International Journal of Applied Social Science *RESEARCH PAPER*
Volume 6 (3), March (2019) : 599-608 ISSN : 2394-1405
Received : 11.01.2019; Revised : 26.01.2019; Accepted : 11.02.2019

Hand Measurements and Intake of Energy and Macronutrients: Differences between Preschool Girls from Anganwadi and Kindergarten

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ABSTRACT

To assess the differences in hand measurements and energy and macronutrient intake of preschool girls from anganwadi (AW) and kindergarten (KG), a longitudinal study was carried out. Total 150 girls from age groups of 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, energy and energy yielding nutrients consumed by subjects were calculated at the beginning (0 month) and at the end (12 months) of the study period. The results revealed that preschool girls from KG belonging to high socioeconomic status consumed significantly greater amounts of macronutrients and energy as compared to AW girls. Thus, all anthropometric characteristics were lower in KG groups than KG groups and standards. AW girls from age groups 3+, 4+ and 5+ yrs failed to meet the age wise standards for many anthropometric measurements like height, weight, hand circumferences like mid upper arm, forearm and wrist as well as hand measures like arm length, palm width, palm length and hand span. Also, these AW girls showed deficient intakes of energy and protein. KG girls showed satisfactory growth in terms of above anthropometric measurements. They consumed excess daily energy and protein which if not controlled can lead to obesity which then may cause many undesired consequences. The study showed the differences in hand measurements of AW and KG girls which are attributed to differences in intake of energy and energy giving nutrients and hence, a well designed balanced diet is needed for AW and KG girls so that there will not any surplus or deficit intake of nutrients.

Key Words : Hand measurements, Anthropometric measurements, Energy & macronutrient intake, Dietary recall

INTRODUCTION

School going children are the future generation of the country and their nutritional needs are critical for the well-being of the society. Good nutrition during school age is critical to cover the deficits suffered during childhood (Sultan, 2014).

Childhood malnutrition is characterized by growth failure. Anthropometric measurements especially that of children is particularly important in assessing their nutritional status. Heights and weights of children, particularly those less than 5 or 6 years of age are accepted measures for monitoring their growth and nutritional status. Growth is one of the most important indices in child health. The best and most effective way to investigate child health is measuring the physical growth indices such as weight, height and certain body circumferences. Among these measures, weight is the

How to cite this Article: Sahu, Anubha and Nande, Prajakta (2019). Hand Measurements and Intake of Energy and Macronutrients: Differences between Preschool Girls from Anganwadi and Kindergarten. *Internat. J. Appl. Soc. Sci.*, **6** (3) : 599-608.

simplest and the most effective way to determine child growth status. In addition to weight, measuring body height and circumferences like upper arm would also give more direct information on growth (www.unsystem.org/sen/archives/npp07/ch08.htm).

MUAC is used for the assessment of nutritional status. MUAC is recommended for use with children for assessing acute energy deficiency. The major determinants of MUAC, arm muscle and subcutaneous fat, are both important determinants of survival in starvation. MUAC is less affected than weight and height based indices by the localised accumulation of fluid common in malnutrition and is a more sensitive index of tissue atrophy than low body weight. It is also relatively independent of height and body-shape (Early Detection and Referral of Children with Malnutrition-In-Mother and Child Nutrition. 2018. Citation from: http://motherchildnutrition.org/early-malnutrition-detection/detection-referral-children-with-acute-malnutrition/muac.htm).

In community based studies, MUAC appears to be the superior predictor of childhood based anthropometric indicators. Hand grip strength of children is determined by measuring palm width and length. Very few studies are conducted on palm width, palm length, hand span and arm length of preschoolers. It is universally accepted that anthropometry is the most useful tool for assessing the nutrition status and risks of poor health and survival of this group. A combination of inadequate dietary intakes and infections are major contributory factors to impaired physical growth and development. Growth retardation in early childhood is linked to socio-economic conditions and living standards.

