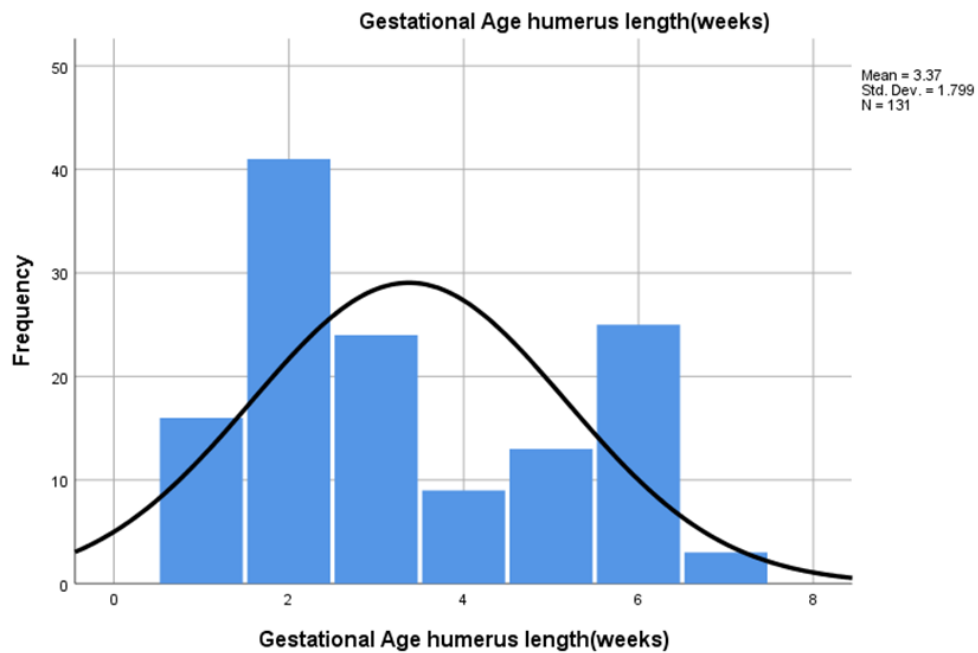

Table No: 10 showing the mean and standard deviation of the gestational ages from LMP, foot length and humerus length

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Gestational Age by LMP(weeks)	131	3.40	1.805	.158
Gestational Age by foot length(weeks)	131	3.52	1.935	.169
Gestational Age humerus length(weeks)	131	3.37	1.799	.157