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Comparison of Rohrer's Ponderal Index in Full-Term Small for Gestational Age (Symmetric and Asymmetric) and Appropriate for Gestational Age Infants

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ABSTRACT:

Rohrer's Ponderal Index (PI) is used to categorize small for gestational age (SGA) infants into symmetric and asymmetric types. Due to non-availability of longitudinal information on growth of PI of symmetric and asymmetric SGA infants, this study aimed to understand auxological dynamics of PI amongst Indian SGA babies. One hundred symmetric (boys: 50, girls: 50), 100 asymmetric (boys: 50, girls: 50) and 100 (boys: 50, girls: 50) appropriate for gestational age (AGA) infants born at full-term to parents representing upper socio-economic strata and inhabiting North-Western parts of India comprised sample for this study. Body weight and crown-heel length were mixed-longitudinally measured at birth, 1, 3, 6, 9 & 12 months of age using standardized anthropometric techniques in Growth Laboratory/Clinic, Advanced Pediatrics Centre, PGIMER, Chandigarh. Symmetric SGA males possessed significantly ($p \leq 0.001$) higher PI than their asymmetric counterparts upto 9 months. While, symmetric SGA females had higher PI than asymmetric infants upto 1 month. Between 3 to 9 months asymmetric SGA female infants possessed higher PI. By 12 months, PI became similar amongst SGA infants of two types and sexes. Symmetric and asymmetric SGA infants exhibit significant gender and intra-group differences for PI hence, should be postnatally treated as distinct entities for this auxological index.

Keywords: *AGA, Asymmetric SGA, Ponderal Index, Symmetric SGA*

INTRODUCTION

Rohrer's Ponderal index (PI) or Corpulence Index first proposed by Fritz Rohrer in 1921, being a valid measure of fetal growth is widely used to differentiate small for gestational age (SGA) babies into symmetric and asymmetric types (Lubchenco et al. 1966, Miller & Hassanein 1971, Holmes et al. 1977, Lockwood & Weiner 1986). Ponderal index is considered useful for predicting outcome in SGA babies, particularly where there is no reliable information on gestational age as it can capture information about timing of the growth retardation as well as the nutritional status of the newborn babies (Villar & Belizan 1982). This index is independent of gender, race and birth order (Walther & Ramaekers 1982) and is calculated by dividing weight (g) by cube of CHL (cm^3) × 100. A high PI at birth denotes symmetric growth retardation. Inhibiting factors which operate early in pregnancy (first trimester) due to chemical exposure or viral infection leads to symmetric reduction in weight, length as well as head circumference of the baby. While, a low PI demonstrates asymmetric growth retardation in weight and risk of hypoglycemia due to lack of energy and diminished subcutaneous fat reserves (Brandt 1981, Miller & Merritt 1979) as a result of late pregnancy insult. Though usefulness of PI in symmetric and asymmetric SGA infants has been elaborately elucidated in pediatric literature at birth, yet no attempt has been made to track the postnatal longitudinal pattern of PI further during infancy. Therefore, in this presentation an attempt has been made to understand postnatal auxological dynamics of PI amongst symmetric and asymmetric SGA infants of Indian origin.

MATERIAL AND METHODS:

The sample for this mixed-longitudinal study consisted of 200 SGA (symmetric SGA: boys 50 & girls 50; asymmetric SGA: boys 50 & girls 50) and 100 AGA (boys 50 & girls 50) singleton newborn babies born in the Labor Room of Postgraduate Institute of Medical Education & Research (PGIMER), Chandigarh, India. These babies were born to parents residing in north-western parts of India and represented upper middle to upper high socioeconomic strata (Aggarwal et al. 2005).

Infants weighing below 10^{th} percentile of intrauterine growth curves (Lubchenco et al. 1963) at birth were categorized as SGA, those weighing within 10^{th} to 90^{th} percentile as AGA. The full-term SGA babies with Ponderal Index (PI) below 2.2 g/cm^3

were treated as asymmetric SGA, and those having ≥ 2.2 g/cm^3 as symmetric SGA (Lubchenco et al. 1966, Mohan et al. 1990, Ott 1996, Akram & Arif 2005, and Kashyap & Dwivedi 2006). The written informed consent of one of the parents of each child was obtained prior to his/her enrolment in the study. This research venture has been duly approved by the 'Ethics Committee of the Institute' as well as 'Departmental Review Board' of the Department of Pediatrics, PGIMER, Chandigarh.