Because children are growing and developing, they need more nutritious food in proportion to their size than do adults. Children from lower income group have the poorest nutritional status on almost every measure. According to World Health Organization, protein energy malnutrition refers to "an imbalance between the supply of protein and energy and the body's demand for them to ensure optimal growth and function" (Onis and Blossner, 1997). It is a major public health problem in India. It affects particularly the preschool children (<6 years) with its dire consequences ranging from physical to cognitive growth and susceptibility to infection. This affects the child at the most crucial period of time of development which can lead to permanent impairment in later life (Gragnolati *et al.*, 2005).

Anthropometric measurements are main indicators in assessing nutritional status. Nutritional status is a sensitive indicator of community health and nutrition. The present study is an attempt to assess the hand measurements and intake of energy and energy giving nutrients of preschool girls from AW and KG from Nagpur, Maharashtra.

METHODOLOGY

Study area and sample selection:

For this longitudinal study**,** 300 girls from age group 3-5 years were selected from well-known KG and AW schools from Nagpur city. Subjects were studied for one year *i.e.* during 0 month (at the beginning), 6 months and 12 months (at the end) of study period.

Table 1: Age Wise Classification of Sample

Sr. No.	Age Groups (Years)	Subjects (N = 300)	
		AW Girls	KG Girls
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:

For this, 24 hour's dietary recall method was followed 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 were

done using F test and 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

Preschool children are the important segment of our society. Their growth, development and body weight is of utmost significance and presents general health status of a community and nation as a whole.

Table 2 shows data on height and weight of girls.

Anthropometry is a key component of nutritional status assessment in children. Anthropometric data for children reflect general health status, dietary adequacy

Table 2: Data on height & weight of girls 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)			11.6*	13.4*
i	M±SD	83.16±2.5	86.40±3.25	89.37±3.75	92.34±5.00	96.37±4.75	101.84±4.25		
ii	Range	79.00-89.00	83.00-96.00	85.00-100.00	80.00-100.00	85.00-104.00	91.00-108.00		
iii	F Values§		46.87*			51.96*			
iv	Standard			98.20					
v	%E/D	-	-	-8.99	-	-	+3.71		
	(z Values↕)			(16.70*)			(6.06*)		
2.		Age Group 4+ Yrs (n=50)			Age Group 4+ Yrs (n=50)			7.19*	6.32*
i	M±SD	91.74±5.74	95.78±5.73	99.98±5.66	98.58±3.50	102.44±3.28	105.64±2.83		
ii	Range	81.00-103.00	85.00-105.00	89.00-108.00	90.00-105.00	94.00-109.00	98.00-110.00		
iii	F Values§		26.03*			60.44*			
iv	Standard			105.10					
v	%E/D	-	-	-4.87	-	-	+0.51		
	(z Values↕)			(6.4*)			(1.35)		
3.		Age Group 5+ Yrs (n=50)			Age Group 5+ Yrs (n=50)			5.71*	33.8*
i	M±SD	98.58±3.50	102.58±3.50	107.40±2.39	102.58±3.50	107.40±2.39	111.38±2.39		
ii	Range	90.00-105.00	94.00-109.00	100.00-110.00	94.00-109.00	100.00-112.00	104.00-116.00		
iii	F Values§		96.84*			123.04*			
iv	Standard			111.00					
v	%E/D	-	-	-3.24	-	-	-0.34		
	(z Values↕)			(10.70*)			(1.12)		
II	**Weight (kg)**								
1.		Age Group 3+ Yrs (n=50)			Age Group 3+ Yrs (n=50)			10.5*	15.0*
i	M±SD	10.30±1.97	10.70±1.92	11.20±1.99	14.47±1.99	15.47±1.94	16.56±1.55		
ii	Range	8.00-11.30	8.30-11.40	8.30-11.40	11.00-17.50	11.20-18.00	11.40-20.50		
iii	F Values§		2.05			16.19*			
iv	Standard			14.50					
v	%E/D	-	-	-22.76	-	-	+14.21		
	(z Values↕)			(11.70*)			(9.39*)		
2.		Age Group 4+ Yrs (n=50)			Age Group 4+ Yrs (n=50)			10.6*	13.1*
i	M±SD	11.40±1.96	11.80±1.89	12.10±1.82	15.17±1.61	15.86±1.56	16.54±1.56		
ii	Range	8.00-12.00	8.00-12.30	8.00-12.80	12.40-20.00	12.70-20.20	12.80-20.00		
iii	F Values§		1.73			9.44*			
iv	Standard			16.0					
v	%E/D	-	-	-24.38	-	-	+3.38		
	(z Values↕)			(15.20*)			(2.45**)		
3.		Age Group 5+ Yrs (n=50)			Age Group 5+ Yrs (n=50)			3.19*	15.1*
i	M±SD	12.17±1.61	12.86±1.56	13.10±1.29	15.86±1.56	16.57±1.29	16.90±1.22		
ii	Range	9.50-14.00	9.90-14.10	10.00-14.20	13.80-20.80	14.00-20.90	14.30-21.20		
iii	F Values§		5.22*			7.58*			
iv	Standard			17.70					
v	%E/D	-	-	-25.99	-	-	-4.52		
	(z Values↕)			(25.20*)			(4.64*)		

