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Comparison of Foetal Kidney Length with foetal Biometric Parameters (Biparietal Diameter, Abdominal Circumference, Head Circumference and Femur Length) in the Third Trimester of Pregnancy

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ABSTRACT

Introduction: The basis for an obstetrician's capacity to successfully organise an intervention, administer prenatal care, and conduct prenatal testing. exact awareness of the gestational age. This study conducted to find out correlation of foetal kidney length with foetal biometric parameters like BPD, AC, HC and FL in the third trimester of pregnancy

Methodology: A cross-sectional observational research was carried out on third-trimester pregnant patients who were seen in the obstetrics and gynaecology outpatient department at a tertiary care hospital in India. The study included all women who were singleton pregnant in the third trimester (28 to 40 weeks), had date scans that were documented, were certain of their last menstrual cycle, had a normal prenatal period, and had no risk factors connected with them.

Results: A reasonably excellent positive correlation between MKL and GA. With a decent fit and a R squared (R2) value of 0.599. There is a reasonably strong positive correlation (r) between MKL and GA by HC. With a decent fit and a R squared (R2) value of 0.545, this regression model explains 54.5 percent of changes in GA by HC with MKL. According to the Pearson Association Coefficient (r), there is a relatively strong positive correlation (r) between MKL and GA via AC. A high positive correlation (very good) between MKL and GA via FL. With a decent fit and a R squared (R2) value of 0.668, this regression model explains 66.8% of changes in GA by FL with MKL.

Conclusion: That there is a high correlation between the mean kidney length of the foetus and established biometric markers of gestational age, including femur length, head size, belly circumference, and biparietal diameter.

INTRODUCTION

The basis for an obstetrician's capacity to successfully organize an intervention, administer prenatal care, and conduct prenatal testing. exact awareness of the gestational age. Failure can lead to prematurity, which is associated with increased perinatal morbidity and death.[1] There is no way to tell with certainty when ovulation, fertilisation, and implantation occur, even if the menstrual cycle start date is correct. Women may go through many "waves" of vesicle formation during the normal menstrual cycle, which might result in irregular ovulation at any given cycle. It is not totally reliable to use the "known" pregnancy date since sperm can remain in a woman's reproductive system for five to seven days. Recent research indicates that there may be an 11-day variation in the time between ovulation and implantation, which might affect the foetus's size and development. [2] Given all of these variables, it would appear to be challenging to determine gestational age from menstrual history.[2]

When certain tests need to be performed, such as chorionic villus sampling, amniotic fluid and serum testing, and foetal treatment planning, accurate GA estimate is also necessary. The practise of women asking for an elective caesarean delivery on a certain day—11.11.11, 12.12.12, the first day of the New Year, or a date suggested by an astrologer—has become more popular in recent years. An sudden spike in operating rates was seen on these days. [3]

Ultrasound measures of the foetal biometry, such as the Crown rump length (CRL), Bi-parietal diameter (BPD), Femur length (FL), Abdominal circumference (AC), and Head circumference (HC), are considered to be trustworthy when performed in the first and early second trimester (less than 24 weeks). There is currently no single foetal measurement that can be used to accurately estimate gestational age in the third trimester, especially in situations when the woman booked late and had doubts about her LMPs. [4] It remains difficult to accurately time pregnancies in the late second or third trimester for women who seek maternity care later in life and are unsure about the date of their LMP. [1] However, as gestational age grows, they become increasingly unreliable because to the intrinsic diversity of size in relation to age.

It was recently discovered that there is a significant association between gestational age and foetal kidney length (FKL). The results of these studies suggest that when dates are unclear or women seek ultrasound foetal biometry dating during the third trimester itself, the foetal kidney length may be used to determine gestational age. [5,6] It is recommended that all pregnancies longer than 20 weeks use all four biometric indicators in order to reduce variability. GA may be reliably predicted by BPD, HC, AC, and FL in the second trimester (± 10–14 days). As pregnancy goes on, these factors become increasingly unreliable in predicting gestational age. [3]

Fetal biometry measures are helpful in correctly estimating gestational age (GA) in the early second trimester, but as the foetus grows older, biological size differences cause these parameters' accuracy to change, making it difficult to date a foetus in the late second or third trimester.

