

**CORRELATION BETWEEN CROWN RUMP LENGTH MEASURED IN EARLY FIRST TRIMESTER AND BIRTH WEIGHT OF THE RESPECTIVE NEWBORN**M. Samutirika Devi<sup>1</sup>, N. S. Raghupathy<sup>2</sup>, M. Mathivanan<sup>3</sup> and M. Srilakshmi Chordia<sup>4\*</sup><sup>1</sup>Post Graduate, Department of Paediatrics, Aarupadai Veedu Medical College and Hospital, Puducherry.<sup>2</sup>Professor, Department of Paediatrics, Aarupadai Veedu Medical College and Hospital, Puducherry.<sup>3</sup>Professor & Head, Department of Paediatrics, Aarupadai Veedu Medical College and Hospital, Puducherry.<sup>4</sup>Assistant Professor, Department of Paediatrics, Aarupadai Veedu Medical College and Hospital, Puducherry.**\*Corresponding Author: M. Srilakshmi Chordia**

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**ABSTRACT**

**Background and Aim:** Determination of early fetal growth abnormalities is one of the most important aspects of antenatal healthcare. In this study, we attempted to sonographically assess the correlation of early first trimester (>8 to <11 weeks) crown-rump length (CRL) with birth weight. **Method:** A prospective observational study with 252 women (19-39 years) having uneventful pregnancies were assessed for CRL during the early first trimester sonographically and followed up till delivery. The birth weight of their respective newborn was categorized into Small for Gestational Age (SGA), Appropriate for Gestational Age (AGA) and Large for Gestational Age (LGA). Both variables were correlated and analysed using SPSS 21.0 software. Analysis of variance (ANOVA), independent 't'-test, kappa-coefficient, Pearson bivariate correlation and linear regression were performed. **Results:** Mean early first-trimester CRL was 26.24±8.41 mm. There was a significant incremental trend of CRL with gestational age. The first-trimester CRL predicted AGA in 203 (80.6%), SGA in 37 (14.7%) and LGA in 12 (4.8%) pregnancies. At delivery, 205 (81.3%) were AGA, 35 (13.9%) were SGA and 12 (4.8%) were LGA. Agreement between estimated and actual growth categories was observed in 228/252 (90.5%) cases. Sensitivity, specificity, PPV, NPV and accuracy of CRL based estimations of birth weight category were 93.7%, 76.6%, 94.6%, 73.5%, 92.1% for AGA, 80%, 95.9%, 75.7%, 95.9%, 93.7% for SGA and 66.7%, 98.3%, 66.7%, 98.3% 96.8% for LGA. **Conclusion:** The findings of this study suggest that early first-trimester CRL can be used for the prediction of birth weight in uncomplicated pregnancies.

**KEYWORDS:** Early first-trimester, Crown-rump length, Sonography, birth weight, SGA, AGA, LGA.**INTRODUCTION**

Low birth weight (LBW) is defined as birth weight less than 2500 grams and is a useful indicator of maternal and foetal health. It is also a useful marker for the prediction of mortality, growth and well-being of the new born.<sup>[1]</sup> The term small for gestational age (SGA) is used to indicate the birth weight or birth crown-heel length below the 10th percentile for gestational age (or) 2 standard deviations below the mean for the infant's gestational age as estimated by at least two ultrasound growth assessment.<sup>[2]</sup> The term Very Small for Gestational Age (VSGA) is defined as birth weight less than 5th percentile for gestational age.<sup>[3]</sup> On the other hand, Large for Gestational Age (LGA) and Very Large for Gestational Age (VLGA) are the terms used for birth weights more than 90th percentile and 95th percentile respectively.<sup>[3]</sup> All other babies with birth weights not falling in these extremes are termed as Appropriate for Gestational Age (AGA). Both SGA, as well as LGA, are associated with a substantial burden of morbidity and

