

Differences in hand measurements and intake of energy and macronutrients: One year study among preschool boys from Anganwadi and Kindergarten

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ABSTRACT

Hand measurements especially palm width and length are helpful in assessment of growth and hand grip strength of the children whereas mid upper arm circumference (MUAC), forearm circumference (FC) and wrist circumference (WrC) determine body frame size of children. These measurements vary with nutrient intake especially macronutrients. This study deals with the differences in hand measurements of preschool boys aged 3-5 years from anganwadi (AW) and kindergarten (KG). Total 150 boys from age group 3+, 4+, and 5+ years from well known AW and KG from Nagpur city were studied purposively. Anthropometric measurements like height, weight, mid upper arm circumference (MUAC), forearm circumference (FC), wrist circumference (WrC), arm length, palm width, palm length and hand span were measured at 0, 6 and 12 months of study period of one year. Based on three day's dietary recall, nutrient intake of subjects was calculated at the beginning (0 month) and at the end (12 months) of the study period. Mean energy and protein intake of boys from KG from all age groups was found to be higher than boys from AW. Boys from KG had higher mean intake of energy and protein as compared to RDAs. Weight correlated positively with intake of energy of subjects. None of the age groups of KG boys were categorized as underweight. Age wise KG boys possessed wider and longer palms than AW boys; also greater mean values of MUAC, FC and WrC were observed in KG boys than AW boys.

Key Words : Hand measurements, Forearm, Wrist, Energy intake, Macronutrient intake, Dietary recall

INTRODUCTION

Growth refers to the positive change in size over a period of time in preschoolers. Preschool children represent the most nutritionally vulnerable group. Assessing growth, using anthropometric measures, not only serves as a means of evaluating the health and nutritional status of children but is also regarded as a sensitive indicator of differences in overall socio-economic development at a population level (<http://www.fao.org/docrep/008/y5825e/y5825e08.htm#>). In addition to weight, measuring body height and circumferences like upper arm would give more direct information on growth (www.unsystem.org/sen/archives/npp07/ch08.htm).

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MUAC is an important measurement which is often used for the assessment of nutritional status among preschool children. In community based studies, MUAC appears to be the superior predictor of childhood based anthropometric indicators. Hand grip strength of children can be determined by measuring palm width and length which also indicate growth pattern among preschoolers. Similarly, arm length is the most reliable method in predicting the height of the children whereas arm span is crucial in evaluation of body proportions.

Because children are growing and developing, they need more nutritious food in proportion to their size than do adults. They may be at risk for malnutrition when they have poor appetite for a long period, eat a limited number of foods or dilute their diets significantly with nutrient-poor foods. Children from lower income group have the poor nutritional status on almost every measure and the high prevalence of wasting in this group is of particular concern. A child's entire life is determined in large measures by the food given to her/him during her/his first five years. Childhood is a period of rapid growth and development and nutrition is one of the influencing factors in this period (Anuradha *et al.*, 2014). Present research was conducted to find out the differences in hand measurements and intake of energy and macronutrients among boys from AW and KG.

METHODOLOGY

Study area and sample selection:

For this study, total 300 boys from age group 3-5 yrs were selected from well known KG and AW schools from Nagpur city. Subjects were studied for one year *i.e.* during 0, 6 and 12 months of study period. Table 1 shows age wise classification of boys.

Table 1: Age wise classification of sample (N = 300)

Sr. No.	Age Group (years)	Subjects	
		AW	KG
1.	3+	50	50
2.	4+	50	50
3.	5+	50	50

Anthropometric measurements:

Anthropometric indices like height, weight, mid upper arm circumference (MUAC), forearm circumference (FC) and wrist circumference (WrC) as well as arm length, palm width, palm length and hand span were measured using standard procedures and equipments. Comparisons were done with reference standards for age (National Nutrition Monitoring Bureau/NIN/ICMR, 2002 and Indian Nutrition Profile, 1998).

Nutrient intake:

24 hour's dietary recall was used to collect three day's dietary recall of subjects. Based on this, nutritive values (energy, carbohydrate, protein and fat) of diets of subjects were calculated using standard food value tables (Gopalan *et al.*, 2012). Nutrient intake of subjects was compared with recommended dietary allowances (RDAs) (National Institute of nutrition (NIN)/Indian Council of Medical Research (ICMR), 2009).

Statistical analysis:

Data was collected and tabulated. Mean, standard deviation, minimum, maximum and percentage

values were calculated. Within age group comparisons at the beginning and at the end of the study period were done using z test. Pearson's product moment coefficient of correlation was used to derive correlations. A level of significance was tested at 5% and 1%.

RESULTS AND DISCUSSION

Growth is one relevant indicator of a child's nutritional status and is a tool for assessing health and well-being of children (WHO, 1995). Child growth status is based on height, weight and age.