A large-scale study conducted to correlate foetal kidney length with gestational age and other biometric biometric parameters like BPD, AC, HC and FL in the third trimester of pregnancy. A paper from the same study with an objective to determine the gestational using foetal kidney length during third trimester pregnancy as already published elsewhere. [6] This paper is in continuation of the same study presented with an objective to find out correlation of foetal kidney length with foetal biometric parameters like BPD, AC, HC and FL in the third trimester of pregnancy

METHODOLOGY

Cross-sectional observational research was carried out on third-trimester pregnant patients who were seen in the obstetrics and gynaecology outpatient department at Krishna Hospital in Karad.

Sample Size

The formula for estimating sample size is sample size (n) = n=$([\boldsymbol{Z\alpha}+\boldsymbol{Z\beta}]/\boldsymbol{C})\mathbf{2}$+3.

where r was and c was 0.5ln(1+r/1-r). The relationship between gestational age and the length of the foetal kidney is correlated, and (r) = 0.907. [7] Thus, the sample size determined by this formula is 120.

This study included all ANC patients in the third trimester who visited the outpatient department (OPD) of a tertiary medical centre after receiving written informed permission with a reasonably reliable LMP and a recorded dated scan of varying parities and ages.

Eligibility Criteria: The study included all women who were singleton pregnant in the third trimester (28 to 40 weeks), had date scans that were documented, were certain of their last menstrual cycle, had a normal prenatal period, and had no risk factors connected with them.

The study excluded pregnant women with the following conditions: oligohydramniosis or polyhydramniosis; dilated renal pelvis (> 4 mm); congenital and chromosomal abnormalities; abnormal renal morphology (nephromegaly, agenesis, hypoplasia, cyst, polycystic kidney, hydronephrosis, etc.); obscured adrenal and renal borders or margins; multiple pregnancies; gross maternal obesity; gestational diabetes mellitus; or preeclampsia.

Procedure

Every patient that was part of the trial had sonography performed on them utilising ultrasound technology. To measure the length of the foetal kidney, a longitudinal slice will be obtained in the sagittal plane. Each kidney's length—left and right—will be measured. The ultimate measurement will be the average of their length in millimetres. We shall measure the unborn kidney from the outside to the outer boundary.

Biometric measurements of the foetus, such as BPD, AC, HC, and FL, were also taken at the same scan.

By finding the anatomic reference points, the thalami and the cavum septi pellucidi, the broadest axial dimension of the skull, or BPD, may be determined. BPD is measured from the outer edge of the proximal parietal bone to the outside edge of the distal parietal bone.

With the stomach bubble and a brief section of the umbilical vein visible at the portal sinus level, AC was measured using ultrasonography equipment.

The ossified parts of the diaphysis and metaphysis were measured using FL. To guarantee that the complete osseous femur was measured without foreshortening or elongation, the proximal and distal epiphyseal cartilage were visible but not included in the FL measurement. FL was established for the femurs on the left and right. The last measurement was the average of their length in millimetres.

Before the study began, the "Institutional Ethics Committee" approval was requested.

Statistical Methods

Throughout the study, data was evaluated using the proper statistical techniques, including frequency, percentage, mean, standard deviation (SD), chi-square test, and "t" test. The regression coefficient and Pearson's correlation between gestational age and renal length were also computed. P values less than 0.05 are deemed significant.

RESULTS

The current study involved 120 pregnant women. The distribution of study participants by age is displayed in Table 1. Of the 120 participants in all, the majority were between the ages of 25 and 29, then 20 and 24. Of the 120 cases, 52 (43.3%) were in the 25–29 age range, and 45 (37.5%) were in the 20–24 age range. Of the 120 individuals, 62 (51.7%) were primipara and the remaining 58 (48.3%) were multipara.

Table 2 shows MKL and Gestational age (GA) by other foetal biometric parameters according to GA by LMP. From 27.18 ± 2.20 mm at 28 weeks to H8.0 ± I.80 mm at H9 weeks, the average renal length increased in a regular manner with gestational age. At 28 weeks and 39 weeks of gestation, respectively, the mean GA by BPD was 27.09 ± 1.88 weeks and 37.91 ± 1.71 weeks. At 28 weeks and 39 weeks of gestation, respectively, the mean GA by HC was 27.29 ± 1.60 weeks and 37.41 ± 2.21 weeks. At 28 weeks and 39 weeks of gestational age, respectively, the mean GA by AC was 28.71 ± 0.78 weeks and 39.39 ± 0.39 weeks. At 28 weeks and 39 weeks of gestation, the mean GA by FL was 26.69 ± 1.19 weeks and 38.91 ± 1.11 weeks, respectively.