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 ($p>0.05$).

and growth and development over time (Margaret *et al.*, 2010).

For girls from AW and KG from age groups 3+, 4+ and 5+, it was noted that with the increase in the age, the height was also found to be increased significantly (F=26.03 to 123.04, p<0.01, Table 2). Height is an important nutritional anthropometric indicator which can easily help to understand the growth rate of child. In this case, girls from KG (age groups 3+, 4+ and 5+ yrs) surpassed the standard reference values of height for age indicating influence of income level and better food choices on height. In contrast, mean values of height of girls from AW (age groups 3+, 4+ and 5+ yrs) were found to be significantly below the standard reference values of height for age. Similar results were observed by Hegde, *et al.* (2014) in their study on children in the age group of 2-5 years attending AW under Sarjapura and they found that all mean heights were lower than 95% of the expected. Height is genetically affected but also nutritionally influenced. Weight is an important indicator for the assessment of nutritional support (WHO, 1995). The heights and weights of 200 rural preschool aged boys and girls from Andhra Pradesh, studied by Bandikolla and Chinnari Harika (2015) were lower than the NCHS standards.

Both AW and KG girls showed periodical gain in weight but the gain was insignificant among AW girls aged 3+ and 4+ yrs (F=2.05 and 1.73, respectively, p>0.05). All three age groups of KG girls showed significant gain in weight during a period of one year (F=16.19, 9.44 and 7.58, respectively, p<0.01) which is attributed to effect of good nutrition. AW girls from 3+, 4+ and 5= yrs were unable to meet the standards for height and weight for age (z=6.4 to 25.20, p<0.01). With the exception of 5+ girls, rests of the two groups of KG girls were found to be taller and heavier than the standards for height and weight for age (z=1.35 to 9.39).

For this study, annual increase in the height for 3+, 4+ and 5+ yrs was of 6.21, 8.24 and 8.82 cm for AW girls and 9.5, 7.06 and 8.8 cm for KG girls, respectively. Annual gain in the weight for 3+, 4+ and 5+ yrs was of 0.9, 0.7 and 0.93 kg for AW girls and 2.09, 1.37 and 1.04 kg for KG girls, respectively. At the beginning and at the end of the study period, KG girls were found to be significantly taller and heavier than KG girls which clearly show impact of income level on nutritional status.