Table 2 shows data on height and weight of boys.

Table 2: Data on height and weight of boys for 0, 6 and 12 months of study period									
Sr. No.	Parameters	Anganwadi (AW)			Kindergarten (KG)			z Values#	
		0 Month	6 Month	12 Month	0 Month	6 Month	12 Month	During 0 month	During 12 month
I Height (cm)									
1		Age Group 3+ Yrs (n=50)			Age Group 3+ Yrs (n=50)			7.66*	12.0*
i	M±SD	85.22±5.22	86.83±4.73	90.11±4.03	93.22±5.22	96.85±4.72	100.86±4.86		
ii	Range	80.00-98.00	83.20-102.00	85.00-105.00	83.00-103.00	87.20-107.00	93.00-110.00		
iii	F Values§	14.14*			29.95*				
iv	Standard				99.10			-	-
v	%E/D	-	-	-9.07	-	-	+1.78	-	-
	(z Values†)				(15.80)			(2.56)	
2		Age Group 4+ Yrs (n=50)			Age Group 4+ Yrs (n=50)			7.92*	10.5*
i	M±SD	92.82±5.23	94.41±4.82	98.24±4.50	100.04±3.77	103.71±3.16	105.78±2.38		
ii	Range	85.00-102.00	88.20-105.40	90.00-107.00	90.00-108.00	93.00-109.00	95.00-113.00		
iii	F Values§	16.43*			42.45*				
iv	Standard				105.7			--	--
v	%E/D	-	-	-7.06	-	-	+0.08	-	-
	(z Values†)				(11.70)			(0.24)	
3		Age Group 5+ Yrs (n=50)			Age Group 5+ Yrs (n=50)			5.28*	9.22*
i	M±SD	99.04±3.77	102.71±3.16	104.48±2.17	102.71±3.16	105.48±2.17	108.48±2.17		
ii	Range	90.00-106.00	93.00-109.00	95.00-110.00	99.00-109.00	106.00-113.00	110.00-115.00		
iii	F Values§	39.95*			64.38*				
iv	Standard				111.5			-	-
v	%E/D	-	-	-6.30	-	-	-2.71	-	-
	(z Values†)				(22.90)			(9.84)	
II Weight (kg)									
1		Age Group 3+ Yrs (n=50)			Age Group 3+ Yrs (n=50)			25.7*	29.2*
i	M±SD	10.50±1.03	10.90±0.93	11.50±0.93	15.80±1.03	16.43±0.93	16.93±0.93		
ii	Range	8.00-11.00	8.00-11.20	8.20-11.70	11.40-18.00	11.60-18.50	11.80-19.00		
iii	F Values§	13.62*			17.23*				
iv	Standard				15.1			-	-
v	%E/D	-	-	-22.30	-	-	+14.39	-	-
	(z Values†)				(25.10)			(16.20)	
2.		Age Group 4+ Yrs (n=50)			Age Group 4+ Yrs (n=50)			23.7*	30.1*
i	M±SD	12.40±1.22	12.60±1.17	12.90±1.17	17.27±0.79	18.16±0.75	18.90±0.79		
ii	Range	8.30-12.60	8.50-12.90	9.00-13.20	12.80-18.00	13.00-18.55	13.20-19.00		
iii	F Values§	2.25			55.18*				
iv	Standard				14.8			-	-
v	%E/D	-	-	-21.82	-	-	+14.55	-	-
	(z Values†)				(21.80)			(21.48)	

Table 2 contd...

Contd... Table 2

3.		Age Group 5+ Yrs (n=50)			Age Group 5+ Yrs (n=50)			29.0*	33.4*
		M±SD	12.40±0.79	13.16±0.75	14.30±0.61	17.16±0.75	17.30±0.61		
ii	Range	10.00-13.80	10.20-13.90	10.30-14.60	13.80-19.55	14.00-20.60	14.40-20.00		
iii	F Values§		9.32*			96.19*			
iv	Standard			14.6				-	
v	% E/D (z Values†)	-	-	-21.43 (45.20)	-	-	+4.07 (6.80)	-	-

E/D - Excess/Deficit; § - F values are for within group comparison (*i.e.* comparison between data taken during 0, 6 and 12 months of the study period); # - z values are for between group comparison (*i.e.* for comparison between data of subjects from Anganwadi and Kindergarten during 0 month and during 12 month); † - z values are for comparison between mean values during 12 months of the study period and standards; * - Significant at both 5 % and 1% levels ($p < 0.01$); ** - Significant at 5 % level but insignificant at 1 % level ($0.01 < p < 0.05$); Values without any mark indicate insignificant difference at both 5% and 1% levels ($p > 0.05$).