The relationship between mean kidney length and GA by head circumference (HC) is seen in Figure 2. (MKL). According to the Pearson Association Coefficient (r), there is a reasonably strong positive correlation (r) between MKL and GA by HC. With a decent fit and a R squared (R2) value of 0.545, this regression model explains 54.5 percent of changes in GA by HC with MKL.

Figure 3 displays the relationship between mean kidney length and GA as measured by abdominal circumference (AC) (MKL). According to the Pearson Association Coefficient (r), there is a relatively strong positive correlation (r) between MKL and GA via AC. With a decent fit and a R squared (R2) value of 0.612, this regression model explains 61.2 percent of changes in GA by AC with MKL.

Table 1: Distribution of study participants according to their age, parity and gestational age

Variables	Women (n=120) (%)
Age of mother in years	
<=19	9 (7.5)
20-24	45 (37.5)
25-29	52 (43.3)
30-34	12 (10)
>=35	2 (1.7)
Parity	
Primipara	58 (48.3)
Multipara	62 (51.7)

Table 2: Comparison of Gestational age by LMP with MKL and GA by other foetal biometric parameters

Gestational Age by LMP	Cases	MKL (mm)	Gestational Age (Mean ± SD weeks) according to Foetal Biometry			
			BPD	HC	AC	FL
28	8	27.18±2.2	27.09±1.88	27.29±1.6	28.71±0.78	26.69±1.19
29	6	28.44±2.05	28.47±2.04	28.47±2.11	29.43±1.43	28.8±1.22
30	13	29.82±1.9	30.17±2.36	30.26±2.33	30.58±1.55	28.76±0.79
31	11	31.13±2	31.16±2.1	31.03±2.04	30.89±1.25	29.47±1.11
32	14	32.57±2.1	31.65±1.63	31.65±1.63	33.18±0.97	32.53±0.82
33	9	33.6±2.35	32.09±1.81	32.2±1.87	33.81±0.86	32.26±1.29
34	10	34.79±2.6	33.09±1.88	33.27±2.04	33.89±1.16	33.74±1.08
35	11	35.47±2.8	34.48±1.6	35.01±2.18	34.04±1.35	35.28±2.35
36	13	36.31±3	35.92±1.05	36.59±1.52	36.6±1.02	36.38±2.44
37	10	36.86±2.25	36.62±2.17	37.13±2.46	37.07±1.55	36.8±2.44
38	8	37.57±1.5	36.91±2.17	37.33±2.63	38.16±1.1	38.42±1.66
39	7	38±1.8	37.91±1.71	37.41±2.21	39.39±0.39	38.91±1.11

LMP – Last menstrual period; MKL – Mean Kidney Length; BPD – Bi-parietal Diameter; HC – Head Circumference; AC – Abdominal Circumference; FL – Femur Length

