

Gestational Age-based Neonatal Anthropometry in Full-term Symmetric and Asymmetric Small for Gestational Age Babies

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ABSTRACT: Etiologically symmetric and asymmetric small for gestational age (SGA) infants are two distinct entities. Growth data on symmetric and asymmetric small for gestational age (SGA) infants is globally scarce, and altogether missing on full-term Indian infants. In view of absence of longitudinal information on growth pattern of Indian babies, we studied gestational age-wise auxological dynamics of symmetric and asymmetric SGA neonates. Body weight, length and head circumference were measured at birth amongst full-term (37-40 weeks) 100 symmetric (boys 50, girls 50), 100 asymmetric (boys 50, girls 50) SGA and 100 (boys 50, girls 50) AGA babies born to parents residing in North-western parts of India. The babies who fulfilled the inclusion criteria were enrolled from the labor room of PGIMER, Chandigarh, India. Ponderal Index (PI) was used to categorize SGA babies into symmetric SGA ($PI \geq 2.2 \text{ g/cm}^3$) and asymmetric SGA ($PI < 2.2 \text{ g/cm}^3$). Of all the full-term (i.e. 37-40 weeks) SGA and AGA babies representing this study majority of babies were born at 38 weeks of gestation. Though being etiologically more affected, symmetric SGA babies weighed marginally heavier than their asymmetric counterparts at each full-term gestational age. While, asymmetric babies measured longer and possessed larger head circumference than symmetric SGA babies. Male symmetric SGA and AGA infants had greater mean weight, length and head circumference than females. Significantly lower growth attainments in SGA infants of two types as compared to AGA counterparts reveals that symmetric and asymmetric SGA infants demonstrate a compromised nutritional state, as they never came at par with their normal peers.

INTRODUCTION

Small for Gestational age (SGA) refers to a neonate with birth weight below 10th percentile of gestational age and sex of the reference standards (Bakketeig, 1998). Depending on the timing and severity of insult etiologically, small for gestational age (SGA) infants are classified into symmetrical (proportionate) and asymmetrical (disproportionate)

phenotypes (Gruenwald, 1974; Villar and Belizan, 1982). Inhibiting factors like viral infection, inherited abnormality of cellular development and chemical exposure which operate early in pregnancy (first trimester), yield symmetrically growth retarded fetus. Conversely, a late pregnancy insult leads to birth of a baby with asymmetric growth retardation (Gruenwald, 1974; Kurjack *et al.*, 1978; Villar and Belizan 1982; Bakketeig, 1998; Thureen *et al.*, 2001). In infants affected in first trimester, retardation will affect weight, length and head circumference (symmetric growth

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retardation). If the insult/nutritional deprivation occurs later in pregnancy the brain will be spared (as head circumference measures normal) but length as well as weight will be decreased, resulting into birth of disproportionate baby (asymmetric growth retardation) (Kelnar and Butler, 2008). However, there is complete absence of gestational age-wise anthropometric data on growth attainments of symmetric as well as asymmetric SGA babies of Indian origin. Hence, in this study we attempted to understand growth dynamics of both symmetric as well as asymmetric SGA babies born at different gestational ages and representing north-western regions of India.

MATERIALS & METHODS

A total of 200 full-term SGA (i.e. Symmetric SGA: boys 50 and girls 50; Asymmetric SGA: boys 50 and girls 50) babies born in the Labor Room of the Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, to parents representing upper middle to upper high socio-economic strata comprised the sample for the present study. In addition, 100 (boys 50 and girls 50) full-term AGA babies of the two sexes belonging to similar socio-economic strata served as controls for this study.

The babies born between 37 and 41 completed weeks of gestation (259-293 days) were designated as full-term (Singh, 1993; McIntosh and Stenson, 2003, 2008). The gestational age of every infant included in the study was assessed from first day of the last menstrual period (LMP) to the day of birth, in terms of completed weeks. The gestational age estimated by using the New Ballard Score was used in case of three subjects in whom exact information about LMP could not be ascertained. The Socio-Economic-Status (SES) of the family of study subjects was determined as per standardized socio-economic scale (Aggarwal *et al.*, 2005).

