
**“GROWTH VELOCITY AND ITS ASSOCIATION
WITH DIET AMONG UNDER FIVE CHILDREN
RESIDING IN RURAL AREA OF BELAGAVI-A
LONGITUDINAL STUDY”**

Thesis submitted to
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***For the award of the degree of
Doctor of Philosophy
in
the Faculty of Science***

By

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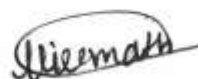
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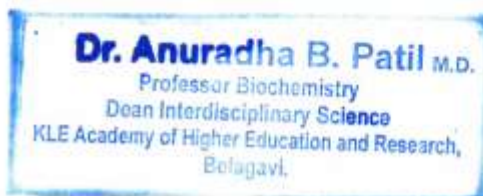
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Date:

Miss. Manasa M Hiremath

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LIST OF ABBREVIATIONS USED

ANOVA	-	Analysis of variance
AW	-	Anganwadi
AWW	-	Anganwadi worker's
BAZ	-	Body mass index for age z-score
BL	-	Baseline
BMI	-	Body Mass Index
CI	-	Confidence Interval
Cms	-	Centimeter
COVID	-	Corona Virus Disease
DC	-	Data collection
DD	-	Diet Diversity
DDS	-	Diet Diversity Score
DM	-	Diabetes Mellitus
DSS	-	Dietary Serving Score
EBF	-	Exclusive Breast Feeding
EDHS	-	Ethiopia Demographic and Health Survey
FVS	-	Food Variety Score
GLV	-	Green leafy vegetable
GV	-	Growth velocity
HAZ	-	Height-for-age-z-score
HC	-	Head Circumference
i.e.	-	That is,
kg	-	Kilogram
kg/ m ²	-	Kilograms per square meter

LPG	-	Liquefied petroleum gas
MICS	-	Multiple indicator cluster surveys
MUAC	-	Mid upper arm circumference
NFHS -5	-	National Family Health Survey
NICU	-	Neonatal intensive care unit
No	-	Number
NS	-	Nutritional status
PG	-	Postgraduate
PHC	-	Primary health center
PUC	-	Pre-university course
RDA	-	Recommended Dietary Allowance
SAM	-	Severe acute malnutrition
SD	-	Standard deviation
SES	-	Socioeconomic Status
SPSS	-	Statistical Package for the Social Sciences
WAZ	-	Weight-for-age-z-score
WHO	-	World Health Organization

ABSTRACT

Background

Growth and development are unique features in children. Child grows continuously till the adulthood. There are periods of rapid growth and slower growth in every child but the pattern of growth differs in children depending on various factors ranging from genetics to environment, socio demography. Nutrition plays an important role in maintaining growth of children.

Objectives

Primary Objective:

1. Assessment of growth velocity among children aged between 1-5 years residing in rural area

Secondary Objective:

1. To study the diet diversity, socio-economic and environmental determinants of growth velocity.
2. To study the association between growth velocity and anthropometry of parents.

Methodology

The present longitudinal study conducted in the rural practice area of medical college that is primary health center under field practice area of J N Medical College over a period of one year from September 2021 to August 2022. There are five Sub centres under PHC Vantamuri, out of 5 Sub centres, 2 Sub centres were randomly selected namely Vantamuri and Bhutaramanahatti three anganwadis from Sub centre Vantamuri and another four was from Sub center four Bhutaramanahatti were selected

All AW under the selected two Sub centres list of children aged between 1-4 years was prepared; children from AWs under the selected Sub centres were selected till required sample size was reached i.e., 270 children.

Growth velocity of selected children was done, through anthropometric measurements (height/ length, weight, head circumference and mid arm circumference) every month. At the end of one-year assessment was done to know the growth velocity among selected children. Children who were stunted and wasted was noted by using WHO “Z” score for weight for age, height for age and weight for height. Association/ correlation was done between growth velocity and various factors like diet, socio demographic, environmental variables and parents anthropometry.

Results

The majority of the children were aged between 13-24 months. Male children slightly outnumbered female children, comprising 50.74% of the sample. Weight velocity was highest in children aged 37 months and above, followed by those aged 25-36 months, and lowest in those aged 13-24 months; however, this difference was not statistically significant.

Height velocity was also highest among children aged 37 months and above, compared to those aged 13-24 and 25-36 months, with the difference not being statistically significant. BMI velocity was highest from baseline to 6 months in the 13-24 months age group compared to the other two age groups, and this difference was statistically significant ($p < 0.05$).

There was significant association between dietary diversity scores (DDS) and weight-for-age, at 3,6,9 and 12 months. Regardless of the number of rooms in the house, the nutritional status of children improved over one year. There was correlation between DDS and MUAC at all different time points and also DSS with MUAC at 6

months. FVS had a correlation at 6 months and 12 months DSS correlation with HC at baseline.

In our study, participants from socio-economic classes I-III had better mean growth velocity for weight compared to classes IV and V, with this difference being statistically significant ($p<0.05$). Our study demonstrated a positive correlation between fathers' weight and the weight of their children at baseline, 6 months, and 12 months, which was statistically significant ($p<0.05$). No such correlation was observed with mothers' weight. Similarly, there was a positive correlation between fathers' height and their children's height at baseline, 6 months, and 12 months, which was statistically significant ($p<0.05$). No such correlation was found with mothers' height. Additionally, there was a positive correlation between fathers' BMI and their children's BMI at 12 months, which was statistically significant ($p<0.05$). No such correlation was found with mothers' BMI

Conclusion

Weight and height velocity decreased among those who were less than 25th centile for weight and height. Weight and height velocity was better among those aged ≥ 37 months. BMI velocity was better among 13-24 months. Growth velocity for weight was better among children who received EBF for ≥ 6 months this was statistically significant with $p<0.006$. Adequacy of weaning food was associated with growth velocity for weight, height, MUAC and HC. There was association between number of rooms, overcrowding and proper ventilation with growth velocity for BMI and MUAC. Fathers height, weight and BMI was positively correlated with child's height, weight and BMI velocity.