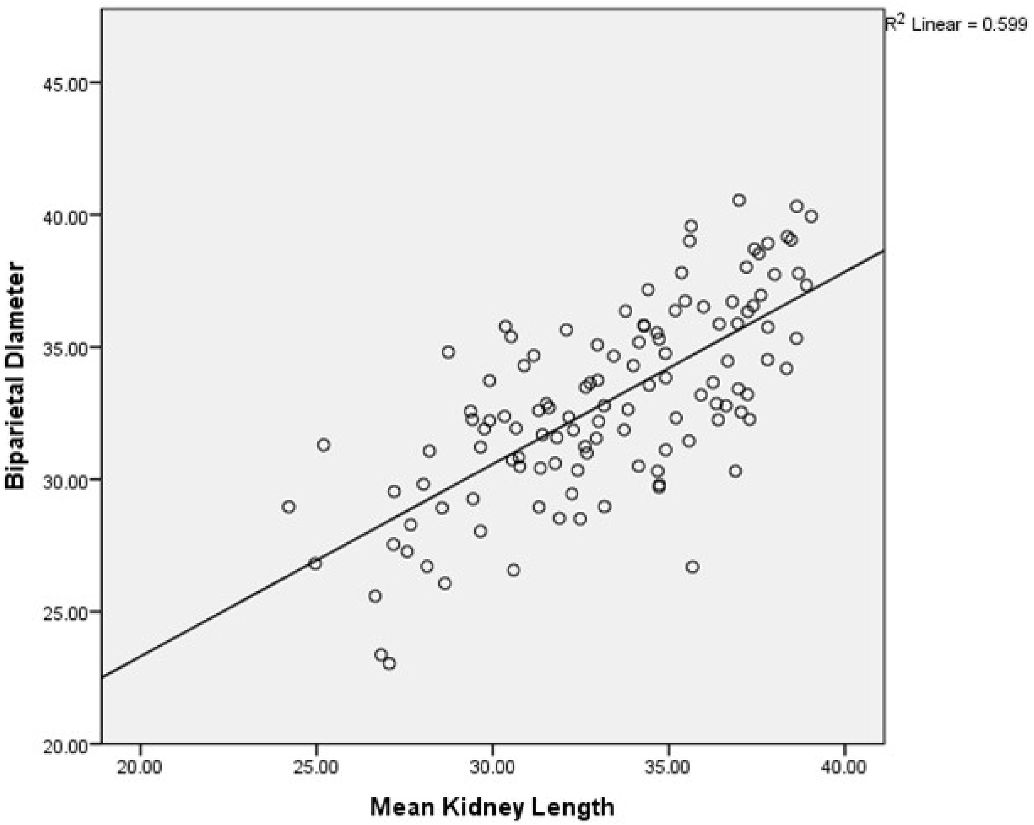

Figure 1: Correlation between GA by Biparietal Diameter (BPD) and mean kidney length (MKL) (Pearson Correlation Coefficient (r) 0.706)

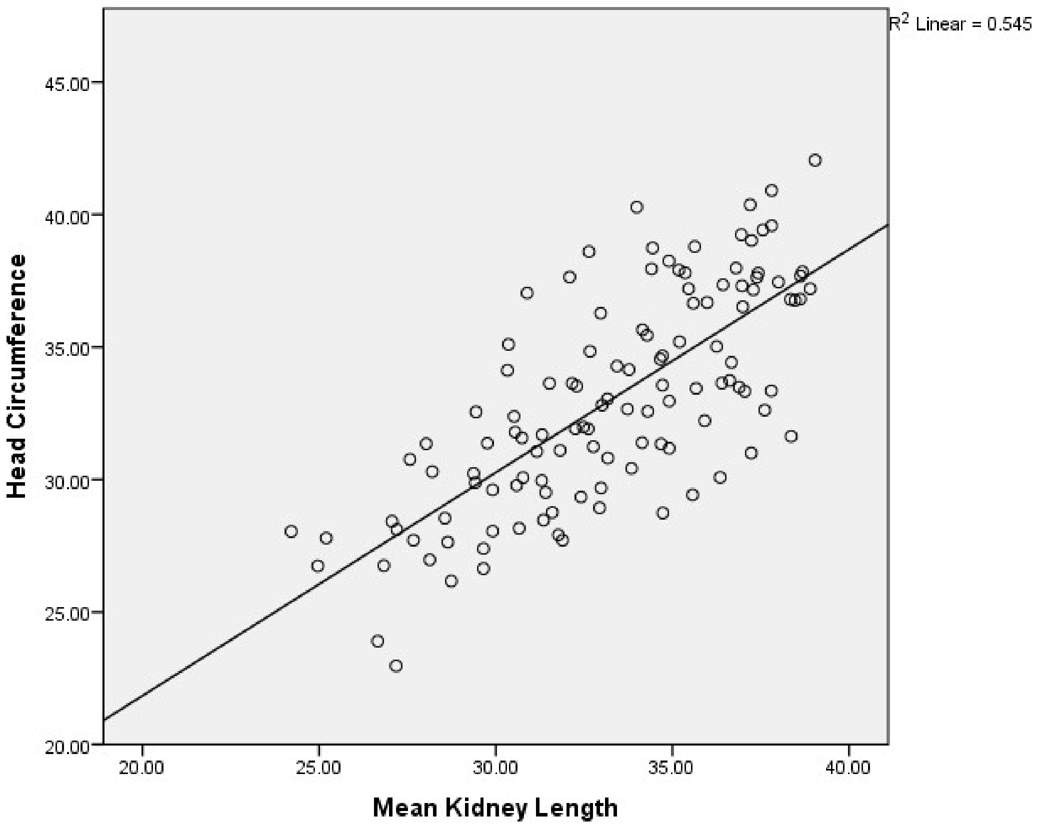

Figure 2: Correlation between GA by Head Circumference (HC) and Mean Kidney Length (MKL) (Pearson Correlation Coefficient (r) 0.689)

