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Study on the Correlation between the First Trimester Crown-Rump Length with Birth Weight

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Abstract

Background: Fetal growth must be accurately monitored since aberrations raise the risk of low birth weight (LBW), small for gestational age (SGA), and poor postpartum outcomes. The most accurate indicator of gestational age and a good indicator of early growth trajectories is crown-rump length (CRL), which is measured during the first trimester. Research indicates that while percentile-based analysis enhances risk categorization, CRL below the 10th percentile predicts LBW, SGA, premature birth, and NICU admission. Maternal age also affects fetal growth, although it's not known how it affects the association between CRL and birth weight. The necessity for prospective studies to confirm CRL as an early marker and improve prenatal surveillance is highlighted by the paucity of population-specific data from India.
Materials and Methods: A prospective observational cohort study was conducted over 18 months in the Department of Obstetrics and Gynaecology after ethical approval. Pregnant women aged 18-40 years with ultrasound-confirmed singleton pregnancies between 8-13 weeks enrolled (n=370), excluding ART conceptions, major anomalies and high-risk conditions. Baseline maternal parameters were recorded and CRL measured in the mid-sagittal plane was categorized into <10th, 10th-90th and >90th percentiles. Maternal age was grouped as teenage (≤19), normal (20-34) and advanced (≥35). Neonatal birth weight was measured at delivery with LBW defined as <2.5 kg and outcomes compared across CRL percentiles and maternal age groups.
Results: There were 370 pregnant women in all; 89.2% of them gave birth at term, and 73.5% of the newborns had normal birth weights. The mean birth weight grew gradually from 2450 ± 430 g (<10th percentile) to 3320 ± 510 g (>90th percentile) ($p < 0.001$) throughout first-trimester crown–rump length (CRL) percentile groups. Low birth weight was substantially more common in fetuses with CRL <10th percentile (54.2%; OR 4.6, 95% CI: 2.3–9.1; $p < 0.001$). Higher rates of preterm delivery (22.9% vs. 4.2%; $p = 0.01$), NICU admission (29.2% vs. 6.3%; $p = 0.002$), and 5-minute Apgar score <7 (18.8% vs. 2.1%; $p < 0.001$) were also linked to lower CRL percentiles. Birth weight and CRL had a moderately positive connection ($r = 0.46$, $p < 0.001$), which was significant for teenage pregnancies ($r = 0.42$, $p = 0.004$) and pregnancies with older mothers ($r = 0.39$, $p = 0.006$)
Conclusion: Neonatal birth weight and perinatal outcomes are significantly correlated with first-trimester CRL, confirming its function as a non-invasive early predictor of fetal growth and risk classification.

INTRODUCTION

Antenatal monitoring and fetal growth Pregnancy is a period of perpetual development that begins at conception. Growth monitoring is crucial to prenatal care since aberrations can result in low birth weight (LBW), small for gestational age (SGA) status, and increased newborn morbidity and death.[1,2] Crown rump length (CRL), the most accurate indicator of gestational age, is the primary basis for first trimester evaluation, whereas second and third trimester monitoring depends on bi-parietal diameter, femur length, and anticipated birth. weight.[3,4] Crown Rump Length in Early Pregnancy CRL is constant and mostly independent of the fetus's position, measured between 6 and 13+6 weeks. Despite being frequently used for dating, variations in CRL, even with normal gestational age, imply distinct growth trajectories. Persistently lower CRL measurements are predictive with LBW and SGA infants. A critical neonatal health indicator, LBW (<2500 g) is linked to issues such preterm birth, respiratory distress, sepsis, hypoglycemia, NICU hospitalization, and an increase in perinatal mortality.

Embryos with CRL below expected standards were more likely to develop LBW or SGA babies, according to the first significant investigation.Growth restriction begins throughout embryogenesis, as evidenced by the fact that CRL below the 10th percentile in the early stages of pregnancy increases the risk of LBW and other adverse consequences.[5]

Regardless of mother BMI and other factors, further cohort studies showed positive correlations between first trimester CRL and birth weight.Preterm birth, SGA infants, and NICU stay were associated with lower CRL, according to recent study [6-8].

