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Physical Growth and Nutritional Status of Children aged 6-8 years of Panchkula city (Haryana), India

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ABSTRACT:
The present study aims to evaluate physical growth and nutritional status of children, ranging in age from 6 to 8 years. The cross-sectional sample of 253 children (133 boys and 120 girls) belonging to low socio-economic status were drawn from various government schools of Panchkula. Height, weight, head circumference, chest circumference and upper arm circumference were taken on each child following standard anthropometric techniques. Indices used for nutritional assessment were weight-for-age, height-for-age and BMI-for-age based on WHO (2007) standards. Results indicated statistically significant sex differences for height, weight, head circumference and chest circumference in the total sample. ANOVA revealed significant differences between age groups for height and weight in both the sexes. Height associated significantly with all the anthropometric measurements but weight revealed significant associations with BMI and upper arm circumference in both the sexes as is evident from the value of total correlations. When compared with reference population, 28.8% children (25.6% boys, 32.5% girls) were found to be under weight (weight-for-age z-score <-2 S.D.); stunting (height-for-age z-score <-2 S.D.) was noticed among 19.4% children (17.9% boys, 20.9% girls); and wasting (BMI-for-age z-score <-2 S.D.) was witnessed in 17.8% children (18.8% boys, 16.6% girls). Therefore, girls were found to be more undernourished in comparison with boys for weight-for-age and height-for-age indices, while, boys showed higher wasting than girls. The poor nutritional status of children may be attributed to synergistic action of inadequate nutrition associated with repeated infections caused due to poor environmental conditions, economic stresses, illiteracy, poor infant and young child feeding and caring practices.

KEY WORDS: *Anthropometry; Height; Weight; Body mass index; Undernourished; Stunting; Wasting.*

INTRODUCTION

Growth status of a child is influenced by the genetic and environmental factors. The most important environmental factor which regulates growth is nutrition. Nutritional requirements of a child vary with the stages of prenatal and post natal growth. A child having adequate and balanced nutrition as per the stage of development exhibits normal growth. Malnutrition retards growth due to deficiency (protein energy or micronutrient) as well as due to excess or imbalance of nutrients in the body giving rise to undernutrition and overnutrition. In India, malnutrition, particularly in children, is one of the major health problems. With one sixth of the global population residing in India, one third of about two billion people suffering from vitamin and micronutrient deficit are in India (Kotecha 2008). Anemia is one of the important public health nutritional problems in India and also in many other parts of the world affecting the persons of all ages and economic groups (Sidhu et al, 2002). Malnourished mothers often give birth to underweight babies who are 20 percent more likely to die before the age of five. A majority of malnourished children fail to attain their full genetic potential in bodily dimensions and may develop stunting and wasting, besides other deficiency disorders. Children belonging to poorer sections of society are highly susceptible to malnutrition and infections. It seems that the synergistic action of inadequate nutrition and repeated infections retards their growth. It is also well known that chronic under-nutrition is associated with slower cognitive development and serious health impairment later in life that reduces the quality of life (Scrimshaw 1995). There is evidence from around the world that within population differences in height are strongly associated with within population differences in cognitive outcomes (Case & Paxson 2010), productivity (Vogl 2012) and health. Globally there are 171 million stunted children throughout the world, most of whom live in developing countries which is expected to decrease to 142 million by 2020 (de Onis 2011). Many studies have revealed that the prevalence of undernutrition is high among infants, children (National Family Health Survey 2007, UNICEF 2009), adolescents (Bisai et al. 2012) and adults (National Family Health Survey 2007) in India. In fact, these rates are among the highest in the world (UNICEF 2011). Despite having a much better economic growth during the last few decades, and implementation of a large number of the national programmes to combat this menace, prevalence of child undernutrition in India remains much higher than even the poorer countries of sub-Saharan Africa (Panagariya 2013). Thus, countries like India which are undergoing nutritional and life style transition having

diverse populations has regions still struggling with the huge burden of undernutrition but at the same time there are rapidly emerging population sub-groups which are falling into the trap of affluence related problems of over nutrition, thereby, showing a dual burden.

Nutritional status of an individual or that of a population can be assessed using clinical signs of malnutrition, biochemical indicators, dietary intake and anthropometry. Through nutritional surveys we get to know the prevalence and geographic distribution of nutritional problems of a community. The initial outcome of nutritional inadequacies affects the functional capacity and growth rate of a child making him/her vulnerable to infections. A child's body responds to malnutrition in two ways that can be measured by anthropometry: a deceleration or cessation of growth, which over the long term results in low height-for-age or stunting; and body wasting, which is a short-term response to inadequate intakes, and commonly assessed by weight relative to height. Height-for-age and weight-for-height thus discriminate between different biological processes, unlike weight-for-age, which could be low because of stunting or short stature and/or wasting or recent weight loss (de Onis 2000). Anthropometry offers an effective means of assessing the nutritional status of the children. Anthropometry is the single most universally applicable, inexpensive, and non-invasive method available to assess the size, proportion and composition of human body (WHO 1995).Several studies have concluded that prevention of different grades of malnutrition will improve health status of children and future humankind (Gaur & Singh 1994, Gaur et al.1995, Schroeder & Martorell 1997, Monyeki & Cameron 2000, Mian et al. 2002, Medhi et al. 2006, Talwar et al. 2007, Chowdhury et al. 2008, Mukherjee et al. 2008, Prabhakar & Gangadhar 2009, Bisai & Mallick 2011, Manna et al. 2011, Sati & Dahiya, 2012, Srivastava et al. 2012, Fazili et al. 2012, Coffey et al. 2013, Chakraborty & Bose 2014). The situation of child malnutrition is grave in Haryana state of India and needs urgent attention, as according to National Family Health Survey (2005-06) [NFHS, 2007] the prevalence of wasted, stunted and underweight children in this state was 19%, 38% and 46% respectively. There is paucity of data on this aspect from this region, particularly on children (Talwar et al. 2007, Sati & Dahiya 2012, Kumar et al. 2014). Therefore, more studies should focus on nutritional assessment of children/population of this region to know the prevalence of undernutrition, with emphasis on targeting support at pregnant and breast feeding women and children below two years to prevent chronic malnutrition. To augment data in this direction, the present study has been undertaken to evaluate the physical growth and nutritional status of

school-going children aged 6 to 8 years, belonging to Panchkula city of District Panchkula, Haryana.