Body weight and crown-heel length of each child was measured at birth, 1 month (±3 days), 3, 6, 9 and 12 months of age with a time tolerance limit of ±15 days in the Growth Clinic/ Growth Laboratory, Child Growth & Anthropology Unit, Department of Pediatrics using standardized techniques and instruments (Weiner & Lourie 1969, Eveleth & Tanner 1990). The body weight of infants upto four months was measured with an Electronic Weighing Scale (Make: Avery, India Limited, Capacity: 12kg, Least count: 2g). Subsequently, a different Electronic Weighing Scale (Make: Avery, India Limited, Capacity: 150 kg, Least count: 50g) was used to weigh children upto 12 months. The crown-heel length (CHL) till 1 month of age was measured with 'Neonatometer' (Make: Holtain Limited) and afterwards, 'Supine Length Measuring Table' (Make: Holtain Limited) with an accuracy of 1mm was used.

Ponderal Index (PI) was calculated by dividing weight (g) by cube of CHL (cm^3) × 100 for all the study subjects. Age and sex specific (mean and standard deviation) distance growth statistics for PI was computed amongst two types of SGA and AGA infants. The magnitude of intra-group (symmetric vs. asymmetric), inter-group (SGA vs. AGA) as well as gender differences for distance growth was calculated by applying Student's unpaired t-test.

RESULTS

The mean and SD of Ponderal Index (PI) obtained for symmetric SGA, asymmetric SGA and AGA male and female infants are shown in Table 1 & Figs 1 & 2. Ponderal Index amongst all the study groups showed an initial increase from birth to 3 months barring female symmetric and male asymmetric SGA who did so till 1 month of age. Afterwards, PI declined upto 12 months in all study subjects. Symmetric SGA males possessed statistically significant ($p \leq 0.001$) higher mean PI values than their asymmetric counterparts upto 9 months. At 12 months both symmetric and asymmetric SGA males

possessed similar (2.1 g/cm3) PI (Table 1). The symmetric SGA female infants possessed higher PI than asymmetric females upto 1 month of age. Between 3 to 9 months of age asymmetric SGA female infants had higher mean PI. The magnitude of intra-group differences between symmetric and asymmetric SGA female infants was found to be statistically significant at birth ($p \leq 0.001$) and at 9 months of age ($p \leq 0.01$). By 12 months of age female SGA babies of the two types as well as AGA infants depicted similar mean PI attainments measuring 2.2 g/cm3 (Table 1). Ponderal Index in symmetric SGA male babies measured more than their AGA counterparts upto around 7 months while, asymmetric SGA male infants lagged significantly ($p \leq 0.001$) behind their AGA control counterparts throughout the study period. The symmetric SGA female infants possessed lesser mean PI than AGA females and the magnitude of this difference became statistically significant at birth ($p \leq 0.001$), 6 month ($p \leq 0.05$) and 9 months ($p \leq 0.01$) of age (Table 1).

The symmetric male infants in general, possessed higher mean PI than the female infants however, gender differences became statistically significant ($p \leq 0.01$) at 3 and 6 months. In contrast to their symmetric counterparts, asymmetric SGA male infants showed significantly lower mean PI than the female ones at 3 month ($p \leq 0.01$), 6 & 9 month ($p \leq 0.001$) and 12 ($p \leq 0.01$) months of age (Table 1). Interestingly, AGA male and female babies had same mean PI during first year of life.

DISCUSSION

Since body proportions change during the course of gestation, proportionality of size may provide a better index than proportionality for age for assessing growth faltering. In the present study, Rohrer's Ponderal Index has been used to categorize SGA infants into symmetric and asymmetric types following universally accepted criteria given by Bakketeig (1998), Singh (2008), Walther and Ramaekers (1982), Gould (1986), Miller & Hassanein (1971).

