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GROWTH DYNAMICS & SECULAR CHANGES IN CALF CIRCUMFERENCE OF CHANDIGARH INFANTS

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ABSTRACT

The secular trend in terms of growth of calf circumference of full-term, normal birth weight infants of the two sexes, representing Cohort I (Male: 44, Female: 30) born between 1978-1980 and Cohort II (Male: 50, Female: 50) born between 2006-2007 was longitudinally studied. The babies representing two separate cohorts were born to parents belonging to upper socio-economic strata and hailing from Chandigarh, India. All babies were enrolled from Labor Room of the Postgraduate Institute of Medical Education & Research (PGIMER), Chandigarh and subsequently followed in Growth Clinic of the Department of Pediatrics, PGIMER, Chandigarh. Cohort I male infants possessed significantly larger calf circumference than female infants throughout the study period. While, gender differences for Cohort II infants favoring males became statistically significant during second half of infancy. The lower placement of calf circumference growth curves plotted for infants born in Chandigarh, than their European counterparts may be due to affiliation of the infants to population belonging to different ethnic, hereditary and environmental backgrounds. The mean calf circumference of infants representing Cohort II, measured significantly (pd"0.001) greater than Cohort I infants during first year of life. Better auxological attainments noticed amongst Cohort II infants than those of Cohort I suggest existence of positive secular change experienced over a period of 27 years by Chandigarh infants representing almost similar ethnic, regional and socio-economic backgrounds.

Keywords: Calf Circumference, Chandigarh Infants, Infant Growth, Secular Changes.

INTRODUCTION

Secular trends of human morphological traits which focus on changes in body dimensions and growth rate spanning last 150 years, have been apparent all over the world (Meredith 1976, Tanner *et al.* 1982, Eveleth & Tanner 1990). The secular changes reflect overall environmental improvements, specifically changes in health practices and living conditions leading to improvement in mortality rates and life expectancy (Roche 1979). Studies in India investigating secular changes are scarce.

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In majority of the instances, detection of growth aberrations, nutritional deficits and inferences related to secular trends have been obtained only in terms of weight and height measurements ignoring other body parameters. Most studies have examined such changes for preschool children (Rao *et al.* 2012), adolescent growth (Shatrugna & Rao 1987), menarcheal age (Singh & Malhotra 1988) or for the final sizes at adulthood (Kapoor *et al.* 1985, Rao & Rau 1986). Barring studies on infants (Haschke & Van't Hof 2000) and older children (Dasgupta 2015, Ghosh & Malik 2006), published longitudinal information with regard to secular changes in terms of growth of calf circumference is altogether missing.

The usefulness of calf circumference as a valid anthropometric surrogate for predicting low birth weight, in the settings where weighing scales are either not available or cannot be used by health workers is well recognized (Neela *et al.* 1991, Raman *et al.* 1992, Samal & Swain 2001, Kumar *et al.* 2013). Its utility to detect selected health risks, morbidity, mortality and frailty in some population groups (Chumlea 2006) as well as nutritional status of hospitalized patients have been established (Bonnefoy *et al.* 2002, Cuervo *et al.* 2009, Portero-McLellan *et al.* 2010,). Coelho *et al.* (2006) found it a stronger indicator of under-nutrition than BMI amongst hospitalized patients. It has long been established in a study by Visweswara *et al.* (1978), that calf circumference correlates better with clinical signs of protein energy malnutrition (PEM) amongst children of Indian origin. Recent evidence also suggests a significant association between calf circumference and growing cardio-vascular related mortality (Debette *et al.* 2008, Tsai *et al.* 2011).

Hence, keeping in mind scientific importance of this simple, non-invasive, less time consuming and economical measure of growth in this presentation, an attempt has been made to study longitudinal growth dynamics of the calf circumference and secular changes over a period of about 27 years (1978-1981 and 2006-2008), amongst full-term, normal birth weight infants belonging to well-off socio-economic strata of Chandigarh.

MATERIAL & METHODS

To accomplish objectives of the study, two separate data sets (Cohort I & Cohort II) were examined. A total of 74 (boys: 44, girls: 30) babies (Cohort I) born between 1978-1980 to parents representing upper socio-economic strata and residing in Chandigarh and a separate group of 100 (boys: 50, girls: 50) babies (Cohort II) born between 2006-2007 to parents living under similar geographic and socio-economic conditions comprised sample for this mixed-longitudinal study. All babies representing two separate cohorts were enrolled from Labor Room of the Postgraduate Institute of Medical Education & Research (PGIMER), Chandigarh. Every child included in the study weighed ≥ 2500 g at birth and had gestational age between 37 and 41 completed weeks of gestation. Babies born with multiple gestations, major congenital/ chromosomal/ bodily anomalies, under-nutrition and neurological complications at birth or during follow-up as well as those with serious illness were excluded from the study.