Table 3 shows data on body circumferences of girls. Mean MUAC measurement values during 0, 6 and

Table 3: Data on body circumferences of girls for 0, 6 and 12 months of study period

Sr. No.	Parameters	GIRLS		
		Anganwadi (AW)	Kindergarten (KG)	z Values#
I	**Mid Upper Arm Circumference (MUAC) (cm)**			
1.	Age Group 3+ Years			
i	0 Month	11.74±0.75(10.00-13.00)	12.83±0.88(10.50-14.00)	10.6*
ii	6 Month	12.23±0.83(10.20-13.50)	13.32±0.90(10.90-14.50)	
iii	12 Month	12.71±0.88(10.50-14.00)	14.59±0.90(11.60-15.20)	
iv	F Values§	3.58**	7.87*	
v	Standard	16.40		
vi	%E/D (z Values↕)	-22.50 (30.50)	-11.04 (15.00)	
2.	Age Group 4+ Years			
i	0 Month	12.86±1.00 (10.00-14.00)	14.32±1.50(12.00-18.00)	6.23*
ii	6 Month	13.04±1.08 (10.20-14.50)	14.70±1.78(12.30-19.40)	
iii	12 Month	13.56±1.10(10.40-14.80)	15.38±1.75(13.00-20.00)	
iv	F Values§	3.87**	5.10*	
v	Standard	16.80		
vi	%E/D (z Values↕)	-19.29 (24.00)	-8.45 (7.76)	
3.	Age Group 5+ Years			
i	0 Month	14.32±1.00(11.00-15.00)	15.70±1.55(12.30-18.50)	2.85*
ii	6 Month	14.70±1.03(11.30-15.40)	15.84±1.60(12.60-19.00)	
iii	12 Month	15.14±1.05 (11.60-15.80)	15.98±1.80 (12.80-20.00)	
iv	F Values§	3.09**	3.75**	
v	Standard	17.30		
vi	%E/D (z Values↕)	-12.49 (22.00)	-7.63 (9.51)	

Contd.... Table 3

Table 3 contd…

II	**Forearm Circumference (FC) (cm)**			
1.	Age Group 3+ Years			
i	0 Month	10.00±0.80(9.00-11.00)	10.66±0.75(10.20-12.00)	3.41*
ii	6 Month	10.80±0.86(9.40-11.50)	10.90±0.76(10.50-12.50)	
iii	12 Month	11.01±0.84(9.60-11.70)	11.51±0.61(11.00-13.60)	
iv	F Values§	0.97	1.59	
2.	Age Group 4+ Years			
i	0 Month	10.38±0.75(9.50-13.00)	11.00±0.61(10.30-13.20)	12.0*
ii	6 Month	10.83±0.77(9.70-13.30)	11.18±0.59(10.55-13.50)	
iii	12 Month	11.03±0.77(10.00-13.60)	12.70±0.61(11.20-14.40)	
iv	F Values§	1.10	0.98	
3.	Age Group 5+ Years			
i	0 Month	11.00±0.61(10.30-14.00)	12.10±0.59(10.50-14.70)	10.6*
ii	6 Month	11.18±0.59(10.50-14.30)	12.74±0.57(10.90-15.10)	
iii	12 Month	11.74±0.57(10.90-14.65)	12.94±0.56(11.00-15.60)	
iv	F Values§	1.48	2.33	
III	**Wrist Circumference (WrC) (cm)**			
1.	Age Group 3+ Years			
i	0 Month	8.00±0.80(7.00-10.00)	10.10±0.75(9.00-11.00)	16.3*
ii	6 Month	8.20±0.86(7.60-10.50)	10.70±0.76(9.55-11.50)	
iii	12 Month	8.60±0.84(8.10-10.70)	10.99±0.61(10.00-12.30)	
iv	F Values§	0.79	0.59	
2.	Age Group 4+ Years			
i	0 Month	9.38±0.75(9.00-11.00)	10.50±0.61(10.00-12.35)	5.04*
ii	6 Month	10.00±0.77(9.30-11.40)	10.90±0.59(10.00-12.40)	
iii	12 Month	10.45±0.77(9.45-11.75)	11.15±0.61(10.25-12.55)	
iv	F Values§	2.00	2.46	
3.	Age Group 5+ Years			
i	0 Month	10.60±0.61(10.00-11.80)	11.80±0.59(10.50-12.65)	8.5*
ii	6 Month	10.98±0.59(10.30-12.00)	12.00±0.57(10.65-12.90)	
iii	12 Month	11.34±0.57(10.55-12.65)	12.30±0.56(10.75-13.00)	
iv	F Values§	1.80	1.66	

