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Secular changes in Mid-Upper-Arm Circumference of Chandigarh Infants

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ABSTRACT:

The secular trend in terms of growth of mid-upper-arm circumference (MUAC) 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 to parents representing upper socio-economic strata, in Chandigarh was longitudinally evaluated as the same so far has not been studied. All babies were enrolled from Labor Room of the Postgraduate Institute of Medical Education and Research and subsequently, followed in Growth Clinic of the Department of Pediatrics. MUAC amongst infants of the two sexes representing both the Cohorts grew uninterruptedly between 1 to 12 months. Cohort I and II male infants in general, possessed larger MUAC than females. However, statistically significant gender differences were recorded for Cohort II infants only at 9 months. The mean MUAC of infants belonging to Cohort II, measured significantly ($p \leq 0.001$) greater than Cohort I infants during first year of life. Higher growth attainments recorded for MUAC in Cohort II infants than those of Cohort I speak of existence of progressive secular trend amongst Chandigarh infants over a period of about three decades.

Keywords: Chandigarh Infants, Infant Growth, MUAC, Secular Changes.

INTRODUCTION

Secular changes, noticed since the 19th century, traditionally indicate the tendency of human populations living in same territories towards any change affecting their overall size, developmental and maturational processes over a period of time (Roche 1979, Danubio & Sanna 2008). The secular trends are appreciable public health resource which manifest the living conditions of a population and also highlight any imbalance in health trends within the same population (INSERM 2007). Previous studies concerning secular trend, chiefly were either restricted to increase in height or reduction in mean menarcheal age (Hermanussen et al 1995, Thomas et al 2001, Bodzsar 2000, Herman-Giddens 2006). More recently, research on secular changes has extended to the domains of motor development during preschool years (Sedlak et al 2015), physical fitness and attitude of children and adolescents towards sports, owing to their association with increase in incidence of overweight and obesity (Westerstahl et al 2003, Wedderkopp et al 2004, Matton et al 2007). As compared to information on secular changes evaluated in terms of body weight, height and maturity status, data for mid-upper arm circumference (MUAC) amongst infants and children of Indian origin are lacking. However, secular changes affecting growth of MUAC in older children studied abroad in Shiraz (Ayatollahi et al 2016) over a period of 15 years, in Portugal (Sousa et al 2012) between 1996-1998 and 2007-2009 and amongst US men and women (Bishop et al 1981) are noteworthy.

Mid-upper arm circumference (MUAC) is a successful diagnostic tool to assess malnutrition amongst children in both community and established facility based settings (Brown et al. 2009, Nyirandutiye et al. 2011). Low MUAC, determined on the basis of a fixed cut-off value, acts as a screening tool and has frequently been used as a proxy for low weight-for-height i.e. wasting (Onis et al 1997). In 2009, the World Health Organization (WHO) and UNICEF recommended a MUAC cutoff of <11.5 cm as one of three screening criteria for identifying and managing severe acute malnutrition in infants and children aged 6–60 months. Increasingly, MUAC is also being used to assess nutritional status and determine eligibility for nutrition support among adolescents and adults representing low income strata, especially among pregnant women and those receiving antiretroviral therapy for HIV (Bahwere et al 2011, Tumilowicz 2010, Ververs 2013).

The use of MUAC being a handy measure involving relatively simple procedure offers an advantage to arrive at meaningful scientific and nutritional inferences among children growing under variety of environmental, regional, ethnic, socio-economic and other health related constraints and conditions in a less time consuming and cost effective way. Hence, keeping in mind the diagnostic, nutritional and clinical importance as well as lack of secular trend related information on MUAC, in this presentation an attempt has been made to study secular changes affecting auxological dynamics of MUAC measured amongst full-term, normal birth weight infants, belonging to well-off socio-economic strata of Chandigarh.

MATERIAL AND METHODS

To accomplish objectives of the study, two separate data sets (Cohort I and 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 well-off 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 and 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.

The left mid-upper arm circumference of every infant was measured at the mid-point between acromion and olecranon with the help of a fiber glass tape (accuracy of 1 mm) 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 between 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 MUAC 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 and 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 diseases and health complications experienced by these babies was also kept. Advice on health care of each infant was provided to the mother/caretaker particularly, with regard to importance of breast feeding and food supplementation. The 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 MUAC recorded amongst Cohort I and 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 for MUAC at each age.

