



## NUTRITIONAL STATUS: ANTHROPOMETRIC PERSPECTIVE OF PRE-SCHOOL CHILDREN

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### ABSTRACT

**Background:** The present investigation was undertaken with the aim of assessing the nutritional status of pre-school children (4-6 years) of Jorhat, Assam through anthropometric indices. **Methods:** A total of 200 pre-school children (4-6 years) were selected by a multistage random sampling technique from four schools of Jorhat town of Assam. A schedule was formulated to record the data on anthropometric measurements, viz. height, weight and mid-upper arm circumference of the target population. Anthropometric measurements namely height, weight and mid-upper arm circumference of each respondent was recorded using standardized tools and techniques. The mean and standard deviation was calculated from the data obtained on measurement of height, weight and mid-upper arm circumference of the target population. 't' test was also employed for determining the level of significance. The BMI was also calculated. The results obtained were compared with 95<sup>th</sup> centile values of ICMR, NCHS standard, Waterlow classification of height-for- age, Indian Academy of Pediatrics (IAP) classification of weight-for-age and WHO (2007) Z-scores. **Results:** The present study revealed that the height measurements of the target children were significantly lower than the 95<sup>th</sup> centile values of height (ICMR) ( $p < 0.01$ ). The 4 years children had normal heights which were quite comparable with NCHS standard while the 5- and 6-years children had significantly lower height than the NCHS standard ( $p < 0.01$ ). As per Waterlow classification of height-for- age, 63 per cent of the children had normal height while 32 per cent had marginal malnutrition, 2.5 per cent had moderate malnutrition and a negligible amount (0.5%) had severe malnutrition. WHO (2007) Z-scores of height-for-age revealed that 71.5 per cent of the children had normal height-for-age while 28.5 per cent were stunted. The weight measurements revealed that the 4-6 years boys and 4 year girls had normal weight as compared to 95<sup>th</sup> centile values of weight (ICMR) and NCHS standard whereas the mean weights of the 5 and 6 years girls were significantly lower than the 95<sup>th</sup> centile values of weight (ICMR) as well as the international (NCHS) standard ( $p < 0.05$ ). The Indian Academy of Pediatrics (IAP) classification of weight-for-age revealed that 85 per cent of the respondents were in the normal range of nutritional status whereas 15 per cent had Grade I malnutrition and 0.5 per cent had Grade II malnutrition. As per WHO (2007) Z-scores of weight-for-age, majority (84.5 per %) were in the normal category whereas 15.5 per cent were underweight. The mean observed Mid- Upper Arm Circumference (MUAC) of the 5 year boys and girls were significantly lower than the ICMR standards ( $p < 0.05$ ). WHO (2007) Z-scores of BMI-for-age categorized majority (66.5 per cent) of the children as normal while 12 per cent as moderate undernourished and 3 per cent as severely undernourished and 17.5 and 4 per cent of them as overweight and obese respectively. **Conclusion:** The present study revealed that majority (84.5 per cent) of the respondents had normal nutritional status while (17 per cent) had different grades of malnutrition ranging from mild to moderate malnutrition.

**Key words:** nutritional status, pre-school children, Waterlow classification

## INTRODUCTION

Child malnutrition is the single biggest contributor to under-five morbidity and mortality (Rijal P *et al.*, 2011). The World Health Organization (WHO) refers to malnutrition as “Failure of cells to perform their physical function due to inability to receive and use the energy and nutrients needed in terms of amount, mix and timeliness”. Malnutrition prevents children from reaching their full physical and mental potential. Health and physical consequences of prolonged states of malnourishment among children are: delay in their physical growth and motor development; lower intellectual quotient (IQ), greater behavioural problems and deficient social skills; susceptibility to contracting diseases (Food Security Statistics, 2008). The term malnutrition correctly includes both undernutrition and overnutrition. Overweight/obese children are at a high risk of developing hypertension, angina pectoris, non-insulin dependent diabetes mellitus and hypercholesterolaemia (Langendijk *et al.*, 2003). Overnutrition is the outcome of excess intake

of food than the dietary requirements. The problems of malnutrition are often thought of as separate issues of rich and poor, but in reality both are increasingly rooted in poverty. This is the double burden of malnutrition.

Globally, an estimated 162 million children under five years of age were stunted, 99 million were underweight, 51 million were wasted and 44 million were overweight in the year 2012 (UNICEF-WHO-World Bank Joint Child Malnutrition Estimates, 2013). According to World Health Statistics 2013, 15.7 per cent of the under five children in the world are underweight. The prevalence of obesity among preschool has increased from 4.2 per cent, in 1990, to 6.7 per cent, in 2010, worldwide and is expected to reach 9.1 per cent, in 2020 (Muhhi, 2013; Grieken *et al.*, 2013).

According to the records of Children in India 2012, a statistical appraisal by the Union ministry of statistics and programme implementation, acute malnutrition, as evidenced by wasting, results in a child being too thin for his/her height. While 19.8 per cent of children, under five years of age, are wasted in the country, which indicates that one out of every five children in India is wasted, 43 per cent of children under five years of age are underweight for their age (CHILDREN IN INDIA, 2012). Evidence suggests that almost half of children under age five years (48%) are chronically malnourished in India. In numbers it would mean that more than 47 million children under five years are stunted, 43 per cent of children under age five years are underweight for their age and about 20 per cent of children younger than five years of age are wasted (Ministry of Health & Family welfare, GOI, 2013). Raj *et al.* (2007) reported that the prevalence of obesity

among the 5-16 years children of Ernakulam district of Kerala, South India, increased from 4.94 per cent of the total children in 2003 to 6.57 per cent in 2005. A study conducted by Kaur

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*et al.* (2010) among 2-5 years children of Amritsar, Punjab, reported that the overall prevalence of overweight and obesity among the children was 6.42 per cent and 2 per cent, respectively.