At birth, symmetric SGA infants had significantly higher PI than the asymmetric babies. It may be a reflection of the relative effects of duration of intrauterine nutritional insult affecting weight and length measurements used to compute PI in all categories of our study subjects. It is well known that PI relies on the principle that length is spared at the expense of weight during periods of malnutrition. As the duration of insults gets

longer and chronic in nature, length gets more reduced as is the case in our symmetric SGA infants who get affected earlier during antenatal life (i.e. first trimester). On the contrary, an intrauterine insult of shorter duration (i.e. during last trimester of pregnancy) yields asymmetric SGA. The implication is that intrauterine insults of relatively brief duration would yield reduction in body weight, while length attainments remain unaffected resulting in reduced PI. On the other hand, insults of long duration would have had more time to exert negative auxological effects on both weight and length thus leading to normal PI.

After birth, PI grew rapidly to attain a peak at 1 month of age amongst male asymmetric and female symmetric SGA infants while, asymmetric female and symmetric male infants attained it at 3 months. After attaining peak value, PI declined rapidly after 6 months in symmetric SGA male infants to become similar with their asymmetric counterparts by 12 months. While, amongst female symmetric babies it decreased continuously till 12 months. This reveals that symmetric and asymmetric SGA infants tend to undo the effect of intrauterine etiological insult, postnatally. The potential for doing so was recorded to be much higher in symmetric male SGA as their PI measured even higher than their AGA peers during first half of infancy (Fig 1). While, amongst female asymmetric SGA it very well matched with that recorded for female AGA infants, but never exceeded mean attainments. These observations corroborate with findings of Cardoso & Falção (2007) who observed no differences in Ponderal index of preterm SGA and AGA infants of Brazilian origin from birth to first 28 days of life. The relative postnatal alterations in the magnitude of PI during infancy experienced by our two types and gender of SGA babies are in consonance with findings of Davies et al (1980) who also reported changes in the ponderal index over the first year of life in light-for-date (LFD), heavy-for-date (HFD) and appropriate-for-date (AFD) babies. However, we did not study HFD (i.e. large for gestational age) babies in the present study as our research remains restricted only to small and appropriate for gestational age infants. At birth HFD babies had a significantly higher ponderal index than AFD indicating relative fatness, while LFD babies a significantly lower PI indicating wasting. At one year of age the PI in each of the three groups was the same, this fully resembles with pattern encountered amongst our female SGA and AGA babies who possessed same PI values at 12

months. Symmetric SGA male infants between 1 to 6 months of age possessed higher PI than the female peers while, male asymmetric SGA infants possessed lesser PI than female asymmetric infants. On the contrary, both male and female AGA infants possessed similar values for this index of proportionality throughout first year of life. However, due to non-availability of gender specific data for PI on symmetric and asymmetric SGA infants, comparison with other population stocks could not be made.

From the above discussion it clearly emerges that both full-term symmetric and asymmetric SGA infants of the two sexes tend to undo adverse effect of antenatal nutritional insult when reared in sound and healthy postnatal nutritional environment (as our all study subjects belonged to upper socio-economic strata and did not experience any severe health complications). Almost similar observations have also been reported by Oluwafemi et al. (2013) who reported a continuum of PI from normal values (mostly in symmetrical SGA babies) to low PI values in both symmetrical and asymmetrical SGA babies, probably reflecting varying durations of intrauterine insult however, this postnatal auxological change was found to vary in nature and magnitude with advancement of age amongst two sub-types and gender of SGA infants.

Conflict of Interest: None

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Table 1: Mean, SD and t-values of Ponderal Index (g/cm^3) of Male & Female Symmetric SGA, Asymmetric SGA and AGA Infants