Keywords: Growth velocity, children, rural, weight-for-age, height-for-age, Body mass index, Food variety score, Diet diversity score, Dietary serving score

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INTRODUCTION

Growth and development are unique features in children. Child grows continuously till the adulthood. There are periods of rapid growth and slower growth in every child, but the pattern of growth differs in children depending on various factors ranging from genetics to environment. The growth velocity can be shown in the form of sigmoid curve with lag phase, exponential phase and stationary phase. During this phase child can assume different type of physical pattern like ectomorphs, endomorphs and the mesomorphs ¹. Physical growth in a child can be considered as an indicator of nutritional status. Proper nutrition helps in not only growth but also development of the child.

NFHS-5 data (conducted in the year 2019-20) revealed that, 32.9% children were underweight, 35.4%, 8.4% and 19.5% children under -5 years were stunted, severely wasted and wasted respectively ². A study done in Rural and Urban slum in Maharashtra showed prevalence of wasting in rural 15.9% urban 18.4%, stunting 42.1% in rural, Urban 49.7%, underweight 34% in rural and Urban 36.8% ³. Despite various nutritional interventions still malnutrition is prevalent and a public health problem. Malnutrition could be attributed to morbidity and mortality among under-five children. Wasting is associated with short term deficiency of nutrition or due to illness. Stunting shows long term impact of deficient diet or the factors affecting the growth have persisted for a longer time. ¹.

Physical growth can be assessed at one time and compared with reference standards to check whether child is growing normally or not. This also helps to know the nutritional status of children by using various classifications, commonly used method being “Z” scores. It is an easy method to assess the growth of children and

take action. By this method constitutionally thin and short children are classified as malnourished children despite having normal growth velocity.

One-time measurement of either weight or height, does not give information whether the rate of growth has been normal in the recent past. A child with normal growth at a given point may not show normal velocity of growth in future or a child whose growth is lesser than the reference value may have normal growth velocity if conditions become favorable. It is always better to record weight, height and other anthropometric measurements at intervals to check normal growth velocity, on two occasions with at least 3 months interval.⁴ Anthropometric examination is mandatory tool in any research to assess growth, health and nutritional condition in childhood. Physical measurements like weight, height, mid- upper arm circumference have been extensively used to define health and nutritional status of communities.

The nutrient density of the diet provided to children many a times inadequate to meet their nutritional needs, hence by increasing the diversity of foods given to the children, such as meat, poultry, fish, eggs, fruits and vegetables helps to improve micronutrient intakes and reduce its deficiency.¹ It is a known fact that nutrition is key determinant of good health and is critical for survival, good quality of life and well-being. Despite improving diet of children through many nutritional programs, still malnutrition is one of the public health problems⁵. There is interplay of genetic, nutritional and environmental factors in determining the weight, height and body structure of children. Correction of micro nutrient deficiency is very important along with provision of adequate calories and proteins. Hence diet quality index needs to be used while assessing adequacy of the diet.⁶

It is also important to know the role of genetic factor in determining height, weight and BMI of children. Some studies have shown maternal nutritional status has a direct relation to the child's nutritional status, where maternal weight was correlated with child's ⁷. Some other studies have shown association between parent's heights with height of children in the absence of prolonged deficit of nutrition. ⁸ Some studies have shown positive correlation with parent's height especially mother's height. Though shorter Parent's height was correlated with stunting, but not always statistically significant as per study in Malaysia. ⁷

Socio demographic factors and environmental factors also play an important role in determining growth of children. According to a study done in South India showed that poor hand hygiene, poor personal hygiene and less frequency of head bath was associated with poor growth leading to malnutrition. ⁹ A studies done in multi country showed that maternal age, education, employment status was associated with growth of children ¹⁰.

Growth monitoring in India is done by anganwadi workers by measuring the weight of the children at regular frequency. Ideally measurements should be done once a month for infants , once in two months for children aged between 1-2 years, once in three months for children aged between 2 to 5 years. Sometimes constitutionally short and thin children may get classified as stunted and wasted if only one reading is taken despite child being growing normally. A child whose anthropometric measurements may be normal or above at a given time may not show normal growth in future due to inter play of various factors. There is a need for growth monitoring through measurement of growth velocity at different intervals.

Need for the Study

Growth monitoring is a tool to assess the nutritional status. Despite many interventions like ICDS, National Nutritional anaemia prophylaxis program, Iodine deficiency disorder control program, vitamin A Prophylaxis program, still > 30% of the children are stunted and wasted. In ICDS program the child's growth monitoring is done only checking the weight, but many of the stunted children are missed. So, there is a need to study the growth velocity among children. Many of the existing programs are concentrated on first thousand days of life but growth monitoring beyond 1000 days is also very important. A study showed 61% of children could attain catch up growth at 3 years.⁸ Following intensive growth monitoring and planning we can prevent morbidity and mortality among under 5 children. The present longitudinal study intends to estimate pattern of growth velocity (height, weight and BMI velocity) of children age 1 -5 years by using anthropometric measurements like height, weight, also other anthropometric measurements (head circumference, mid arm circumference was also measured at different time intervals). The pattern of catch-up growth among normal, wasted and stunted children was done. Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods, and is also a proxy for nutrient adequacy of the diet of individual. Individual dietary diversity scores aim to reflect nutrient adequacy. Studies in different age groups have shown that an increase in individual dietary diversity score is related to increased nutrient adequacy of the diet. Dietary diversity scores have been validated for several age/sex groups as proxy measures for macro and /or micronutrient adequacy of the diet. Diet diversity at individual level helps in identifying nutrient adequacy with the diet.