Growth refers to a positive change in size, and/or maturation, often over a period of time (<https://en.wikipedia.org/wiki/Growth>, retrieved on-19/9/2016) and height is a first sign of growth in preschoolers.

Results from Table 2 clearly depict that boys from KG (age groups 3+, 4+ and 5+ yrs) were taller and heavier than boys from AW (age groups 3+, 4+ and 5+ yrs). Boys from KG (age groups 3+, 4+ and 5+ yrs) surpassed the standard reference values of height for age indicating influence of income level and nutritional habits on height. In contrast, mean values of height of boys from AW (age groups 3+, 4+ and 5+ yrs) were found below the standard reference values of height for age. Height is genetically affected but also nutritionally influenced. Similarly, Kavosi *et al.* (2014) also identified in their study that stunting was significantly associated with lower family income and lower maternal education among under 6 yrs old Iranian children.

For this research, annual increase in the height for 3+, 4+ and 5+ yrs was of 4.89, 5.42 and 5.44 cm for AW boys and 7.64, 5.74 and 5.77 cm for KG boys, respectively. Annual gain in the weight for 3+, 4+ and 5+ yrs was of 1, 0.5 and 1.9 kg for AW boys and 1.13, 1.63 and 1.78 kg for KG boys, respectively.

Table 3 show data on body circumferences (MUAC, FC and WrC) of boys.

Table 3: Data on body circumferences of boys for 0, 6 and 12 months of study period					
Sr. No.	Parameters	Boys			z Values#
		Anganwadi(AW)	Kindergarten(KG)		
I		Mid Upper Arm Circumference (MUAC) (cm)			
1.		Age Group 3+ Years			
i	0 Month	10.60±1.00(8.00-12.00)	12.76±0.90(10.50-14.10)	15.7*	
ii	6 Month	11.03±1.00(8.50-12.50)	13.39±0.94(10.90-14.65)		
iii	12 Month	11.23±1.00(8.70-12.70)	14.19±0.88(11.55-15.00)		
iv	F Values§	4.18**	4.68**	-	
v	Standard		16.6	-	
vi	% E/D (z Values†)	-32.35 (39.40)	-14.52 (21.00)	-	
2.		Age Group 4+ Years			
i	0 Month	12.16±1.00 (10.00-14.00)	14.29±1.25 (12.00-17.00)	6.28*	
ii	6 Month	13.19±0.88 (10.20-14.50)	14.50±1.55 (12.20-18.40)		
iii	12 Month	13.29±1.04 (10.35-14.85)	14.91±1.50 (13.00-19.00)		

Table 3 contd...

Contd... Table 3

iv	F Values§	4.18**	4.68**	-
v	Standard		16.6	-
vi	% E/D	-32.35	-14.52	-
	(z Values †)	(39.40)	(21.00)	
2.		Age Group 4+ Years		
i	0 Month	12.16±1.00 (10.00-14.00)	14.29±1.25 (12.00-17.00)	6.28*
ii	6 Month	13.19±0.88 (10.20-14.50)	14.50±1.55 (12.20-18.40)	
iii	12 Month	13.29±1.04 (10.35-14.85)	14.91±1.50 (13.00-19.00)	
iv	F Values§	3.08**	3.56**	-
v	Standard		17.0	-
vi	% E/D	-21.82	-12.29	-
	(z Values †)	(27.30)	(11.30)	
3.		Age Group 5+ Years		
i	0 Month	13.50±0.94 (11.20-14.95)	14.90±1.63 (12.20-18.70)	2.59*
ii	6 Month	13.90±0.96 (11.25-15.10)	14.65±1.54 (12.65-18.80)	
iii	12 Month	14.65±1.05 (11.55-15.70)	15.32±1.50 (12.85-19.85)	
iv	F Values§	3.67**	3.39**	-
v	Standard		17.4	-
vi	% E/D	-15.80	-11.95	-
	(z Values †)	(22.60)	(12.60)	
II		Forearm Circumference (FC) (cm)		
1.		Age Group 3+ Years		
i	0 Month	9.18±0.98(9.00-11.10)	10.58±0.98(10.00-13.00)	5.08*
ii	6 Month	10.40±0.92(9.70-11.10)	11.10±0.92(10.30-13.30)	
iii	12 Month	11.00±0.91(10.00-11.30)	11.93±0.92(10.80-14.00)	
iv	F Values§	1.15	2.34	-
2.		Age Group 4+ Years		
i	0 Month	10.46±0.54(10.10-13.20)	11.00±0.77(10.20-14.50)	5.10*
ii	6 Month	11.68±0.51(10.40-13.40)	11.33±0.68(10.60-15.50)	
iii	12 Month	12.21±0.52(11.10-13.90)	12.88±0.77(12.20-15.90)	
iv	F Values§	2.36	1.59	-
3		Age Group 5+ Years		
i	0 Month	11.60±0.77(10.00-14.00)	12.30±0.68(11.40-16.00)	3.29*
ii	6 Month	12.00±0.68(10.40-14.20)	12.90±0.83(11.50-16.30)	
iii	12 Month	12.30±0.83(10.50-14.45)	13.20±1.75(11.60-16.50)	
iv	F Values§	2.78	2.46	-
III		Wrist Circumference (WrC) (cm)		
1		Age Group 3+ Years		
i	0 Month	8.18±0.98(7.60-10.40)	10.28±0.98(9.20-11.20)	10.9*
ii	6 Month	8.50±0.92(8.00-10.80)	10.80±0.92(9.70-11.80)	
iii	12 Month	9.00±0.91(8.50-11.00)	11.00±0.92(10.20-12.45)	
iv	F Values§	1.22	1.47	-