A fiber glass tape up to the accuracy of 1 mm was used to measure calf circumference of every infant using standardized technique (Weiner and Lourie 1969). Infants comprising the Cohort I were measured at monthly age intervals with a time tolerance limit of ±3 days from 1 to 12 months of age from 1978-1981 in the Growth Clinic of Department of Pediatrics then housed in Nehru Hospital of PGIMER, Chandigarh. While, those representing Cohort II were measured for calf circumference between 2006-2008 at 1 month (time tolerance ±3 days), 3 months, 6 months, 9 months and at 1 year of age with a time tolerance limit of ±15 days on the day of measurement in Growth Laboratory & Growth Clinic, Advanced Pediatrics Centre, PGIMER, Chandigarh. The subjects who failed to report for follow-up on pre appointed date and time were contacted through telephone or postal correspondence, and were given new appointment. Those infants, who did not report for follow-up despite all efforts, were examined in their homes.

A thorough health examination of each child included in this study was carried out at each visit to the hospital. A record of ailments, diseases and health complications experienced by these babies was also kept. Advice on health care of each infant was provided to the mother, particularly with regard to importance of breast feeding and food supplementation. Dietary intake of each baby was noted using 24 hours dietary recall method. Each infant was immunized as per age.

Age and sex wise distribution of the sample subjects who could be examined during different follow ups are shown in Table 1. Mean and standard deviation (SD) for calf circumference recorded amongst Cohort I & II infants of the two sexes were computed. Student's unpaired t-test was employed to quantify the magnitude of inter-group (Cohort I vs. Cohort II) and gender differences recorded for calf circumference at each age.

RESULTS

The mean, standard deviation (SD) for calf circumference measured amongst full-term male and female infants representing Cohort I & Cohort II in first year of life is shown in Table 1, Fig 1 & 2. An uninterrupted increase in mean calf circumference was noticed amongst both male and female infants of the two groups throughout the age range (i.e. 1 to 12 months) considered. The mean calf circumference of Cohort I male and female infants (born between 1978-1980) measured 11.58±0.73 cm and 10.98±0.70 cm at 1 month and 17.19±1.11 cm and 16.68±0.79 cm at 12 months of age, respectively. The mean calf circumference of Cohort II (born between 2006-2007) male infants was 12.8±0.89 cm at 1 month and 18.0±1.15 cm at 12 months while, for female infants it measured 12.6±1.19 cm and 17.4±1.06 cm at 1 and 12 months respectively. Male infants belonging to Cohort I possessed significantly larger calf circumference than female infants throughout the period of study. While, gender differences for Cohort II infants favoring males became statistically significant only at 9 months ($p \leq 0.05$) and 1 year (pd"0.01) of age (Table 1).