The present study intends to know the growth velocity among under five and association between diet and growth velocity, so that some interventions could be suggested to improve the existing nutritional programs. This study also intends to know the effect of parent's anthropometry on the child's height, weight and BMI and also the effect of some socio-demographic and environmental factors on growth velocity.

BACKGROUND

Study of growth velocity among under five children is very important, which helps in understanding the potential risk factors that affect the normal growth. Growth is a complex process assessed by measuring weight, height, weight for height, BMI, Mid upper arm circumference etc. which depends on interplay of many factors. Growth and development are unique features in children, growth faltering also affects the development. Hence it is important to assess the growth velocity among under five children and its correlation with diet diversity, parents anthropometry, sociodemographic factors and environmental factors.

Many cross sectional studies are done to know the anthropometry of children using either WHO “z” scores as reference values or Waterlow’s classification for malnutrition.^{11,12} One-time assessment of growth is easy and practical method, but growth is a dynamic process may get affected due to multiple factors needs repeated measurements at fixed time interval. A longitudinal study is very much required to throw light on not only to study the growth pattern at a given point of time in the beginning of the study, but also how is the growth velocity among different age groups, whether catch up growth occurs, if so among which age group, so that some intervention during that period may help children gain the correct weight or height.

We can also find association or correlation between growth velocity and other factors like diet, sociodemographic variables, environmental variables and genetics (parents’ anthropometry).

Many studies are done to find association between nutritional status of children and diet, or socio-demographic variables or environmental variables using

cross sectional study design. Few studies have concentrated on the association between nutritional status of children and parent's anthropometry either using cross sectional study or longitudinal study.^{13,14} Adequacy of diet among children was studied either using quantitative or qualitative information at one time. Very few studies are done to know the association between growth velocity among children and various factors associated with it.

Despite implementing so many nutritional programmes for vulnerable groups, still many children fail to grow normally. Reasons could be many like the quantity of diet in the form of calories and proteins to be consumed but rarely address the micro nutrients essential for growth. This can be addressed by understanding the quality of diet consumed (food variety, diet diversity and diet serving score) at household level and at Anganwadi. If food variety is more, children will enjoy different foods which avoid monotony. Assessment of diet diversity helps us to know the important food groups consumed by children (household) and the food groups that are consumed less frequently. Diet serving score is based on the number of servings of cereals, vegetables and foods of animal origin served per day.¹⁵ This knowledge adds to improve or modify the existing menu at Anganwadi or at household level.

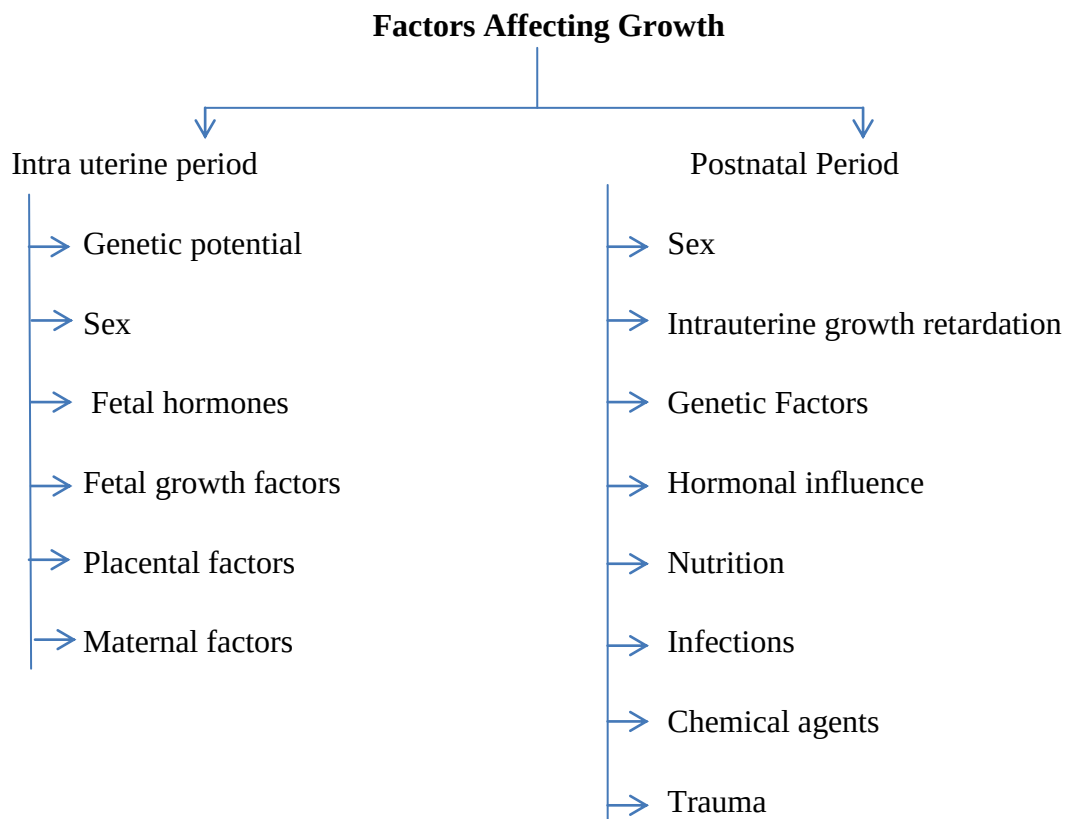
The present study being a longitudinal planned to assess the velocity of growth among under five children at 3 months interval for a period of one year. The velocity of growth was compared (weight for age, Height for age, BMI, Mid arm circumference and head circumference etc) in different age groups ,among boys and girls and among malnourished and well-nourished children. Correlation and association was assessed between growth velocity and diet (quality and quantity), parent's anthropometry, socio-demographic and environmental variables. The uniqueness of the present study being, it was conducted during COVID pandemic,

when Anganwadis were closed and dry ration was distributed to children and many parents who were dependent on daily wages or were in private job faced financial crisis. In the middle of the study Anganwadis started preparing food for children and children started attending the Anganwadi, which improved the quantity of diet consumed by children and also the quality of diet. Hence role of diet on growth velocity could be studied.