Contradictory results from community-based research, however, indicate that catch-up growth might happen later in pregnancy [9]. This highlights the need for prospective studies that integrate maternal and environmental factors to clarify the relationship between early CRL and delivery outcomes.

Percentile-Based CRL Analysis Percentile-based analysis is more reliable than absolute CRL values.[10] It distinguishes between normal biological variation and clinically important abnormalities. Classifying CRL into percentile groups enables pregnancy stratification, closer monitoring, and timely interventions.[11,12] Foetuses with CRL below the 10th percentile are more likely to experience LBW and SGA. [13]

The idea that early growth trajectories affect later results is supported by this consistent, repeatable approach, which improves clinical and research reliability. Maternal Age and Growth of the Foetus Foetal growth is strongly influenced by maternal age. Growth restriction, premature birth, and low birth weight are linked to both teenage pregnancies and advanced maternal age.[14, 15] Adolescents' growth is hampered by biological immaturity, anemia, malnutrition, and inadequate prenatal care, all of which have an impact on placental development.[16] It's Uteroplacental perfusion is hampered in older moms by placental aging and chronic illnesses like diabetes and hypertension [17]. Although maternal age is known to influence birth weight, no research has been done to determine whether this influences the association between CRL and birth weight. Examining this could improve CRL's usefulness as an early risk marker and uncover age-specific development trends.

Wider Consequences of Early Growth Birth weight, gestational age at delivery, Apgar scores, NICU necessity, and perinatal morbidity are all impacted by first trimester growth differences [18]. These disruptions may be the result of anomalies in the placenta or the mother-foetal interface, which have a long-lasting effect during pregnancy. A useful paradigm for risk categorization is provided by evaluating results across CRL percentile categories [19]. Early risk assessment could be strengthened by integrating CRL into prenatal surveillance.

Gaps Particular to Populations, there is little evidence from the Indian population, and despite a great deal of study conducted worldwide, results are still conflicting. Growth trends are influenced by ethnicity, nutrition, socioeconomic level, and availability to prenatal care, which limits the generalizability of Western data [20]. There are few prospective studies in India, especially when it comes to maternal age effects and CRL percentile distributions [21]. Filling in the gaps is crucial to validating CRL early markers for fetal growth and enhancing prenatal surveillance techniques.

AIM AND OBJECTIVES:

This study aimed to evaluate the correlation between first-trimester crown–rump length (CRL) and neonatal birth weight. The primary objective was to assess the correlation between CRL and birth weight, while the secondary objectives were to determine the association in teenage and advanced maternal age pregnancies and to compare feto-maternal outcomes across CRL percentile groups.

MATERIALS AND METHODS:

Aprospective observational cohort study was carried out at the Department of Obstetrics and Gynecology at a tertiary care facility for more than 18 months after approval from institutional ethical committee. Pregnant women between the ages of 18 and 40 who had ultrasound-confirmed singleton pregnancies between 8 and 13 weeks gestation were enrolled after their consent. Using the Lwanga & Lemeshow method with prevalence 60%, CI 95%, and margin of error 5%, the sample size was determined to be 369; a final 370 participants were included to account for attrition [22].

ART conceptions, substantial fetal abnormalities, repeated miscarriages, ectopic or molar pregnancies, uterine abnormalities, and pregnancies complicated by serious medical conditions or a bad obstetric history were all excluded. Age, obstetric/medical history, and BMI were recorded as baseline maternal parameters. Using crown-to-rump measurement, neutral fetal position, and conventional reference charts for gestational age assignment, ultrasound assessment evaluated CRL in the mid-sagittal plane. Maternal weight monitoring and documentation of complications were part of the normal prenatal appointments.

Maternal age was divided into three categories: advanced (≥35 years), normal (20–34 years), and teenage (≤19 years). CRL was divided into three percentiles: <10th, 10th–90th, and >90th. Neonatal outcomes across CRL percentiles, correlations between CRL and birth weight, and relationships in pregnancies involving teenagers and older mothers were among the outcome measures. A calibrated digital scale was used to measure the neonatal birth weight upon delivery, the gestational age was noted, and low birth weight was defined as less than 2.5 kg.

