

## Age of Equalization of Head and Chest Circumference in Term Normal and Small for Gestational Age Infants

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### **ABSTRACT**

*The dynamics of the timing of equalization of the head and chest circumference in full-term 74 normal Punjabi and 200 small for gestational age (SGA) infants of the two sexes born to parents representing upper socio-economic strata was serially studied. A regular increase in both the head and chest circumference of normal Punjabi and SGA infants of the two sexes was noticed between 1 to 12 months of age. Normal Punjabi infants of the two sexes as compared to their SGA counterparts possessed significantly ( $p \leq 0.001$ ) larger head and chest circumference during first year of life. In general, both Punjabi and SGA male infants possessed greater head and chest circumference values than their respective female peers throughout the study span. Amongst normal male and female Punjabi infants equalization of head and chest circumference took place by 4 and 5 months of age respectively. While, the equalization of head and chest circumference never occurred amongst SGA of both the sexes between 1 to 12 months of age. This clearly shows that SGA infants as compared to normal Punjabi peers remain undernourished during infancy and failed to compensate for the effect of earlier nutritional insult experienced by them during pre-natal life.*

**Keywords:** chest circumference, head circumference, age of equalization, infant growth, normal Punjabi infants, SGA

### **INTRODUCTION**

The growth of chest circumference is often studied in relation to that of head circumference to determine nutritional and auxological status of infants and children. At birth, the head circumference is usually larger than the chest circumference (Manocha & Sangwan 2006). As the child grows, at a certain age the chest circumference becomes larger than that of

the head and thereafter, it generally remains larger. It has been observed that during the critical phase of growth, the rate of growth of head circumference remains unaffected while that of chest circumference is slowed down due to nutritional factors (Sundaram et al 1995). The actual difference in the size between head and chest circumference is taken as a rough guide to the degree of growth failure (Dean 1965) and delayed equalization of the head and chest circumference is thought to indicate undernutrition. It has been suggested that the percentage of children at different ages who have larger head circumference than that of the chest should be calculated and reported (Martorell et al 1975).

In children with protein energy malnutrition (PEM), due to poor growth of chest, the head circumference may remain greater than chest even at 2.5 to 3 years. In developed countries, the circumference of head is slightly greater than that of chest until about the six months when due to more rapid growth of chest, equalization takes place. By the twelfth month, there is a distinct prevalence of average chest circumference over head circumference. Thus, it has become a well-recognized practice to study growth of chest circumference in relation to that of the head of children during their early years of life. It is not only the absolute figures of head and chest circumferences that are of great importance, but equally important is the relative rate of increase of chest size in comparison with that of head circumference.

The time of equalization of head and chest circumference has been used as an indicator to assess physical growth and to determine the extent of under nutrition particularly, in the community setting. However, in this regard the relevant sets of data mainly emanated from developed western world have often been used. Similar information on Indian infants is scant and particularly of longitudinal nature is altogether absent. In this presentation we have discussed growth dynamics of the age of equalization of head and chest circumference in the context of full-term normal as well as small for gestational age (SGA) babies belonging to upper socio-economic strata.

## **MATERIAL AND METHODS**

A total of 74 (boys: 44, girls: 30) upper-class normal Punjabi infants weighing over 2500 g at birth as well as 200 SGA (boys: 100, girls: 100) babies comprised the sample for this study. Both Punjabi and SGA babies were born at full-term i.e. between 37 to 41 weeks of gestation. Using intrauterine growth curves established by Lubchenco et al (1963), infants weighing below

10<sup>th</sup> percentile at birth were considered SGA. The Socio-Economic-Status (SES) of the family of SGA infants was determined by using standardized socio-economic scale (Aggarwal et al 2005). Both normal Punjabi and SGA infants were born in the Labor Room of the Postgraduate Institute of Medical Education & Research (PGIMER), Chandigarh, a tertiary care hospital. Babies born with multiple gestations, major congenital/ chromosomal/ bodily anomalies and neurological complications at birth or during follow-up as well as those with serious illness were excluded from the study.