Using intrauterine growth curves established by Lubchenco *et al.* (1963), infants weighing within 10th to 90th percentile were treated as AGA, while those weighing below 10th percentile at birth were considered SGA (Bakketeig *et al.*, 1998; Martinez and Simmons,

2005). Full-term SGA babies possessing Ponderal Index (PI) below 2.2 g/cm³ were treated as asymmetric SGA, and those with Ponderal Index ≥ 2.2 g/cm³ as symmetric SGA (Miller and Hassanein, 1971, Akram and Arif, 2005). Babies born with multiple gestations, major congenital/ chromosomal/ bodily anomalies at birth or during follow-up and babies with moderate to severe illness (meningitis, septicemia, bone or joint infections, necrotizing enterocolitis) and on mechanical ventilation were excluded from the study. The written informed consent of one of the parents of each child was obtained prior to his /her enrolment in the study on a standardized proforma. The study protocol was duly approved by the Institutional Ethics Committee of PGIMER, Chandigarh.

Each child included in the study was measured for body weight, crown-heel length and head circumference at birth using standardized anthropometric techniques (Weiner and Lourie, 1969) and instruments.

Statistical Considerations

Gestational-age wise statistics in terms of mean, standard deviation (SD) for weight, length and head circumference was computed for both symmetric and asymmetric SGA and AGA babies. Student's unpaired t-test was employed to quantify the magnitude of intra-group (Symmetric vs. asymmetric), inter-group (SGA vs. AGA) as well as gender (male vs. female) differences recorded for distance growth attainments.

There was no conflict of interest while conducting the study.

RESULTS & DISCUSSION

The gestational age wise distribution of symmetric SGA, asymmetric SGA and AGA babies is presented in Table 1. Of all the full-term (i.e. 37-40 weeks) SGA and AGA babies representing this study, majority of babies belonging to each category were born at 38 weeks of gestation. Exception was female asymmetric SGA babies, maximum (38%) of whom were born at 37 weeks of gestation. A substantial reduction in the proportion of babies with advancement of gestational age was recorded.

TABLE 1
Gestational age-wise distribution of male and female symmetric SGA, asymmetric SGA&AGA babies

Gestational Age (Weeks)		Symmetric SGA		Asymmetric SGA		AGA	
		Male	Female	Male	Female	Male	Female
37	N	14	8	19	19	9	17
	%	28.0	16.0	38.0	38.0	18.0	34.0
38	N	19	17	19	11	21	17
	%	38.0	34.0	38.0	22.0	42.0	34.0
39	N	12	13	7	15	13	9
	%	24.0	26.0	14.0	30.0	26.0	18.0
40	N	4	12	5	5	7	7
	%	8.0	24.0	10.0	10.0	14.0	14.0

Mean and standard deviation (SD) for body weight, crown-heel length and head circumference computed at birth amongst male and female symmetric SGA, asymmetric SGA and AGA babies representing different gestational ages are shown in Table 2.

TABLE 2
Mean and SD of weight (kg), crown-heel length (cm) and head circumference (cm) at birth of SGA & AGA infants at different gestational ages