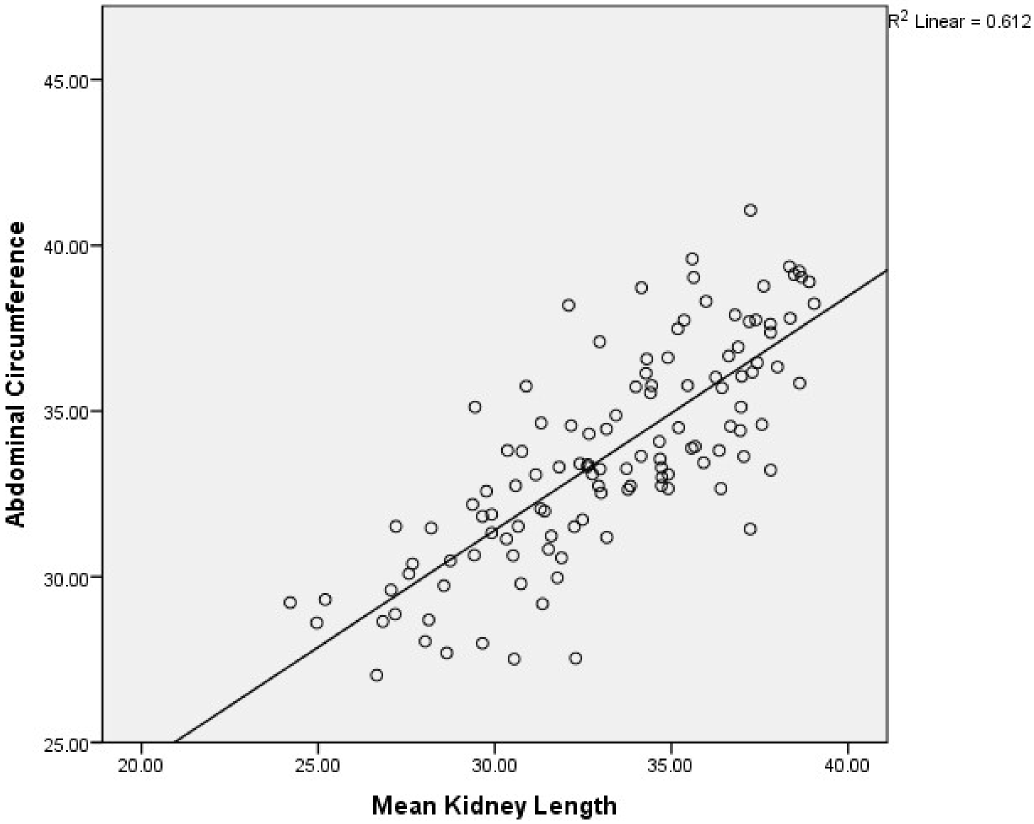

Figure 3: Correlation between GA by Abdominal Circumference (AC) and Mean Kidney Length (MKL) (Pearson Correlation Coefficient (r) 0.783)