STATISTICAL ANALYSIS

A standardized proforma was used to gather the data, which were then entered into Excel and statistically analyzed. Mean ± SD was used to represent continuous data, frequencies and percentages were used to express categorical variables, the Odds ratio was used to analyze associations, and $p < 0.05$ was deemed significant.

RESULTS

The results are represented in tables 1-6 and figures 1-2.

Table 1: Baseline maternal characteristics of the study participants (n = 370)

Variable	Category	Frequency (n)	Percentage (%)
Maternal age (in years)	<20 (Teenage)	40	10.8
	20–34	278	75.2
	≥35 (Advanced maternal age)	52	14
Gravidity	Primigravida	198	53.5
	Multigravida	172	46.5
BMI (kg/m²)	<18.5	38	10.3
	18.5–24.9	244	66.0
	≥25	88	23.7
Gestational age at delivery	Term (≥37 weeks)	330	89.19
	Preterm (<37 weeks)	40	10.81

A total of 370 eligible study participants were included in the study. The age distribution of the study participants revealed that the majority of pregnant women were in the reproductive age group between 20- 34 years, accounting for 75.2% of the total participants. Adolescent pregnancies constituted around 10.8% of cases, while women of advanced maternal age (≥35 years) were around 14% of the study population, representing the two extreme maternal age groups of study participants within the cohort.

Gravidity among the study participants show that majority of them fall under primigravida which accounts for 53.3%, while multigravida accounts for 46.5%.

BMI distribution pattern shows that the majority of the study participant fall under normal BMI, accounts 66%, underweight women constituted 23.7%, and only a small proportion of study participants are in inadequate nutritional status.

The distribution of gestational age at delivery revealed that most pregnancies resulted in term deliveries, accounting for 89.19% of cases; preterm deliveries accounted for only for 10.81% in total.

Table 2: Distribution of first-trimester crown–rump length (CRL)

CRL percentile group	CRL range (mm)*	n	%
<10th percentile	<45 mm	46	12.43
10th–50th percentile	45–54 mm	134	36.21
50th–90th percentile	55–64 mm	146	39.46

CRL percentile group	CRL range (mm)*	n	%
>90th percentile	≥65 mm	44	11.9

*(Measured between 11–13+6 weeks of gestation)

The distribution of crown–rump length (CRL) percentile groups shows that most of the foetuses of study participants fall within the middle percentile ranges. 36.21% of foetuses with CRL measurements falling between the 10th and 50th percentiles (45–54 mm), while those foetuses with CRL measurements that fall between the 50th and 90th percentiles (55–64 mm) accounted for the largest proportion at 39.4%.

Foetuses with CRL measurement values below the 10th percentile (<45 mm) comprised 12.43% of cases. Almost an equal proportion of foetuses (11.9%) had CRL measurements above the 90th percentile (≥65 mm), indicating a symmetrical representation at both extremes of the CRL distribution.

Three-fourths of the CRL percentile distribution fall within the 10^{th} to 90^{th} percentile range, which accounts for (75. 67%) were within the 10th to 90th percentile range, reflecting a predominance of the CRL values within the expected range for first-trimester gestation. This distribution pattern further indicates a balanced distribution across the CRL percentile categories within the study population.

Table 3: Birth weight distribution of neonates

Birth weight category	Birth weight (g)	n	%
Low birth weight (LBW)	<2500	74	20.0
Normal birth weight	2500–3999	272	73.5
Macrosomia	≥4000	24	6.5

The distribution of birth weight among the neonates in the study population showed that the majority were born with a normal birth weight. Neonates with normal birth weight formed the largest group, around 73.5% of all births, indicating that most newborns had birth weights within the normal range (2500–3999).

Low birth weight infants constituted 20% of the neonates, defined as those weighing less than 2500 g. The infants with higher birth weights of 4000 g or more accounted for a smaller proportion, comprising 6.5% of the total births. The birth weight distribution shows that nearly three-fourths of neonates had normal birth weight, while about one-fifth were classified as low birth weight, and a small proportion were higher birth weight infants.