Gestation age (Weeks)		Symmetric SGA				Asymmetric SGA				AGA			
		Male		Female		Male		Female		Male		Female	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
37	Weight	2.12	0.19	2.15	0.12	2.08	0.23	1.99	0.21	2.94	0.25	2.75	0.28
	Length	44.2	1.66	44.6	1.09	46.6	1.28	45.8	1.43	49.0	1.40	48.2	1.39
	HC	31.3	0.72	30.6	0.87	32.1	0.91	31.5	1.14	33.4	0.61	33.3	1.47
38	Weight	2.19	0.15	2.27	0.13	2.21	0.17	2.04	0.23	2.95	0.19	2.89	0.26
	Length	45.2	2.27	45.2	1.55	48.2	1.37	46.2	1.89	49.1	0.94	47.8	1.36
	HC	31.6	0.99	31.8	0.70	32.6	0.99	31.7	1.30	33.6	0.80	33.4	1.23
39	Weight	2.29	0.11	2.16	0.28	2.13	0.32	2.23	0.15	3.01	0.29	3.08	0.25
	Length	45.1	1.57	45.1	2.08	46.8	2.62	47.8	1.27	49.6	1.63	48.7	1.12
	HC	31.8	1.19	31.5	1.21	31.8	1.46	32.3	0.59	34.0	0.91	33.3	1.08
40	Weight	2.45	0.23	2.41	0.15	2.29	0.25	2.04	0.29	3.19	0.28	3.15	0.22
	Length	45.2	1.97	46.4	1.09	48.4	2.11	46.5	1.23	50.0	1.88	48.4	1.26
	HC	32.1	0.77	32.3	0.76	33.2	1.42	31.6	0.75	34.1	0.67	34.3	0.68

In general, a progressive increase in mean body weight, crown-heel length and head circumference of both symmetric and asymmetric SGA as well as AGA babies of the two sexes was noticed between 37 to 40 weeks of gestation. The mean percent increase from gestational age 37 weeks to 40 weeks for body weight, CHL and head circumference is depicted in Table 3.

TABLE 3
Mean percent increase for weight (kg), crown-heel length (cm) and head circumference (cm) from gestational age 37 weeks to 40 weeks of SGA & AGA infants at different gestational ages

	Symmetric SGA		Asymmetric Vs.AGA		Asymmetric Vs.AGA	
	Male	Female	Male	Female	Male	Female
Weight	15.5%	12.1%	10%	2.5%	8.5%	14.5%
Length	2.26%	4.03%	3.86%	1.5%	2.0%	0.4%
Head Circumference	2.55%	5.55%	3.43%	0.3%	2.09%	3.0%

Symmetric male babies weighed marginally heavier than their asymmetric counterparts at all gestational age groups, except those born at 38 weeks of gestation where, asymmetric SGA male infants possessed higher birth weight (2.21±0.17 kg) than their symmetric (2.19±0.15 kg) counterparts. Following a pattern similar to the male babies, female symmetric SGA babies also weighed heavier than the asymmetric

female infants at all the gestational ages (except at 39 weeks). While CHL and HC amongst asymmetric SGA babies measured greater than their symmetric counterparts at all gestational ages.

The magnitude of intra-group difference (symmetric vs. asymmetric) for body weight among male SGA infants remained statistically non-significant while, amongst female symmetric and asymmetric SGA babies intra-group difference became statistically highly significant ($p \leq 0.01$) at 38 and 40 weeks of gestation (Table 4). In contrast to male SGA babies, who depicted significant intra-group differences for head circumference, these differences among female SGA babies showed statistical non-significance except at 39 weeks of gestation ($p \leq 0.05$).

Intra-group differences for CHL in general remained statistically significant.

No specific trend regarding gender differences could be observed for symmetric and asymmetric SGA babies. Though AGA male babies possessed greater mean weight, CHL and HC than female babies at each gestational age yet, gender differences remained statistically non-significant. Both symmetric and asymmetric SGA male as well as female babies were lighter, shorter and possessed smaller head circumferences than their respective AGA counterparts of the same sex at birth. The magnitude of inter-group differences exhibited statistically highly significant ($p \leq 0.001$) values at all the gestational ages (Table 4).

TABLE 4

Comparison of weight (kg), crown-heel length (cm), head circumference (cm) and ponderal index (g/cm^3) of male and female Symmetric SGA, Asymmetric SGA and AGA infants at each gestational age.