REVIEW OF LITERATURE

Growth

Growth involves the multiplication and development of cells, which leads in changes in the number of cells (quantity) and also the size. Growth is the ongoing physiological transformations that starts from conception to adulthood, leading to increase in the size of the individual. Hence assessment of "growth" often refers to measurement of changes in size that is height, weight, Body mass index (BMI), mid arm circumference and head circumference up to the age of two years ¹⁶.



Factors Affecting Growth ¹

1. Fetal Growth

Genetic Factors: Parental traits contribute to fetal growth, with tall parents likely to have taller children. Additionally, genetic factors influence the size of the head more than other somatic characteristics.

Sex: Boys tend to be longer and heavier at birth compared to girls.

Fetal Hormones: Thyroxin, insulin, and glucocorticoids play crucial roles in regulating tissue accretion and differentiation during gestation.

Fetal Growth Factors: Various growth factors, including insulin-like growth factors and epidermal growth factor, affect fetal tissue growth through autocrine and paracrine mechanisms.

Placental Factors: Placental weight correlates with fetal weight, and structural and functional changes in the placenta enhance nutrient transport to the foetus.

Maternal Factors: Maternal health, nutrition, and lifestyle choices profoundly impact fetal growth, with factors such as maternal age, diet, and obstetric complications influencing outcomes.

2. Postnatal Period

Genetic Factors: Chromosomal disorders and gene mutations can affect postnatal growth, leading to conditions such as Turner syndrome and Prader-Willi syndrome.

The height, weight, and overall body build of a child or adult result from a combination of genetic and environmental influences, along with their interactions.

Gene expression depends on both the internal environment, influenced by other genes, and the external environment. Body size control involves many genes, but a disturbance in a single gene or group can have significant effects, such as in achondroplasia, a condition inherited as a simple dominant trait. Alternatively, genetic effects can be more specific, such as the independent genetic control over dental and skeletal maturation and the growth of different limb segments. Dental development and the sequence of ossification are primarily genetically driven, with the timing of classification influenced by both genetic and environmental factors. Overall maturation is more affected by environmental factors, though genetic influences remain detectable. Heredity affects growth rates in early or late matures, with parent-offspring height correlations reported from birth to maturity. Chromosomal abnormalities further indicate genetic control over growth, and genetic factors likely contribute significantly to differences in male and female growth patterns.

Hormonal Influence: Hormones like growth hormone, thyroxin, and cortisol are crucial for postnatal growth, while androgens and estrogens influence the pubertal growth spurt.

Nutrition: Adequate nutrition is essential for normal growth, while deficiencies in nutrients like calcium, iron, and vitamins can retard growth. Conversely, overeating and obesity can accelerate somatic growth.

Nutrition is closely linked to growth, with adequate food essential for normal development. Sufficient calorie intake is crucial and varies with development phases. Nine essential amino acids are necessary for growth, and the absence of any leads to disordered or stunted growth. Other essential factors include zinc, which is involved in protein synthesis and certain enzymes, and deficiencies cause stunting, sexual

development interference, and hair loss. Iodine is needed for thyroid hormone production, while calcium, phosphorus, magnesium, and manganese are essential for proper bone growth. Iron is crucial for haemoglobin production. Vitamins also play a significant role: Vitamin A regulates osteoblast activities, Vitamin C is vital for forming the intercellular substance of bone, and Vitamin D prevents rickets. Malnutrition during childhood delays growth and during pre-adolescence delays the adolescent growth spurt. Studies show malnutrition can severely impair growth, generally referring to inadequate calorie or major dietary component intake. Diseases affecting appetite, digestion, and assimilation can also cause malnutrition, leading to stunted or wasted growth and preventing children from reaching their genetic growth potential.

Infections and infestations: Infections, especially persistent ones, can impair growth, highlighting the importance of maintaining good health. Infestation can also affect the nutritional status by affecting absorption of nutrients and also by causing anaemia etc.

3. Social Factors

Socioeconomic Level: Children from higher socioeconomic backgrounds typically have better access to nutrition and healthcare, leading to improved growth outcomes.

Socioeconomic status also influences growth, with children from higher socioeconomic levels generally larger at all ages. The reasons for this include better nutrition and habits associated with regular meals, sleep, exercise, and overall home organization. Growth differences are more closely related to home conditions than strictly economic status, reflecting parental intelligence and personality. Large families with limited income often provide less adequate nutrition and individual care, resulting in smaller and lighter children compared to those in smaller families.

Healthy growth and development require family-centred, community-based, culturally competent, coordinated care throughout life, from preconception and prenatal periods through adulthood. Poverty is associated with hunger, under nutrition, and increased susceptibility to infections, all of which can hinder growth and development.

Natural Resources: Adequate access to natural resources correlates with improved nutrition and overall better growth outcomes, often seen in communities with higher gross national product and income levels.

Climate: Climate can influence growth rates, with seasonal variations impacting agricultural productivity and food availability, thereby affecting children's growth patterns. Additionally, climate-related factors like infections may influence growth outcomes.

Seasonal effects on growth velocity are evident in most human growth data, with height growth fastest in spring and weight growth fastest in autumn, across all ages, including adolescence. The exact mechanism behind this seasonal effect is unknown, but hormone secretion variations are likely involved. Climate appears to have a minor effect on overall growth rates. Some studies suggest that each major human race's stature varies according to their climate, though this is not universally consistent. Longitudinal studies show that only about 30% of children exhibit strictly seasonal growth patterns, with the rest showing non-seasonal growth accelerations and decelerations.