RESULTS

The mean, standard deviation (SD) for MUAC measured amongst full-term male and female infants representing Cohort I and Cohort II in first year of life is shown in Table 1, Fig 1 and 2. An uninterrupted increase in mean MUAC was noticed amongst both male and female infants of the two cohorts throughout the age range (i.e. 1 to 12 months) considered. The mean MUAC of Cohort I (1978-81) male and female infants measured 10.15±0.75 cm and 10.01±0.15 cm at 1 month and 14.05±1.07 cm and 14.24±0.25 cm at 12 months of age, respectively. The mean MUAC of Cohort II (2006-2008) male infants was 11.6±0.80 cm at 1 month and 14.7±0.85 cm at 12 months. In female infants, it measured 11.2±0.98 cm and 14.4±0.90 cm at 1 and 12 months, respectively. Cohort I and II male infants in general, possessed larger MUAC than females. Statistically significant ($p \leq 0.05$) gender differences favoring Cohort II male infants were recorded at 9 months only (Table 1).

The mean auxological attainments for MUAC 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 28 years ago. The pattern of growth observed for MUAC in our Cohort I and II infants is similar to that observed for affluent Indian (Agarwal et al 1994) and MGRS (WHO 2006) infants. Cohort I infants significantly lagged behind their Cohort II, affluent Indian and MGRS peers. While, Cohort II infants on average not only measured larger than their Cohort I and affluent Indian counterparts, but also caught-up well with their MGRS peers beyond 6 months of age. This may be due to influence of positive secular changes noticed in the growth of MUAC of infants born in Chandigarh over a period of about 28 years. The distance growth curve plotted for MUAC of Cohort I male infants ran between 5th to 10th centile of Euro growth reference study (Haschke & Van't Hof 2000). Amongst female infants, it corresponded well with 10th centile. While, the MUAC growth curves plotted for Cohort II infants of the two sexes initially being at 50th centile at 1 month of age, subsequently ran around 25th centile.

DISCUSSION

Secular trends in growth are important for analyzing evolution of the physical health and highlighting social inequalities between different human population groups (Franca et al 2000, Vargas et al 2010). In the present study, distance growth curves plotted for both normal male and female infants belonging to Cohort I and II demonstrated a continuous increase in mean values throughout first year of life (Fig. 1 & 2). However, rapidity of this increase was relatively sharper during the first half of infancy than the later one. This may be attributed to protective effects of breast feeding which continued amongst majority of infants representing two cohorts for about 6 months of life.

The MUAC curves of Cohort II male and female infants ran significantly above their Cohort I and affluent Indian (Agarwal & Agarwal 1994) counterparts during first year of life. Pattern-wise these curves not only showed a close similarity with MGRS (WHO 2006) infants, but also demonstrated higher auxological attainments beyond 9 months in male and 6 months in female infants (Fig. 1 & 2). Further, a comparison with European infants (Haschke & Van't Hof 2000) revealed that growth attainments of Cohort I infants (1978-81) which ran around 10th centile towed a trajectory between 50th-25th centile for MUAC of infants of two sexes belonging to Cohort II (2006-08). Better auxological attainments recorded for this circumferential measure of growth amongst Cohort II infants when contrasted with infants of Cohort I, suggest existence of progressive secular trend amongst Chandigarh infants over a period of about last three decades. This may be due to the effect of availability of relatively improved environmental, nutritional, educational, occupational and health related opportunities to the inhabitants of Chandigarh, yielding better expression of biological growth potential of Cohort II infants than

Cohort I infants evaluated about 28 years of ago. According to Malina (1990), occurrence of such positive secular growth trends can be attributed more than anything, to the environmental influences resulting from improvements in sanitary, economic and social conditions of the people. As per the official website of Chandigarh administration (2016), Chandigarh ranks Number 1 in the country in terms of Human Development Index (HDI), quality of life and e-readiness. It has the highest per capita income- “Wealthiest town of India”. A low infant mortality rate (Chandigarh: 21, India: 40), low crude death rate (Chandigarh: 4, India: 7), low birth rate (Chandigarh: 14.7, India: 21.4) (SRS 2013) and a high total literacy rate [Chandigarh: 86.43% (Male: 90.54%, Female: 81.38%), India: 74.04%] (Census 2011). Recently, Chandigarh has emerged as the second most ‘cleanest’ and ‘greenest’ city of the country (Swachh Survekshan 2016). These vital health statistics and socio-economic conditions related figures recorded for people of Chandigarh as compared to National figures undoubtedly, speak of the better environment in which our study infants have grown in the recent past. Hence, improved health practices and living conditions leading to improvement in mortality rates and life expectancy could be placed as important causes for secular trend amongst Chandigarh infants. A positive correlation between secular tendency in growth and HDI though amongst Brazilian adolescents has also been reported by Vargas et al (2010).