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% & 1% levels ($p>0.05$)

12 months of the study period for girls from KG (3+, 4+, 5+ yrs) were found to be higher than AW girls which clearly show differences in income level and nutrition. However, AW girls also showed periodical increment in MUAC which was significant at 5% level (F=3.09 to 3.58) whereas the difference was significant at 1% level for 3+ and 4+ KG girls (F=7.87 and 5.10, respectively). But all groups of KG and AW girls failed to meet the standards of MUAC for age but the difference was more for AW girls (z=22.0 to 30.50) than AW girls (z=7.76 to 15.00).

Since for the present study, both AW and KG girls 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 for nutritional grading based on their MUAC during 12 months of the study period. Results are presented in Fig. 1.

The classification states that MUAC $\leq$12.2 cm is severe undernutrition. On the basis of this, it is evident that quite higher % of AW girls were graded as severely malnourished (16, 36 and 30% AW girls from age groups 3+, 4+ and 5+, respectively). 24, 14 and 40 % AW girls from age groups 3+, 4+ and 5+, respectively were graded

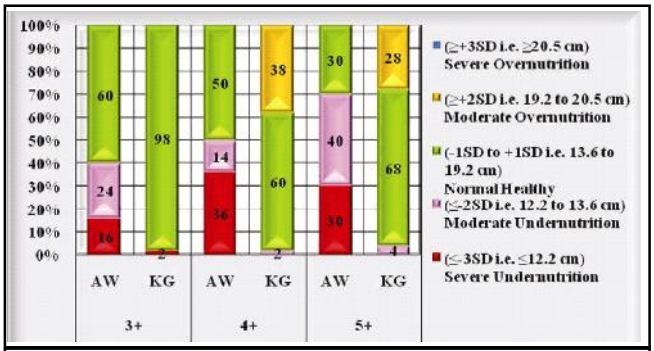

Fig. 1 : Distribution of AW and KG girls for nutritional grading based on MUAC

as 'moderately undernourished' as their MUAC ranged between 12.2 to 13.6 cm. In contrast, 38% and 28% 4+ and 5+ yrs KG girls were rated 'moderately over nourished'. None of the KG girls aged 3+ yrs were found to be over nourished, majority of them were fell in the category of normal healthy for their MUAC 98% (Fig. 1). It is reported that various percentile values of MUAC of preschool female children were found to be below the standards provided by Harvard and NCHS (Shashi and Indira, 2005).

For all AW and KG groups of girls, annual increase in mean forearm and wrist circumference was found to be insignificant at both 5% and 1% levels. Between group comparisons for both forearm and wrist circumferences revealed that all groups of KG girls possessed significantly greater mean values (z=3.41 to 12.0 for FC and z=5.04 to 16.3 for WrC, p<0.01). There found high impact of income level and nutritional level on these indices.

The arm length/hand length is found to be the most reliable alternative and the hand can be used as a basis for estimating age-related loss in height. The 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). Nurcan *et al.*, (2009) conducted a study to assess the relationship between height and arm span in Turkish children and arm span was found to be strongly correlated with height. 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.

Data on hand measurements of AW and KG girls is given in Table 4.

Annual increase in the mean arm length for 3+, 4+

Table 4: Data on arm length, palm width, palm length and hand span of girls for 0, 6 and 12 months of study period