Emotional Factors: Emotional support and stability within the family environment play a crucial role in growth regulation, with children from nurturing environments more likely to experience optimal growth.

Cultural Factors: Cultural practices, including dietary habits and child-rearing methods, can impact nutrition and growth outcomes. Religious beliefs may also influence food choices and dietary patterns, thereby affecting growth and development.

Cultural factors significantly impact physical growth, with differences correlating with varied cultural groups. Cultural adaptations to different geographical areas affect body growth patterns.

Parental Education: Maternal education levels influence health-promoting behaviours, which can indirectly impact a child's growth and development.

Assessment of growth ⁴

Assessment of growth is done by using anthropometric measurements for weight, height, mid arm circumference and head circumference up to 2 years it has importance is measured at given time. One time measurement will give information about whether the growth is attained for a given age at a given time, longitudinal measurements will give information about not only attained growth at a given time but also gives information regarding pattern of growth for future.

Weight

Weight is a key indicator of nutrition and growth and is easy to measure. Before digital scales, two types were commonly used:

Beam Balance Scales: More accurate, with moving weights.

Spring Balance Scales: Less accurate.

Infant Weighing

Infant Scales: Basket or pan type scales are used for infants up to 10 kg, measuring in 10 g increments.

Digital Scales: Portable and measure up to 5 g differences; should have a tarring facility for clothing/diaper deduction.

Older Children Weighing

Platform Scales: Used for children who can stand, measuring in 100 g in cm.

Calibration: Regular calibration with known weights is essential.

Methods of Recording growth velocity

The different methods used to assess growth velocity are

- Use of percentiles curves over a period at different time points
- Use of 'Z' scores for weight, height, BMI, MUAC, head circumference at different points.
- Actual increase in weight, height, BMI, MUAC, head circumference at different points.

Measurement of weight

Infants: Weigh naked or deduct diaper weight. Ensure scale is on a stable surface and check the zero before weighing.

Older Children: Weigh with minimal clothing. Stand at the scale's centre, distribute weight evenly, and avoid holding onto anything. Preferably use the same scale for follow-up measurements.

Measurement of Length of Infants

The Harpenden infantometer is a tool used to measure the length of new-borns and infants. This device features a horizontal wooden board with two vertical planks at each end, positioned perpendicularly. One end has a fixed plank (headpiece), while the other end has a movable plank (foot piece) to adjust to the infant's length. A calibrated reading strip in the middle of the board allows the length of the baby to be read directly. The infantometer can measure lengths ranging from 0 to 100 cm with a precision of 1 mm.

Steps for Measuring Length

Preparation

Undo the infant's braids and remove any hair ornaments to ensure proper head positioning.

Remove the infant's diapers to make it easier to hold their legs together and straighten them.

Positioning the Infant

An assistant is required for the measurement process.

The assistant stands at the head end of the infantometer.

Positioning the Head

Place the child supine on the measuring board.

Ask the assistant to hold the child's head while you steady the legs.

Position the child's head in the Frankfort plane. This means the crown touches the headpiece and a vertical line from the ear canal to the lower border of the eye socket is perpendicular to the board.

Apply gentle traction to ensure the head is in contact with the fixed headpiece.

Positioning the Foot

Stand on one side of the infantometer.

Hold down the baby's legs with one hand and move the foot piece with the other.

Align the child's shoulders and hips at right angles to the long axis of the body.

Apply gentle pressure on the knees to straighten the legs and prevent flexing.

Move the footboard to rest firmly against the child's feet, ensuring the soles are flat on the board and the toes point directly upwards.

Record the measurement to the nearest 0.1 cm from the digital counter on the measuring board.

Stadiometer is used for measuring standing height. Alternatively, height can be measured against a calibrated flat wall.

Measurement of height

Remove hair ornaments and footwear.

Positioning: Child stands with back against the stadiometer or wall, feet slightly apart at 60° angle, weight evenly distributed, and back of the head, shoulder blades, buttocks, calves, and heels touching the vertical board.

Head Position: Ensure the Frankfort plane is horizontal.

Measurement: Push tummy gently to help young children stand straight. Record the reading to the nearest 1 mm.

Head Circumference

Measured from birth to 6 years, it represents brain growth. The tape is placed over the occiput at the back and supraorbital ridges in front.

Method of Recording Head Circumference

Infants are held in the mother's lap; older children can stand or sit.

Positioning: Tape should be perpendicular to the face's long axis, compressing hair and skin.

Measurement: Take three measurements and record the maximum to the nearest 0.1 cm.

Mid-Arm Circumference (MAC)

Used for children between 6 months and 5 years to assess malnutrition.

Method of Recording MAC

Landmarks: Palpate and mark the acromion process and olecranon.

Mid-Arm Point: Mark halfway between the acromion and olecranon.

Measurement: Hang the arm freely, tape around the midpoint, record to the nearest 0.1 cm.

Body Mass Index (BMI)

Calculated as $\text{weight} / (\text{height}^2)$, expressed in kg/m^2 . For adults, normal BMI ranges between 18.5 and 23.

Velocity of Growth

Tracking growth velocity helps identify growth issues early. Monitoring frequency varies by age.

Infants: Monthly

Second Year: Every three months

3-5 Years: Every six months

Growth Patterns

Infancy: Maximum growth velocity.

2-10 Years: Decelerating growth.

Puberty: Second growth spurt, with peak velocity during sexual maturity stages.

Accurate measurement and consistent monitoring of these parameters are crucial for assessing and ensuring healthy growth and development in children.

Interpretation of Growth Measurements

After taking physical measurements, it's crucial to determine if they are within a normal range. This involves comparing the observed value with standard or reference values, usually expressed as percentiles.