The under five mortality rate in Assam is 88 per 1000 live births. About 36.4 per cent children under five years of age are underweight [The situation of Children in India (UNICEF, 2011)]. According to a report by the Comptroller and Auditor General (CAG) of India, the percentage of malnourished and severely malnourished children in Assam is 31.32 per cent and 0.46 per cent respectively as on March 2011 as per the World Health Organization (WHO) growth standard (Prabhakaran, 2013). Sikdar (2012) reported that the prevalence of overweight among 6 to 10 years children of Mishing Community of Assam, Northeast India, was 6.66-7.81 per cent according to WHO criteria.

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). Anthropometry is widely recognized as one of the useful technique to assess the growth and nutritional status of an individual or population (Gorstein *et al.*, 1994; Jelliffe, 1966; Rao *et al.*, 1986). Anthropometric measurements of young children are particularly sensitive to changes in nutritional status (Waterlow, 1976). Measurement of height, weight, mid-upper arm circumference are reliable means by which the progress of normal child is evaluated and gross abnormalities detected even when no other clinical signs of illness are manifested (Marathe *et al.*, 1994). Therefore an attempt has been made to assess the nutritional status of 4-6 years children of Jorhat, Assam through anthropometric measurements.

## **MATERIALS AND METHODS**

A total of 200 pre-school children (4-6 years) were selected by a multistage random sampling technique from four schools of Jorhat district of Assam. A schedule was formulated to record the data on anthropometric measurements, *viz.* height, weight and mid-upper arm circumference of the target population. Anthropometric measurements namely height, weight and mid-upper arm circumference of the sample were recorded using standardized tools and technique. The mean and standard deviation was calculated from the data obtained on measurement of height, weight and mid-upper arm circumference of the target population. The BMI was also calculated as per standard calculation. The results obtained were compared with 95<sup>th</sup> centile values of ICMR, NCHS standard, Waterlow classification of height-for-age, Indian Academy of Pediatrics (IAP) classification of weight-for-age and WHO (2007) Z-scores values for validating the categories according to different grades of malnutrition.

## **RESULTS AND DISCUSSION**

## Height

The comparison of mean observed height of the 4-6 years boys and girls with 95<sup>th</sup> centile values of height (ICMR) has been presented in Table 1

**Table 1. Comparison of mean height of 4-6 year boys and girls with 95<sup>th</sup> centile values of height (ICMR)**

| Age (years)   | No. of Subjects | Mean observed height (cm) ±S.D. | 95 <sup>th</sup> Centile value of height (ICMR) | Mean difference (absolute value) | % of 95 <sup>th</sup> Centile value of height (ICMR) | % excess(+) or deficit(-) | 't' value |
|---------------|-----------------|---------------------------------|---|----------------------------------|--|---------------------------|-----------|
| <b>Boys:</b>  |                 |                                 |   |                                  |  |                           |           |
| 4             | 20              | 101.9±4.77                      | 105.7   | 3.8                              | 96.40  | 3.50(-)                   | 3.55**    |
| 5             | 60              | 106.96±5.16                     | 111.5   | 4.54                             | 95.92  | 4.07(-)                   | 6.88**    |
| 6             | 20              | 110.60± 4.83                    | 118.5   | 7.9                              | 93.33  | 6.67(-)                   | 7.31**    |
| <b>Girls:</b> |                 |                                 |   |                                  |  |                           |           |
| 4             | 20              | 100.54 ± 6.95                   | 105.1   | 4.56                             | 95.66  | 4.34(-)                   | 2.94**    |
| 5             | 60              | 105.39 ± 5.58                   | 111.0   | 5.61                             | 94.95  | 5.05(-)                   | 7.79**    |
| 6             | 20              | 108.75 ± 4.73                   | 117.5   | 8.75                             | 92.55  | 7.45(-)                   | 8.25**    |

Source: ICMR (2010)

a = Reference value – observed mean value

\*\* - Significant at 1 per cent level

The Table 1 reveals that the boys in the age range of 4 years showed 3.50 per cent deficit from the 95<sup>th</sup> centile values of heights (ICMR). A deficit of 6.88 per cent from the standard was noted in the 5 year age group, the height was recorded as 95.92 per cent of the standard. The mean height for 6 year boys was 93.33 per cent of the standard and was 6.67 per cent deficit from the standard. Similarly, the girls in the 4 year age group showed 4.34 per cent deficit from the 95<sup>th</sup> centile values of height (ICMR). The mean height for 5 year girls was recorded to the 105.39cms which was 94.95 per cent of the standard. A deficit of 7.45 per cent from the standard was noted in the 6 year girls, the height was recorded as 92.55 per cent of the standard. The mean height of the boys and girls were significantly lower than 95<sup>th</sup> centile values of height (ICMR) in all the ages ( $p < 0.01$ ). Thus, it is evident that the target children had low height as compared to Indian reference standards in all the age groups. This may be due to the reason that the quality and quantity of the diet of the children were inadequate in terms of growth promoting nutrients such as protein and energy required during this period of life. Apart from that in the absence of insufficient energy from carbohydrates and fats, body metabolizes protein to fulfill its energy requirements which can result in height deficiency and physical impairment. Deficiency in height can be advocated as a reflection of genetic factor too (Gopalan, 1990). Kapure *et al.*, (2005) reported that the mean height of the under five children of North-East Delhi were significantly lower than the Indian standard.

Further an attempt has been made to analyse the observed height of the target group by comparing with the National Center for Health Statistics standard (NCHS) for ascertaining deficit or excess in observed values for height. The mean observed height of the 4-6 years boys and girls were compared with NCHS reference height and presented in Table 2.