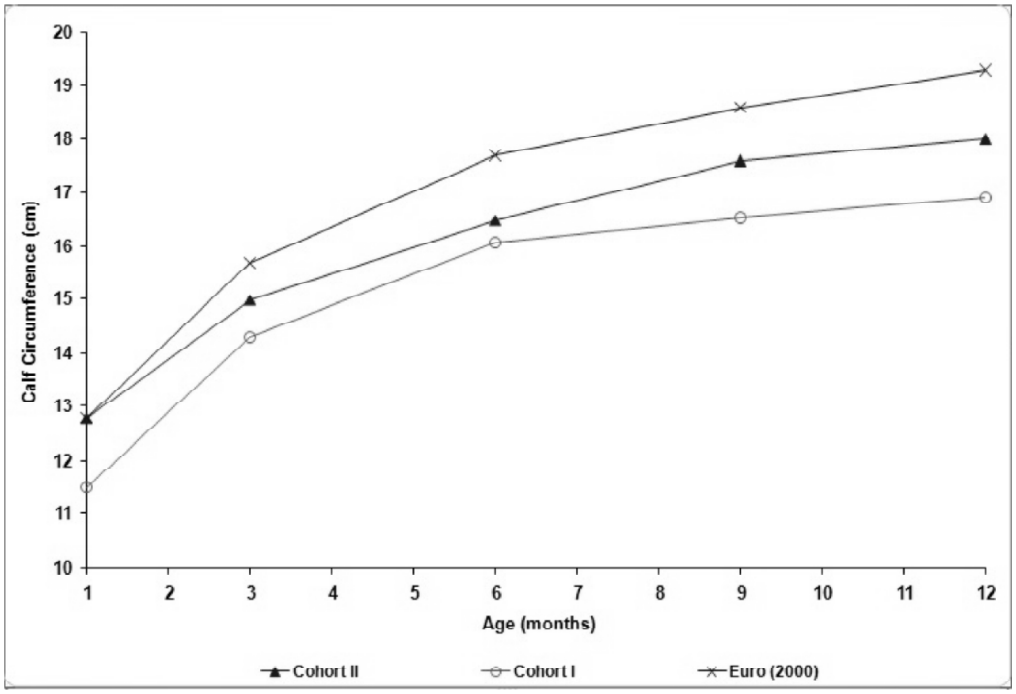

Figure 1: Calf Circumference in Cohort I, Cohort II and European Male Infants

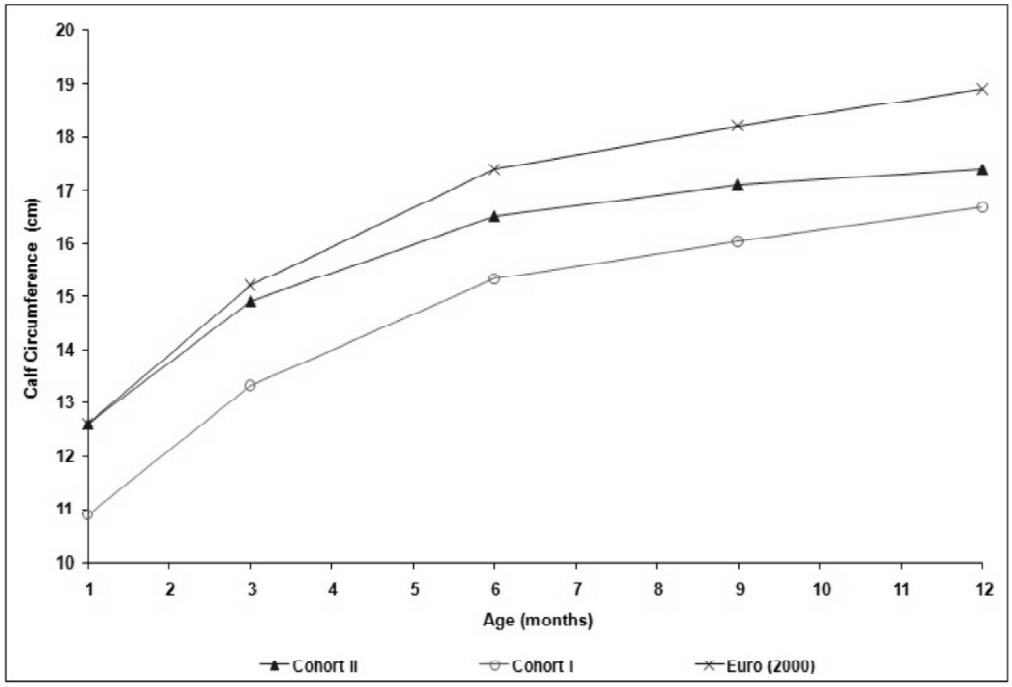

Figure 2: Calf Circumference in Cohort I, Cohort II and European Female Infants

The mean auxological attainments for calf circumference for male and female infants representing Cohort II remained significantly ($p \leq 0.001$) greater at all ages than the Cohort I infants measured about 27 years ago. As compared to the normal European infants (Haschke & Van't Hof 2000), calf circumference amongst infants belonging to Cohort I & II measured significantly smaller between 1 to 12 months. However, the magnitude of this differential was found to be substantially greater between infants representing Cohort I than what could be observed for Cohort II (Fig 1 & 2). This may be due to influence of positive secular changes noticed in the growth of calf circumference of infants born in Chandigarh over a period of about three decades. The distance growth curve plotted for calf circumference of Cohort I male infants ran between 5th to 10th centile of Euro growth references and in the case of female infants, it well corresponded with 5th centile. While, the calf circumference growth curve for Cohort II infants of the two sexes being at 50th centile at 1 month of age, deflected to 25th centile by 6 months, thereafter their curves ran between 10th and 25th percentiles.

DISCUSSION

Bielicki (1986) has remarked that auxological data for a country has a great potential when it looks at secular trends and social gradients simultaneously. The pattern of distance growth observed amongst male and female infants (Cohort I & Cohort II) for calf circumference demonstrated a continuous increase in mean values throughout the study period (Figs 1 & 2). The distance growth curves plotted for calf circumference of Cohort II male and female infants were placed significantly above their Cohort I counterparts during first year of life. These observations suggest better auxological attainments for this circumferential measurement and a progressive secular change recorded over a period of 27 years. Though the Cohort I & II infants represent different time periods yet these babies belonged to almost similar ethnic, regional, environmental and socio-economic backgrounds.