Normal vs. Abnormal Measurements

Percentiles, standard deviation (SD), and Z-scores are used to interpret growth measurements:

Percentiles: The 50th percentile represents the median, with half the observations on either side. The normal range typically falls between the 3rd and 97th percentiles, roughly corresponding to ± 2 SD.

Z-Scores: Z-scores of -1, -2, and -3 correspond to the 15.8th, 2.28th, and 0.13th percentiles, respectively. Conversely, the 1st, 3rd, and 10th percentiles correspond to Z-scores of -2.33, -1.88, and -1.29, respectively. A Z-score of -1 SD aligns roughly with the 15th percentile, and -2 SD with the 3rd percentile.

Conventionally, values are considered abnormal if they are below -2 SD (Z-score, approximately the 2.3rd percentile) or above +2 SD (Z-score, approximately the 97.7th percentile) relative to the median (50th percentile).

Tips to measure growth velocity accurately¹⁷-

1. To properly assess growth, follow established protocols for accurately measuring and recording a child's weight and length while lying down.
2. Precision in these measurements is essential for ensuring the reliability of growth charts as a screening tool.

3. Accurately determining the child's age is crucial for precise growth assessments and interpretations.
4. Plot the recorded measurements on the WHO growth chart, utilizing percentile lines to evaluate body size and growth trends, ensuring consistent monitoring over time.

Studies done on Growth velocity

A Longitudinal data from the Young Lives cohort study in Ethiopia, spanning from 2002 to 2016, was used to track 1,665 children from age 1 to 15 years. The children's weight gain exhibited non-linear patterns and varied significantly across different regions. Children in Addis Ababa, Oromiya, and SNNPR experienced faster weight growth compared to those in Tigray, whereas the weight gain rates between children in Tigray and the Amhara region were similar. Additionally, boys showed a more rapid rate of weight gain than girls.¹⁸

A longitudinal data from 2007 to 2012, focusing on children under the age of five from two urban informal settlements in Nairobi, Kenya to study the linear growth. The study involved 1917 children and 1679 mothers, the study found that child birth weight duration of, exclusive breastfeeding, and immunization status were crucial determinants of linear growth in children aged less than five years. Maternal characteristics like age marital status, socio-economic status and household size, significantly influence child growth. Female children showed faster growth than males.¹⁹

In the year 2018 a longitudinal study was conducted using household survey in 10 districts of Ethiopia's about 1200 homes were selected. This study found that growth velocity weight and height was better during preharvest season as cereal

intake, vitamin A rich food intake, flesh food intake, consumption of egg, legumes, vegetables/ fruits improved in pre harvest seasons. Reduced velocity of growth in summer and winter compared to autumn. Male children showed better growth velocity than female ($p < 0.05$). No illness in past 2 weeks had better growth velocity ($p = 0.54$). low diet diversity associated with negative growth velocity (-1.21).²⁰

A trial was done in the year 2012-2015 in Zimbabwe to know the effect of food and water insecurity on growth trajectory, analysis included 714 infants for the Length for age Z score study from Month 1 to Month 18, and 710 infants for the period from Month 6 to Month 18. The mean LAZ values showed a decline in linear growth over time. From Month 1 to Month 18, lower food availability and quality of food were linked to decreased LAZ ($\beta = -0.09$; 95% CI: -0.19 to -0.13). Similarly, from Month 6 to Month 18, inadequate food access was related to reduced LAZ ($\beta = -0.11$; 95% CI: -0.20 to -0.03). None of the dimensions of water insecurity showed an association with LAZ or its trajectory over time with $p > 0.05$.²¹

A study was conducted in Nepal in the year 2023 WHO Child Growth Velocity Standard Tanner-Whitehouse Height Velocity curves, which showed a consistent decline in 12-month Linear Growth Velocity. The annual median growth velocities for boys/girls were 12.1/12.7, 9.1/9.4, 7.7/7.8, and 7/7 cm/year at 12, 24, 36, and 48 months, respectively, 31.1%, 28.6%, and 29.3% of Nepali children under 6 months, 6-11 months, and 12-23 months, respectively, experienced growth faltering and about 6% of children aged 24-59 months, experienced growth faltering. Among children under 24 months, growth faltering was more common in girls (34.4%) than in boys (25.3%) ($P < 0.05$), but growth faltering was same (about 6%) in older preschool children.²²

A study published in 2021 analysed assembly constituency wise under nutrition among under five children. Attained growth for height, weight and WAZ was done which reflected the nutritional status used the NFHS 4 data for the same. This helps monitoring of national nutrition mission. According stunting was high Kerala, Gujarat, Tripura and Meghalaya the primary analysis sample comprised 222,172 children with a mean (SD) age of 30.03 (17.01) months, including 114,902 boys (51.72%), from 3,940 administrative clusters (ACs) for stunting, underweight, and wasting assessments. stunting ranged from 18.02% to 60.94% with a median (IQR) of 35.56% (29.82%-42.42%); underweight ranged from 10.40% to 63.24% with a median (IQR) of 32.82% (25.50%-40.96%); wasting ranged from 5.56% to 39.91% with a median (IQR) of 19.91% (15.70%-24.27%); For instance, Uttar Pradesh, Jharkhand, and Karnataka had high average AC-level prevalence of child stunting (Uttar Pradesh: 45.29%; Jharkhand: 43.76%; Karnataka: 39.77%) and large standard deviations (Uttar Pradesh: 6.90; Jharkhand: 6.02; Karnataka: 6.72).²³

A study was done between 2018-2020 in different geographical districts in Egypt, 27,537 using multistage sampling among to assess growth velocity. In this study 13,888 were boys (50.4%) and 13,649 were girls (49.6%). Egyptian children were heavier and shorter as compared to WHO standards. Hence there is a need to develop separate standards for every country.²⁴