**Table 2. Comparison of mean height of 4-6 year boys and girls with NCHS standard**

| Age (years)   | No. of Subjects | Mean observed height (cm) ± S.D. | NCHS Reference height (cm) | Mean difference <sup>a</sup> ( absolute value) | % of NCHS | % excess(+) or deficit(-) | 't' value          |
|---------------|-----------------|----------------------------------|----------------------------|--|-----------|---------------------------|--------------------|
| <b>Boys:</b>  |                 |                                  |                            |  |           |                           |                    |
| 4             | 20              | 101.9±4.77                       | 102.9                      | 1  | 99.02     | 0.97(-)                   | 0.92 <sup>NS</sup> |
| 5             | 60              | 106.96±5.16                      | 109.9                      | 2.94   | 97.33     | 2.67(-)                   | 4.45 <sup>**</sup> |
| 6             | 20              | 110.60± 4.83                     | 116.1                      | 5.5  | 95.26     | 4.74 (-)                  | 5.09 <sup>**</sup> |
| <b>Girls:</b> |                 |                                  |                            |  |           |                           |                    |
| 4             | 20              | 100.54 ± 6.95                    | 101.6                      | 1.06   | 98.95     | 1.04(-)                   | .067 <sup>NS</sup> |
|               | 60              | 105.39 ± 5.58                    | 108.4                      | 3.01   | 97.22     | 2.78(-)                   | 4.18 <sup>**</sup> |
| 6             | 20              | 108.75 ± 4.73                    | 114.6                      | 5.85   | 94.89     | 5.10(-)                   | 5.26 <sup>**</sup> |

Source: ICMR (2008)

a = Reference value – observed mean value

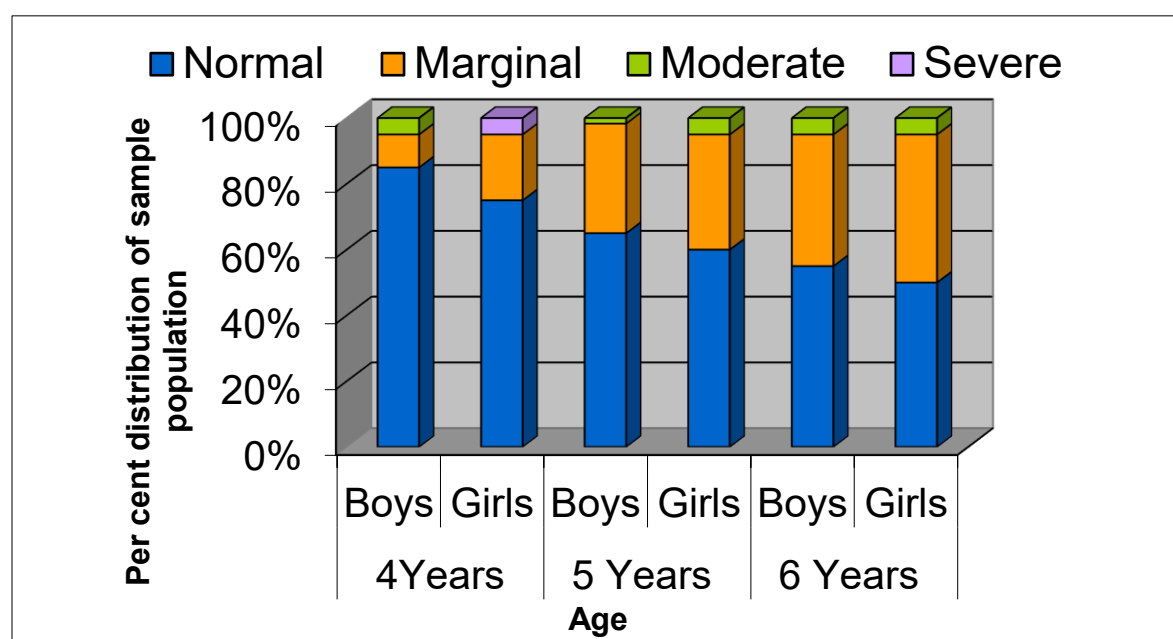
\*\* - Significant at 1 per cent level

It is evident from the table 2 that the boys in the age range of 4 years showed only 0.97 per cent deficit in height from the NCHS standard. A deficit of 2.67 per cent from the standard was noted in the 5 year age group where the height was recorded as 97.33 per cent of the standard. The mean height for 6 year boys was 95.26 per cent of the standard where the deficit was 4.74 per cent from the standard. Similarly, the girls in the 4 year age group showed only 1.04 per cent deficit in height from the NCHS standard. The mean height for 5 year girls was recorded as 97.22 per cent of the standard where the deficit was 2.78 per cent from the standard. A deficit of 5.10 per cent from the standard was noted in the 6 year girls, the height was recorded as 94.89 per cent of the standard. At 5 and 6 years, the mean height of the boys and girls was significantly lower than the NCHS standard ( $p < 0.01$ ).

Thus, it is evident that the 4 years boys and girls had normal heights which are satisfactorily comparable with the international (NCHS) standard. Ganguly (1999) reported that the mean height of 7-9 year boys of Jorhat town, Assam had normal height which were comparable with the international (NCHS) standard. However, at 5 and 6 years, the boys and girls showed a significant deficit in height as compared to NCHS standard. This may be due to nutritional

inadequacy in terms of those nutrients required for proper growth and development during this age of the life cycle. The extent of height deficit in relation to age, as compared to international standard (NCHS) may be regarded as a measure of the duration of malnutrition. A given deficit in height may represent a short period of growth failure at an early age or a longer period of growth failure at a later age (Bhagawati, 1991). However, deficiency in height can be advocated as a reflection of genetic factor too (Gopalan, 1990). Singh *et al.*, (2003) reported that the mean heights of both boys and girls of 1-6 years of Ludhiana, Punjab were significantly lower than the NCHS standard.

For further interpretation, the height of the 4-6 years children were classified according to Waterlow (1977) classification of height-for-age, to estimate the extent of malnutrition. Height-for-age can be used as an index of the nutritional status of population groups as it estimates past or chronic nutritional status. Height-for-age is particularly valuable as an index of 'stunting' of a child's full growth potential. Stunting is a slowing of skeletal growth and stature, defined by Waterlow (1976) as "the end result of a reduced rate of linear growth". Fig.1. shows the per cent distribution of 4-6 years boys and girls according to the Waterlow classification of height-for-age.