Inter-population comparison with European infants (Haschke & Van't Hof 2000) revealed that growth attainments of Cohort I infants (1978-81) which ran around 5th centile, towed a trajectory between 50th-25th centile for calf circumference of infants of two sexes belonging to Cohort II (2006-08) [Fig 1 & 2]. However, lower placement of curves plotted for infants born in Chandigarh, than their European counterparts despite experiencing a positive secular trend may be because of ethnic and environmental differences between these two population groups. These observations are in consonance with those of Ashcroft and Desai (1977), who reviewed data collected from infants and children of African, Indian, Chinese, and European origin in Guyana and Jamaica to compare the influence of ethnic origin and environment on anthropometric measurements and attributed this differential mainly to ethnic differences.

The higher mean calf circumference recorded for Cohort II infants over a period of about three decades may be attributed to influence of positive secular changes experienced by Chandigarh infants. This reflects improvement in the nutritional,

hygienic and general health status of Chandigarh population and speaks of a positive change in the environmental conditions which might have led to better expression of the biological potential of our study subjects. Improved health, nutrition, socio-economic status and changing rates of growth and maturation, as well as changing cultural attitudes about physical fitness have been placed as the possibilities by earlier workers for secular change amongst children of western origin (Schreider 1967, Meredith 1976, Frisancho 1977, Bielicki *et al.* 1981, Flegal *et al.* 1988, Lasker and Mascie-Taylor 1989).

The net percent increase in calf circumference of male infants belonging to Cohort I and Cohort II over a period of 27 years was 10.3% of the initial value at 1 month. While, corresponding increase for female infants measured 15.6%. In view of the non-availability of information about existence of secular trend related data amongst infants of other population stocks, inter-population comparison with regard to calf circumference could not be attempted. However, support to occurrence of positive secular trends for calf circumference noticed amongst Bengali boys aged 7.0 to 16.0 years by Dasgupta *et al.* (2015) may be used to confirm our contention. These authors observed that calf circumferences have also manifested a significant increase in mean values over two study periods i.e. between 1982-1983 and 1999-2011. Relatively, more perceptible nature of the basic auxological phenomenon governing secular trends amongst children of youngest ages and adolescence rather than other periods of the postnatal life i.e. adulthood, has also been advocated by Eveleth and Tanner (1990) & Sousa *et al.* (2012).

With improvement in socio-economic conditions and healthcare in most countries, there is a dramatic secular increase in growth attainments of populations from Asia and other developing countries, though the positive secular trends in growth have slowed or even plateaued in developed countries in Europe and North America. The major transitional processes responsible for manifestation of secular phenomena influencing growth of different body parameters of children needs to be explored in future to have holistic understanding of auxological dynamics of secular changes, amongst Indian children during their different phases of growth.

Table 1: Mean, Standard Deviation (SD) and t-values of Calf Circumference (cm) of Male and Female Cohort 1 & Cohort 2 Infants

Age (months)	*Cohort 1*					*Cohort 2*					*Cohort 1 vs. Cohort 2 (t-value)*	
	Male		*Female*		*Gender Diff. (t-value)*	*Male*		*Female*		*Gender Diff. (t-value)*		
	N	*Mean (SD)*	*N*	*Mean (SD)*		*N*	*Mean (SD)*	*N*	*Mean (SD)*		*Male*	*Female*
1	44	11.6(0.73)	30	10.9 (0.70)	3.54***	50	12.8 (0.89)	50	12.6 (1.19)	0.95	7.08***	8.29***
2	44	13.1 (0.83)	30	12.3 (0.74)	4.59***	-	-	-	-	-	-	-
3	44	14.4 (0.98)	30	13.3 (1.01)	4.68***	50	15.0 (1.04)	48	14.9 (0.99)	0.52	2.87***	6.89***
4	44	15.2 (1.0)	30	13.9 (1.01)	5.57***	-	-	-	-	-	-	-
5	44	15.7 (1.0)	30	14.6 (0.99)	4.72***	-	-	-	-	-	-	-
6	44	16.1 (1.21)	30	15.3 (1.01)	3.27**	47	16.5 (1.01)	47	16.5 (1.21)	0.06	1.72	4.52***
7	44	16.4 (1.27)	30	15.4 (1.38)	3.14**	-	-	-	-	-	-	-
8	44	16.7 (1.17)	30	15.9 (0.97)	3.15**	-	-	-	-	-	-	-
9	44	16.7 (1.08)	30	16.1 (0.99)	2.40*	48	17.6 (0.89)	46	17.1 (1.06)	2.49*	4.38***	4.12***
10	44	16.8 (1.03)	30	16.3 (0.91)	2.41*	-	-	-	-	-	-	-
11	44	17.0 (1.14)	30	16.4 (0.82)	2.46*	-	-	-	-	-	-	-
12	44	17.2 (1.11)	30	16.7 (0.79)	2.18*	49	18.0 (1.15)	48	17.4 (1.06)	2.78**	3.40***	3.11***

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

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