MATERIAL AND METHODS

District Panchkula is the 19th populated district of Haryana State in India. The major towns included in the district are Panchkula, Barwala, Pinjore, Kalka and Raipur Rani. Panchkula is a planned satellite city of Union Territory of Chandigarh. As per Census, 2011, Panchkula had population of 561,293 of which male and female were 299,679 and 261,614 respectively. Panchkula is surrounded by Himachal Pradesh in the north and east, Punjab and Chandigarh Union Territory in the west and by Ambala District in the south and east. A cross-sectional sample of 253 children (133 boys and 120 girls) ranging in age from 6 to 8 years, belonging to low socio-economic status were drawn from various government schools of Panchkula city, Haryana. The data were collected from four schools situated in sectors- 17, 18, Rajiv Colony and Mauli Jagran. After explaining the purpose of the study, informed consent was obtained from all subjects. Information about age of the subjects was recorded from the school registers and all doubtful cases were excluded. The decimal ages were calculated following decimal age calendar (Tanner & Whitehouse 1966). Anthropometric measurements taken on each child included height, weight, head circumference, chest circumference and upper arm circumference. All measurements were taken using standard instruments following Weiner and Lourie (1981). Since all the measurements were taken by the same investigator, the second author, there were no inter observer technical error of measurement (TEM). Random checks were made to find out intra observer technical error of measurement which was found to be less than 1%. Intra observer error for stature was 0.2 - 0.8 cm. For body weight, it was between 0 and 0.5 kg; for circumferences values ranged from 0.1 to 0.3 cm. The nutritional status was evaluated with the help of anthropometric indices. Height and weight were used as the two basic measurements for assessment of nutritional status. The whole year mean annual increments were calculated by subtracting the mean of the preceding age group from that of the succeeding group (Tanner, 1962). Body mass index (BMI) was computed from height and weight. Following the recommendations of World Health Organization (WHO), Geneva, (de Onis et al. 2007), the derived indices used here for assessing the nutritional status are weight-for-age (underweight), Height-for-age (stunting), and BMI-for-age (wasting). The nutritional status of each individual was calculated as z-scores or S.D. scores using WHO reference standards. The cut-off point for

malnourished children was taken as -2 S.D. scores below the reference median, as recommended by World Health Organization (2007). The cut off points for mild, moderate and severe malnutrition for z-scores of these indices were -1.1 to -2.0 S.D., -2.0 to -3.0 S.D. and less than -3.1 S.D., respectively. Additional information about the educational and occupational status of their parents and their dietary habits was collected through interview based schedule. Majority of mothers were uneducated, few were literate only 10% were educated up to primary/middle level. Most of them were working as maids doing household work. Majority of fathers were literate (40%) and were working as laborers. 35% fathers were educated up to middle standard and were skilled workers working in /as masons/carpenters/drivers and the rest were matriculates doing government jobs like peon, attendant etc and working in shops..The staple diet of children was wheat, vegetables and cereals. Milk and fruit consumption was minimum. The most frequently consumed beverage was tea. Most of these children were living in poor environmental conditions.

RESULTS

Growth Status

The descriptive statistics of the various anthropometric measurements of children of the present study according to age and sex have been presented in **Table 1**. As is evident from the table, except for BMI, the bodily dimensions of the sample children witnessed a general increasing trend with the advancing age. Boys were found to be taller, heavier than the girls and showed superior growth in head circumference than them at all ages. In chest and upper arm circumference, boys exhibited greater mean values than girls up to 7 years after which the girls overtook the boys. BMI in both the sexes decreased with advancing age. Significant sex differences were seen for height, weight, head circumference and chest circumference in the total sample ($p<0.05$). However, age specific sex differences were observed for height and weight at age 6 and for head circumference at 6 and 8 years. ANOVA also revealed significant differences between age groups for height, weight in both the sexes. Among girls, head circumference, chest circumference and upper arm circumference also exhibited significant differences between age groups ($p<0.05$).

Table 2 presents the correlation between different variables according to age and sex. Height and weight showed significant association between themselves as is evident from the value of total correlation coefficient (r). Both these variables also correlated significantly with head

circumference, chest circumference and upper arm circumference in both the sexes. BMI showed significant correlation with weight and upper arm circumference in both the sexes and with head circumference in boys only. Upper arm circumference correlated significantly with head and chest circumference as is seen from the table.

Nutritional Status

The nutritional status of children of District Panchkula was evaluated with the help of anthropometric indices, namely, weight deficit-for-age, height deficit-for-age and BMI-for-age, expressed as z-scores below the reference median. Age and sex specific mean z-scores according to the above three anthropometric indices i.e. Wt/Age, Ht/Age and BMI/Age have been presented in **Table 3**. t-values revealed statistically significant sex differences for Ht/Age in the total sample and age specific sex differences for Wt/Age and Ht/Age at 6 years ($p<0.05$) were obtained. ANOVA revealed significant differences between age groups for Wt/Age and BMI/Age in boys only.

Table 4 presents the percentage distribution of children in different z-score categories, according to various indicators of malnutrition, by age and sex. It is evident from the table that, a majority of the children have z-scores -1 S.D or more below the reference median, by Ht/Age, Wt/Age and BMI/Age indicating some degree of malnutrition. The frequency of children classified as normal (with z-scores of -1 S.D or less) was the maximum by BMI/Age (47.8%) and minimum by Wt/Age (35.9%). The percentage of children classified as malnourished (those with z-scores of – 2 S.D or more) was 19.4%, 28.8%, and 17.8% as assessed by Ht/Age, Wt/Age and BMI/Age, respectively. The percentage of stunted children (19.4%) was more than those with wasting (17.8%). The percentages of malnourished boys according to Ht/Age, Wt/Age and BMI/Age were 17.9%, 25.6%, 18.8%, respectively and that of malnourished girls were 20.9%, 32.5%, 16.6%, respectively. Therefore, girls were found to be more undernourished in comparison with boys for weight-for-age and height-for-age indices, while, boys showed higher wasting than girls.

DISCUSSION

Health and nutritional status of a population is reflected in growth of its children. Growth monitoring and promotion of optimal growth are essential components of primary health care for

children, both at individual and population level, which in turn help in administering timely health intervention programmes. As is evident from the results, significant sex differences were seen for height, weight, head circumference and chest circumference in the total sample ($p<0.05$). However, age specific sex differences were observed for height and weight at age 6 and for head circumference at 6 and 8 years. ANOVA also revealed significant differences between age groups for height, weight in both the sexes. Sex differences before the adolescent spurt are consistent although minor. Boys on the average tend to be taller and heavier than girls (Malina et al. 2004). Similar findings have been reported by many earlier studies (Singh et al. 1987; Gaur et al. 1995; Talwar et al. 2007) including the present study. The body mass index declines from 6 to 8 years in both the sexes and the sex differences are not significant in their BMI.

To study the population differences in growth patterns, mean heights and weights of the children of the present study have been compared with WHO standards and various Indian studies. The height curves of sample children when compared with similar curves for WHO (2007) coincide 25^{th} percentiles at 6 years for boys and lie between 5^{th} and 15^{th} percentiles for girls. At 7 years, the height curves of boys and girls coincide 15^{th} percentiles and fluctuate between 5^{th} and 15^{th} percentiles at 8 years (**Fig 1a & b**).The mean weight of sample boys lie between 15^{th} and 25^{th} percentile and for sample girls between 5^{th} and 15^{th} percentile of WHO (2007) standards at 6 years. The mean values of weight of boys and girls lie between 5^{th} and 15^{th} percentile at 7 years and near 5^{th} percentiles at 8 years for both boys and girls (**Fig 2a & b**).

The BMI curves of sample boys and girls when compared with similar curves for WHO fluctuate between 15^{th} and 25^{th} percentiles at 6 years, coincide the 15^{th} percentile at age 7 and, lie between 5^{th} and 15^{th} percentiles at 8 years (**Fig 3 a, b**). As expected, boys and girls of the present study showed a poor growth performance as per WHO (2007) standards. Genetic and environmental factors are believed to underlie the above differences in size attainments between children from Western and developing countries.