mortality during intrauterine and postnatal life. Despite the declining rate in LBW, the associated morbidity and mortality is an issue of concern for the medical fraternity with Asian countries (Bangladesh, India, Pakistan and Sri Lanka) having the highest incidences.<sup>[1,4]</sup> Dietary and nutritional deficiencies in mothers during pregnancy have been identified to be responsible for low-birth-weight babies apart from maternal medical problems like pregnancy-induced hypertension (PIH), gestational diabetes mellitus (GDM), cardiac diseases and chronic infections.<sup>[5]</sup> The factors that could influence the *in utero* growth of the fetus and result in low birth weight include maternal factors like extremes of reproductive age, nulliparity, grand-multiparity, malnutrition, uterine anomalies, systemic illness, teratogenic exposure, etc.; placental factors including uteroplacental insufficiency, placental abnormalities, haemorrhage, etc.; and fetal factors like prematurity, malformations, chromosomal abnormalities, TORCH infections, etc.<sup>[2,3]</sup> Nearly 50% of SGA and late preterm neonates end up developing

complications like hypoglycemia, hypocalcemia, hypothermia, hypotension, polycythemia, persistent pulmonary hypertension, etc. in the neonatal period; metabolic disorders in infancy; impaired functioning of organs in childhood.<sup>[2,3,6]</sup> Nowadays, ultrasound is used frequently for fetal surveillance for detecting various fetal biometric parameters. Amongst them, Crown-Rump Length (CRL) has been shown to have a good correlation with birth weight<sup>[7,8]</sup> and is defined as the measurement of the length of fetuses from the top of the head (crown) to the bottom of the buttocks (rump).<sup>[9]</sup> For prevention, early detection and intervention of SGA and LGA, early first-trimester detection of CRL measurement is beneficial. Hence, this study aims to assess the relationship between early first-trimester CRL and the birth weight of the respective newborn to predict AGA, SGA and LGA.

### MATERIAL AND METHODS

A prospective observational study was conducted in the Department of Paediatrics in collaboration with the Department of Radiology and Department of Obstetrics and Gynaecology of a tertiary healthcare teaching centre over a period of 20 months (December 2019 – September 2021). This study was approved by Institutional Ethics Committee for Human Subjects (IECHS) - AVMC/IEC2019/73. All consenting antenatal mothers

booked and immunised in AVMC in the early first trimester (8 weeks + 0 days to 10 weeks + 6 days) with singleton, live pregnancies were taken into the study. Their demographical profile, medical and obstetric histories were taken. The early first-trimester CRL was noted ultrasonographically. Based on CRL measurements, the fetuses were classified as SGA, AGA and LGA. These mothers were followed up till delivery. At birth, the weight, length, head circumference and chest circumference of the respective newborns were noted. They were further categorised in SGA, AGA and LGA babies according to the International Fetal size standards chart.<sup>[10]</sup> Data was entered into MS-Excel 2013 software and statistical analysis was performed using SPSS-21.0. Analysis of variance (ANOVA), independent samples 't'-test, kappa-coefficient, Pearson bivariate correlation and linear regression were performed. Sensitivity, specificity, positive and negative predictive values were calculated. The values were represented as a number (%) and mean  $\pm$  SD.

### RESULTS

A total of 252 pregnant women falling in the sampling frame were enrolled in the study and their demographic and obstetric profiles were noted and documented (Table 1).