Age (months)	Symmetric SGA		Asymmetric SGA		AGA	
	Male	Female	Male	Female	Male	Female
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
0	2.5 (0.23)	2.4 (0.19)	2.0 (0.14)	2.1 (0.11)	2.5 (0.25)	2.6 (0.29)
1	2.7 (0.42)	2.6 (0.32)	2.5 (0.17)	2.5 (0.33)	2.6 (0.27)	2.6 (0.42)
3	2.7 (0.29)	2.5 (0.22)	2.4 (0.22)	2.6 (0.33)	2.6 (0.32)	2.6 (0.31)
6	2.6 (0.27)	2.4 (0.18)	2.3 (0.17)	2.5 (0.30)	2.5 (0.27)	2.5 (0.31)
9	2.3 (0.25)	2.3 (0.15)	2.2 (0.15)	2.4 (0.23)	2.4 (0.20)	2.4 (0.20)
12	2.1 (0.18)	2.2 (0.16)	2.1 (0.16)	2.2 (0.21)	2.2 (0.16)	2.2 (0.14)

t-values									
Age (months)	**Gender differences**			**Symmetric SGA Vs Asymmetric SGA**		**Symmetric SGA Vs AGA**		**Asymmetric SGA Vs AGA**	
	Symmetric SGA	**Asymmetric SGA**	**AGA**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
0	1.108	1.567	**2.095***	**11.384*****	**11.082*****	0.804	**4.077*****	**11.776*****	**12.814*****
1	1.434	1.084	0.162	**4.134*****	1.607	1.374	0.021	**3.771*****	1.358
3	**3.223****	**2.760****	0.715	**5.740*****	0.407	**2.221***	1.404	**2.967****	0.823
6	**3.179****	**4.062*****	0.637	**5.953*****	1.517	1.054	**2.472***	**4.762*****	0.773
9	1.712	**5.227*****	1.137	**3.995*****	**2.783****	1.728	**2.915****	**6.881*****	0.080
12	2.332	**3.584****	0.100	0.786	0.917	**3.183****	0.994	**4.153*****	0.151

*p <0.05, **p < 0.01, ***p < 0.001

Fig 1: Comparison of Ponderal Index (g/cm3) of Male Symmetric SGA, Asymmetric SGA and AGA Infants

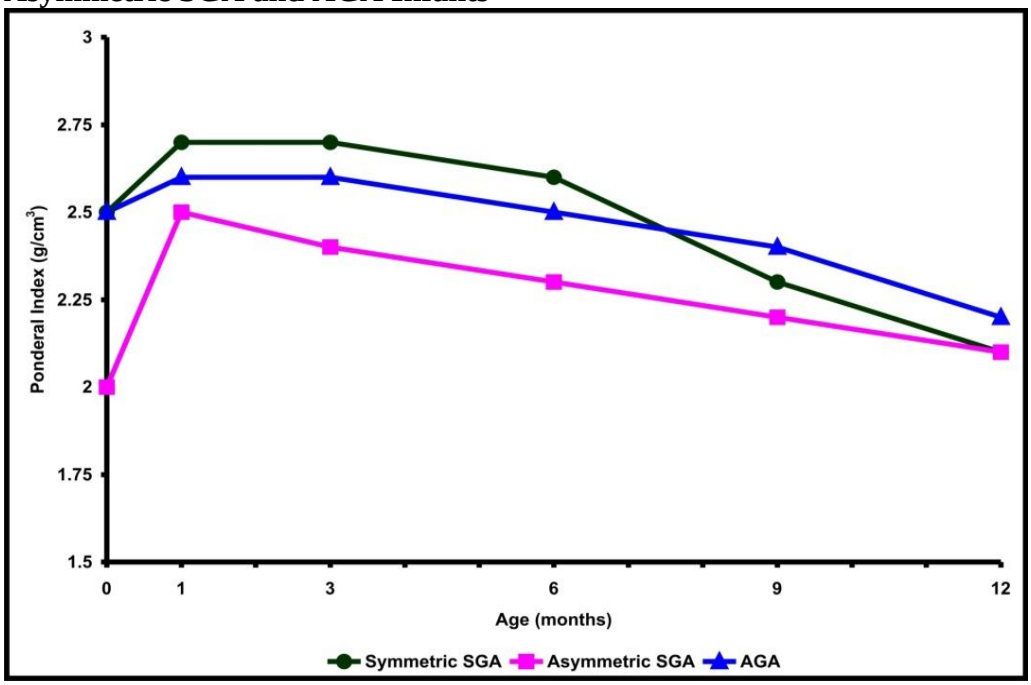

Fig 2: Comparison of Ponderal Index (g/cm3) of Female Symmetric SGA, Asymmetric SGA and AGA Infants