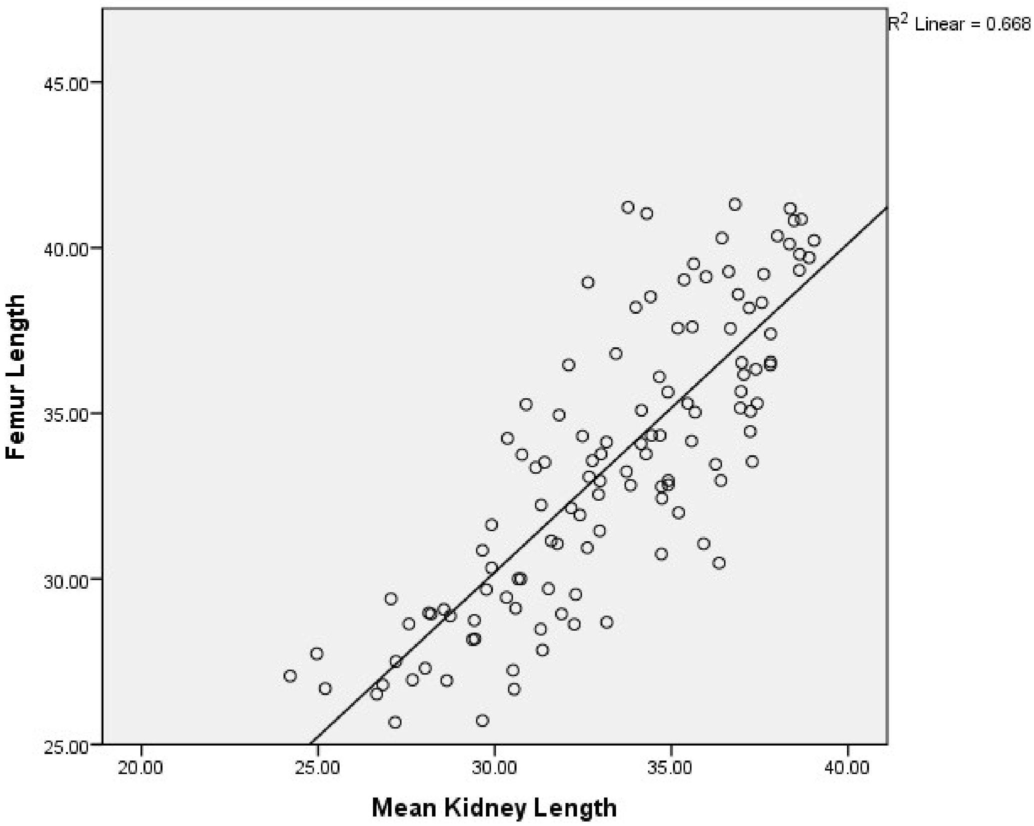

Figure 4: Correlation between GA by Femur Length (FL) and Mean Kidney Length (MKL) (Pearson Correlation Coefficient (r) 0.817)

The relationship between GA by femur length (FL) and mean kidney length is seen in Figure 4. (MKL). According to the Pearson Association Coefficient (r), there is a high positive correlation (very good) between MKL and GA via FL. With a decent fit and a R squared (R2) value of 0.668, this regression model explains 66.8% of changes in GA by FL with MKL.

Figure 1 illustrates the relationship between mean kidney length and GA as measured by BPD (MKL). By using BPD, the Pearson Association Coefficient (r) showed a reasonably excellent positive correlation between MKL and GA. With a decent fit and a R squared (R2) value of 0.599, this regression model explains 59.9% of changes in GA by BPD with MKL.

DISCUSSION

To assess and track a pregnant patient, an obstetrician has to precisely ascertain the gestational age and expected date of delivery (EDD). [7]

In the current study, the mean kidney length increased from 27.18 ± 2.20 mm at 28 weeks to 38.0 ± 1.80 mm at 39 weeks, showing a steady increase in kidney lengths measured in millimetres with gestational age. The mean kidney length rose steadily with increasing gestational age in a research by Ramachandran K et al (2021) [8], going from 15.2± 2.4 millimetres at 18 weeks to 37.8± 3.3 weeks at 38 weeks. According to Bardhan J. et alstudy .'s [9], the mean kidney length rises with GA. The mean kidney length (MKL) was 28.15 mm at 28 weeks of gestation and 38.15 mm at 38 weeks. The research by Samira-Al-Mlah et al. (2019)[10] found that the length of the foetal kidney increased linearly in millimetres as the gestational age increased in weeks. comparable outcomes to those reported in the study by Aremu OA et al (2005). [11]

Our study's average measurements of BPD, FL, HC, and AC at various gestations were similar to those reported by other authors. [12,13]

In the current investigation, the mean kidney length (MKL) and gestational age (GA) by LMP have a positive link with a highly good Pearson Correlation Coefficient (r) of 0.877. P value of <0.001 indicates a substantial correlation between the two variables. A excellent match and an explanation of 76.9% of the changes in GA with MKL is shown by the regression model's R squared (R2) value of 0.769. The study conducted by Ramachandran K et al. (2021) [8] found that there is a high positive connection (r = 0.876) between mean kidney length (MKL) and GA. Our results and this outcome are nearly identical. These findings are consistent with earlier research. The correlation coefficient (r=0.877) found in our investigation was similar to that found in research conducted by Cohen et al. [14] and Schlesinger et al. [15] (r=0.859). The correlation coefficients between other biometric indicators and gestational age were likewise similar to those found in earlier research.