Table 4: Association between CRL percentile groups and mean birth weight

CRL percentile	Mean birth weight (g) ± SD	p-value (ANOVA)
<10th	2450 ± 430	<0.001
10th–50th	2780 ± 460	
50th–90th	3050 ± 490	
>90th	3320 ± 510	

This table demonstrates a clear and statistically significant association between first-trimester crown–rump length (CRL) percentile groups and mean neonatal birth weight. There is a progressive and graded increase in mean birth weight with increasing CRL percentile, indicating a strong relationship between early foetal size and subsequent growth at birth.

Foetuses with CRL measurements below the 10th percentile had the lowest mean birth weight (2450 ± 430 g), placing many of these neonates close to the low-birth-weight threshold. This suggests that relatively smaller foetal size in the first trimester may reflect a growth trajectory that continues throughout pregnancy.

Neonates with CRL measurements that fall between the 10th–50th percentile group had a higher mean birth weight (2780 ± 460 g), while those in the 50th–90th percentile group demonstrated a further increase (3050 ± 490 g). These findings indicate that foetuses with average to above-average CRL measurements in early gestation are more likely to achieve normal and optimal birth weights. It was observed that foetuses with CRL measurements >90th percentile in the first-trimester have the highest mean birth weight (3320 ± 510 g), highlighting that accelerated foetal growth in the first trimester is associated with higher birth weight at delivery.

The overall difference in mean birth weight across CRL percentile groups was found to be highly statistically significant (ANOVA $p < 0.001$), confirming that the observed trend is unlikely to be due to chance. Collectively, these results reinforce the concept that first-trimester CRL is not merely a dating parameter but also a meaningful early marker of foetal growth potential, with important implications for predicting birth weight and identifying pregnancies at risk for growth-related outcomes.

Table 5: Association between CRL percentile and low birth weight (LBW)

CRL percentile	LBW n (%)	Normal BW n (%)	Odds Ratio (95% CI)	p-value
<10th	26 (54.2)	22 (45.8)	4.6 (2.3–9.1)	<0.001
10th–50th	32 (24.2)	100 (75.8)	1.6 (0.9–2.9)	0.08
50th–90th	14 (9.9)	128 (90.1)	Ref	
>90th	2 (4.2)	46 (95.8)	0.4 (0.1–1.5)	0.18

It evaluates the association between first-trimester crown–rump length (CRL) percentile groups and the occurrence of low birth weight (LBW), highlighting the predictive value of early foetal growth on neonatal outcomes. In the <10^{th} percentile CRL group, there are 54.2% of babies fall under low birth category, with an odds ratio of 4.6 (95% CI: 2.3–9.1) compared to the reference group, and this association was statistically significant (p < 0.001). Contrast findings observed in >90^{th} percentile, only 4.2% of neonates were of low birth weight and the odds ratio (0.4; 95% CI: 0.1–1.5) suggested a protective effect against LBW, but this association was not statistically significant (p = 0.18).

In the 10^{th}-50^{th} percentile group, only 24.2% of neonates are LBW, and the odds of LBW were higher among the study group than the reference category (OR = 1.6; 95% CI: 0.9–2.9), this association was not statistically significant (p = 0.08).

The 50th–90th percentile group were used as the reference category, showing a relatively low LBW prevalence (9.9%), which represents the most favourable early growth pattern and optimal neonatal outcome among the groups studied.

Overall, the findings observed show a strong and clinically meaningful association between low CRL measurements in the first trimester and the risk of low birth weight at delivery. The results emphasise that markedly reduced early foetal growth is an important risk marker for adverse birth outcomes, reinforcing the value of first-trimester CRL as an early, non-invasive tool for identifying pregnancies that may benefit from closer surveillance and targeted interventions.

Table 6: Foetal and neonatal outcomes across CRL percentile groups

Outcome	<10th %	10th–50th %	50th–90th %	>90th %	p-value
Preterm birth (%)	22.9	12.1	6.3	4.2	0.01
NICU admission (%)	29.2	15.9	8.5	6.3	0.002