Gestational age		Symmetric Vs. Asymmetric		Symmetric Vs. AGA		Asymmetric Vs. AGA		Gender Differences		
		Male	Female	Male	Female	Male	Female	Symm. SGA	Asymm. SGA	AGA
37	Weight	0.488	1.885	8.921***	5.726***	8.995***	9.134***	1.683	1.135	1.683
	Length	4.789***	2.098*	7.237***	6.477***	4.503***	5.195***	1.389	1.928	1.389
	HC	2.924**	1.958	7.541***	4.825***	3.943***	4.215***	0.199	1.852	0.199
38	Weight	0.362	3.339**	13.555***	9.030***	12.761***	8.919***	0.723	2.216*	0.723
	Length	4.938***	1.513	7.289***	5.152***	2.526*	2.581*	3.591***	3.332**	3.591***
	HC	3.320**	0.256	7.164***	4.700***	3.375**	3.515**	0.531	2.194*	0.531
39	Weight	1.546	0.885	7.952***	7.991***	6.120***	10.375***	0.546	1.030	0.546
	Length	1.747	4.165***	7.002***	4.648***	2.993**	1.717	1.480	1.249	1.480
	HC	0.012	2.286*	5.190***	3.667**	4.173***	3.063**	1.658	1.046	1.658
40	Weight	0.983	3.467**	5.106***	8.272***	5.696***	7.580***	0.318	1.482	0.318
	Length	2.669*	0.075	4.547***	3.123**	1.382	2.505*	1.901	1.703	1.901
	HC	0.903	1.541	3.398**	6.014***	1.516	6.455***	0.514	2.201*	0.514

* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$, $df = n - 2$

This presentation for the first time charts the course of auxological dynamics at birth of full-term symmetric SGA, asymmetric SGA and AGA babies representing north-western regions of India in relation to their gestational ages.

Distance growth curves plotted for both symmetric and asymmetric SGA male babies pattern-wise demonstrated close similarity between 37 to 38 weeks for body weight where after asymmetric babies weighed lighter. On the contrary, female SGA babies of the two types demonstrated an inconsistent trend (Fig.1). Barring, 39 weeks of gestation the curves plotted for female asymmetric SGA babies ran lower than their symmetric counterparts throughout the

gestational age considered demonstrating relatively compromised weight attainments. While, male babies did so beyond 38 weeks of gestation (Fig.1).

As compared to body weight, a reversal of trend for crown-heel length among two sub-types of SGA babies was recorded as growth curves plotted for symmetric SGA were placed lower than their asymmetric counterparts between 37 to 40 weeks of gestation (Fig.2). The pattern of growth recorded for head circumference among symmetric and asymmetric SGA babies depicted close similarity with that of the CHL throughout the gestational age considered. However, as compared to their male symmetric counterparts female SGA babies grew relatively inconsistently (Fig.3).