Figure 4(a, b) shows comparison of height of present sample with affluent Indian children (Agarwal et al. 1992, Khadilkar et al. 2009), scheduled caste rural children (Gaur et al. 1995) and Scheduled caste children of Naraingarh (Talwar et al. 2007). The sample boys and girls were considerably shorter than affluent children. The boys of present study showed greater mean height than scheduled caste boys of Naraingarh and scheduled caste rural boys except at 7 years

when rural boys of Tehsil Kharar show slightly greater height. Sample girls are taller than scheduled caste girls of Nariangarh at 6 and 7 years and shorter than them at 8 years. As compared to scheduled caste rural girls, mean height of the sample girls almost coincides at 7 and 8 years but is less at 6 years. **Figure 5(a, b)** depicts a comparison of weight of present sample with affluent Indian children (Agarwal et al. 1992, Khadilkar et al. 2009), scheduled caste rural children (Gaur et al. 1995) and Scheduled caste children of Naraingarh (Talwar et al. 2007). The sample boys and girls were lighter than affluent Indian boys at all ages. The boys and girls of present study showed greater mean weight than Scheduled caste rural children of Tehsil Kharar. In comparison to scheduled caste children of Naraingarh, boys of the present study were found to be heavier at 7 and 8 years and girls weighed more than them at 8 years.

Table 5 gives the comparison of Body mass index and various circumferences of sample children with different Indian studies. As compared to BMI of affluent Indian children (Agarwal et al. 2001, Khadilkar et al. 2009) and WHO (2007) references, children of the present study showed considerably lesser values of BMI at all ages. Sample children had lesser mean head and chest circumference than affluent Indian children (Agarwal et al. 1992) and scheduled caste rural children (Gaur et al. 1995). When compared with Scheduled caste boys and girls of Naraingarh (Talwar et al. 2007), boys of the present study possessed higher head circumference at 6 and 8years but lesser chest circumference than them at 7 and 8 years and girls had higher values of head circumference and chest circumference than them at 7 and 8 years and at 6 and 7 years respectively. Children of the present study possessed lesser mean values for upper arm circumference as compared to affluent Indian children, although they showed similar values of upper arm circumference as that of scheduled caste rural children (Gaur et al. 1995) and scheduled caste children of Naraingarh (Talwar et al. 2007). It clearly shows that socio-economic status is one of the environmental determinants and differences in size attained by children from contrasting socio-economic backgrounds vary among different populations. Nearly one-third of neonates born in India have low birth weight (ICMR 2003) and a large percentage of them are small for gestational age (SGA). These preterm small for gestational age children have been found to be shorter, lighter and have the smallest head circumference (Chaudhari et al. 2008). Children born small for gestational age have a seven fold increased risk of growth failure (Karlberg & Albertsson-Wikland 1995) and their final height is said to contribute to 20% of the short adult population. These differences in body size among children of the present study from

that of affluent children may be attributed to poor environmental conditions, nutritional inadequacies caused by economic stresses, poor infant and young child feeding and caring practices, illiteracy , along with high rate of infections. Children of Nariangarh and rural children from Kharar were also from low socio-economic status , therefore, exhibited lesser differences in the magnitude of growth.

Changes in metabolic rate occur during the first five years of life (Grillo et al. 2005), the same period that stunting most often occurs (Fox & Hillsdon 2007). A decreased metabolism could be an efficient method in response to low calorie availability (Wilson et al. 2012). Stunting reflects a process of failure to reach linear growth potential, and is an indicator of past growth failure. Wasting, on the other hand is a very good index for short duration malnutrition. This index helps to identify children suffering from current or acute under nutrition or wasting. Underweight children reflect an amalgamation of disturbances in linear growth and body proportions. National surveys indicate that a third of the children from high income group who have not experienced any deprivations are undernourished (Ramachandran 2007). Thus, undernutrition prevails in all sections of society but the causes are different. So it becomes imperative to look for the causes and factors responsible for its higher prevalence in our country.

In the present study, the frequency of children classified as normal (with z-scores of -1 S.D or less) was the maximum by BMI/Age (47.8%) and minimum by Wt/Age (35.9%). The percentage of children classified as malnourished (those with z-scores of – 2 S.D or more) was 19.4%, 28.8%, and 17.8% as assessed by Ht/Age, Wt/Age and BMI/Age, respectively. The percentage of stunted children (19.4%) was more than those with wasting (17.8%). The percentages of malnourished boys according to Ht/Age, Wt/Age and BMI/Age were 17.9%, 25.6%, 18.8%, respectively and those of malnourished girls were 20.9%, 32.5%, 16.6%, respectively. Therefore, girls were found to be more undernourished in comparison with boys for weight-for-age and height-for-age indices, while, boys showed higher wasting than girls. This indicates that girls are more at a nutritional disadvantage right from the infancy as compared to boys who in turn are under greater effect of current undernutrition. Children of the present study have been compared with other Indian studies for prevalence of undernutrition (**Table 6).**

It is evident from the results that of all the studies, maximum prevalence of stunting (54.1%) is seen among school-going children from Hissar in Haryana; maximum wasting (63.5%) and maximum percentage of underweight (63.9%) children belong to Fatehabad district of Haryana.

Children from the present study exhibited higher percentage of stunting than the children of Santal, Bandipora and Army school, Pune and showed its lower prevalence than the Rural Metei children of Manipur, scheduled caste children of Punjab and Haryana, school-going children from Hissar and Fatehabad and tribal children belonging to Jenukuruba and Kora-Mudi. The prevalence of wasting and underweight was lower in sample children than the tribal children of Santal, Jenukuruba, Kora-Mudi,school-going children from Assam, Hisar, Fatehabad and Scheduled caste Punjabi children. However, higher rate of wasting and underweight was found in the children of the present study as compared to Rural Metei children, Scheduled caste children of Haryana, school-going children of Bandipora and Army school, Pune. The above comparison clearly shows variations in the prevalence of undernutrition among different communities and tribal populations. The range for wasting lies between 1.7% and 63.5%, for stunting it is 9.3% to 54.1% and from 9.8% to 63.9% for underweight categories. These are quite alarming figures. Children from Hissar and Fatehabad in Haryana show maximum prevalence of undernutrition

Several factors are responsible for high prevalence of undernutrition in India. There are inter-state differentials in malnourishment among children in India as has been reported by National Family Health Surveys of, 1992-93, 1998-99 and 2005-06. In fact, in Haryana while the percentage of people below the poverty line declined from 25.04% in 1993-94 to 8.74% in 1998-99 the percentage of malnourished children remained the same i.e. 34.6% (Kumar 2007). The extent of malnourished children has increased from 34.6 to 41. 9% in 2005-06. This is hardly surprising because the study has shown that factors other than poverty like the age at marriage/age of women at first child birth, prevalence of early breast feeding of children and awareness among women about factors affecting health, which are being increasingly recognized as having a strong impact on child malnourishment, are important in this regard at the regional level (Nair 2007).