**Figure. 1. Per cent distribution of children (4-6 Years, n=200) according to Waterlow (1977) classification of height- for- age**

Waterlow (1977) Classification of height- for- age:

- <85 % Expected height-for-age : Severe malnutrition
- 85-90% Expected height-for-age : Marginal malnutrition
- 90-95% Expected height-for-age : Marginal malnutrition
- >95 % Expected height-for-age : Normal

In this present investigation while height measurements were classified according to Waterlow classification, it was revealed that a maximum percentage of 85 boys in the 4 years category had normal height-for-age, followed by 65 per cent in the 5 years and 55 per cent in the 6 years age group. The boys under the studied population who had marginal malnutrition as per classification given by Waterlow (1977) were in the order of 10 per cent in 4 years, 33.33 per cent in 5 years and 40 per cent of the boys in 6 years categories. According to the same classification, 5 per cent of the boys in 4 and 6 years and 1.67 per cent in 5 years were suffering from moderate malnutrition. Among the girls, 75 per cent in the 4 years category were recorded as having normal height-for-age, followed by 60 per cent in the 5 years and 50 per cent of the girls in the 6 years age group. As per Waterlow classification, 20 per cent, 35 per cent and 45 per cent of the target children in 4, 5 and 6 year age group were suffering from marginal malnutrition. Only 5 per cent of the 5 and 6 year girls were suffering from moderate malnutrition and 5 per cent of the 4 year girls were suffering from severe malnutrition. The present picture establishes the fact that there was prevalence of marginal malnutrition among the studied population in each age group. The prevalence of marginal malnutrition among the target children may be due to inadequate intake of food and nutrients both in terms of quality and quantity required to fulfill the nutritional demands of the growing children. The influence of possible genetic and ethnic differences must also be considered when evaluating height-for-age. The findings of the present study is in concurrent with the results reported by Manna *et al.*, (2011) where 5-12 years children of North Bengal were suffering from mild malnutrition in all the ages according to Waterlow classification of height-for-age due to the reason that the children frequently suffer from diseases such as diarrhoea, malaria, jaundice, fever, skin disease and common cold and also low parental income results in low intake of food than recommended which leads to deficiency in energy, protein and vitamins. Laishram (1996) in a study conducted among 3-12 years children of Jorhat, Assam reported that 64-76 per cent of the children were well nourished, 14-34 per cent were marginally malnourished, 15-32 per cent were moderately malnourished and 4-12 per cent were severely malnourished according to Waterlow classification of height-for-age. While assessing the nutritional status of 3-5 years children of Karaikal district of Pondicherry, William *et al.*, (2012) reported that 63.25 per cent of the children were normal, 34.41 were mildly stunting and 2.34 were moderately stunting. Murugkaret *et al.*, (2013) reported that 53 per cent of the 6-9 years children of Bhopal district, Madhya Pradesh were normal while 21 per cent were marginally malnourished, 20 per cent were moderately malnourished and 6 per cent were severely malnourished which was due to illiteracy of mother, poverty, nutritional inadequacy and poor infrastructure.

The mean observed height of the 4-6 year boys and girls were further classified according to World Health Organization (WHO, 2007) Z-scores of height-for-age to observe the prevalence of stunting among the study sample. Table 3 shows the per cent distribution of 4-6 year boys and girls according to WHO (2007) Z-scores of height-for-age.

**Table 3. Percent distribution of 4-6 year boys and girls according to WHO (2007) Z-scores of height- for-age**

| Age (years)   | Observed no. of subjects (n=200) | height-for-age(Z-scores) |                 |
|---------------|----------------------------------|--------------------------|-----------------|
|               |                                  | Normal and above(>-2SD)  | Stunting(<-2SD) |
| <b>Boys:</b>  |                                  |                          |                 |
| 4             | 20                               | 80                       | 20              |
| 5             | 60                               | 78.33                    | 21.67           |
| 6             | 20                               | 65                       | 35              |
| <b>Girls:</b> |                                  |                          |                 |
| 4             | 20                               | 75                       | 25              |
| 5             | 60                               | 66.67                    | 33.33           |
| 6             | 20                               | 60                       | 40              |

**Source:** World Health Organization (2007) Z-Scores of height-for-age

From the Table 3 it has been observed that 80, 78.33 and 65 per cent of the boys in the age group of 4, 5 and 6 years respectively were in the normal category of nutritional status. The prevalence of stunting among the 4-6 year boys was 20, 21.67 and 35 per cent at age 4, 5 and 6 years respectively. The height for age assessment results according to the given standard for girls revealed that at the age of 4, 5 and 6 years 75, 66.7 and 60 per cent of them respectively were in the normal range of nutritional status. The prevalence of stunting among the 4-6 year girls was 25, 33.33 and 40 per cent at age 4, 5 and 6 years respectively.

The per cent distribution of 4-6 year boys and girls according to WHO (2007) Z-scores of height-for-age revealed that although the majority of the boys and girls were in the normal range of nutritional status, there was prevalence of stunting among the studied children in each age group. Stunting reflects a failure to reach linear growth potential due to sub-optimal health and/or nutritional conditions. It is an indicator of chronic undernutrition, the result of prolonged food deprivation and/or disease or illness (Das *et al.*, 2011). Some investigators suggested that children who are stunted have adapted to their chronic dietary restriction, resulting in limited linear growth (Trowbridge, 1979). Waterlow (1994) reported that, etiology of linear growth retardation is multi-factorial but has been explained by three major factors: poor nutrition, high levels of infection and problematic mother-infant interaction, which is closely related to the socio-economic status of the family. In the present investigation, the prevalence of stunting may be due various factors either poor nutrition, infectious diseases and genetic factor. Parental income may also directly or indirectly influence the qualitative and quantitative food availability at the household, which may determine the food and nutrient intake during pre-school age and thereby result in impaired nutritional status. The findings of the present study is concurrent with the results reported by Kaur *et al.*, (2005) that the prevalence of stunting among 1 to 5 years children of Punjab was 11.42 per cent which was due to a wide variety of biological, behavioural



and socio-economic variables that influence the health status of young children in developing countries. EdrisMelkie (2007) found that 24 per cent of under five children in a rural locality called Gumbrit of Northwest Ethiopia were stunted which could be attributed to a large extent to the income of the parents. While evaluating the rates of stunting among 2-6 year old rural children of Hoogly district, West Bengal, India, Mandal *et al.*, (2008) found that the overall prevalence of stunting was medium (20-29%) which indicated that there existed medium level of chronic undernutrition due to prolonged food deprivation. Ahmadi *et al.*, (2014) reported that 25.4 per cent of 3-5 years children in Shiraz, Iran were stunted which was due to prevalence of poverty and inappropriate dietary intake.