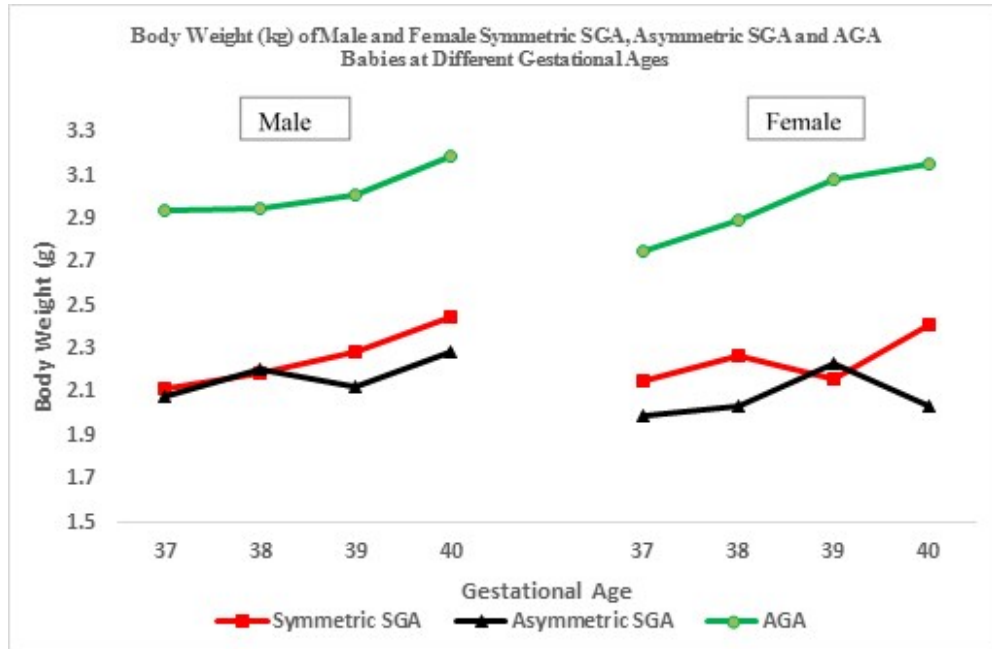


Figure 1: Body weight (kg) of male and female symmetric SGA, asymmetric SGA and AGA babies at different gestational ages



Figure 2: Crown-heel length (cm) of male and female symmetric SGA, asymmetric SGA and AGA babies at different gestational ages

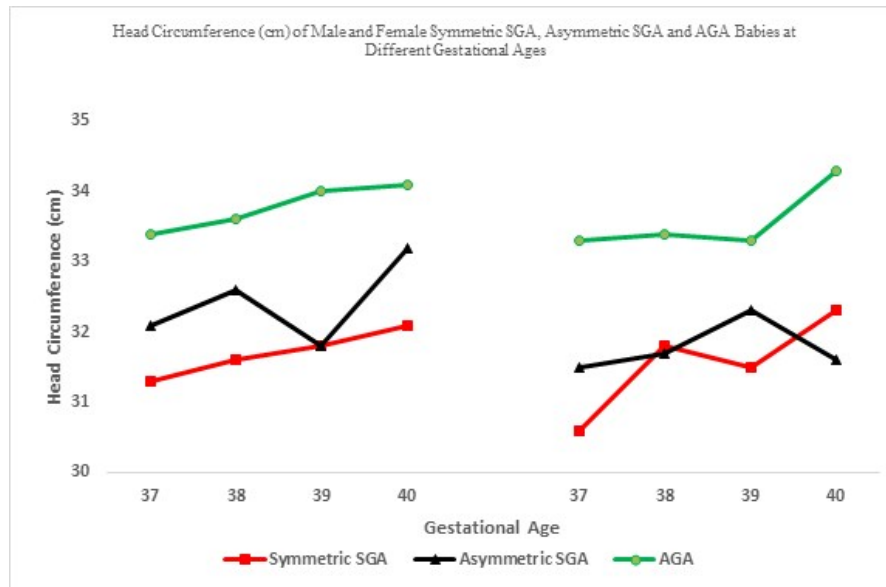


Figure 3: Head circumference (cm) of male and female symmetric SGA, asymmetric SGA and AGA babies at different gestational ages

It is noteworthy, that as compared to their AGA counterparts both male and female SGA babies of two sub-types possessed compromised mean growth attainments. The magnitude of which for body weight barring 37 to 38 weeks of gestational age in males and 39 weeks in females remained substantially greater among asymmetric babies than what could be observed for symmetric SGA babies. On the contrary, CHL and head circumference attainments amongst symmetric and asymmetric SGA babies remained lesser than their AGA counterparts throughout the gestational age considered yet the magnitude of this differential was recorded to be substantially greater between AGA and asymmetric babies than between AGA and asymmetric babies. The depiction of relatively, lesser growth attainments recorded for symmetric as well as asymmetric SGA babies as compared to their AGA counterparts reveals that growth impairment in two distinct type of SGA babies starts during fetal life and continues to remain as such till their birth.

In view of the non-availability of comparative data on gestational age related growth pattern of symmetric and asymmetric SGA babies belonging to different racial stocks, inter-population comparison could not be attempted.

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