**Table 1: Demographic and obstetric profile of women enrolled in the study (n=252).**

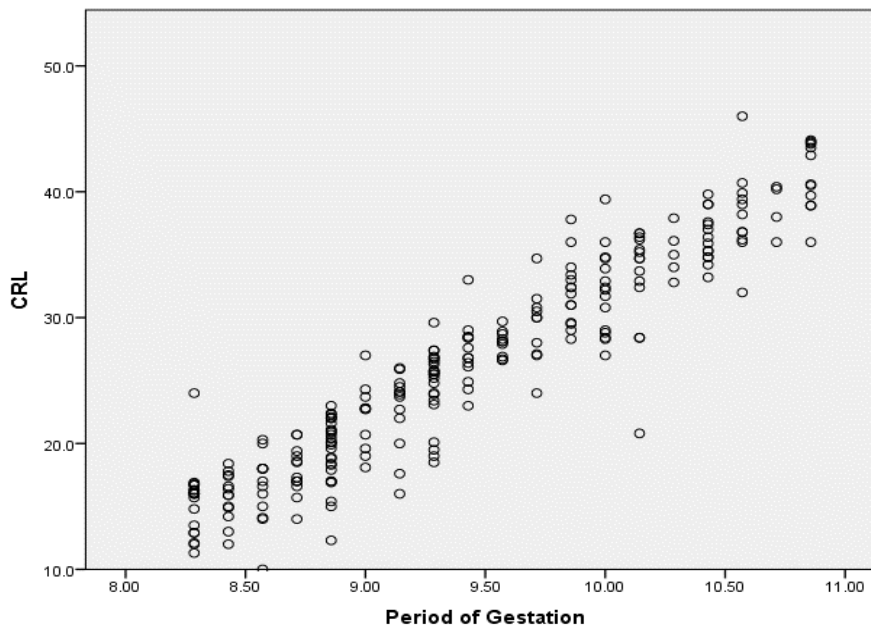
SN	Characteristic	No.	%
1.	Maternal age		
	≤20 Years	9	3.6
	21-25 Years	105	41.7
	26-30 Years	96	36.1
	31-35 Years	29	11.5
	>35 Years	13	5.2
	Mean age $\pm$ SD (Range) years	26.71 $\pm$ 4.27 (19-39)	
2.	Socioeconomic Class		
	II	72	28.6
	III	120	47.6
	IV	60	23.8
3.	Obstetric Profile		
	Gravida		
	G1	88	34.9
	G2	105	41.7
	G3	53	21.0
	G4	6	2.4
	History of abortions		
	No history	232	92.1
One	20	7.9	
Two or more	0	0	

The age of pregnant women enrolled in the study ranged from 19 to 39 years (mean of 26.71 $\pm$ 4.27 years). The maximum age of these women was between 21-25 years (41.7%) with almost half belonging to Socioeconomic class III (47.6%), maximum gravida score was 2 (41.7%). Only 7.9% of these women had a history of abortion.

**Table 2: Crown Rump Length Measurements according to Period of Gestation (mm).**

SN	POG	Minimum	Maximum	Mean	SD
1.	8 weeks 1 day to 9 weeks (n=84; 33.3%)	10	24	17.28	2.97
2.	9 weeks 1 day to 10 weeks (n=108; 42.9%)	16	39.4	27.22	4.53
3.	10 weeks 1 day to 10 weeks 6 days (n=60; 23.8%)	20.8	46.0	37.01	4.20
Total (n=252)		10	46.0	26.74	8.41

F=433.32; p<0.001 (One-way ANOVA)



**Fig. 1: Correlation between period of gestation and CRL (r=0.944).**

Amongst the women who underwent early first trimester CRL measurements sonographically, majority of them were evaluated between the gestational age of 9 weeks 1 day to 10 weeks 6 days (42.9%). The CRL measurements

ranged from 10 to 46 mm with a significant incremental trend with the gestational age (p<0.001) (Table 2). There was a strong correlation between the period of gestation and CRL (Fig. 1).

**Table 3: Distribution of cases according to sex of baby and anthropometric characteristics.**

SN	Characteristic	Boys (n=124)		Girls (n=128)		Total (n=252)		Statistical significance (Independent samples 't'-test)	
		Mean	SD	Mean	SD	Mean	SD	't'	'p'
1.	Birthweight (kg)	2.99	0.42	2.88	0.39	2.94	0.41	2.24	0.026
2.	Length (cm)	48.96	1.24	48.85	1.10	48.91	1.17	0.75	0.452
3.	Head circumference (cm)	33.43	0.73	33.43	0.69	33.39	0.71	1.03	0.306
4.	Chest circumference (cm)	30.89	1.00	30.82	0.98	30.85	0.98	0.554	0.580

All deliveries took place between 37 weeks to 40 weeks 4 days. Anthropometric measurements of the newborn (weight, length, head circumference and chest circumference) were measured and documented (Table

3). On comparing the data between the two genders, a significant difference (p 0.026) was found in birth weight only with the mean birth weight of boys being slightly higher as compared to that of girls.

