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Original article

Use of mid upper arm circumference and head circumference as indicators of pre-pubertal growth in school going children with different socioeconomic status in an urban area.

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ABSTRACT

Background:

Children from both urban and rural areas in our country suffer from delay in growth and development due to a compromised socioeconomic status. Body weight, height and BMI are generally performed to assess growth and development during their pre-pubertal growth. In spite of high accuracy and high performance acceptability, mid upper arm circumference (MUAC), head circumference (HC) and sitting heights are seldom used as markers of pre-pubertal growth in school going children.

Materials & methods:

The present study was undertaken as a cross sectional study for assessing the effectivity of MUAC, HC and sitting height and to compare them with the classical growth markers like body weight and general height of the school going children of an urban area. All these variables were measured using standardised techniques in 400 school going children, 200 children each in high socioeconomic group and middle-low socioeconomic groups. All students were in 6-8 years of age.

Results:

Body weight, height and MUAC were found significantly lower in the middle-low socioeconomic group. No differences were observed in sitting height and HC between the two groups. Pearson correlation analysis revealed that MUAC was significantly associated with body weight in middle-low socioeconomic group whereas HC and sitting height were positively correlated to body weight and height in both groups.

Conclusion:

MUAC was a better indicator than HC and sitting height for assessing the difference in pre-pubertal growth between the high and middle-low socioeconomic groups of children. Brain development as indicated by the HC, and sitting height both showed direct association with increase in body weight and height in the pre-pubertal growth period of children irrespective of their socioeconomic status. However, the muscle mass and fat content of the body as indicated by the MUAC, was found to be directly associated with the body weight only in the pre-pubertal growth period of middle-low socioeconomic group of children.

INTRODUCTION

LDL-cholesterol (LDLc) is implicated as one of major risk factor in the development of coronary heart disease. It is the primary basis for diagnosis, treatment and risk classification of patients with hyperlipidaemia [1,2]. Estimation of LDLc with accuracy and precision is of paramount importance in coronary heart disease. Reference method for estimation of serum LDLc is by β-quantitation procedure (BQ) [3] by ultracentrifugation technique. However, the procedure is time consuming, expensive, requires large volume of serum and is not available in routine laboratories. The two commonly used methods used in clinical laboratories for quantification of LDLc by Friedewald's formula and by direct homogeneous assays for LDLc measurement.

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A balanced an adequate diet is necessary for the normal growth and development of a child. However, variations in socioeconomic status and cultures have influenced the availability of a balanced and nutritious diet for children throughout the world significantly through ages[1]. Changes in socioeconomic status are reflected in quality and calories of food which finally determine the cardinal nutritional indicators like body weight, height etc.[2-5] Apart from the body weight and height, cognitive development has also been influenced significantly by the nutritional and socioeconomic status. In India, a significant association has been reported between the socioeconomic status dependent food access and markers of nutritional status in huge parts of rural India, who had poor quality of food, particularly high sugar and fat in place of adequate amount of protein that prevailed in their predominant vegetarian food intake[6]. In West Bengal, Chowdhuri et al (2011) reported a significant link between the cognitive development in growing children with their socioeconomic and nutritional status among some tribal groups[7]. Head circumference (HC) has been found to vary according to the socioeconomic status in some school going children in countries like Chile [8]. In another large scale study undertaken in Mexico sitting height was reported as one of the major indicators that varied in the school going children of 6-12 years of age according to their socioeconomic and nutritional status[9]. Mid upper arm circumference (MUAC) is another important anthropometric marker that is measured in the left arm at its upper region at the mid-point between the tip of the shoulder and the tip of the elbow (olecranon process and the acromium). In comparison to the body mass index (BMI) it has been reported as a better marker for nutritional assessment in the context of its easier technique, lack of instrumentation and widespread applicability among the children. Hence, it has been widely used as a screening procedure for nutritional assessment in children world wide even in chronic malnourishing disorders like tuberculosis and immune deficiency disorders[10].

The worldwide problem of undernutrition in children becomes substantial in India because it has almost 21% of its total population in adolescent age group [11]. Along with the rural parts of the country, its urban areas are also significantly prone to the problem of undernutrition in adolescent or school going children. In one study undertaken in the school children in the urban part of Puduchhery, the prevalence of undernutrition was reported to be as high as 33.3%[12]. As this particular age in children is essentially associated with their pre-pubertal growth spurt so any lack of appropriate nutrition due to prevalent causes including a compromised socioeconomic status may lead to an early delay in growth and development that later becomes clinically relevant and irreversible.