Every child included in the study was measured for head circumference and chest circumference using a fiber glass tape and following standardized techniques (Weiner and Lourie 1969, Committee on Nutrition Advisory to CDC, FNB, NAS-NRC 1974). Each normal Punjabi infant was measured at monthly age intervals from 1 month to 12 months of age with a time tolerance limit of  $\pm 3$  days using pure longitudinal growth study design (Bhalla 1983). While, each SGA child was measured at 1 month (time tolerance  $\pm 3$  days), 3 months, 6 months, 9 months and at 1 year of age with a time tolerance limit of  $\pm 15$  days on the day of measurement following a mixed-longitudinal research design in Growth Laboratory & Growth Clinic, Department of Pediatrics, PGIMER, Chandigarh. The subjects who failed to report for follow-up on pre appointed date and time were contacted through telephone or postal communication, and were given new appointment. The infants who did not report in the hospital for growth assessment despite all efforts were followed and measured in their homes using same instruments and techniques. Age and sex wise distribution of the sample subjects who could be examined during different follow ups is shown in Table 1.

Mean and standard deviation (SD) for head and chest circumference recorded amongst full-term normal Punjabi as well as SGA infants of the two sexes were computed. Student's unpaired t-test was employed to quantify the magnitude of inter-group (Normal Punjabi vs. SGA) and gender differences for these two measurements at each age level.

## RESULTS

The mean, standard deviation (SD) for head circumference and chest circumference measured amongst full-term male and female normal Punjabi and SGA infants in first year of life is shown in Table 1 & 2. A regular increase in both the circumferential measurements of normal

**Table 1: Mean, Standard Deviation (SD) and t-values of Head Circumference (cm) of Male and Female Full-Term Normal Punjabi & SGA Infants**

Age (months)	Punjabi Infants					SGA Infants					Punjabi vs. SGA (t-value)	
	Male		Female		Gender Diff. (t-value)	Male		Female		Gender Diff. (t-value)	Male	Female
	N	Mean (SD)	N	Mean (SD)		N	Mean (SD)	N	Mean (SD)			
1	44	36.5 (1.20)	30	36.1 (1.01)	1.499	100	35.6 (1.26)	100	35.0 (1.21)	3.434**	4.005***	4.525***
2	44	38.3 (1.10)	30	37.8 (1.01)	1.983*	-	-	-	-	-	-	-
3	44	39.7 (1.11)	30	39.1 (1.22)	2.193*	92	38.8 (1.37)	93	38.1 (1.17)	3.738***	3.799***	4.029***
4	44	40.9 (1.08)	30	40.2 (1.21)	2.607**	-	-	-	-	-	-	-
5	44	41.7 (1.13)	30	41.2 (1.22)	1.809	-	-	-	-	-	-	-
6	44	42.7 (1.20)	30	41.9 (1.28)	2.741**	90	41.6 (1.30)	90	40.9 (1.06)	3.959***	4.715***	4.242***
7	44	43.8 (1.26)	30	42.6 (1.30)	3.971***	-	-	-	-	-	-	-
8	44	43.9 (1.19)	30	43.1 (1.36)	2.679**	-	-	-	-	-	-	-
9	44	44.3 (1.19)	30	43.6 (1.34)	2.360*	98	43.2 (1.03)	95	42.4 (0.91)	5.712***	5.604***	5.575***
10	44	44.8 (1.23)	30	43.9 (1.28)	3.041**	-	-	-	-	-	-	-
11	44	45.1 (1.24)	30	44.2 (1.24)	3.065**	-	-	-	-	-	-	-
12	44	45.5 (1.23)	30	44.5 (1.19)	3.479***	91	44.2 (1.05)	94	43.6 (0.96)	4.058***	6.370***	4.210***

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

Punjabi and SGA infants of the two sexes was noticed between 1 to 12 months of age. Mean head circumference of normal Punjabi boys and girls measured 36.5±1.20 cm and 36.1±1.01 cm at 1 month and 45.5±1.23 cm and 44.5±1.19 cm at 12 months of age respectively. The mean

**Table 2: Mean, Standard Deviation (SD) and t-values of Chest Circumference (cm) of Male and Female Full-Term Normal Punjabi & SGA Infants**