In the present study also, children belonged to low-socio economic status and due to poverty were living in unhygienic conditions, did not have proper infant and child care, lacked in personal hygiene and access to adequate food, were more prone to infections and lacked medical care. Unsafe drinking water and open defecation also increase the rate of infections. Moreover, illiteracy especially among women, lack of awareness and poor health status of mother due to poor maternal nutrition has a direct bearing on the nutritional status of children. Although these

children were attending government school and were getting mid day meal also yet they showed a poor nutritional status. The girls were found to be more undernourished in comparison with boys for weight-for-age and height-for-age indices. The results of the present study are in concordance with earlier studies which conclude that Indian girls are at a nutritional disadvantage as compared to boys (Talwar et al. 2007, Srivastava et al. 2012). Thus, improvement in the nutritional status of these children and their mothers requires focused and integrated strategies like providing community based comprehensive, preventive, curative health services and nutritional interventions including behavioral modifications by education. Emphasis should be laid on higher age at marriage and equal status for the girl child, early start of breast feeding and supplementation of solid food after six months to eradicate malnutrition. This can be achieved through reliable large scale surveys undertaken at regular intervals of two to three years to monitor the nutritional status at district level along with National family health surveys at more frequent intervals of time. Recently, Chakraborty & Bose (2014) have suggested the need of longitudinal studies to understand the growth process in Indian children with due consideration of the differential adaptive response of the mother–child unit in diversified ecological circumstances, including socio-economic determinants of resources. This may help determine the more biologically appropriate ethnic specific cut-off points of various indicators of undernutrition in this country of great ethnic diversity.

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Table 1. Means and Standard Deviations of Various Anthropometric Measurements of Children of Panchkula City by Age and Sex.

Age Groups / Variables	6 YEARS		7 YEARS		8 YEARS		Total		ANOVA (F-values)	
	Mean±S.D.		Mean±S.D.		Mean±S.D.		Mean±S.D.			
	Boys (48)	**Girls (43)**	**Boys (49)**	**Girls (41)**	**Boys (36)**	**Girls (36)**	**Boys (133)**	**Girls (120)**	**Boys**	**Girls**
Height (cm)	112.4±6.2#	108.0±6.1#	116.1±7.4	115.3±6.4	119.8±6.7	117.8±5.2	115.8±7.3#	113.4±7.2#	12.4*	29.3*
Weight (kg)	18.2±2.5#	16.5±2.1#	19.3±3.19	18.5±2.8	20.1±3.7	19.1±2.5	19.1±3.2#	17.9±2.7#	3.9*	12.1*
BMI	14.3±1.3	14.1±0.9	14.2±1.2	13.9±1.4	13.9±1.4	13.7±1.2	14.2 ±1.3	13.9± 1.2	1.3	1.1
Head circ (cm)	48.8±1.7#	46.9±1.5#	48.7±1.7	48.1±1.8	49.2±1.5	48.1±1.5#	48.9±1.7#	47.6±1.7#	0.6	7.4*
Chest circ(cm)	52.6±2.3	51.4±1.9	53.4±2.9	53.2±3.1	54.1±3.9	52.7±2.7	53.3±3.1#	52.4±2.7#	2.4	4.9*
Upper Arm circ (cm)	14.6±0.7	14.4±0.9	14.8±0.9	14.9±1.1	14.9±1.1	15.1±0.7	14.8±0.9	14.8±1.0	1.3	6.2*

*Significant at $p<0.05$ for ANOVA

Significant at $p<0.05$ for t-test.

Table 2. Correlation between Various Anthropometric Variables by Age and Sex among Children of Panchkula City.

AGE GROUPS / VARIABLES	6 YEARS		7 YEARS		8 YEARS		TOTAL	
	BOYS(48)	GIRLS(43)	BOYS(49)	GIRLS(41)	BOYS(36)	GIRLS(36)	BOYS (133)	GIRLS(120)
Height (cm)								
Weight (kg)	0.749*	0.835*	0.852*	0.722*	0.823*	0.779*	0.814*	0.808*
Head Circ (cm)	0.335*	0.538*	0.364*	0.359*	0.325	0.143	0.343*	0.467*
Chest Circ (cm)	0.492*	0.542*	0.581*	0.574*	0.649*	0.531*	0.588*	0.565*
Upper Arm Circ (cm)	0.376*	0.514*	0.557*	0.610*	0.674*	0.435*	0.548*	0.596*
BMI	-0.076	-0.075	0.183	-0.068	0.308	0.139	0.066	-0.085
Weight (kg)								
Head Circ (cm)	0.595*	0.417*	0.431*	0.511*	0.496*	0.161	0.489*	0.464*
Chest Circ (cm)	0.209	0.456*	0.473*	0.434*	0.672*	0.522*	0.519*	0.509*
Upper Arm Circ (cm)	0.388*	0.592*	0.589*	0.677*	0.853*	0.707*	0.656*	0.691*
BMI	0.601*	0.480*	0.664*	0.627*	0.781*	0.725*	0.621*	0.508*
Head Circ (cm)								
Chest Circ (cm)	0.056	0.168	0.121	0.012	0.086	-0.014	0.099	0.128
Upper Arm Circ (cm)	0.112	0.298	0.450*	0.320	0.424*	0.043	0.341*	0.325*
BMI	0.501*	-0.112	0.271	0.304	0.557*	0.117	0.408*	0.094
Chest Circ (cm)								
Upper Arm Circ (cm)	0.091	0.451*	0.572*	0.527*	0.632*	0.446*	0.511*	0.512*
BMI	-0.268	-0.001	0.062	0.004	0.350*	0.248	0.052	0.049
Upper Arm Circ (cm)								
BMI	0.145	0.263	0.329*	0.262	0.648*	0.642*	0.360*	0.287*

*Significant at $p<0.05$.

Table 3. Means and Standard Deviations of Z-Scores by Age and Sex for Anthropometric indicators of nutritional status in Children of Panchkula City.

INDICES	6 years			7 years			8 years			TOTAL			ANOVA (F- VALUES)	
	B (48) Mean±S.D.	G (43) Mean±S.D	C (91) Mean±S.D	B (49) Mean±S.D	G (41) Mean±S.D	C (90) Mean±S.D	B (36) Mean±S.D	G (36) Mean±S.D	C (72) Mean±S.D	B (133) Mean±S.D	G (120) Mean±S.D	C (253) Mean±S.D	B	G
Height-for-age	-0.7±1.2	-1.3±1.1	-1.02±1.2#	-0.9±1.3	-1.1±1.2	-0.9±1.3	-1.1±1.2	-1.3±0.9	-1.2±1.1	-0.9±1.2	-1.2±1.1	-1.1±1.2#	0.87	0.07
Weight-for-age	-1.04±1.0	-1.4±0.8	-1.2±0.9#	1.3±1.2	-1.4±1.1	-1.4±1.2	-1.7±1.2	-1.3±2.8	-1.5±2.2	-1.3±1.2	-1.4±1.7	-1.4±1.4	3.6*	0.8
BMI-for-age	-0.8±1.04	-0.9±0.7	-0.8±0.9	-1.1±1.1	-1.2±1.1	-1.1±1.1	-1.5±1.2	-0.7±3.6	-1.1±2.6	-1.1±1.1	-0.9±2.1	-1.5±1.6	3.8*	0.4

*Significant at p<0.05 for ANOVA. # Significant at p<0.05 for t-test. B = Boys; G = Girls; C = Combined

Table 4. Percentage Prevalence of Malnutrition in Children of Panchkula City by Age and Sex.