Table 3 contd...

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		Age Group 5+ Years		
3.				
i	0 Month	10.66±0.77(10.00-11.90)	11.96±0.68(10.80-13.50)	5.55*
ii	6 Month	10.89±0.68(10.40-12.20)	12.20±0.83(10.95-13.90)	
iii	12 Month	11.39±0.83(10.65-12.65)	12.91±1.75(11.00-14.20)	
iv	F Values§	1.57	1.39	-

Figures in parenthesis indicate range; E/D - Excess/Deficit; § - F values are for within group comparison (i.e. comparison between data taken during 0, 6 and 12 months of the study period); # - z values are for between group comparison (i.e. for comparison between data of subjects from Anganwadi and Kindergarten during 12 month); † - z values are for comparison between mean values during 12 months of the study period and standards; * - Significant at both 5 % and 1% levels (p<0.01); ** - Significant at 5 % level but insignificant at 1 % level (0.01<p<0.05); Values without any mark indicate insignificant difference at both 5% and 1% levels (p>0.05).

Mean MUAC measurement values at the end of the study period for boys from KG (3+, 4+, 5+ yrs) were found to be higher than AW boys which clearly show differences in income level and nutrition. Similar results were observed in the study conducted among children between 3 to 5 yrs by Wankhede, K. S. *et al.* (2015) who studied the growth spurt in boys and girls of Malwa region from Madhya Pradesh, India and they found that MUAC increased with increasing age on both sexes.

Since for the present study, both AW and KG boys showed lower mean MUAC values in comparison with standard MUAC for age, further attempt was made to classify subjects on the basis of WHO criteria (1995) for MUAC. For this, subjects were graded based on their MUAC during 12 months of the study period.

Results are presented in Fig. 1.

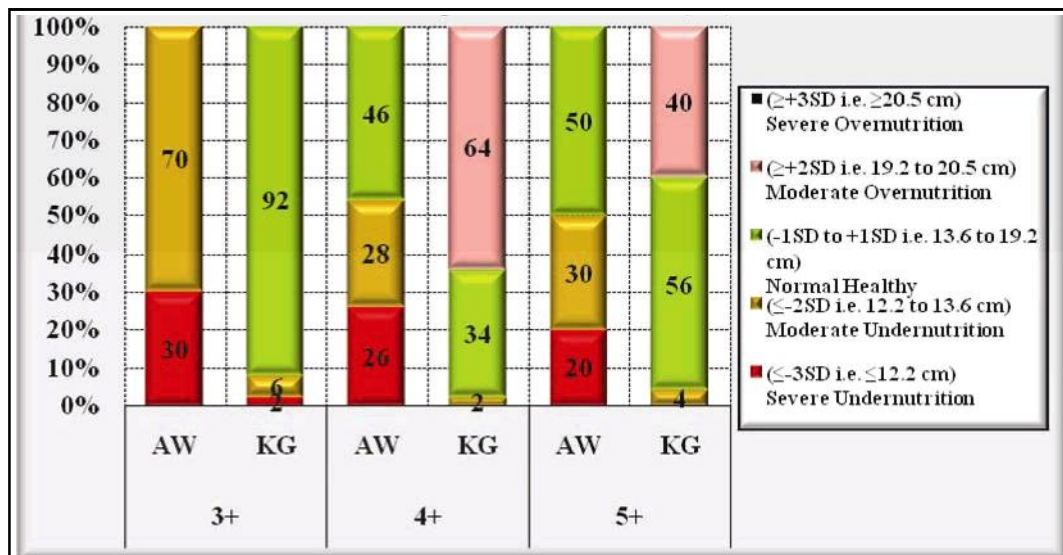


Fig. 1 : Percentage wise distribution of boys for nutritional grading based on MUAC (cm)