In the year 2018 a study conducted to study the velocity of growth among 566 neonates (286 boys and 280 girls) born in West Azerbaijan Province in northwest Iran children's growth was tracked from birth to 4 years of age. Weight and height measurements were taken at birth, 1, 2, 4, 6, 9 months, and 1, 1.5, 2, 3, and 4 years of age. The linear mixed model method was used to identify the factors influencing the growth velocity. The study found that gender, place where delivery took place and

total duration of breast feeding of had an impact on the percentile. Growth curves weight and height were used to study the velocity of growth (5th, 50th, and 95th percentiles) were produced. The development curve for weight and height increased from birth to two years of age, then later remained stable until 4 years of age. This study developed growth standards.²⁵

In the year 2015 for that Franian region as study was conducted in Maku (Iran) among 256 infants. Growth velocity was measured at 1, 2, 4, and 6 months and 1 year in the first year in 2nd year at 18 months and 24 months then onwards yearly once for the next 3 years. Head circumference was measured till they were 1.5 years old. As distribution was not normal they used LMS approach to determine growth velocity centiles using LMS chart builder software. They used weight height and head circumference charts at 5th 50th and 95th percentiles this study found that growth velocity was more among boys in the 1st year. And decreased at 2 years for both sexes later remained constant till 5 years. They also compared growth velocity of children residing in urban area had better velocity for height and weight.²⁶

In the year 2015, a study was conducted in West Azerbaijan, N Iran among 308 neonates (160 males and 148 girls) their growth was tracked for four years. The weights and lengths of the children were recorded at birth, 1, 2, 4, 6, and 9 months, and 1, 1.5, 2, 3, and 4 years of age, head circumferences was measured up to 1.5 years of age. Male children had better growth velocities for length and weight initial few months compared to larger girls, but there is no statistical significant difference. This study showed decline in weight and height from birth till 20 months, then remains constant till 60 months. Head circumference declined till 10 months and remained constant till 20 months.²⁷

A study conducted among childhood growth on subsequent heights of 1,720 children in Shanghai. Both the age at the onset of the childhood growth phase and the length at 6 months of age were significant predictors ($p < 0.05$) of height from 12 months onwards. A one-month delay in the onset of the childhood growth phase resulted in a reduction of 0.4 cm in boys and 0.5 cm in girls at 5 years of age. The age at the onset of the childhood growth phase was negatively correlated ($p < 0.001$) with mid-parental height but positively correlated ($p < 0.001$) with height at 6 months of age. Additionally, there was a distinct pattern in body mass index (BMI) for Chinese children from birth to 6 years of age compared to white children, characterized by a sharp increase in BMI during the first 6 months of life, followed by a gradual decline until 24 months.²⁸

A study on the monthly variation in growth patterns of boys and girls aged 0-49 months was done. During the peak of the monsoon season, 71% of the children were moderately stunted, although none were wasted, with mean height-for-age at -2.61 SD and weight-for-height at -0.91 SD according to NCHS z-score values. Environmental changes from winter to monsoon seasons led to significant weight loss and lower weight-for-height z-scores, particularly in children aged 0-35 months. However, children aged 12-35 months continued to gain height during this period. Children who frequently fell ill experienced significant deficits in weight and height gains. Poor diet and recurrent illnesses contributed to the slow and uneven growth observed.²⁹

A cross-sectional study was conducted at Nkwanta, Ghana in year 2023 among children aged 1-5 years. They used z scores to assess nutritional status. This can also be used to know the attained growth for height, weight. Out of 240 children 12.5% stunted and 27.5% were wasted. Factors found associated with stunting

included parents' working status, family size age of the child, spacing breast fed or not and status of immunization. Factors wasting were education level of parents, working status, age of the child associated with between children, where exclusive or not, loss of appetite, immunization repeated information. Higher prevalence of poor growth could be the importance of prevented through nutritional screening, family planning, and practice of exclusive breastfeeding and timely immunization of the children.³⁰

A study done to know the knowledge of AWW regarding growth monitoring of children in Karnataka in the year 2019. The study showed that AWW weighed children who attended AW, they did not weight children <3 years also did not know about expected weight for the age, 30% made the mistakes while weighing the child. It is important to train them in identifying growth faltering.³¹

In the year 2019 a cross sectional study was done in Ethiopia showed that 36.34% of children was <-2, 12.09% WHZ was <-2, and 24.87% had WAZ <-2. The fitted log-linear model showed that being underweight was associated with stunting (P-value 0.001) and also wasting (P-value 0.001). Stunting and wasting had no association (P-value = 0.999). The model also revealed that there is no three-way interaction between stunting, wasting, and underweight (P-value = 1.000).³²

In the year 2017 a cross sectional study was conducted among 650 under-fives living in an urban field area in Maharashtra. 40.46% of children under the age of five were stunted, 38.15% were underweight, and 16% were wasted. The study found that age above 12 months was associated with stunting and underweight with $p < 0.05$.³³

A cross-sectional study was conducted between 2010 and 2019. Child growth was measured using height-for-age z-scores (HAZ) based on the 2006 WHO Growth Standards. Initially, boys exhibited lower mean HAZ compared to girls in the first 30

months of life. This sex difference was generally absent between 30 and 45 months. However, in several countries, girls had lower HAZ after 45 months. The pooled sex difference (boys minus girls) for the entire sample was -0.10 (95% CI -0.12 to -0.08). Specifically, the difference was -0.17 (95% CI -0.20 to -0.14) at 0–11 months and -0.22 (95% CI -0.25 to -0.19) at 12–23 months. This gap narrowed to -0.10 (95% CI -0.13 to -0.07) at 24–35 months and -0.04 (95% CI -0.07 to -0.01) at 36–47 months. By 48–59 months, evidence suggested a female disadvantage, with boys' mean height-for-age being 0.02 (95% CI 0.00 to 0.05) standard deviations higher than that of girls. Ecological analyses indicated that male disadvantage in HAZ decreased with rising national income and was no longer evident among 4-year-old children, especially in wealthier countries.³⁴