Anthropometric Indices	6 years			7 years			8 years			Age total		Grand Total (253)
	B (48)	G (43)	C (91)	B (49)	G (41)	C (90)	B (36)	G (36)	C (72)	B (133)	G (120)	
Height-for-age (Stunting)	N %	N %	N %	N %	N %	N %	N %	N %	N %	N %	N %	N %
>-1 SD (Normal)	27(56.2)	15(34.9)	42(46.2)	26(53.2)	20(48.8)	46(51.1)	18(50)	11(30.6)	29(40.3)	71(53.4)	46(38.3)	117(46.2)
-1 to -1.9 SD (Mild)	13(27.1)	20(46.5)	33(36.2)	14(28.5)	13(31.7)	27(30)	11(30.6)	16(44.4)	27(37.5)	38(28.6)	49(40.8)	87(34.4)
-2 to -2.9 SD (Moderate)	6(12.5)	5(11.6)	11(12.1)	6(12.2)	6(14.6)	12(13.3)	5(13.9)	9(25)	14(19.4)	17(12.8)	20(16.7)	37(14.7)
-3 and less (Severe)	2(4.2)	3(7)	5(5.5)	3(6.1)	2(4.9)	5(5.6)	2(5.5)	0(0)	2(2.8)	7(5.2)	5(4.2)	12(4.7)
Weight-for-age (Underweight)												
>-1 SD (Normal)	24(50)	12(27.9)	36(39.6)	22(44.9)	16(39)	38(42.2)	10(27.7)	7(19.4)	17(23.6)	56(42.1)	35(29.2)	91(35.9)
-1 to -1.9 SD (Mild)	16(33.3)	19(44.2)	35(38.4)	16(32.7)	12(29.3)	28(31.1)	11(30.6)	15(41.7)	26(36.1)	43(32.3)	46(38.3)	89(35.2)
-2 to -2.9 SD (Moderate)	6(12.5)	10(23.3)	16(17.6)	6(12.2)	8(19.5)	14(15.6)	9(25)	10(27.8)	19(26.4)	21(15.8)	28(23.3)	49(19.4)
-3 and less (Severe)	2(4.2)	2(4.6)	4(4.4)	5(10.2)	5(12.2)	10(11.1)	6(16.7)	4(11.1)	10(13.9)	13(9.8)	11(9.2)	24(9.5)
BMI-for-age (Wasting)												
>-1 SD (Normal)	27(56.2)	25(58.1)	52(57.1)	25(51.1)	18(43.9)	43(47.8)	11(30.6)	15(41.7)	26(36.1)	63(47.4)	58(48.4)	121(47.8)
-1 to -1.9 SD (Mild)	17(35.4)	15(34.9)	32(35.2)	15(30.6)	13(31.7)	28(31.1)	13(36.1)	14(38.9)	27(37.5)	45(33.8)	42(35)	87(34.4)
-2 to -2.9 SD (Moderate)	2(4.2)	3(7)	5(5.5)	6(12.2)	9(22)	15(16.7)	7(19.4)	4(11.1)	11(15.3)	15(11.3)	16(13.3)	31(12.3)
-3 and less (Severe)	2(4.2)	0(0)	2(2.2)	3(6.1)	1(2.4)	4(4.4)	5(13.9)	3(8.3)	8(11.1)	10(7.5)	4(3.3)	14(5.5)

B = Boys; G = Girls; C = Combined

Table 5. Comparison of Body Mass Index and Various Circumferences of the Children of the present study with Children of different studies.

Age Groups	6 Years		7 Years		8 Years	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
BMI						
Present Study	14.3	14.1	14.2	13.9	13.9	13.7
Agarwal et al. (2001)	14.7	14.3	14.8	14.6	14.8	14.9
Khadilkar et al. (2009)	15	14.6	15.4	15.1	15.8	15.6
WHO (2007)	15.3	15.3	15.5	15.4	15.7	15.7
Head Circumference(cm)						
Present Study	48.8	46.9	48.7	48.1	49.2	48.1
Agarwal et al. (1992)	50.7	49.5	50.9	49.9	51.2	50.3
Talwar et al. (2007)	48.2	48.2	49.2	47.8	48.5	47.5
Gaur et al. (1995)	49.5	49.4	49.6	49.5	50.4	49.7
Chest Circumference(cm)						
Present Study	52.6	51.4	53.4	53.2	54.1	52.7
Agarwal et al. (1992)	55.1	53.2	55.8	54.5	57.5	56
Talwar et al. (2007)	52.1	50.3	54.5	50.7	55.1	53.2
Gaur et al. (1995)	54.6	52.5	55.1	54.8	55.6	55.8
Upper Arm Circumference(cm)						
Present Study	14.6	14.4	14.8	14.9	14.9	15.1
Agarwal et al. (1992)	16	15.9	16.1	16.2	16.3	16.8
Talwar et al. (2007)	13.9	14.3	14.6	14.2	14.6	15.4
Gaur et al. (1995)	14.3	14.4	14.7	14.8	15.04	15.3

Table 6. Prevalence of Undernutrition in Children of Different Studies compared with Children of Panchkula City (Haryana).

Studied children (Name & Year of Study)	District	State	Age Group	Sample Size	Underweight (%)	Stunting (%)	Wasting (%)
Rural Meitei Children (Gaur &Singh 1994)	Bishenpur	Manipur	5-11	301	26.3	28.6	1.7
Punjabi Scheduled Caste Children (Gaur et al. 1995)	Ropar	Punjab	6-12	436	49.5	27	31.8
School-going Children (Medhi et al. 2006)	Dibrugarh	Assam	6-8	302	51.7	47.4	21.1
Scheduled Caste Children (Talwar et al. 2007)	Ambala	Haryana	6-12	299	28.6	28.2	13.5
Santal Children (Chowdhury et al.2008)	Puruliya	West Bengal	5-12	442	33.7	17.8	29.4
Army school Children (Mukherjee et al. 2008)	Pune	Maharastra	5-11	760	9.8	13.8	6.7
Jenukuruba Children (Prabhakar & Gangadhar 2009)	Mysore	Karnataka	6-10	135	60	46	30.4
Kora-Mudi Children (Bisai & Mallick 2011)	Paschim Medinipur	West Bengal	6-13	72	47.2	48.6	19.4
Urban Slum Children (Srivastava et al. 2012)	Bareilly	Uttar Pradesh	5-15	384	38.4	19.9	33.3
School-going Children (Fazili et al. 2012)	Bandipora	Jammu and Kashmir	5-14	940	11.1	9.3	12.3
School-going Children (Sati & Dahiya 2012)	Hissar	Haryana	7-9	200	55.5	54.1	_
School-going Children (Kumar et al 2014)	Fatehabad	Haryana	6-10	397	63.9	48.6	63.5
Present Study	Panchkula	Haryana	6-8	253	28.8	19.4	17.8