The classification states that MUAC =12.2 cm is severe undernutrition. On the basis of this, it is evident that quite higher % of AW subjects were graded as severely malnourished (30, 26 and 20% AW boys from age groups 3+, 4+ and 5+, respectively, Fig. 1). 70, 28 and 30% AW boys from age groups 3+, 4+ and 5+, respectively were graded as ‘moderately undernourished’ as their MUAC

ranged between 12.2 to 13.6 cm. In contrast to this, with the exception of 3+ KG boys (2%), none of the KG subjects were found to be either severely or moderately undernourished. With the exception of 4+ KG boys group (34%), majority of KG groups of subjects were found to be 'normal healthy' for their MUAC. In both industrialized and developing countries, the double burden of malnutrition including undernutrition and overweight has also increased worldwide (Drewnowski and Specter, 2004). 64% from 4+ yrs group of KG boys were categorized as 'moderately over nourished' as their MUAC values were in the range of 19.2 to 20.5 cm. None of the KG boys aged 3+ yrs were found to be over nourished, majority of them fell in the category of normal healthy for their MUAC (98 and 92%, respectively).

For all AW and KG groups of boys, annual increase in mean forearm and wrist circumference was found to be insignificant at both 5% and 1% levels (Table 3). Between group comparisons for both forearm and wrist circumferences revealed that all groups of KG boys possessed significantly greater mean values ($z=3.29$ to 5.10 for, $p<0.01$). There found high impact of income level and nutritional level on these indices.

The arm length, also known as hand length, could be used to predict body weight status and body surface area independent of the sex of the individual (Bidmos, 2009 and Ibegbu, 2015). Correlation between hand length and foot length has also been studied and that if the hand length is known, the foot length can be predicted and *vice-versa*. Hand length has been shown to be a reliable and precise means in predicting the height of an individual (Gauld and Rakhir, 1996 and Ebites *et al.*, 2000). Studies on hand measurements like arm length, palm width, palm length and hand span among preschoolers are not done exclusively.

For the present study, data on hand measurements of AW and KG boys is given in Table 4.

Table 4: Data on Arm length, Palm width, Palm length and Hand span of boys for 0, 6 and 12 months of study period				
Sr. No.	Parameters	Boys		
		Anganwadi (AW)	Kindergarten (KG)	z Values#
I		Arm Length (cm)		
1		Age Group 3+ Years		
i	0 Month	40.80±0.22(40.30-40.95)	43.80±0.29(43.10-44.20)	42.2*
ii	6 Month	41.00±0.54(40.40-41.15)	44.00±0.30(43.40-44.95)	
iii	12 Month	41.10±0.24(40.45-41.30)	44.30±0.48(43.85-44.90)	
iv	F Values§	0.67	2.13	-
v	Standard		41.81	-
vi	%E/D (z Values!)	-1.70 (20.90)	+5.96 (36.68)	-
2		Age Group 4+ Years		
i	0 Month	41.30±0.25 (40.50-41.65)	44.45±0.33 (43.85-45.30)	50.7*
ii	6 Month	41.40±0.26 (40.65-41.90)	44.65±0.31 (43.95-45.40)	
iii	12 Month	41.60±0.33 (40.95-41.90)	44.80±0.30 (44.25-45.70)	
iv	F Values§	0.93	2.29	-
v	Standard		42.20	-
vi	%E/D (z Values!)	-1.42 (12.90)	+6.16 (61.28)	-

Table 4 contd..