Age (months)	Punjabi Infants					SGA Infants					Punjabi vs. SGA (t-value)	
	Male		Female		Gender Diff. (t-value)	Male		Female		Gender Diff. (t-value)	Male	Female
	N	Mean (SD)	N	Mean (SD)		N	Mean (SD)	N	Mean (SD)			
1	44	34.9 (1.80)	30	34.6 (1.45)	0.755	100	33.6 (1.72)	100	32.5 (1.75)	4.483***	4.119***	5.981***
2	44	37.3 (1.76)	30	36.7 (1.83)	1.417	-	-	-	-	-	-	-
3	44	39.2 (1.91)	30	38.4 (1.60)	1.886	92	37.5 (1.77)	93	36.7 (1.48)	3.336**	5.107***	5.363**
4	44	41.2 (1.92)	30	39.8 (1.25)	3.514***	-	-	-	-	-	-	-
5	44	42.2 (2.03)	30	41.1 (1.46)	2.549**	-	-	-	-	-	-	-
6	44	43.1 (2.19)	30	42.5 (1.78)	1.245	90	40.4 (1.99)	90	39.3 (1.51)	4.177***	7.134***	9.603***
7	44	44.2 (2.21)	30	43.3 (1.87)	1.828	-	-	-	-	-	-	-
8	44	44.8 (2.19)	30	44.1 (1.94)	1.413	-	-	-	-	-	-	-
9	44	45.2 (2.14)	30	44.6 (1.83)	1.254	98	41.7 (1.47)	95	40.7 (1.58)	4.554***	11.318***	11.339***
10	44	45.9 (1.74)	30	45.3 (1.47)	1.548	-	-	-	-	-	-	-
11	44	46.2 (1.83)	30	45.9 (1.65)	0.720	-	-	-	-	-	-	-
12	44	46.7 (2.10)	30	46.8 (1.58)	0.221	91	42.5 (1.18)	94	41.6 (1.40)	4.720***	14.864***	17.163***

\*p&lt;0.05, \*\*p&lt;0.01, \*\*\*p&lt;0.001, df= n-2

head circumference of SGA male infants was 35.6±1.26 cm at 1 month and 44.2±1.05 cm at 12 months while, for female infants it measured 35.0±1.21 cm and 43.6±0.96 cm at 1 and 12 months respectively (Table 1). Chest circumference amongst normal Punjabi male and female infants measured 34.9±1.80 cm and 34.6±1.45 cm at 1 month and 46.7±2.10 cm and 46.8 ±1.58

cm at 12 months of age respectively. While, for SGA male and female infants it measured  $33.6 \pm 1.72$  cm and  $32.5 \pm 1.75$  cm at 1 months and  $42.5 \pm 1.18$  cm and  $41.6 \pm 1.40$  cm at 12 months. Normal Punjabi infants of the two sexes, as compared to their SGA counterparts possessed significantly ( $p \leq 0.001$ ) larger head and chest circumference for the entire study span (Table 2). In general, both Punjabi and SGA male infants possessed larger head and chest circumference values than their respective female peers throughout the study period. The magnitude of gender differences favoring male infants remained statistically significant for head circumference amongst Punjabi infants barring, 1 & 5 months of age. While, for chest circumference significant gender differences were observed at 4 ( $p \leq 0.001$ ) and 5 ( $p \leq 0.01$ ) months of age amongst normal Punjabi infants. However, gender differences favoring male SGA infants for both the circumferential measurements remained statistically highly significant ( $p \leq 0.001$ ) throughout the study period (Table 1 & 2).

Amongst normal male and female Punjabi infants equalization of head and chest circumference took place by 4 and 5 months of age respectively. While, the equalization of head and chest circumference never occurred amongst SGA of both the sexes during the entire period of infancy (Fig 1 & 2).

## DISCUSSION

The head and chest circumference of both male and female full-term normal Punjabi and Small for Gestational Age (SGA) infants demonstrated a continuous increase in mean attainments during first year of life. However, this increase was marked by an initial sharp gain during the first half of infancy followed by a slower gain in second half (Table 1&2, Fig 1&2).