Sr. No.	Parameters	GIRLS		
		Anganwadi (AW)	Kindergarten (KG)	z Values#
I	**Arm Length (cm)**			
1	Age Group 3+ Years			
i	0 Month	40.60±0.20(40.10-40.90)	43.50±0.80(41.00-44.20)	70.9*
ii	6 Month	40.74±0.28(40.10-41.20)	43.90±0.21(43.65-44.50)	
iii	12 Month	40.91±0.20(40.40-41.20)	44.20±0.26(43.80-44.85)	
iv	F Values§	0.56	2.11	
v	Standard	41.90		
vi	%E/D	-2.36 (z Value↕- 35.0*)	+5.49 (z Value↕- 65.22*)	
2	Age Group 4+ Years			
i	0 Month	41.10±0.20 (40.60-41.40)	44.40±0.31 (43.70-44.90)	46.4*
ii	6 Month	41.25±0.24 (40.65-41.60)	44.60±0.29 (43.95-45.10)	
iii	12 Month	41.40±0.33 (40.90-41.50)	44.80±0.40 (44.20-45.50)	
iv	F Values§	0.86	2.33	
v	Standard	43.50		
vi	%E/D	-4.83 (z Value↕- 45.00*)	+2.99 (z Value↕- 22.9*)	
2	Age Group 5+ Years			
i	0 Month	41.70±0.44 (41.10-42.10)	44.90±0.33 (44.30-45.70)	61.0*
ii	6 Month	41.80±0.25 (41.15-42.20)	45.10±0.45 (44.40-45.85)	
iii	12 Month	41.95±0.22 (41.40-42.40)	45.30±0.32 (44.60-44.80)	
iv	F Values§	0.98	2.47	
v	Standard	45.47		
vi	%E/D	-7.74 (z Value↕- 113.0*)	-0.37 (z Value↕- 3.76*)	

Contd…. Table 4

Table 4 contd…

II	**Palm Width (cm)**			
1	Age Group 3+ Years			
i	0 Month	5.16±0.39(4.50-6.00)	5.18±0.39(4.55-6.00)	5.52*
ii	6 Month	5.67±0.39(5.00-6.50)	5.69±0.40(5.00-6.40)	
iii	12 Month	5.80±0.39(5.20-6.70)	6.22±0.37(5.50-6.80)	
iv	F Values§	1.08	1.53	
2	Age Group 4+ Years			
i	0 Month	5.50±0.40(4.80-6.50)	5.59±0.52(5.00-6.70)	6.96*
ii	6 Month	5.70±0.41(5.00-6.00)	6.30±0.48(5.30-6.90)	
iii	12 Month	5.85±0.38(5.20-6.75)	6.40±0.41(5.50-7.00)	
iv	F Values§	0.98	1.12	
3	Age Group 5+ Years			
i	0 Month	5.60±0.52(5.10-6.70)	6.30±0.52(5.50-7.30)	4.46*
ii	6 Month	6.10±0.48(5.40-6.90)	6.86±0.44(5.60-7.70)	
iii	12 Month	6.60±0.44(5.50-7.20)	7.03±0.52(5.80-7.80)	
iv	F Values§	1.26	1.81	
III	**Palm Length (cm)**			
1	Age Group 3+ Years			
i	0 Month	9.57±0.19(9.10-10.00)	10.29±0.30(9.50-10.50)	13.3*
ii	6 Month	9.88±0.21(9.30-10.30)	10.68±0.36(9.65-10.85)	
iii	12 Month	10.20±0.18(9.40-10.55)	10.99±0.38(10.00-11.20)	
iv	F Values§	2.08	2.63	
2	Age Group 4+ Years			
i	0 Month	10.30±0.59(9.40-10.70)	11.00±0.58(10.20-11.30)	5.66*
ii	6 Month	10.45±0.50(9.50-10.80)	11.15±1.20(10.30-11.45)	
iii	12 Month	10.50±0.48(10.00-11.20)	11.38±0.99(10.35-11.65)	
iv	F Values§	1.57	1.88	
3	Age Group 5+ Years			
i	0 Month	10.55±0.64(10.20-11.45)	11.45±0.18(10.40-11.70)	4.77*
ii	6 Month	10.70±0.28(10.25-11.50)	11.60±1.22(10.50-11.90)	
iii	12 Month	11.00±0.55(10.50-11.65)	11.70±0.88(10.60-11.95)	
iv	F Values§	2.10	2.76	
IV	**Hand Span (cm)**			
1	Age Group 3+ Years			
i	0 Month	13.24±0.26(12.70-13.70)	14.82±0.34(14.20-15.40)	25.3*
ii	6 Month	13.37±0.29(12.70-13.72)	15.00±0.36(14.20-15.75)	
iii	12 Month	13.56±0.28(12.90-13.95)	15.19±0.36(14.40-16.00)	
iv	F Values§	0.58	0.89	
2	Age Group 4+ Years			
i	0 Month	13.66±0.25(12.95-14.20)	15.47±0.28(15.20-16.00)	35.0*
ii	6 Month	13.77±0.27(13.20-14.20)	15.60±0.28(15.20-16.20)	
iii	12 Month	13.92±0.26(13.20-14.50)	15.81±0.28(15.50-16.20)	
iv	F Values§	1.38	1.56	
3	Age Group 5+ Years			
i	0 Month	14.15±0.27(13.40-14.50)	16.05±0.30(15.50-16.50)	36.6*
ii	6 Month	14.26±0.30(13.45-14.70)	16.22±0.31(15.70-16.70)	
iii	12 Month	14.42±0.25(13.70-14.70)	16.44±0.30(16.00-17.00)	
iv	F Values§	1.28	1.49	