Contd... Table 4

3		Age Group 5+ Years		
i	0 Month	41.75±0.25 (41.15-42.15)	45.00±0.35 (44.40-45.75)	45.7*
ii	6 Month	41.95±0.28 (41.40-42.40)	45.20±0.34 (44.60-45.85)	
iii	12 Month	42.10±0.26 (41.60-42.50)	45.40±0.44 (44.70-44.95)	
iv	F Values§	1.15	2.76	-
v	Standard	45.70		-
vi	%E/D (z Values!)	-7.88 (97.90)	-0.66 (4.82)	-
II		Palm Width (cm)		
1		Age Group 3+ Years		
i	0 Month	5.17±0.25(4.70-5.50)	5.43±0.40(5.00-5.60)	6.64*
ii	6 Month	5.49±0.22(5.00-5.90)	5.71±0.35(5.10-6.20)	
iii	12 Month	5.69±0.33(5.30-6.20)	6.30±0.56(5.60-6.85)	
iv	F Values§	0.99	2.13	-
2		Age Group 4+ Years		
i	0 Month	5.40±0.44(5.00-6.00)	5.63±0.50(5.50-6.90)	3.57*
ii	6 Month	5.70±0.66(5.10-6.20)	6.11±0.22(5.55-6.90)	
iii	12 Month	6.10±0.56(5.30-6.40)	6.46±0.44(6.00-7.00)	
iv	F Values§	1.00	1.99	-
3		Age Group 5+ Years		
i	0 Month	6.20±0.22(5.20-6.70)	6.66±0.22(6.00-7.00)	6.41*
ii	6 Month	6.40±0.66(5.30-6.80)	6.80±0.35(6.20-7.35)	
iii	12 Month	6.75±0.25(5.40-6.90)	7.04±0.20(6.40-7.50)	
iv	F Values§	1.10	2.06	-
III		Palm Length (cm)		
1		Age Group 3+ Years		
i	0 Month	9.65±0.58(9.20-10.30)	10.33±0.88(9.50-10.55)	4.31*
ii	6 Month	9.70±1.00(9.35-10.45)	10.74±1.00(9.65-10.90)	
iii	12 Month	10.00±1.33(9.45-10.60)	11.10±1.22(10.00-11.30)	
iv	F Values§	0.74	1.35	-
2		Age Group 4+ Years		
i	0 Month	10.35±2.00(9.40-10.80)	11.34±0.88(10.00-11.55)	4.9*
ii	6 Month	10.50±1.22(9.55-10.90)	11.47±1.11(10.10-11.70)	
iii	12 Month	10.55±1.11(10.10-11.30)	11.58±0.99(10.20-11.85)	
iv	F Values§	1.87	2.25	-
3		Age Group 5+ Years		
i	0 Month	10.66±0.55(10.30-11.50)	11.65±1.22(10.30-11.90)	3.06*
ii	6 Month	10.72±0.88(10.40-11.65)	11.75±0.99(10.35-11.95)	
iii	12 Month	11.22±1.22(10.65-11.80)	11.80±0.55(10.40-12.00)	
iv	F Values§	2.00	2.67	-
IV		Hand Span (cm)		
1		Age Group 3+ Years		
i	0 Month	13.29±0.25(12.70-13.70)	14.88±0.38(14.20-15.50)	27.1*
ii	6 Month	13.39±0.26(12.95-13.70)	15.08±0.34(14.50-15.75)	
iii	12 Month	13.56±0.26(12.95-14.00)	15.26±0.36(14.70-16.00)	
iv	F Values§	0.56	1.06	-

Table 4 contd..

Contd... Table 4

		Age Group 4+ Years		
2				
i	0 Month	13.68±0.24(13.20-14.20)	15.49±0.28(15.20-16.00)	33.9*
ii	6 Month	13.85±0.24(13.30-14.25)	15.66±0.31(15.20-16.20)	
iii	12 Month	13.95±0.26(13.50-14.50)	15.82±0.29(15.50-16.30)	
iv	F Values§	2.08	1.79	-
3		Age Group 5+ Years		
i	0 Month	14.21±0.26(13.70-14.75)	16.10±0.31(15.50-16.80)	31.8*
ii	6 Month	14.40±0.26(13.70-14.80)	16.26±0.30(15.75-16.85)	
iii	12 Month	14.55±0.28(14.00-15.00)	16.46±0.32(15.75-17.00)	
iv	F Values§	2.20	2.57	-

Figures in parenthesis indicate range; E/D - Excess/Deficit; § - F values are for within group comparison (*i.e.* comparison between data taken during 0, 6 and 12 months of the study period); # - z values are for between group comparison (*i.e.* for comparison between data of subjects from Anganwadi and Kindergarten during 12 month); † - z values are for comparison between mean values during 12 months of the study period and standards; * - Significant at both 5 % and 1% levels ($p < 0.01$); ** - Significant at 5 % level but insignificant at 1 % level ($0.01 < p < 0.05$); Values without any mark indicate insignificant difference at both 5% and 1% levels ($p > 0.05$).

Annual increase in the mean arm length for 3+, 4+ and 5+ yrs was of 0.3, 0.3 and 0.35 cm for AW boys and 0.5, 0.35 and 0.4 cm for KG boys, respectively. Mean arm lengths of AW boys from all age groups were significantly lower than that KG boys ($z = 42.2$ to 50.0 , $p < 0.01$). All AW groups of boys showed significantly lower mean arm length values than the standards ($z = 12.9$ to 97.9 , $p < 0.01$). In contrast, KG boys from age groups 3+ and 4+ yrs had longer arms than standards ($z = 2.13$ and 2.29 , respectively, $p > 0.05$).