## Weight

The mean observed weight of the 4-6 years boys and girls were compared with 95<sup>th</sup> centile values of weight (ICMR) and presented in Table 4.

**Table 4. Comparison of mean weight of 4-6 year boys and girls with 95<sup>th</sup> centile values of weight (ICMR)**

| Age (years)   | No. of Subjects | Mean observed weight (kg) ± S.D. | 95 <sup>th</sup> Centile values of weight (ICMR) | Mean difference <sup>a</sup> ( absolute value) | % of 95 <sup>th</sup> Centile values of weight (ICMR) | % excess(+) or deficit(-) | 't' value          |
|---------------|-----------------|----------------------------------|--|--|---|---------------------------|--------------------|
| <b>Boys:</b>  |                 |                                  |  |  |   |                           |                    |
| 4             | 20              | 16.17±1.93                       | 16.5   | 0.33   | 98.00   | 2.00(-)                   | .76 <sup>NS</sup>  |
| 5             | 60              | 17.63 ± 2.95                     | 18.2   | 0.57   | 96.87   | 3.13(-)                   | 1.5 <sup>NS</sup>  |
| 6             | 20              | 19.70 ± 2.29                     | 20.4   | 0.70   | 96.57   | 3.43(-)                   | 1.37 <sup>NS</sup> |
| <b>Girls:</b> |                 |                                  |  |  |   |                           |                    |
| 4             | 20              | 15.05 ± 2.66                     | 16.0   | 0.95   | 94.06   | 5.93(-)                   | 1.61 <sup>NS</sup> |
| 5             | 60              | 16.33 ± 2.44                     | 17.7   | 1.37   | 92.26   | 7.74(-)                   | 4.42*              |
| 6             | 20              | 18.10 ± 2.77                     | 20.0   | 1.90   | 90.5  | 9.50(-)                   | 3.11*              |

Source: ICMR (2010)

a = Reference value – observed mean value

\*- Significant at 5 per cent level

It is evident from the Table 4 that the boys in the age range of 4 year showed 2 per cent deficit from the 95<sup>th</sup> centile values of weight (ICMR) standard. A deviation of 3.13 per cent from the standard was noted in the 5 year age group, the weight was recorded as 96.87 per cent of the standard. The mean weight for 6 year boys was 96.57 per cent of the standard where the deficit was 3.43 per cent of the standard. Similarly, the girls in the 4 year age group showed 5.93 per cent deficit from the 95<sup>th</sup> centile values of weight (ICMR) standard. The mean weight for 5 year girls was 92.26 per cent of the standard and the deficit was 7.74 per cent of the standard. A deficit of 9.50 per cent from the standard was noted in the 6 year girls, the weight was recorded as 90.5 per cent of the standard. Thus it is observed that the mean observed weight of the target

population were comparable with Indian reference standards in all the age groups except for 5 and 6 year girls whose mean weight were significantly lower than the Indian standard ( $p < 0.01$ ). While assessing the growth pattern of under five children of North- East Delhi (Kapure *et al.*, 2005) reported that the mean weight of the children were significantly lower than the Indian standard.

Further an attempt has been made to analyse the observed weight of the study sample by comparing with the National Center for Health Statistics standard (NCHS) for ascertaining deficit or excess in observed values for weight. The mean observed weight of the 4-6 years boys and girls were compared with NCHS reference weight and presented in Table 5.

**Table.5. Comparison of mean weight of 4-6 year boys and girls with NCHS standard**

| Age (years)   | No. of Subjects | Mean observed weight (kg) $\pm$ S.D. | NCHS Reference weight (kg) | Mean difference <sup>a</sup> ( absolute value) | % of NCHS | % excess(+) or deficit(-) | 't' value          |
|---------------|-----------------|--------------------------------------|----------------------------|--|-----------|---------------------------|--------------------|
| <b>Boys:</b>  |                 |                                      |                            |  |           |                           |                    |
| 4             | 20              | 16.17 $\pm$ 1.93                     | 16.7                       | 0.53   | 96.82     | 3.17(-)                   | 1.23 <sup>NS</sup> |
| 5             | 60              | 17.63 $\pm$ 2.95                     | 18.7                       | 1.07   | 94.27     | 5.72(-)                   | 1.59 <sup>NS</sup> |
| 6             | 20              | 19.70 $\pm$ 2.29                     | 20.7                       | 1.00   | 95.17     | 4.83(-)                   | 1.92 <sup>NS</sup> |
| <b>Girls:</b> |                 |                                      |                            |  |           |                           |                    |
| 4             | 20              | 15.05 $\pm$ 2.66                     | 16.0                       | 0.95   | 94.06     | 5.94(-)                   | 1.58 <sup>NS</sup> |
| 5             | 60              | 16.33 $\pm$ 2.44                     | 17.7                       | 1.37   | 92.26     | 7.74(-)                   | 4.41*              |
| 6             | 20              | 18.10 $\pm$ 2.77                     | 19.5                       | 1.4  | 92.82     | 7.18(-)                   | 2.25*              |