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 ($p>0.05$)

and 5+ yrs was of 0.31, 0.3 and 0.25 cm for AW girls and 0.7, 0.4 and 1.0 cm for KG girls, respectively. All AW groups of girls showed significantly lower mean arm length values than the standards (z=35.0 to 113.0, p<0.01) whereas all KG girls showed significantly higher mean arm length readings than standards (z=3.76 to 65.22, p<0.01).

Insignificant annual increment for palm width and palm length among girls from AW and KG was observed, However, KG girls possessed significantly wider and longer palms than AW girls and the differences were significant at both 5% and 1% levels (p<0.01). Annual increment in mean palm width for 3+, 4+ and 5+ yrs was of 0.64, 0.35 and 1.0 cm for AW girls and 1.04, 0.81 and 0.73 cm for KG girls, respectively while annual increment in mean palm length for 3+, 4+ and 5+ yrs was of 0.63, 0.2 and 0.45 cm for AW girls and 0.7, 0.38 and 0.25 cm for KG girls, respectively.

Between AW and KG groups comparisons for hand span at the end of the study period revealed that KG girls showed significantly larger hand span than AW girls (z=25.3 to 36.6 for AW vs. KG girls, p<0.01). Also, annual increment in hand span was higher for KG girls.

AW girls followed 3 meals per day dietary pattern. On the contrary, majority of KG girls were found to be following 6 meals a day pattern. Table 5 presents the data on energy and macronutrient intake of girls during 12 months of study.

Mean energy intake of KG girls aged 3+, 4+ and 5+ yrs was found to be highly exceeding the mean energy intake of AW girls aged 3+, 4+ and 5+ yrs (z=23.7, 22.5 and 27.7, respectively, p<0.01). Similarly, all groups of KG girls consumed significantly larger portions of daily proteins as compared to AW girls (z=10.3, 18.8 and 27.4 for 3+, 4+ and 5+ yrs, respectively). All three groups of kg girls showed highly excessive intake of energy and protein (z=7.91 to 11.73 for energy and z=11.75 to 49.85 for protein, p<0.01). On the contrary, all groups of AW girls showed deficient intake of energy and protein (z=20.8 to 31.2 for energy and z=1.06 to 2.47 for protein). KG girls aged 3+, 4+ and 5+ yrs demonstrated significantly higher mean daily intake of two major energy yielding nutrients-carbohydrates (z=17.5, 16.0 and 21.2, respectively, p<0.01) and fats (z=26.2, 23.1 and 20.6, respectively, p<0.01). These differences in intakes of energy yielding nutrients caused the lower readings of

Table 5: Data on energy and macronutrient intake of girls during 12 months of study period