Keeping these factors in mind, it is evident that along with the rural areas, urban areas of the country are also harbouring significant numbers of children with a risk of under-nutrtion related growth delay. Hence, it is necessary to detect them at an early phase using sensitive nutritional markers that are easy to perform at a wider scale. Other than body weight and general height, HC, sitting height and MUAC are sensitive nutritional markers which can be easily performed at wide scale consuming lesser time. The investigators for the present study, however, found few studies related to the comparison of the pre-pubertal growth period in school going children in urban areas of West Bengal using the indicators like HC, sitting height and MUAC which are very cost effective and easy to perform in almost every condition. Hence, the hypothesis for the present study was proposed that these indicators can be used as effective indicators for nutritional assessment and their pre-pubertal growth in school going children in urban conditions and be well correlated to the other common established nutritional markers like their body weights and heights.

METHODOLOGY:

i. Study design and sample size determination: The present cross sectional study was undertaken in an urban setup and was conducted in different schools in Kolkata and 400 (four hundred) children were selected between age groups 6 to 8 years from these schools. Sampling was done using a simple random sampling method. Considering the prevalence of undernutrition in school going children about 33% in urban areas[12], the sample size was calculated to be 354 using the formula : $n = (1.96)^2 \times p(1-p)/d^2$ where p is the prevalence of the disease and d is 5% i.e the margin of error. Keeping about 10% of children to be defaulter due to several reasons, the final number for the target study population was ascertained at 400 for the present study.

ii. Exclusion criteria: Any student suffering from any chronic illness, malnutrition or chronic deprivation were not included in this study as these conditions could interfere with the natural anthropometric measurements.

iii. Ethical consideration: Informed consents were obtained from the legal guardian of every student and the study was approved by the institutional ethics committee of the concerned institution.

iv. Techniques and measurements: All anthropometric measurement were done by standardized techniques. Body weight was measured in Kg by beam balance nearest to 25 g. Both sitting height and general heights were measured in cms using stadiometer nearest to the 0.5 cm. HC and MUAC were both measured using fibre glass measuring tape nearest to the 0.5 cm. Socioeconomic status of the children was ascertained using the modified Kuppuswami scale[13].

v. Statistical calculations: Data obtained were first analyzed for their pattern of distribution using the Smirnov-Kolmogrov's statistical analysis. Results of this analysis indicated that the data obtained followed more or less the normal distribution pattern. Difference in mean values were obtained using independent t test. Strength of association between the study variables were assessed using the Pearson's bivariate correlation analysis. For all statistical analyses the confidence interval was considered to be 95% and the significance level was considered at $P < 0.05$. All statistical measurements were carried out by SPSS software for Windows.

RESULTS:

Table 1 showed the difference in mean values of the study variables high socioeconomic and middle-low socioeconomic children of 6 – 8 years age. An insignificant P value of 0.675 for the age showed that the two groups were age matched. Significant differences were observed in the body weight, height and MUAC between the high and middle-low socioeconomic status children, the later showing the lowered values. However, no significant differences were observed in sitting height and HC between the two groups.

Table 1: Independent t test results showing difference in mean values of study variables between the high economic status (HES) children and middle-low economic status (MLES) groups of children:

	HES Mean (SD). n = 200	MLES Mean (SD). n = 200	t value	P value
Age in years	7.01 (0.83)	7.04 (0.80)	-0.42	0.675
Weight in kg	23.25 (2.31)	20.10 (2.63)	12.7	<0.001
Height in cm	121.06 (4.34)	117.57 (5.08)	7.36	<0.001
HC in cm	49.97 (2.52)	49.53 (3.61)	1.38	0.167
Sitting height in cm	63.27 (9.96)	62.4 (4.78)	1.08	0.282
MUAC in cm	14.88 (1.70)	14.27 (1.06)	4.33	<0.001

P value considered to be significant at P < 0.05 for 95% confidence interval.