In view of the non-availability of information about existence of secular trend related data amongst infants of other population stocks, inter-population comparison for MUAC could not be attempted. However, secular trends evaluated in terms of weight, height, head circumference and chest circumference amongst Japanese children aged 0-6 years between 1960 to 2000 (Tanaka & Fujii 2011) and rural Indian children between 1985-2001 (Rao et al 2012) could be used as support to confirm occurrence of secular changes as an important phenomenon affecting growth of children during infancy.

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Table 1: Mean, Standard Deviation (SD) of Mid-upper Arm Circumference (cm) of Male and Female Cohort I & Cohort II Infants

Age (months)	Cohort I					Cohort II					Cohort I vs. Cohort II (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	10.15 (0.75)	30	10.01 (0.15)	0.76	50	11.6 (0.8)	50	11.2 (0.98)	1.750	6.846***	6.588***
3	44	11.9 (0.9)	30	11.70 (0.17)	0.95	50	12.9 (0.80)	48	12.8 (0.74)	0.593	5.703***	7.997***
6	44	13.26 (1.16)	30	13.01 (0.16)	1.0	47	13.9 (0.98)	47	13.8 (0.75)	0.605	2.899**	5.678***
9	44	13.74 (0.97)	30	13.51 (0.18)	1.01	48	14.6 (1.00)	46	14.1 (0.81)	2.460*	4.219***	3.922***
12	44	14.05 (1.07)	30	14.24 (0.25)	0.68	49	14.7 (0.85)	48	14.4 (0.90)	1.545	3.278***	0.949***