**Table 4: Level of Agreement between Estimated Birth weight and Actual birth weight.**

Estimated birth weight category	Actual Birth weight for gestational age category			
	AGA	SGA	LGA	Total
AGA	192	7	4	203
SGA	9	28	0	37
LGA	4	0	8	12
<b>Total</b>	205	35	12	252

κ = 0.704; p<0.001 (Strong agreement); Agreement: 228/252 = 90.5%

Birth weight categories according to gestational age of the fetuses were estimated at the time measurement of CRL in first trimester according to Papageorghiou *et al*<sup>[10]</sup> study. At birth, the respective newborns were categorised

into AGA, SGA and LGA according to standard definitions.<sup>[2]</sup> The level of agreement between the estimated and actual birth weight was strong (90.5%) and statistically significant ( $p < 0.001$ ) (Table 4).

**Table 5: Predictive Efficacy of First trimester CRL based birth weight estimations.**

SN	Outcome	TP	FP	FN	TN	Sens	Spec	PPV	NPV	Accuracy
1.	AGA	192	111	13	36	93.7	76.6	94.6	73.5	92.1
2.	SGA	28	9	7	208	80.0	95.9	75.7	95.9	93.7
3.	LGA	8	4	4	236	66.7	98.3	66.7	98.3	96.8

The overall sensitivity, specificity, positive predictive value, negative predictive value and accuracy of the predictive efficacy of early first trimester CRL based birth weight estimations were calculated for AGA, SGA

and LGA and they were found to have high accuracy values with the highest accuracy, specificity and NPV for LGA category and highest sensitivity and PPV for AGA category.

**Table 6: Multivariate Predictive Model for estimation of birth weight based on CRL in early first trimester and gestational age at the time of estimation (Multivariate Linear Regression).**

SN	Variable	Coefficient±SE	'p' value
1.	CRL	0.068±0.008	<0.001
2.	Gestational age at estimation (Decimalized)	-0.696±0.091	<0.001
3.	Constant	7.771±0.659	<0.001

$r^2=0.469$

#### Derived equation:

**Birth weight (kg) = 7.771 + 0.068\*CRL – 0.696\*Gestational age at estimation**

On multivariate analysis, taking into consideration the decimalized gestational age at the time of CRL assessment and early first trimester CRL to be the independent factors predicting birth weight, both the independent variables were found to be significantly associated with dependent variable ( $p < 0.001$ ). However, these two characteristics had an average explanatory power ( $r^2=0.469$ ; 46.9%) (Table 6).

## DISCUSSION

In the present study, we attempted to study whether early first-trimester crown-rump length (CRL) measurements can be useful in the prediction of birth weight. For the present study, we defined early first trimester as gestational age between 8 weeks+0 days and 10 weeks+6 days.

A number of workers have assessed the usefulness of the gestational age between 11 to 14 weeks to evaluate CRL in prediction of birth weight.<sup>[3,11-16]</sup> There are only a few studies using gestational age <10 weeks as the basis to evaluate the usefulness of CRL in prediction of birth weight.<sup>[12,17]</sup> In this study, we targeted the embryonic state itself to predict the birth weight and carried out our investigations in the sub-fetal state.<sup>[18]</sup> The purpose of targeting this gestational age was that early detection of growth abnormalities might help in initiating appropriate interventions to change the outcome favourably.

In the present study, the age of the enrolled women fell between 19 to 39 years with a mean age of  $26.71 \pm 4.27$  years with a majority of them falling in Socioeconomic Class III and IV having Gravida 1 and 2 predominantly.

We focused on the inclusion of normal healthy pregnancies with no known risk factor influencing the outcome of pregnancy. Hence, those with bad obstetric history or any other complications during current or previous pregnancy were excluded. Almost all women had a relatively safe profile. Most of the previous studies done by Kang *et al*<sup>[17]</sup>, Vafei *et al*<sup>[19]</sup>, Tabassum *et al*<sup>[20]</sup>, Janardhan *et al*<sup>[21]</sup> also excluded women with Bad Obstetric History (BOH).<sup>[17,19-21]</sup>

In the present study, the gestational age of the included women ranged from 8 weeks 1 day to 10 weeks 6 days with the dominant group between 9 weeks 1 day to 10 weeks (42.9) which was comparable with the study done by Janardhan *et al*<sup>[21]</sup> which included women between 6 to 14 weeks of gestation with dominant group of 9 to 10 weeks (49%).