Insignificant annual increment in both palm width and length of boys from AW and KG was observed. However, KG boys possessed significantly wider and longer palms than AW boys ($p < 0.01$). Annual increment in mean palm width for 3+, 4+ and 5+ yrs was of 0.52, 0.7 and 0.55 cm for AW boys and 0.87, 0.83 and 0.38 cm for KG boys, respectively while annual increment in mean palm length for 3+, 4+ and 5+ yrs was of 0.35, 0.2 and 0.56 cm for AW boys and 0.77, 0.24 and 0.15 cm for KG boys, respectively.

Between AW and KG group comparisons for hand span values at the end of the study period revealed that KG boys showed significantly larger hand span than AW boys ($z = 27.1$ to 33.9 for AW vs. KG boys, $p < 0.01$).

For this study, it was noted that 100 % KG boys carried tiffin from their homes. In contrast to this, 100% AW boys were dependent only on meals provided by the anganwadis.

Table 5 presents data on energy and macronutrient intake of boys during 12 months of study.

100% AW boys under this study showed deficient consumption of energy with % deficit ranged from 33.36 to 39.87. In contrast, all age groups of KG boys showed higher mean energy intake than RDAs ($z = 3.48$ to 7.50 , $p < 0.01$). Energy intake of preschool children aged 4-6 yrs from Kanpur studied by Shakti *et al.* (2015) was lower than the RDAs and was only 35.93% of RDAs. Ahmadi *et al.* (2014) also reported the mean intake of energy for the Iranian kindergarten children less than the recommended values.

KG boys from all age groups had higher mean intake of carbohydrate than AW boys. Difference of 184.55, 73.81 and 97.58 g was derived between AW and KG boys aged 3+, 4+ and 5+ yrs, respectively for their mean carbohydrate intake, hence, indicating a huge gap of this major energy yielding nutrient (Table 5). Ahmadi *et al.* (2014) reported the mean intake of carbohydrate for the kindergarten Iranian children below the recommended values.

Table 5: Data on energy and macronutrient intake of boys during 12 months of study period										
Sr. No.	Age (Yrs)		Energy (kcal)			Carb (g)		Protein (g)		Fat (g)
			M±SD (Range)	RDA [■]	%E/D (z Values [†])	M±SD (Range)	M±SD (Range)	RDA [■]	%E/D (z Values [†])	M±SD (Range)
1.	3+	AW	809±78.74 (1112-1699)	1214	-33.36 (36.4)	148.99±11.53 (103.55-186.55)	17.25±6.50 (13.46-28.1)	18.5	-6.76 (1.36)	16.00±3.31 (12.81-18.88)
		KG	1298±170.95 (925-1586)		+6.91 (3.48)	214.56±30.01 (148.5-266.3)	35.90±9.34 (23.88-44.8)		+94.05 (13.17)	32.89±5.71 (26.11-37.9)
		z Values#	18.4*	-	-		11.6*	-	-	
2.	4+	AW	843±115.93 (669-1064)	1320	-36.10 (29.1)	156.67±21.31 (123-198.6)	18.22±7.32 (15.22-27.1)	19.14	-4.81 (0.89)	15.99±4.45 (12.89-17.92)
		KG	1418±92.38 (1017-1573)		+7.43 (7.50)	230.48±18.94 (151-255)	43.51±3.72 (31.2-47.88)		+127.32 (46.32)	35.79±3.99 (32-40.12)
		z Values#	27.4*	-	-		21.8*	-	-	
3.	5+	AW	875±123.99 (710-1117)	1456	-39.87 (33.1)	161.39±21.78 (131.11-208.89)	18.97±8.19 (13.55-28.5)	20.2	-6.09 (1.06)	17.11±4.94 (14.55-18.56)
		KG	1563±102.09 (1083-1636)		+7.38 (7.41)	258.97±18.01 (170-260.22)	46.12±3.78 (29.76-50)		+128.32 (48.49)	38.12±3.55 (35.11-43.88)
		z Values#	30.3*	-	-		21.3*	-	-	

Values in parentheses indicate Range; [■]-Recommended Dietary Allowances (RDA)-(National Institute of Nutrition (NIN)/Indian Council of Medical Research (ICMR), 2009); Carb-Carbohydrate; # - z values are for between group comparison (*i.e.* for comparison between data of boys from Anganwadi and Kindergarten during 12 month); [†] - z values are for comparison between mean values during 12 months of the study period and RDAs; * - Significant at both 5 % and 1% levels (p<0.01); ** - Significant at 5 % level but insignificant at 1 % level (0.01<p<0.05); Values without any mark indicate insignificant difference at both 5% & 1% levels (p>0.05).