The link between mean kidney length (MKL) and gestational age (GA) as measured by BPD is positively correlated, with a reasonably excellent strength, according to the study's Pearson Correlation Coefficient (r) of 0.706. P value of <0.001 indicates a substantial correlation between the two variables. With a decent fit and a R squared (R2) value of 0.599, this regression model explains 59.9% of changes in GA by BPD with MKL. The study conducted by Ramachandran K et al. (2021) [8] found that there was a very significant positive correlation (r = 0.905) between the GA correlation measured by BPD & MKL.

The link between mean kidney length (MKL) and gestational age (GA) by HC is positively correlated, with a reasonably excellent strength, according to the study's Pearson Correlation Coefficient (r) of 0.689. P value of <0.001 indicates a substantial correlation between the two variables. With an excellent fit and a R squared (R2) value of 0.545, this regression model explains 54.5 percent of changes in GA by HC with MKL. A very high positive association is shown by the Pearson correlation coefficient (r) of 0.865, which is found in the correlation of GA by HC & MKL in the research by Ramachandran K et al. (2021) [8].

In the current investigation, the mean kidney length (MKL) and gestational age (GA) by AC have a positive association with a relatively excellent Pearson Correlation Coefficient (r) of 0.783. P value of <0.001 indicates a substantial correlation between the two variables. With a decent fit and a R squared (R2) value of 0.612, this regression model explains 61.2 percent of changes in GA by AC with MKL. A very high positive correlation is indicated by the Pearson correlation coefficient (r) of 0.801 for the GA correlation by AC & MKL in the research by Ramachandran K et al. (2021) [8].

The link between mean kidney length (MKL) and gestational age (GA) by FL in the current study is positively correlated, with a highly excellent correlation coefficient (r) of 0.817. P value of <0.001 indicates a substantial correlation between the two variables. With a decent fit and a R squared (R2) value of 0.668, this regression model explains 66.8% of changes in GA by FL with MKL. A very moderately positive connection is indicated by the Pearson correlation coefficient (r) of 0.587 for the GA by FL & MKL correlation in the Ramachandran K et al. (2021) [8] investigation. In comparison to our study, the correlation coefficient value is smaller.

The study by Divyasree B. Reddy et al. (2017) [16] indicates a linear relationship between gestational age and the length of the foetus' kidney. With an R2 value of 0.98, the foetal kidney length, however, more accurately dates the pregnancy than BPD, HC AC, and FL. A study by C.M. Shanmughavadivu et al. [17] in 2014 discovered a correlation coefficient of (R2 = 0.94). Previous research by Konje et al. in 2002 [1] concluded that measuring the length of the foetal kidneys was a more accurate way to determine gestational age than other foetal biometric indices 25 (R2 =91). According to a research by Nahid Yusuf et al. [4] from 2007, the correlation coefficient (R2 = 0.94). Fetal Kidney Length (FKL), the most accurate single parameter for estimating GA compared to other biometric indices in the late 2nd and 3rd trimester, showed a statistically significant correlation with GA (weeks). FKL could be easily integrated into the models for estimating gestational age (KL; R2 = 0.95). It was discovered that this outcome and the research of Indu Kaul et al., 2012, were comparable. [18]

The biometric indices used in the second trimester are still used in the third trimester, despite a wealth of evidence indicating that the standard deviation for these measurements expands with growing gestation and, so, were likely to be increasingly erroneous as the GA develop. [19] Measures of the gestational sac's length, diameter, and volume may all be used to accurately estimate gestational age in the early stages of pregnancy [20], while measurements of the femur length and biparietal diameter can only be utilised much later. [21] But dating pregnant women who book late might be difficult, especially if they don't know when they last had a period.

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CONCLUSION

We draw the conclusion from this study that there is a high correlation between the mean kidney length of the foetus and established biometric markers of gestational age, including femur length, head size, belly circumference, and biparietal diameter. The best association between these four biometric parameters and gestational age as assessed by femur length was seen in the measurements of mean kidney length and belly circumference. When calculating gestational age in a third trimester pregnancy with an unknown LMP, the length of the foetal kidneys may be quite useful.

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