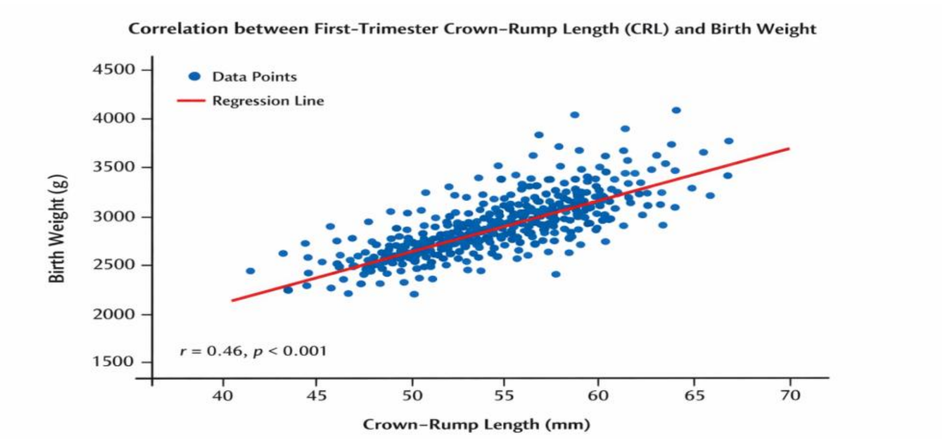
Outcome	<10th %	10th–50th %	50th–90th %	>90th %	p-value
Apgar <7 at 5 min (%)	18.8	9.8	4.2	2.1	0.01

This table compares key foetal and neonatal outcomes across first-trimester crown–rump length (CRL) percentile groups and demonstrates a clear gradient in adverse outcomes corresponding to early foetal size. The preterm birth rate was observed among foetuses, with lower CRL percentiles <10th percentile (22.9%) and this pattern steadily decreases with the increasing CRL percentile, 4.2% in the >90th percentile group. The difference observed was statistically significant (p = 0.01) among the groups. NICU admission rates showed a similar pattern, with one-third of neonates (29.2%) with <10th percentile required intensive care. The NICU admission rate dropped with the increasing CRL measurements, 6.3% with >90th percentile and its association was statistically significant (p=0.002). It shows the clinical importance of foetal growth in early pregnancy as a predictor of neonatal morbidity.

In the <10th percentile group, the neonates with an Apgar score at 5 minutes of <7 were substantially higher (18.8%), compared to those neonates in the>90th percentile group (2.1%).

These findings show that the reduced CRL in the first trimester is associated with the compromised neonatal outcome, and this is statistically significant (p=0.0).

Figure 1: Scatter plot showing correlation between first-trimester CRL and birth weight



The relationship between first-trimester crown–rump length (CRL) and neonatal birth weight is illustrated by this figure, where CRL is plotted on the x-axis and birth weight on the y-axis, and each point on the scatter plot represents an individual pregnancy.

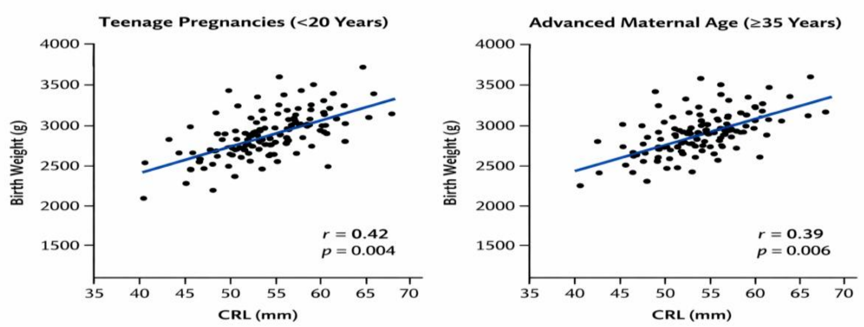
The upward-sloping regression line, which demonstrates a positive linear relationship between CRL and birth weight, indicates that larger CRL measurements in early pregnancy are generally associated with higher birth weights at delivery. The data points are reasonably clustered around the regression line, suggesting a consistent trend rather than a chance association.

The reported Pearson correlation coefficient ($r = 0.46$) indicates a moderate positive correlation, while the p-value (<0.001) confirms that this relationship is statistically highly significant. This means that the likelihood of observing such a correlation by chance is very low.

This figure strengthens the concept from a clinical perspective that foetal growth patterns are established early in pregnancy. Foetuses with smaller CRL values tend to cluster toward lower birth weights, whereas those with higher CRL measurements are more likely to achieve normal or higher birth weights. Though the variability is evident, which reflects the influence of maternal and placental factors, the overall trend remains clear.