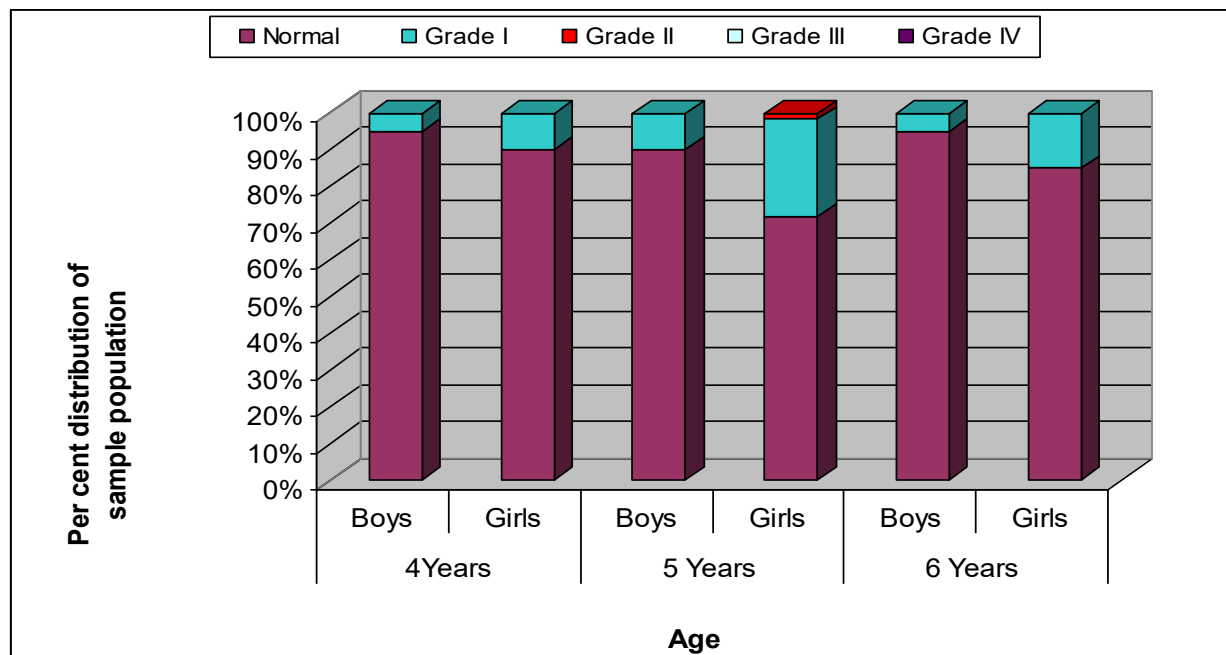
Source: ICMR (2008)

a = Reference value – observed mean value

\*- Significant at 5 per cent level

From the Table 5, it is seen that the average deficit percentage of NCHS standard for weight among boys were 3.17 per cent, 5.72 per cent and 4.83 per cent at 4, 5 and 6 years respectively. Among girls, the average deficit percentage of NCHS standard for weight were 5.94 per cent, 7.74 per cent and 7.18 per cent at 4, 5 and 6 years respectively where the 5 and 6 year girls had significant weight deficit as compared to the NCHS standard. Thus, it is observed that the mean weight of the sample population were quite comparable with the NCHS standard, except for 5 and 6 year girls, whose mean weight were significantly lower than the international standard ( $p < 0.05$ ). Weight deficiency appears to be the best indicator of growth retardation. This weight deficit may be due to nutritional deficiency in the diets of the 5 and 6 year girls. Similar results were reported by Singh *et al.*, (2003) that the mean weights of the 4-6 years children of Ludhiana city were significantly lower than the NCHS standards.

For further interpretation, the weight of the sample population were classified according to Indian Academy of Paediatrics (1972) classification of weight-for-age, to estimate the extent of malnutrition. Fig. 2 shows the per cent distribution of 4-6 year boys and girls according to Indian Academy of Paediatrics.



**Figure. 2. Per cent distribution of children (4-6 Years, n=200) according to Indian Academy of Paediatrics (1972) classification of weight- for- age**

Indian Academy of Paediatrics (1972) Classification of weight- for- age

<50% weight- for- age = Grade IV

51-60% weight- for- age = Grade III

61-70% weight- for- age = Grade II

71-80% weight- for- age = Grade I

>80% weight- for- age = Normal

From Fig. 2, it has been observed that 95 per cent of the boys in the 4 and 6 years age group and 90 per cent in the 5 years age group, were recorded as having normal weight-for-age. According to the same classification, 5 per cent of the boys in 4 and 6 years and 10 per cent of the boys in 5 years age group were suffering from Grade I or (mild) malnutrition. Among the girls, 90 per cent of the girls in the 4 year age group, 71.67 per cent in the 5 years and 85 per cent in the 6 year age group, were recorded as having normal weight-for-age. According to the same classification, 10 per cent, 26.67 per cent and 15 per cent of the girls in 4, 5 and 6 years age group were suffering from Grade I or (mild) malnutrition. There was no prevalence of Grade II, Grade III and Grade IV malnutrition among the sample population except for 5 year girls where 1.66 per cent were suffering from Grade II malnutrition. The per cent distribution of children according to

Indian Academy of Paediatrics classification revealed that there was prevalence of Grade I malnutrition among the 4-6 year boys and girls in each age group which may be the result of nutritional deficiency. Jayatissa *et al.*, (2011) in a study conducted among 3-6 years preschool children of Nagapattinam district, Tamil Nadu, India, reported that according to the Indian Academy of Paediatrics (IAP) classification, 24.6 per cent boys and 14.1 per cent girls were categorized under Grade I malnutrition, 16.3 per cent boys and 15.7 girls were under Grade II malnutrition, 6.7 per cent boys and 8.9 per cent girls were under Grade III malnutrition and 4 per cent boys and 4.4 per cent girls were under Grade IV malnutrition. While assessing the nutritional status of under-five children in Kakati-A sub-centre, under Primary Health Centre Vantamuri of Belgaum district, of South India, Mathad *et al.*, (2011) reported that according to the Indian Academy of Paediatrics (IAP) classification the prevalence of Grade I malnutrition was 47.10 per cent, Grade II was 10 per cent and Grade III and IV were 1.40 per cent. A study done by Srivastava *et al.*, (2012) found that according to the Indian Academy of Paediatrics (IAP) classification nearly 32.5 per cent, 16.9 per cent, 8.4 per cent and 8.4 per cent of under five children of Brailley, Uttar Pradesh, were suffering from grade I, II, III and IV malnutrition respectively..

The mean observed weight of the 4-6 year boys and girls were further classified according to World Health Organization (WHO, 2007) Z-scores of weight-for-age to observe the prevalence of underweight among the study sample. Table 6. shows the per cent distribution of 4-6 year boys and girls according to WHO (2007) Z-scores of weight-for-age.