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

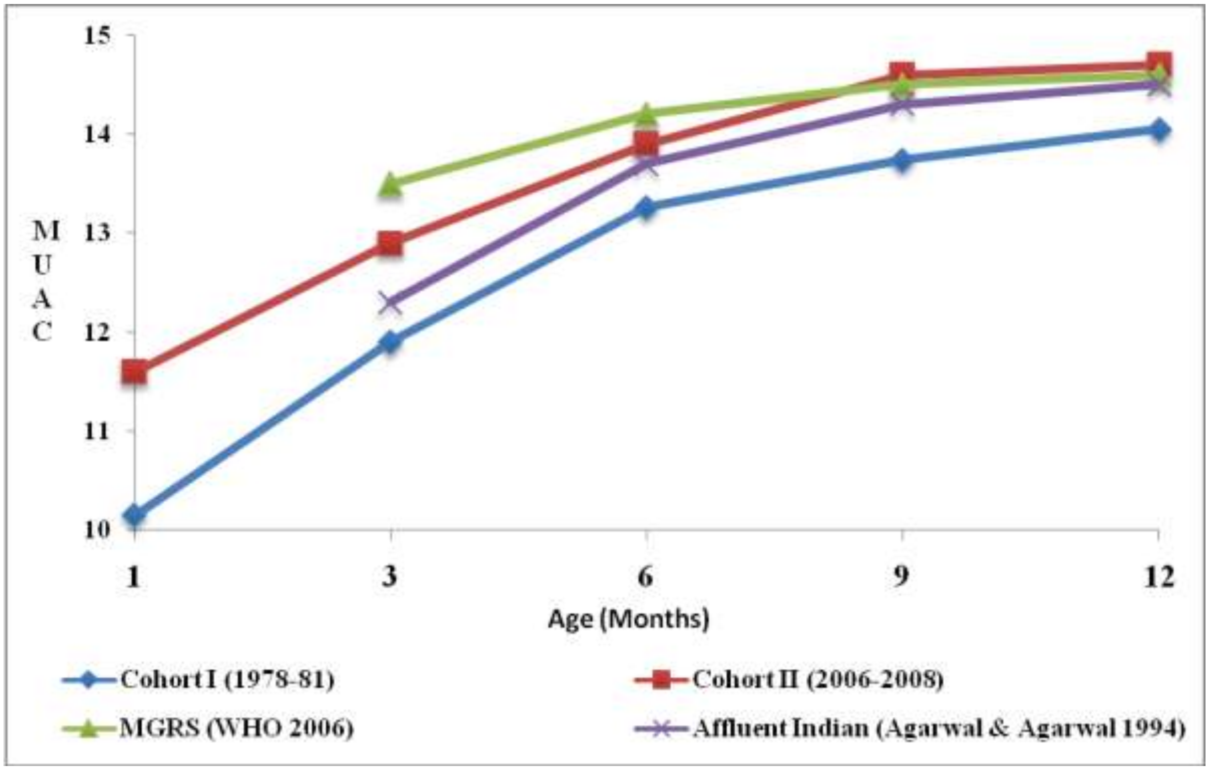

Fig 1: Mid-upper Arm Circumference (cm) of Cohort I, Cohort II, WHO & Indian Affluent Male Infants

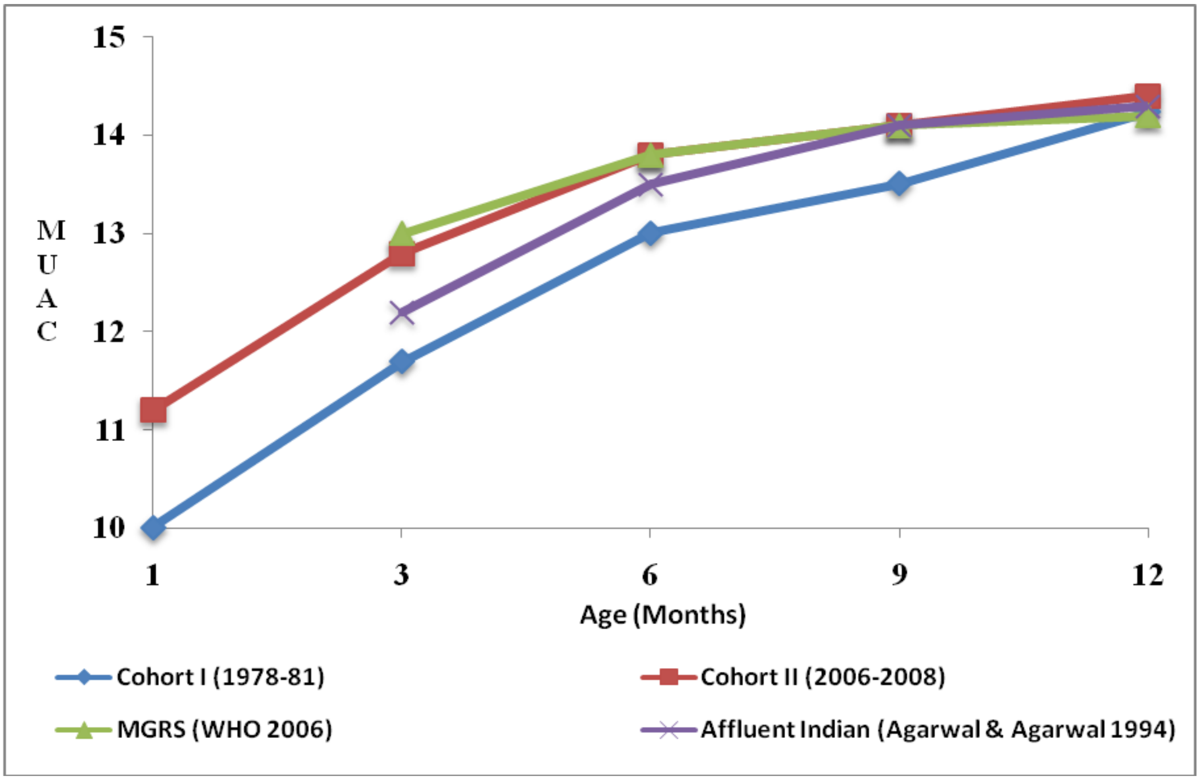

Fig 2: Mid-upper Arm Circumference (cm) of Cohort I, Cohort II, WHO & Indian Affluent Female Infants