Sr. No.	Age (Yrs)		Energy (kcal) M±SD (Range)	RDA▪	%E/D (z Values↕)	Carb (g) M±SD (Range)	Protein (g) M±SD (Range)	RDA▪	%E/D (z Values↕)	Fat (g) M±SD (Range)
1.	3+	AW	764±101.39 (571-980)	1087	-29.71 (22.5*)	137.68±18.37 (100-175.2)	16.58±7.56 (13.2-25.8)	18.13	-8.55 (1.45)	16.33±3.35 (13.1-19.51)
		KG	1279±115.75 (904-1554)		+17.66 (11.73*)	209.6±22.52 (145.5-254.3)	35.3±10.33 (21.55-43.5)		+97.4 (11.75*)	33.22±3.09 (26.2-40.25)
		z Values#	23.7*	-	-	17.5*	10.3*	-	-	26.2*
2.	4+	AW	881±108.43 (678-1082)	1200	-26.56 (20.8*)	164.61±19.86 (125-198)	17.48±7.18 (13.00-27.4)	18.56	-5.82 (1.06)	16.99±3.66 (14.0-19.99)
		KG	1372±110.15 (966-1610)		+14.35 (11.04)	225.13±17.87 (148-265.6)	38.93±3.64 (30.0-42.67)		+109.8 (39.57*)	35.10±4.17 (28.22-41.88)
		z Values#	22.5*	-	-	16.0*	18.8*	-	-	23.1*
3.	5+	AW	837±111.15 (675-1082)	1328	-36.97 (31.2*)	154.55±20.39 (123-199.55)	17.42±6.10 (14.57-25.6)	19.55	-10.9 (2.47**)	16.57±5.23 (13.88-20.11)
		KG	1452±110.91 (1098-1626)		+9.34 (7.91*)	235.99±17.97 (169.3-263.66)	44.79±3.58 (38.1-48.22)		+129.1 (49.85*)	36.55±4.43 (29.8-42)
		z Values#	27.7*	-	-	21.2*	27.4*	-	-	20.6*

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% and 1% levels (p>0.05)

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

Sr. No.	Parameters	Correlation Coefficient Values (r)	
		AW (n=150)	KG (n=150)
1.	Energy Intake vs. Weight	0.5086*	0.7062*
2.	Energy Intake vs. Height	0.2384*	0.2088*
3.	Energy Intake vs. MUAC	0.2233*	0.4321*
4.	Energy Intake vs. Forearm Circumference	0.1211*	0.3440*
5.	Protein Intake vs. Weight	0.1889**	0.4152*
6.	Protein Intake vs. Height	0.2100*	0.4300*
7.	Protein Intake vs. MUAC	0.2086*	0.5499*
8.	Fat Intake vs. Weight	0.3277*	0.4566*
9.	Fat Intake vs. MUAC	0.1456	0.4001*

* - 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 indices of AW girls.

Energy, protein and fat intake reflected significant and positive correlation with weight and MUAC. Also, energy and protein intake showed direct relationship with height. Energy intake was found to be correlated positively with forearm circumference. All these correlations show importance of daily intake of energy and energy giving nutrients for growth indicators among preschool girls. Nurcan *et al.,* (2009) found significant correlation between height and mid upper arm in Turkish children. 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 ($p<0.001$). Significant correlation between the height and hand length and other anthropometric parameters was found out by Ibegbu *et al.* (2015) in school children. 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.

From the results of this study, it is concluded that AW girls from age groups 3+, 4+ and 5+ yrs failed to meet the age wise standards for many anthropometric measurements like height, weight, hand circumferences like mid upper arm, forearm and wrist as well as hand measures like arm length, palm width, palm length and hand span. Also, these AW girls showed deficient intakes of energy and protein. KG girls showed satisfactory growth in terms of above anthropometric measurements. They consumed excess daily energy and protein which if not controlled can lead to obesity which then may cause many undesired consequences. Hence, it is concluded that a well designed balanced diet is needed for AW and KG girls so that there will not any surplus or deficit intake of nutrients.

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