**Table.6: Per cent distribution of 4-6 year boys and girls according to WHO (2007) Z-scores of weight- for-age**

| Age (years)   | Observed no. of subjects (n=200) | Weight-for-age(Z-scores) |                     |
|---------------|----------------------------------|--------------------------|---------------------|
|               |                                  | Normal and above (>-2SD) | Underweight (<-2SD) |
| <b>Boys:</b>  |                                  |                          |                     |
| 4             | 20                               | 95                       | 5                   |
| 5             | 60                               | 88.33                    | 11.67               |
| 6             | 20                               | 100                      | -                   |
| <b>Girls:</b> |                                  |                          |                     |
| 4             | 20                               | 85                       | 15                  |
| 5             | 60                               | 73.33                    | 26.67               |
| 6             | 20                               | 80                       | 20                  |

Source: World Health Organization (2007) Z-Scores for weight-for-age

From the Table 6, it is apparent that 95 per cent of the boys at 4 years, 83.33 per cent at 5 years and 100 per cent at 6 years were in the normal range of nutritional status. 5 per cent and 11.67 per cent of the boys were underweight at ages 4 and 5 years respectively. Surprisingly, none of the 6 year boys were underweight. Among the girls, 85 per cent, 73.33 per cent and 80 per cent

were in the normal range of nutritional status at 4, 5 and 6 years respectively. The prevalence of underweight among the 4-6 year girls was 15 per cent, 26.67 per cent and 20 per cent at age 4, 5 and 6 years respectively. The per cent distribution of 4-6 year boys and girls according to WHO (2007) Z-scores of weight-for-age revealed that cent per cent of the 6 year boys were enjoying normal nutritional status. Except 6 year boys, there was prevalence of underweight among the boys and girls at each age. In all the ages, underweight was more prevalent in girls than boys. It may be due to early childhood diseases association among girls than boys. Underweight reveals low body mass with chronological age, which is influenced by both child's height and weight (Das *et al.*, 2011). According to Rayhan and Khan (2006), the factors that can cause underweight problem in children were birth interval, size at birth, mother's body mass index at birth as well as parents educational level. The findings of the present study is similar to a study reported by Rijalet *et al.*, (2011) ) that 28.9 per cent of the children below 5 years of age, in Attarkhel, Kathmandu, Nepal, were undernourished might be due to the effect of low level of education of the parents and low socio-economic status. A study done by Kaur *et al.*, (2005) found that 15.04 per cent of 1 to 5 years children of Punjab, were under weight which can be explained in terms of poverty and lack of education. In a study conducted by Edris (2007) among under five children of Gumbrit of Northwest, Ethiopia, reported that 28.5 per cent of the children were underweight which due to the low income of parents that limits the kinds and foods available for consumption. A study done by Francis *et al.*, (2010) reported that 10.3 per cent of the (5-12 years) children in Jos-Plateau of Nigeria were underweight which might be due to poor socio-economic status. A study done by Makenet *et al.*, (2012) among 2-10 years Hmar tribal children of Aizwal district, Mizoram, found that the overall prevalence of underweight was 28.40 per cent due to low economic condition.

### Mid-Upper Arm Circumference (MUAC)

The 4-6 year boys and girls were therefore subjected to MUAC measurements and the results obtained were compared with ICMR (1984) standard and presented in Table 7.

**Table.7. Comparison of mean mid-upper arm circumference of 4-6 year boys and girls with ICMR standard**

| Age (years)  | No. of subjects | Mean observed MUAC(cm)+S.D. | ICMR Reference MUAC (cm) | Mean difference <sup>a</sup> (absolute value) | % of ICMR | % excess(+) or deficit (-) | 't' value          |
|--------------|-----------------|-----------------------------|--------------------------|---|-----------|----------------------------|--------------------|
| <b>Boys</b>  |                 |                             |                          |   |           |                            |                    |
| 4            | 20              | 14.95 ± 1.31                | 15.5                     | 0.55  | 96.45     | 3.55(-)                    | 1.89 <sup>NS</sup> |
| 5            | 60              | 15.30 ± 1.36                | 15.7                     | 0.4   | 97.45     | 2.55(-)                    | 2.35*              |
| 6            | 20              | 15.89 ± 1.38                | 16.2                     | 0.31  | 98.08     | 1.91(-)                    | 1 <sup>NS</sup>    |
| <b>Girls</b> |                 |                             |                          |   |           |                            |                    |
| 4            | 20              | 14.63 ± 1.04                | 15                       | 0.37  | 97.53     | 2.47(-)                    | 1.60 <sup>NS</sup> |

|   |    |              |      |      |       |         |                   |
|---|----|--------------|------|------|-------|---------|-------------------|
| 5 | 60 | 14.93 ± 1.07 | 15.4 | 0.47 | 96.95 | 3.05(-) | 3.61*             |
| 6 | 20 | 15.38 ± 1.80 | 15.7 | 0.32 | 97.96 | 2.03(-) | 0.8 <sup>NS</sup> |

Source: Ghosh (1992)

a = Reference value – observed mean value

\*- Significant at 5 per cent level

The Table 7 reveals that the mean observed MUAC of the boys were lower than the ICMR standard by 3.55 per cent, 2.55 per cent and 1.91 per cent respectively at 4, 5 and 6 years. Among girls, the average deficit percentage of ICMR standard for MUAC were 2.47 per cent, 3.05 per cent and 2.03 per cent at 4, 5 and 6 years respectively. Thus, it is observed that the mean observed MUAC of the sample population were quite comparable with the ICMR standard, except for 5 year boys and girls whose mean MUAC were significantly lower than the ICMR standard ( $p < 0.05$ ). The deficit in MUAC among the 5 years children may be attributed by the nutritional quality of the pre-schoolers diet where probably the growth promoting factors in the diet like quality and quantity of protein and energy may be deficient. Similar results were reported by Singh *et al.*, (2003) where the mean MUAC of both boys and girls in all the age group(1-6) years were significantly lower than the standard. Kapure *et al.*, (2005) found that the mean MUAC of under five children of North-East Delhi was significantly lower than the standard due to inadequate intake of food and nutrient.