Male and female Punjabi infants of the present study equalized their head and chest circumference by 4 and 5 months of age respectively, while, this event never took place amongst SGA infants of the two sexes. In contrast to our normal Punjabi and SGA infants, Agarwal & Agarwal (1994) reported that amongst affluent Indian children the mean values for head circumference and chest circumference were exactly similar at 12 months of age. In a study conducted by Srivastava et al (1978) equalization of head and chest circumference never occurred during the study tenure i.e. 1 to 6 months of age. While, in a study conducted on full-term small-for-date (SFD) infants in the West Bengal equalization of head and chest

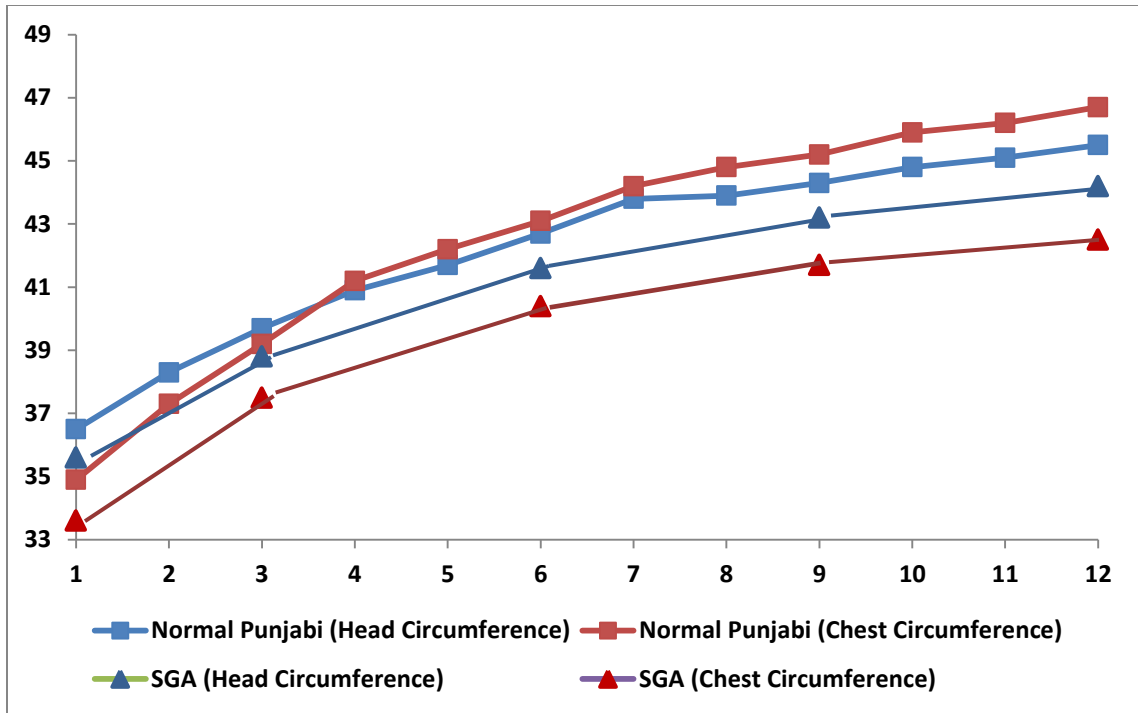


Figure 1: Head and Chest Circumference in Normal Punjabi & SGA Male Infants

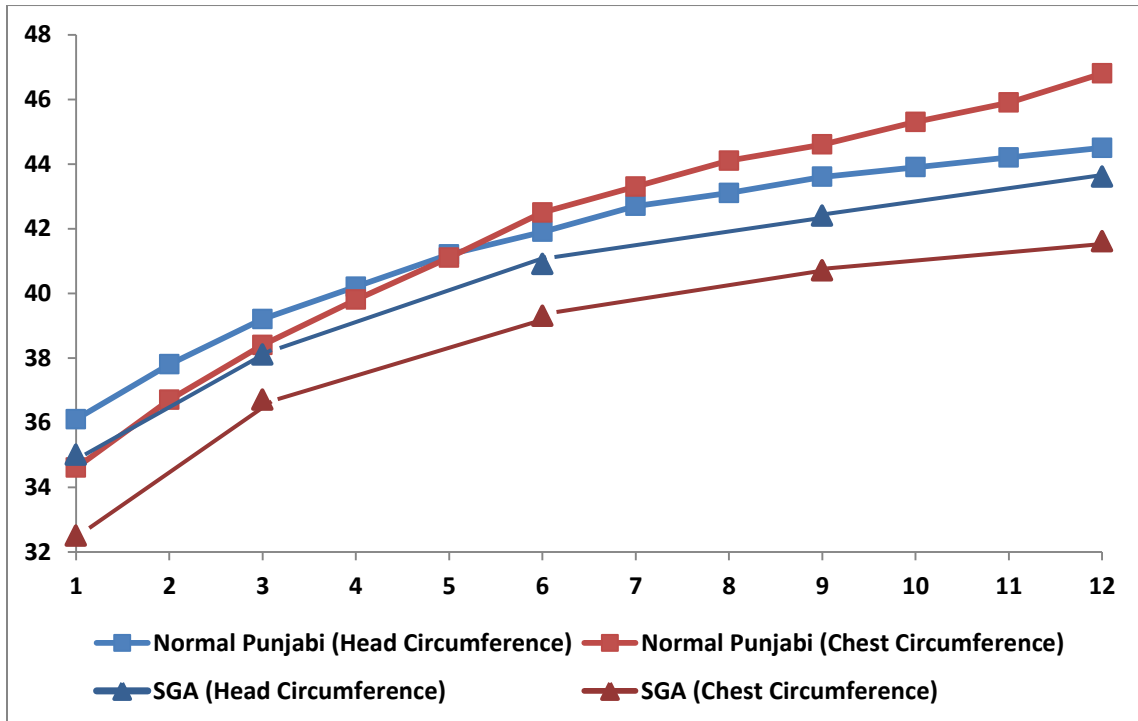


Figure 2: Head and Chest Circumference in Normal Punjabi & SGA Female Infants

circumference occurred around 9 months of age. Ounsted and Moar (1986) observed that in full-term SGA infants head-chest ratios were high at birth; but by 6 months they were very similar to AGA ratios.

Currimbhoy (1963) recorded a difference of 2.3 cm in males and 2.5 cm in females at birth, circumference of the head being greater. It was still greater at six months when the difference was 0.92 cm in males and 1.00 cm in females. Ghai and Sandhu (1968) noted that head circumference at birth was greater than chest circumference by 2.8 cm in males and 2.1 cm in females. At six months, the difference was 0.3 cm in males and 0.4 cm in females, the circumference of the head being still greater.

Some studies on Indian infants (Ghai and Sandhu 1968, Datta Banik et al 1970, Mehta and Merchant 1972) reported that the head and chest circumference become equal between 9 and 12 months of age. Among American infants, this equalization occurs between 6 and 12 months (Vaughan 1975, Watson & Lowery 1967). In Varanasi (Katiyar et al 1978), chest circumference overtook head circumference around 8 months among urban infants while, this was achieved by 44 weeks among males and 52 weeks among females of urban slum area.