This scatter plot provides strong visual support of the study's primary findings and underscores its potential value in early risk assessment and antenatal monitoring.

Figure 2: Scatter plot of CRL versus birth weight in teenage and advanced maternal age pregnancies



This figure shows the relationship between first-trimester crown–rump length (CRL) and neonatal birth weight separately for teenage pregnancies (<20 years) and advanced maternal age pregnancies (≥35 years). The scatter plot, among the teenage pregnancy group, shows the upward trend, which means an increase in CRL measurements increases the birth weight, and the points are clustered along a positively sloped regression line. The correlation coefficient (r=0.42) indicates a moderate positive correlation, and the p value = 0.004, which shows a statistically significant correlation. It denotes that the larger CRL measurements in early pregnancy are associated with a normal and higher birth weight.

The advanced maternal age group shows that there is an evident positive linear correlation between CRL and birth weight. The correlation coefficient (r=0.39), which also shows a moderate positive correlation, and the p-value of 0.006, which is statistically significant.

Both findings were suggestive of the favourable first-trimester CRL and birth weight across extremes of the maternal age group. CRL percentile groups and birth weight values tend to be slightly lower in these groups compared to the general obstetric population; the similar strength of correlations highlights the robustness of CRL as an early marker of foetal growth.

DISCUSSION

There is a plethora of studies conducted in different parts of the world to establish the association between the CRL measurement and birth weight. The purpose of this prospective cohort study is to demonstrate the statistically significant relationship among first-trimester CRL, neonatal birth weight and adverse neonatal outcomes and to observe the graded response among the CRL percentile group. In this study, it was observed that decreased CRL percentile <10th percentile has lower birth weight and adverse neonatal outcomes, like low birth weight, preterm birth, and NICU admission. There are multiple studies showing evidence similar to the present study [2,5,23,24].

The age distribution, BMI profile, gestational age at birth, and percentage of term deliveries are all identical to those seen in Basnet K [25].

In line with the current study, the gravidity pattern in Nair et al. revealed an equal distribution between primigravida and multigravida pregnant women [26].

The baseline maternal characteristics results of the current study were comparable to those of the studies by

Singh et al. and Solomon et al. [27,28] The observed similarity in baseline characteristics between the current study and the other cohort studies indicates that the association between the first-trimester CRL and birth weight is more likely due to variations in early fetal growth patterns rather than being solely influenced by nutritional or demographic factors.

In the present findings the majority of foetuses fall within the 10th-90th percentile range, with a similar pattern observed among Nair et al., [26]. Papageorghiou et al. conducted the INTERGROWTH-21 project, which showed a pattern similar to the present study, where most of the foetuses fall within the mid-percentile ranges [29].

The assessment of CRL percentiles is more important than merely depending on the CRL measurement, and it also provides informative ideas on the growth patterns of the foetuses, as studied by Salomon et al.[30] The importance of CRL percentiles in assessing the growth deviation early in pregnancy with the percentile- based classification was seen. The findings of our study support this evidence.

Smith et al. found that the growth variation seen in first-trimester CRL measurements is not transient, but rather indicates chronic growth restrictions. The first-trimester CRL and birth weight showed a statistically significant positive association when compared to the current study, suggesting that the early growth deviation from the normal range had quantifiable consequences on newborn size [5]. CRL Z-scores in early pregnancy are significant predictors of birth weight was later confirmed by extended observations by Salomon et al, this further emphasizes the significance of gestational age standardization when assessing early growth markers, as it decreased biological variability and increased the strength of association even after controlling for baseline maternal characteristics [23].

Similar results have been supported by other Indian research, such as salomon et al, vafaei et al which found a substantial correlation between first-trimester CRL and newborn birth weight, especially when CRL data were analyzed using percentile or Z-score-based methods [31,32]. Since both studies used standardized ultrasound techniques and prospective data collecting, their findings are directly comparable to the current investigation. Because the study by Odibo Ao et al. and Bukowski et al. included retrospective datasets and wide gestational age ranges, it diluted true biological associations due to measurement variability and dating errors [33,34]. This contrasts findings that reported weak or absent correlations. The larger relationship reported in the current cohort is justified by these plausible methodological variations, which also explain the discrepancy in observed correlations.