### Body mass index

The mean BMI of the 4-6 year boys and girls were further classified according to World Health Organization (WHO, 2007) Z-scores of BMI-for-age. Table 8. shows the per cent distribution of 4-6 year boys and girls according to World Health Organization (WHO, 2007) Z-scores of BMI-for-age

**Table.8. Percent distribution of 4-6 year boys and girls according to WHO (2007) Z-scores of BMI- for-age**

| Age (years)   | Observed no.of subjects (n=200) | WHO classification <sup>a</sup> |                              |                            |                |             |
|---------------|---------------------------------|---------------------------------|------------------------------|----------------------------|----------------|-------------|
|               |                                 | Normal (%)                      | Moderate under nutrition (%) | Severe under nutrition (%) | Overweight (%) | Obesity (%) |
| <b>Boys:</b>  |                                 |                                 |                              |                            |                |             |
| 4             | 20                              | 75                              | 5                            | -                          | 15             | 5           |
| 5             | 60                              | 60                              | 8.33                         | 5                          | 26.67          |             |
| 6             | 20                              | 70                              | 5                            | 5                          | 20             |             |
| <b>Girls:</b> |                                 |                                 |                              |                            |                |             |
| 4             | 20                              | 75                              | 5                            | 5                          | 10             | 5           |
| 5             | 60                              | 73.33                           | 15                           | -                          | 10             | 1.67        |
| 6             | 20                              | 45                              | 15                           | 15                         | 20             | 5           |

Source: World Health Organization (2007) Z-Scores of BMI-for-age

a

|                           |                           |
|---------------------------|---------------------------|
| >Median -2SD to < +1SD    | : Normal                  |
| Median < -2SD to > - 3SD  | : Moderate undernutrition |
| < Median – 3SD            | : Severe undernutrition   |
| Median > +1 SD to < +3 SD | : Overweight              |

From the Table 8, it has been observed that 60-75 per cent of the 4-6 boys were normal in the age group of 4, 5 and 6 years. 5- 8.33 per cent of the boys were suffering from moderate undernutrition at 4, 5 and 6 years respectively. 5 per cent of the 5 and 6 years boys were suffering from severe undernutrition. 15 - 26.67 per cent of the boys were overweight in the age group of 4-6 years. 5 per cent of the 4 year boys were obese. Among girls, 45 - 75 per cent of the girls were normal in the 4, 5 and 6 years age group. 5 -15 per cent of the girls at 4, 5 and 6 years were suffering from moderate undernutrition. 5 per cent of the 4 year girls and 15 per cent of the 6 years girls were suffering from severe undernutrition. 10-20 per cent of the 4, 5 and 6 year girls were overweight. 1.67 - 5 per cent of the girls in the age group of 4, 5 and 6 years were obese. Thus, it is evident that the prevalence of moderate and severe undernutrition among the 4-6 year boys and girls was 5-15 per cent whereas the other proximity of the distribution of BMI-for-age evidenced prevalence of overweight and obesity among the target children was 10-26.67 per cent and 1.67-5 per cent respectively. This may be due to the reason that the children usually like to eat foods with high energy density, especially foods that are high in fat and sugar. Vereecken *et al.*, (2004) found that only a few preschoolers achieved intake recommendations for fruits, vegetables and milk whilst most pre-schoolers over-consumed sugary snacks and drinks. As a consequence, these eating habits contribute to the rising prevalence of childhood obesity. Similar results were reported by Sadowska *et al.*, (2010) that 20 per cent of the 4-6 years preschool children in Szczecin, Poland were overweight which may be a consequence of the fact that parents often repeat at home the meals that the child had already eaten at school. While assessing the nutritional status of 2-6 years preschool children of Sao Paulo, Brazil, Shoepset *et al.*, (2011) reported that 16.8 per cent of the children were overweight and 10.8 per cent were obese which might be due to improvement of living conditions particularly with regard to access to food and health care. A study conducted by Pohet *et al.*, (2012) among 5-6 years children of Klang Valley, Malaysia, found that the prevalence of overweight and obesity was 9.1 per cent and 9.3 per cent respectively. In a study conducted among preschoolers aged 4-6 years in Peninsular Malaysia, MohdNasiret *et al.*, (2012) reported that the prevalence of overweight and obesity were 7.9 per cent and 8.1 per cent respectively.

## SUMMARY

The present investigation revealed that the height measurements of the target children were significantly lower than the 95<sup>th</sup> centile values of ICMR ( $p < 0.01$ ). The 4 years children had normal

heights which are quite comparable with NCHS standard while the 5 and 6 years children had significantly lower height than the NCHS standard ( $p < 0.01$ ). As per Waterlow classification of height-for-age, 63 per cent of the 4-6 years children had normal height while 32 per cent had marginal malnutrition, 2.5 per cent had moderate malnutrition and a negligible amount (0.5%) had severe malnutrition. The per cent distribution of the target children according to WHO (2007) Z-scores of height-for-age revealed that 71.5 per cent of the children had normal height-for-age while 28.5 per cent were suffering from stunting. In the present investigation, the anthropometric assessment in terms of weight revealed that the 4-6 years children had normal weight as compared to 95<sup>th</sup> Centile values of ICMR and NCHS standard except for 5 and 6 year girls whose mean weights were significantly lower than the 95<sup>th</sup> Centile values of weight (ICMR) as well as the international (NCHS) standard ( $p < 0.05$ ). The percent distribution of children according to Indian Academy of Pediatrics classification of weight-for-age revealed that 85 per cent were in the normal range of nutritional status whereas 15 per cent were suffering from Grade I malnutrition and 0.5 per cent were suffering from Grade II malnutrition. As per WHO (2007) Z-scores of weight-for-age, majority (84.5%) were in the normal category whereas 15.5 per cent were underweight. Thus, the present study revealed that the mean observed mid upper arm circumference of the studied population are quite comparable with the national (ICMR) standards except for 5 year boys and girls whose mean Mid Upper Arm Circumference (MUAC) were significantly lower than the ICMR standards ( $p < 0.05$ ). Therefore, the present investigation revealed that 66.5 per cent of the children were in the normal range of nutritional status whereas 12 and 3 per cent respectively were suffering from moderate and severe undernutrition according to WHO (2007) Z-scores of BMI-for-age. According to the same classification, 17.5 and 4 per cent of the 4-6 years children were suffering from overweight and obesity respectively.

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