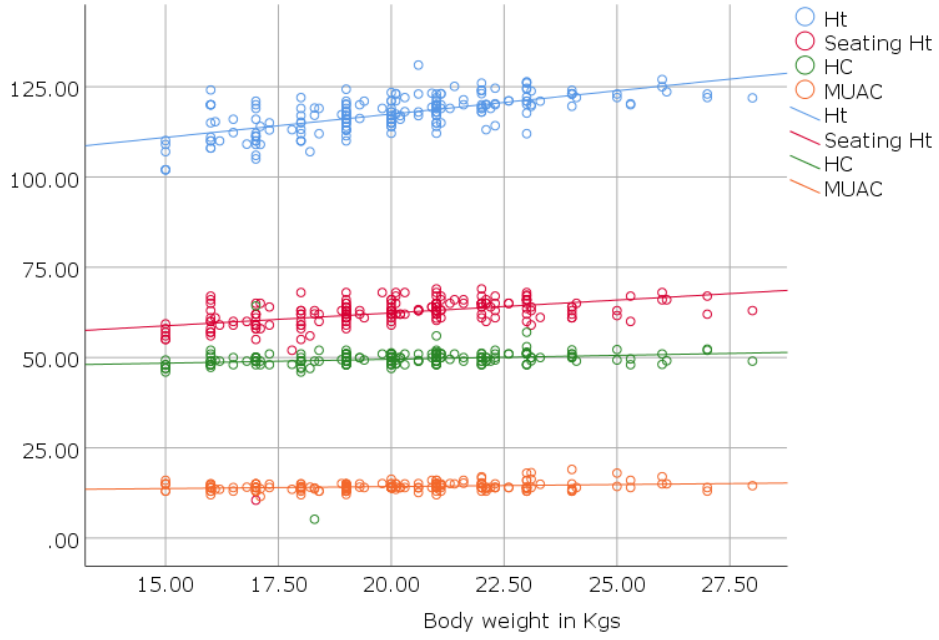
One of the major aims of the study was to compare the effectivity of HC, sitting height and MUAC with the body weight and height as standard anthropometric markers of growth and undernutrition. In table 2, the association of these variables have been shown using the Pearson's bivariate correlation analysis for the middle-low socioeconomic group of children. Data showed that among the middle-low group of children their HC and sitting height were significantly associated with their body weights and heights, whereas their MUAC showed a positive association with their body weights only. However, HC in these children showed no significant association with either their sitting height or MUAC although the later two showed a definite positive correlation between them. Details of these data analyses has been expressed in Figure 1 with individual data as dots and their average trend as the straight line regressing among them.

Table 2: Pearson bivariate correlation analysis showing the strength of association between study variables in the Middle lower socioeconomic group of children:

	Body wt: Correlation coefficient (P value)	Height: Correlation coefficient (P value)	Sitting height: Correlation coefficient (P value)	Head circumference: Correlation coefficient (P value)	Mid upper arm circumference: Correlation coefficient (P value)
Body wt	-	.669 (.000)*	.392(.000)*	.157(.025)*	.273(.000)*
Height	.669 (.000)*	-	.480(.000)*	.317(.000)*	.002(.974)
Sitting height	.392 (.000)	.480 (.000)	-	.055(.433)	.139(.048)
Head circumference	.157(.025)*	.317 (.000)*	.055(.433)	-	.130 (.068)
Mid upper arm circumference	.273(.000)*	.002(.974)	.139(.048)*	.130 (.068)	-

P value considered to be significant at P < 0.05 for 95% confidence interval.

Figure 1: Scatterplot showing the relationship of different growth and nutritional markers with body weight in children in middle-low socioeconomic group.



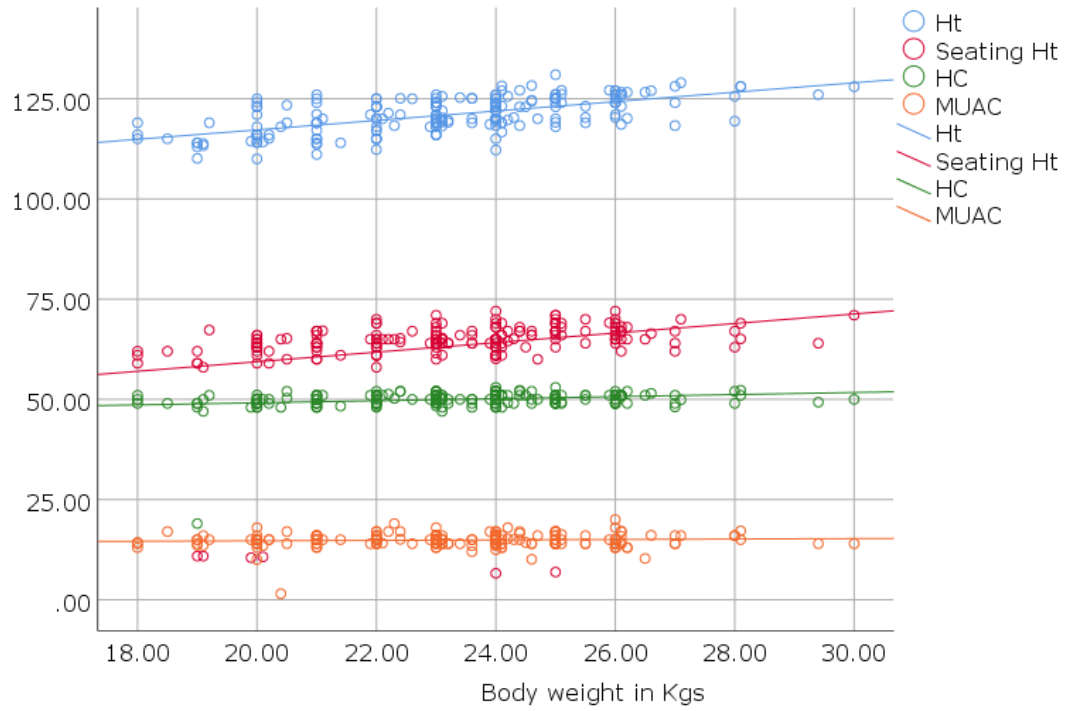
Data in table 3 showed similar assessments for the strength of association between the study variables in the children of high socioeconomic status. Both HC and sitting height of these children also showed significant positive association with their body weights and heights. But, no significant association was observed between their MUAC and their body weights, heights, sitting heights and HC. Details of these data analyses has been expressed in Figure 2 with individual data as dots and their average trend as the straight line regressing among them.