Biologically, the current study's findings are consistent with the early foetal programming hypothesis, first proposed by Barker and later developed by Papageorghiou et al., which proposes that abnormalities in placental implantation, early uteroplacental circulation, and embryonic nutrient supply have long-term effects on fetal growth patterns [29]. Thus, a smaller CRL measurement during the first trimester may be a sign of poor placental growth, which ultimately results in a lower birth weight.

After controlling for mother BMI, parity, and gestational age, more recent research has shown that lower CRL Z-scores at 12–13 weeks were independently linked to lower birth weight, SGA infants, and increased rates of NICU admission [30].

A population-based study done by Van Uitert et al., showed a positive correlation between first-trimester CRL and neonatal anthropometric measurements [35]. The teenage pregnancy with normal growth and proper nutrition showed that lower first-trimester CRL is associated with low birth weight, which was established by Poon et al. [36].

The Van uiterat al. study shows that conception-related factors, such as assisted conception methods and embryo transfer procedures, can affect early CRL values and birth weight [35]. Similar patterns were observed in the earlier study by Sarris et al.'s which emphasised the importance of following CRL measurement criteria stringently to identify significant correlations as small discrepancies in early gestation CRL values can significantly affect growth patterns [37].

The present study showed a statistically significant positive association between birth weight and first-trimester CRL, suggesting that early fetal growth patterns affect neonatal size at birth. The results of the Smith et al. study are in line with the current study, which found that low birth weight and preterm delivery are linked to decreased first-trimester growth [5]. Salomon et al. later verified similar findings, demonstrating that CRL Z-scores in the early stages of pregnancy independently predict birth weight after controlling for maternal variables and gestational age.

First-trimester CRL and birth weight are significantly positively correlated, according to research by salomon et al [30]. Studies by Yang et al. on the other hand, found weak or nonexistent correlations, most likely as a result of their retrospective methodology, larger gestational age ranges, and absence of standardized CRL measurement [38]. The variation in reported results could be explained by these methodological variations.

It is clinically noteworthy that fetuses with CRL below the 10th percentile had a risk of low birth weight that was more than four times higher. Early fetal growth has been demonstrated to predict both low birth weight and small-for-gestational-age status in Indian studies and international cohorts [39].

Instead of adopting clinically appropriate percentile cut-offs, studies showing non-significant correlations frequently lacked adequate power or classified CRL dichotomously. The current research validates the use of low CRL percentile as an early warning indicator, allowing for the prompt detection of pregnancies at risk for growth-related problems.

Findings from international cohorts that associate early fetal growth restriction with poor perinatal outcomes7 are consistent with the rising risk of preterm birth, NICU admission, and low Apgar scores with declining CRL percentile reported in this study. Higher newborn morbidity has also been documented in Indian research for fetuses exhibiting signs of delayed early growth [40].

Differences in newborn care infrastructure, referral patterns, and definitions of morbidity may account for variations in the severity of poor outcomes reported among studies. However, the consistent pattern in a variety of contexts supports the first-trimester CRL assessment's therapeutic significance.

Teenage and advanced maternal age pregnancies are traditionally associated with higher risks of low birth weight and preterm delivery[41]. Early foetal growth largely influences the birth weight of the neonates, and this association is strongly associated with both groups. Despite adjusting for the background characteristics, this association has a moderate positive correlation, and the association shows statistical significance; similar observations have been reported in other international studies [32]. Further research needs to be done on integrating CRL measurement with biochemical markers, Doppler studies, and long-term follow–up.

CONCLUSION

According to the study's findings, neonatal birth weight and perinatal outcomes are substantially correlated with first-trimester CRL. Although multicentric, large-scale studies are needed for validation, incorporating CRL-based risk assessment into normal prenatal care could improve early intervention.

Strong study design, sufficient sample size, standardized CRL measurement, and thorough neonatal outcome evaluation are among its strong points. The clinical usefulness of CRL as a non-invasive, early predictor of fetal growth and perinatal risk is supported by methodological coherence with earlier research.

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