All groups of KG boys showed mean intake of protein higher than RDAs (% excess ranged from 94.05 to 128.42) whereas AW boys showed deficient mean protein intake (% deficit was ranged from 0.89 to 1.36). Majority of AW subjects were vegetarians, the sources of protein in their diets were basically cereals and pulses and to a rare extent milk. The difference among AW and KG boys for protein intake was attributed to the fact that frequent consumption of quality protein sources like milk, curd, paneer, cheese, egg, fish and chicken by KG subjects than by AW subjects. KG subjects also consumed pulses, legumes, nuts and oilseeds regularly in their diets whereas AW subjects were found to be rarely consuming these food sources because of lack of purchasing capacity of their families. KG subjects also consumed oral health supplements which also provided additional protein in their daily diets. Preschool children aged 4-6 yrs from Kanpur studied by Shakti *et al.* (2015) showed deficit intake of protein as compared to the RDAs (23.40%). Mean intake of protein by Iranian kindergarten children studied by Ahmadi *et al.* (2014) was found higher than the recommendations. Kulsum *et al.* (2008) stated that protein calorie adequacy was influenced by age and gender of children and significantly by literacy or economic status of mothers.

For AW subjects, minimum and maximum values for fat intake were found to be 12.81 g and 18.88 g, respectively. For KG subjects, minimum and maximum values for fat intake were found to be 26.11 g and 43.88 g, respectively. KG subjects derived their visible dietary fat from oils, ghee and butter whereas invisible sources for fat in their diets included milk and its products, eggs, non-vegetarian foods like chicken and fish, nuts and oil seeds. For AW children, cooking oil was the only source of visible fat in their diets. They also received some amount of milk (not on regular basis) from anganwadi.

Weight gain is said to be directly proportional to the dietary intake of energy and major nutrients. Table 6 shows correlates of weight, height, mid upper arm circumference of boys from AW and KG during 12 months of study period.

Table 6 : Correlates of weight, height, mid upper arm circumference of boys from AW and KG during 12 months of study period

Sr. No.	Parameters	Correlation coefficient values (r)	
		AW (n=150)	KG (n=150)
1.	Weight vs. MUAC	0.6944*	0.2206*
2.	Weight vs. Forearm Circumference	0.3168*	0.5813*
3.	Weight vs. Wrist Circumference	0.3386*	0.6347*
4.	Height vs. MUAC	0.7137*	0.6955*
5.	Height vs. Palm Length	0.7348*	0.7239*
6.	Energy Intake vs. Weight	0.6829*	0.8783*
7.	Energy Intake vs. Height	0.2727*	0.4226*
8.	Energy Intake vs. MUAC	0.2543*	0.4054*
9.	Energy Intake vs. Forearm Circumference	0.0123	0.3245*
10.	Energy Intake vs. Carbohydrate Intake	0.8300*	0.8900*
11.	Energy Intake vs. Protein Intake	0.7654*	0.8790*
12.	Energy Intake vs. Fat Intake	0.6278*	0.8478*
13.	Protein Intake vs. Weight	0.1949**	0.5222*
14.	Protein Intake vs. Height	0.3075*	0.3560*
15.	Protein Intake vs. MUAC	0.2833*	0.6003*
16.	Fat Intake vs. Weight	0.2358*	0.4600*
17.	Fat Intake vs. MUAC	0.2190*	0.4387*

* - Significant at both 5 % and 1% levels ($p < 0.01$); ** - Significant at 5 % level but insignificant at 1 % level ($0.01 < p < 0.05$); Values without any mark indicate insignificant difference at both 5% and 1% levels ($p > 0.05$).

Anthropometric parameters of boys like height and weight were found to be influenced by the income level of family. However, relationship of income level was more pronounced with weight than height. Forearm and wrist circumferences are considered as indicators of body frame size; broader the parameters larger is the body frame. For boys from AW and KG, these two anthropometric measures reflected direct relationship with body weight. Shafiee *et al.* (2018) also found in their study that wrist circumference had a significant correlation with anthropometric measures including weight and height and wrist circumference performed relatively well in classifying individuals into overweight, generalized obesity and abdominal obesity ($p < 0.001$).

For this study, body measurements like palm width and palm length among AW and KG boys showed significant and positive correlations with height. Significant correlation between the height and hand length and other anthropometric parameters was found in school children studied by Ibegbu *et al.* (2015). Dorjee and Sen (2016) stated that stature was observed to be positively and significantly correlated with age ($r = +0.886$, $p < 0.01$) and arm length ($r = +0.828$, $p < 0.01$) among 3-11 yrs old boys.

It is concluded that KG children from high income group showed satisfactory nutritional status, however, overweight and obesity was also found to be prevalent which if not controlled can lead to adult obesity. The state of health of school-going children in India is far from satisfactory despite the fact that school health programmes along with other nutritional programmes have been in operation for several decades. In the developing countries, like India, the growing children by and large are deprived of good nutrition on account of their poor socio-economic status, ignorance and

lack of health promotional facilities. This nutritional deprivation results in relative stunting of growth.

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