Table 3: Pearson bivariate correlation analysis showing the strength of association between study variables in the higher socioeconomic group of children:

	Body wt: Correlation coefficient (P value)	Height: Correlation coefficient (P value)	Sitting height: Correlation coefficient (P value)	Head circumference: Correlation coefficient (P value)	Mid upper arm circumference: Correlation coefficient (P value)
Body wt	-	.626 (.000)*	.277(.000)*	.236(.001)*	.076(.287)
Height	.626 (.000)*	-	.305(.000)*	.317(.000)*	.002(.974)
Sitting height	.277 (.000)*	.305 (.000)*	-	.393(.000)*	.023(.747)
Head circumference	.236 (.001)*	.317 (.000)*	.393 (.000)*	-	.130 (.068)
Mid upper arm circumference	.076(.287)	.002(.974)	.023(.747)	.130 (.068)	-

P value considered to be significant at $P < 0.05$ for 95% confidence interval.

Figure 2: Scatterplot showing the relationship of different growth and nutritional markers with body weight in children in high socioeconomic group.



DISCUSSION:

The present study included two groups of school children of 6 to 8 yrs of age. Groups were ascertained according the socioeconomic status of the children. Based on the Kuppuswamy indices these groups were ascertained as high socioeconomic and middle-low socioeconomic groups. The major aim of the study was to ascertain whether the HC, sitting height and MUAC could show a good association with the body weight and height and hence they could be used as good markers of nutritional status in school going children as well as the classical nutritional indicators like body weight and height.

The table 1 showed the distribution of average value of the study variables in both groups which were matched for their age (P = .675). As expected body weight and height showed a significantly higher values in the high socioeconomic group (P<0.001). On the other hand, their HC and sitting height values, albeit being a little more in high socioeconomic group, did not show any significant difference from the corresponding values in low socioeconomic group (P = .167 and .282 respectively). However, the MUAC value in the high socioeconomic group was found to be significantly higher (P < .001) in comparison to the middle-low socioeconomic group. These data revealed that mid upper arm circumference is a better indicator than the head circumference and sitting height for ascertaining the nutritional status between different socioeconomic groups. Previous studies have already established the role of MUAC as an effective indicator of whole body fat distribution and its robust association with the body mass index (BMI)[14]. As the upper arm is less affected by water accumulation and reflects the fat and muscle distribution of the body, in absence of edema it is supposed to be a more accurate indicator of the nutritional status than the other markers of nutrition[15].

When the strength of association between the variables were assessed, correlation results of table 2 and 3 showed somehow different outcomes. In middle-low socioeconomic group children their MUAC was found to show significant positive

association with their body weight and sitting height whereas in the high socioeconomic group it did not show significant positive correlation with any of the variables. Considering the data from table 1 and 2 it was evident that along with reduction of body weights in middle-low socioeconomic children their muscle mass and body fat were also reduced in comparison to their counterparts from high socioeconomic status. MAUC has been suggested as an effective indicator for development of muscle mass and body fat during the growth spurt period of children in previous studies also[16]. On the other hand, a significantly greater HC in the high socioeconomic group indicated better cognitive development in this group. Furthermore, significant association of HC and sitting height with the body weight and general height in both groups strongly indicated that cognitive development of the brain is closely linked to overall development in the BMI in both groups. Our findings are supported by reports like those from Bouthoorn et al (2012) that reported that along with nutritional issues, social factors as one of the major causes for lowering brain development[17]. These findings necessitate special remedial measures that can prevent children of middle-low socioeconomic status from a delayed physical and cognitive growth and development.

Considering all these data and facts from the present study, MUAC stands out to be more robust and effective marker than the HC and sitting height for assessing the growth and development in the context of nutritional and socioeconomic status in the school going children during their pre-pubertal growth period. However, as both HC and sitting height show a direct association with the body weight and height and hence the BMI, special precautions should be taken to prevent delayed physical and cognitive development in children falling under the middle-low socioeconomic group.

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