The mean CRL measured in the early first trimester in the present study ranged between 10 to 46 mm (8-9 weeks -  $17.28 \pm 2.97$  mm, 9-10 weeks -  $27.22 \pm 4.53$  mm and 10-11 weeks -  $37.01 \pm 4.20$  mm) showing an incremental fashion as the gestational age progresses. There is almost twice an increase in CRL values within a two weeks span which was closely comparable with the study done by Janardhan *et al*.<sup>[21]</sup> Thus, this finding indicated that the early first-trimester CRL measurements have been shown to have a strong correlation with gestational age.

Statistically, at birth, there was no significant difference between boys and girls with respect to anthropometric measurements. Keeping this in view, it could be assumed

that the applicability of CRL findings could be evaluated irrespective of the sex of the baby. This finding was closely comparable with a study done by Eid *et al.*<sup>[22]</sup>

**Table 7: Predictive efficacy of CRL for birth weight in different studies and their comparison with the present study.**

SN	Author (Year)	Birth weight categories					
		SGA		AGA		LGA	
		Sens	Spec	Sens	Spec	Sens	Spec
1.	Tabassum <i>et al.</i> (2017) <sup>[20]</sup>	62.5%	-	-	-	62%	-
2.	Galal Nasr and Ali Elmorshidy (2018) <sup>[16]</sup>	74%	22.4%	37%	88.2%	71%	19.7%
4.	Present study (2021)	80%	95.9%	93.7%	76.6%	66.7%	98.3%

The newborn babies were classified into AGA, SGA and LGA categories and their actual birth weight categories were compared with the estimated birth weight categories that were predicted during early first trimester CRL measurement. Majority of the babies were found to be AGA (81.3%) followed by SGA (13.9%) and LGA (4.8%) which was comparable with the study done by Eid *et al.*<sup>[22]</sup> that showed majority of babies belonging to AGA category (88.8%). All three birth categories were assessed for sensitivity and specificity of CRL measurements and compared with other similar studies (Table 7). The highest sensitivity was shown for AGA and the highest specificity for LGA. The accuracy of assessment for the corresponding birth weight category was 90.5%. We also found that with increasing gestational age at the time of assessment, the sensitivity for prediction of AGA increased (from 91% for 8-9 weeks to 98% for 10-11 weeks) while sensitivity for prediction of SGA declined (from 85.7% for 8-9 weeks to 71.4% for 10-11 weeks). This can be compared with a study done by Galal Nasr *et al.*<sup>[16]</sup> whose sensitivity and specificity were much lower than the current study. This could be due to various reasons like usage of late first-trimester measurement in his study compared to the early first-trimester measurement used in the present study and different criteria employed for categorization of CRL values.

In the present study, we were of the view that owing to the dynamicity of CRL measurements with progressive gestational age, absolute CRL measurements alone cannot be considered to be an efficient predictor of birth weight. Hence, the inclusion of both CRL and gestational age could be a more accurate and effective solution. For this purpose, we performed a multivariate linear regression in which both absolute CRL measurement as well as gestational age were taken as independent predictors of birth weight and we found that in this multivariate model CRL had a positive linear relationship with birth weight whereas gestational age had a negative linear relationship with birth weight. As already proven, CRL has a strong correlation with gestational age (Fig. 1). This fact seems to balance out the negative influence of gestational age with birth weight and thus, provides a constant value. Therefore, the present study shows that early first-trimester CRL

could be helpful in the prediction of birth weight for gestational age.

The main limitation of our study included lower utility in the prediction of LGA babies even though AGA and SGA babies are in correlation with the study. Further studies on larger sample size are recommended to validate the findings of this study. Another limitation of the study was that it did not evaluate the role of nutritional or medical intervention that could have a modulating effect on continued fetal growth and may have caused some of the loss of accuracy of predictive measures.

## CONCLUSION

We conclude that early first-trimester CRL can be used for the prediction of birth weight in uncomplicated pregnancies.

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### Conflicts of interest

The authors declare no conflicts of interest regarding the publication of this article.

### Ethical clearance

Obtained from IECHS - AVMC/IEC2019/73

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