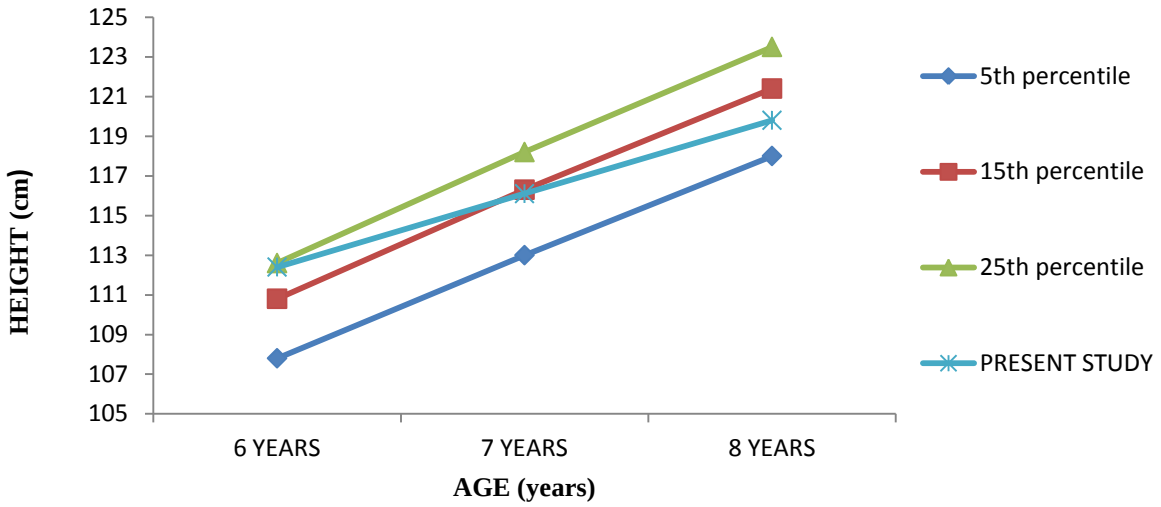

Figure 1 (a) Comparision of Height of boys of Present study with WHO (2007) Standards

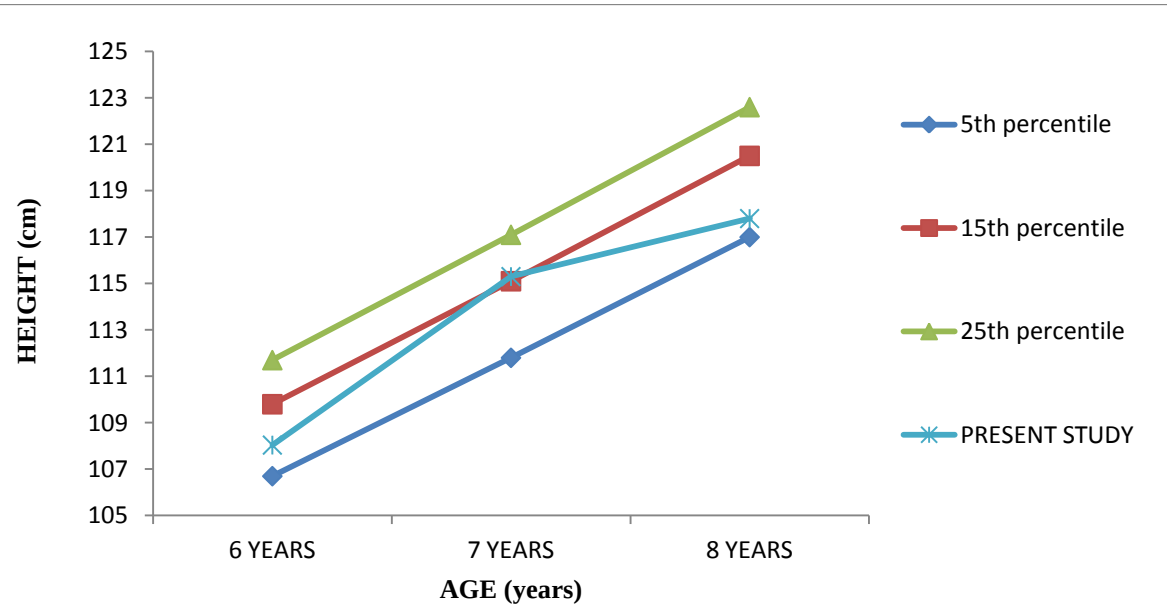

Figure 1 (b) Comparision of Height of girls of Present study with WHO (2007) Standards

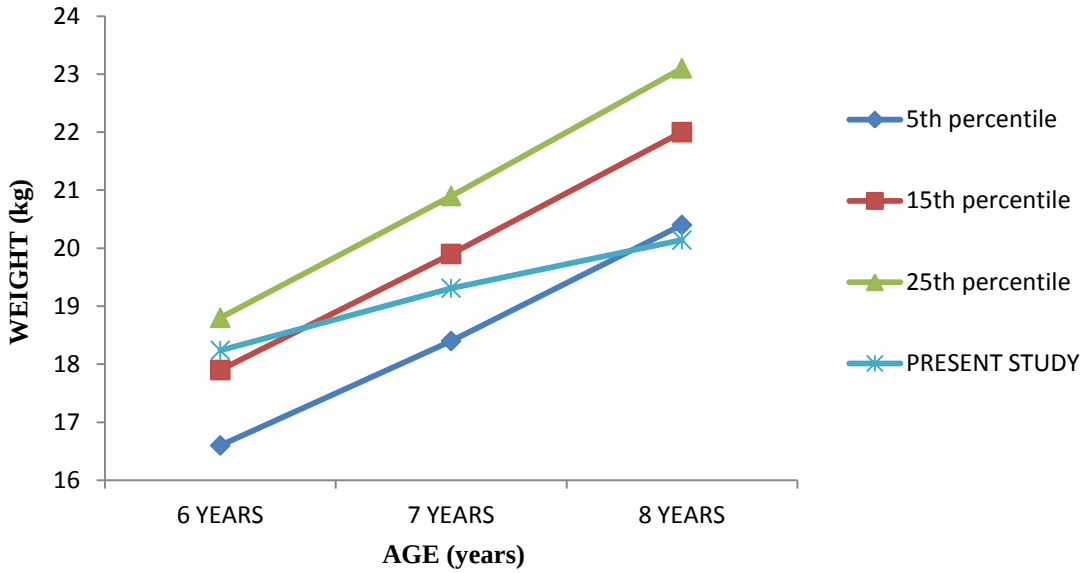

Figure 2(a) Comparision of Weight of boys of Present study with WHO (2007) Standards

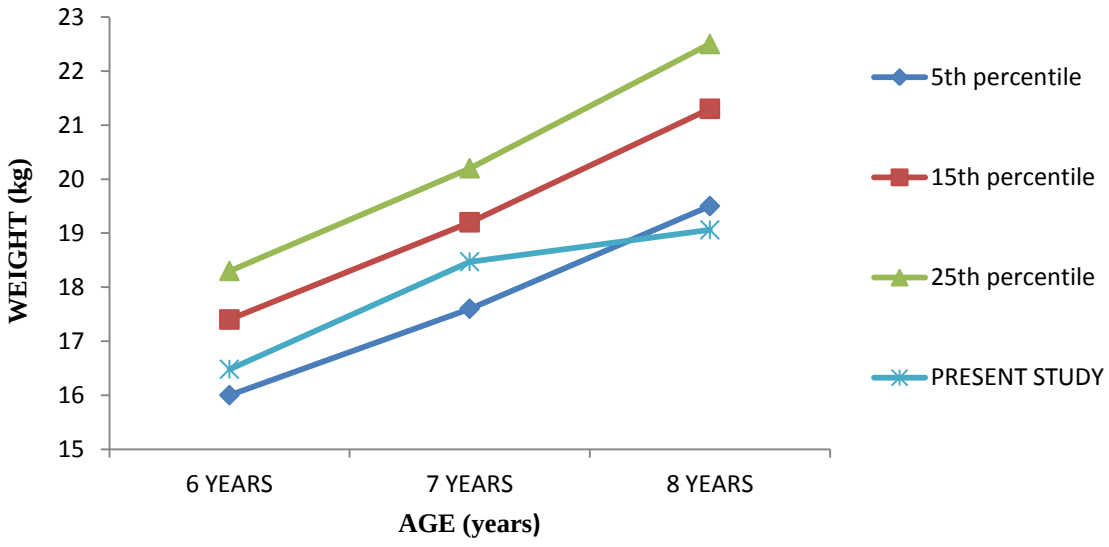

Figure 2 (b) Comparision of Weight of girls of Present study with WHO (2007) Standards