The difference between head and chest circumference at 1 month was 1.6 cm and 2.0 cm amongst normal Punjabi and SGA male infants respectively. While, this difference was found to be 1.5 cm and 2.5 cm respectively for female Punjabi and SGA babies. This difference between head and chest circumference remained more in case of female Punjabi and SGA infants as compared to their male counterparts. The equalization of head and chest circumference never occurred amongst SGA infants of the two sexes during the first year of their life. Amongst normal Punjabi male infants it occurred as early as 4 months of age while, in female Punjabi infants this event took place at around 5 months of age whereafter, chest circumference measured larger than the head circumference. This clearly shows that SGA infants as compared to their normal Punjabi peers remain undernourished during infancy.

Though equalization between head and chest circumference never occurred in SGA infants of both the sexes yet the difference between head circumference and chest circumference got marginally reduced with the advancement of age. The difference between head and chest circumference being 2.0 cm in male and 2.5 cm in female at 1 month of age decreased subsequently to 1.7 cm and 2.0 cm amongst male and female SGA infants respectively, by 12 months of age. This shows that SGA infants, did show meagre improvement in the nutritional



status with advancement of age however, postnatally they failed to fully make-up for nutritional insult experienced by them during their antenatal phase of life, though they enjoyed better socio-economic environment to grow.

The ratio of head and chest circumference being age independent in nature, has utility in detecting under-nutrition amongst children in the community settings as it does not require expensive equipment. Considering the relative ease of measuring head and chest circumferences, this parameter (i.e. age of chest circumference crossing head circumference) could be used to determine nutritional status of children in community particularly, where some health improvement related dietary and other interventions are being instituted.

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