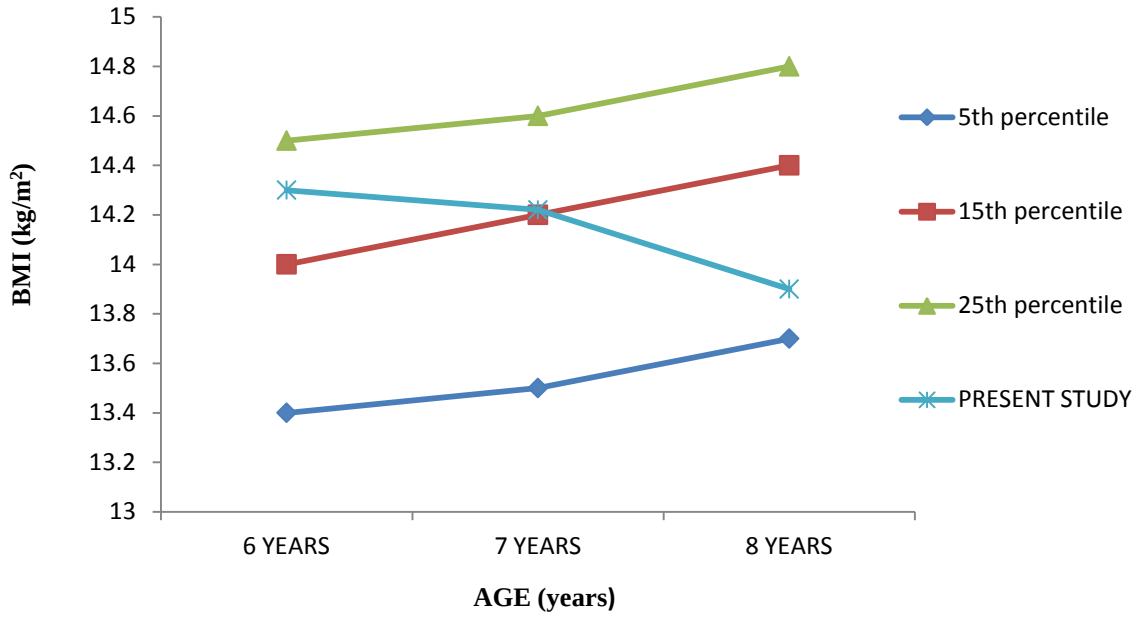

Figure 3(a) Comparision of BMI of boys of present study with WHO (2007) Standards

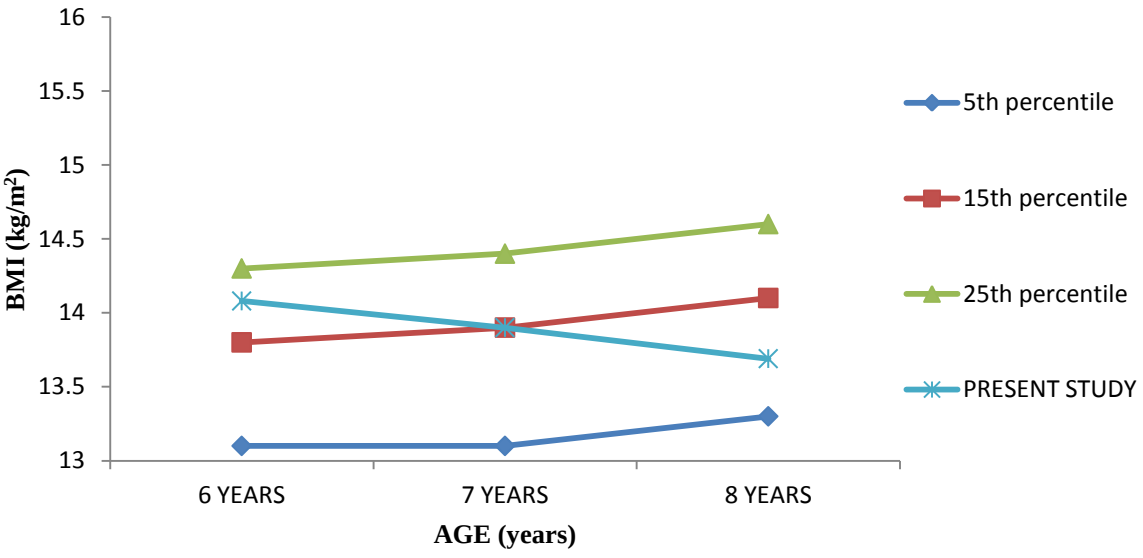

Figure 3 (b) Comparision of BMI of girls of present study with WHO (2007) Standards

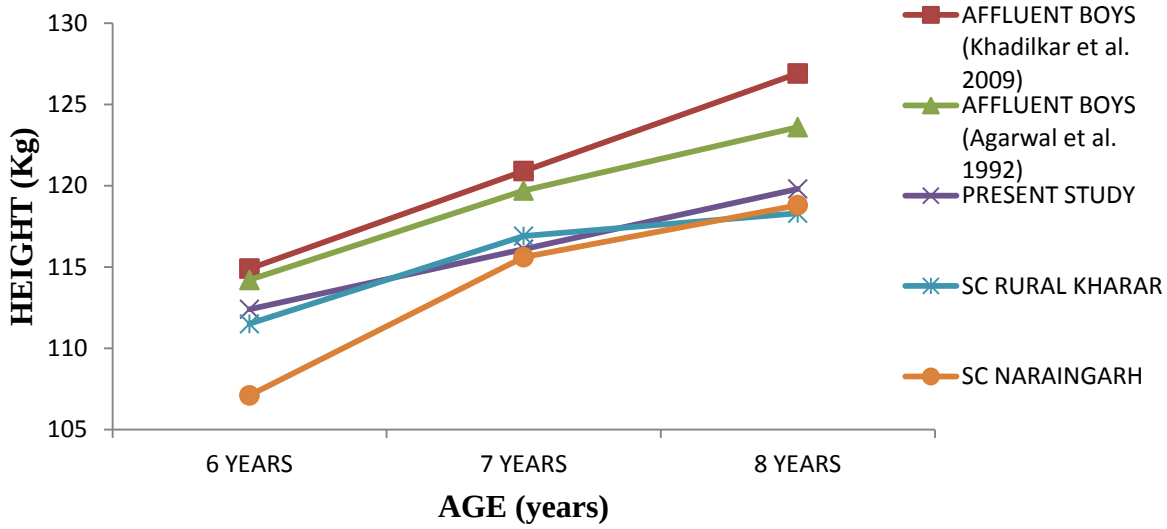

Figure 4 (a) Comparison of Height of Boys of Panchkula City with Affluent Indian Children (Khadilkar et al. 2009; Agarwal et al. 1992), Scheduled Caste Rural Boys (Gaur et al. 1995), Scheduled Caste Naraingarh Boys (Talwar et al.2007).

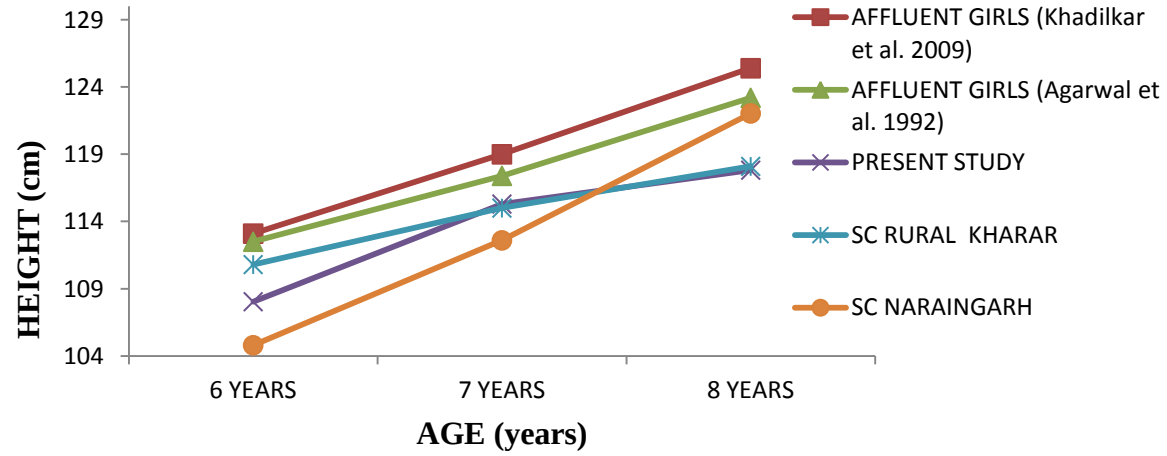

Figure 4 (b) Comparison of Height of Girls of Panchkula City with Affluent Indian Children(Khadilkar et al. 2009; Agarwal et al. 1992), Scheduled Caste Rural Girls (Gaur et al. 1995) and Scheduled Caste Nariangarh Girls (Talwar et al. 2007).

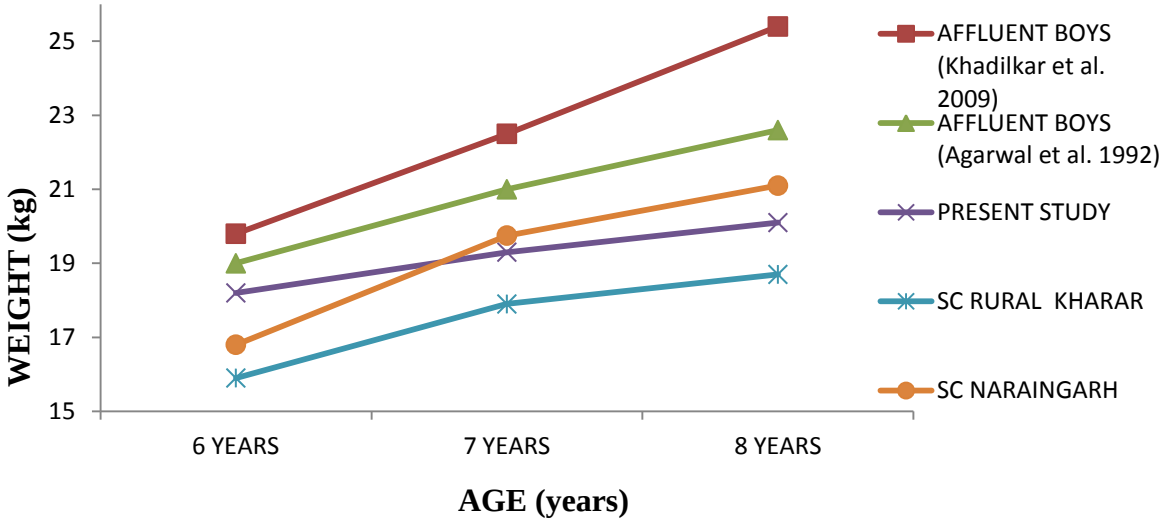

Figure 5 (a)Comparison of Weight of Boys of Panchkula with Affluent Indian Children (Khadilkar et al. 2009, Agarwal et al. 1992), Scheduled Caste Rural Boys (Gaur et al. 1995), Scheduled Caste Naraingarh Boys (Talwar et al.2007).

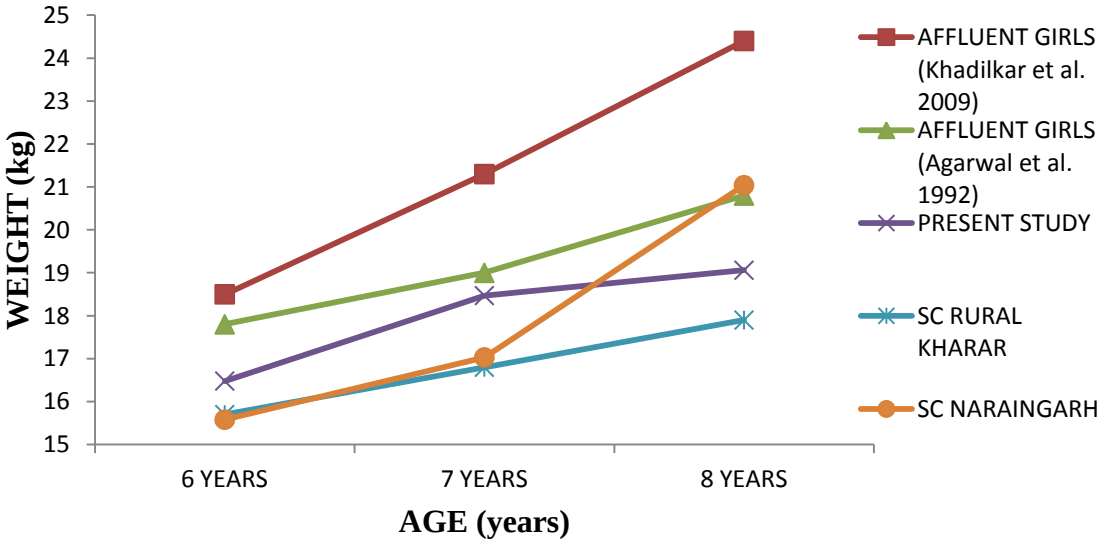

Figure 5 (b) Comparision of Weight of Girls of Panchkula with Affluent Indian Children (Khadilkar et al. 2009, Agarwal et al. 1992), Scheduled Caste Rural Girls (Gaur et al. 1995) and Scheduled Caste Nariangarh Girls (Talwar et al. 2007).