A study was done to compare two survey data (1992 and 2015) to study prevalence of malnutrition, as they used 'Z' scores same, can be used to know the attained level of growth stunting (z score <-2 reduced from 20.8% to 2.7%) under nutrition was 0.8% increased to 2.1% over weight (z score >2) increased from 4.8% to 14.4%.³⁵

A descriptive study was conducted in both rural and urban areas of Ambala, Haryana, a total of 140 children were enrolled through a door-to-door survey. Most of the children were born between 34 and 40 weeks of gestation, with more than half being male. Regarding breastfeeding, (52.1%) were breastfed within one hour of birth. Solid foods were introduced to more than half of the children between 6 and 7 months of age. Half of the fathers were labourers, and almost all of the mothers were housewives. This study assessed attained growth of UFC at given point of time and found that 16.4%, 15.7% and 19.3% were survey stunted, underweight and wasted. Recommended nutrition education programmes for mothers.³⁶

A cross sectional study was done in South Delhi, India in the year 2020, assessed nutritional status of nutritional status using z scores. The mean age of children was 23.04 ± 18.24 months, with males comprising 53.3% of the participants. The prevalence of underweight or WAZ <-2 was 24.5%, with 24.1% severely underweight. Additionally, 27.3% were stunted or with WHZ <-2 , and 17.8% were wasted with WHZ <-2 , this study showed that children <24 months were at higher risk of having WHZ <-2 , those more than 24 months at higher risk of having HAZ score <-2 .³⁷

In the year 2020 a study was done among under five children were divided into five groups 0-11 months, 12-23 months, 24-35 months, 36-47 months, and 48-59 months. They found that child stunting was more. After adjusting age, sex for Sociodemographic, maternal variables they found that 36-47 months age groups is at risk of stunting with or 2.91 in 2016 reason being concentration on children <24 months also should improve quality of diet for children aged between 24-59 months . Aged 24-35 months, followed by 36-47 months and then 48-59 months in 2006. Overall prevalence of stunting reduced in 2016. Prevalence was found in 36-47 months followed by 12-35 months then 48-59 months.³⁸

In the year 2015 conducted in an urban area of district Rohtak 654 children were included in the study. Approximately 32% of study participants had stunting as their nutritional status, but approximately 45% were undernourished when the Composite Index of Anthropometric Failure was included. Girls were more likely to be stunted and underweight.³⁹

In the year 2014 a study was conducted in the Rohtak district's rural region among children aged 1 to 5. The WHO criteria were used for anthropometric

assessment and nutritional status classification in children, which also gives information about attained growth at one point. In this study children stunting was more in 24-35 months age groups followed by 48-59 months wasting was more 24-35 months group followed by 48-59 months. Under nutrition was more in 24-35 months followed by 36-47 months. This study showed more stunting and under nutrition among girls compared to boys.⁴⁰

A cross-sectional study in urban Anganwadis (August 2014 - December 2014) encompassed 307 preschool children, with a gender distribution of 49.51% girls and 50.48% boys. The prevalence rates of under nutrition, stunting, and wasting were 24.8%, 55%, and 23.1%, respectively. Gender differences in weight-for-age and height-for-age were not statistically significant, though weight-for-height differences were significant. But there is statistical significant for weight and height.⁴¹

In the year 2014 a longitudinal study was conducted on 606 children who were assessed repeatedly from birth to 2 years of age. The weight trajectory was significantly influenced by gender, child rank, birth status, and feeding modality. During the trial, boys weighed more. Neonates that were exclusively breastfed weighed more than other neonates. Boys exhibited a faster growth rate up to 6 months of age. Breastfed infants had a faster growth rate up to 6 months, whereas other newborns had a faster growth rate.⁴²

A community-based cross-sectional study assessed the nutritional status of children under five using anthropometric measures. The prevalence of underweight, stunting, and wasting / failure to attain adequate weight, height and BMI was 18.3%, 31.6%, and 20.1%, respectively. Moderate and severe underweight and wasting were

most common in the 11-23 months age group, while moderate and severe stunting peaked in the 48-59 months age group.⁴³

In a study of 658 children under five in a medical college's field practice area, the prevalence of underweight, stunting, and wasting was 34.3%, 58.7%, and 16.9%, respectively. Girls exhibited higher rates of underweight (37.6%) and stunting (61.4%), while boys had a higher prevalence of wasting (18%). This study showed 2/5th of girls failed to attain required weight at a given point, 1/5th of boys showed severe inadequacy at attaining required weight at a given time.⁴⁴

This longitudinal study marks a significant milestone as the first Indian longitudinal growth survey tracking development from early childhood to maturity. According to the study, the height velocity patterns of 303 boys and 260 girls was done from middle-class families in a semi-urban area south of Calcutta. The height of boys was more compared to girls. Height velocity decreased from 1 year to 5 year. From 12.8- 6.20 for boys and at 1 year 11.26- 6.14 at 5 years for girls, 12.18 among one year to 6.20 at 5 years.⁴⁵

A prospective longitudinal study was conducted on 3,327 apparently healthy children aged 3 to 18 years, studying in government and private schools in Krishna district, Andhra Pradesh. Measurements of height and weight were taken at baseline and subsequently at three-month intervals over one-year period (October 2018 to October 2019). Mean height velocity was more between 3-4 years (6.47cms $\pm$ 1.85) as compared to 4-5 years (6.13cms $\pm$ 1.74) for boys. Girls height velocity was more compared to boys mean height velocity and it was more between 3-4 years (7.96 cms $\pm$ 2.60) compared to 4-5 years (6.60cms $\pm$ 2.17).⁴⁶

A prospective longitudinal study done was done to assess height velocity among North Indian children on a representative sample of 7,710 apparently healthy children aged 3–17 years, from various regions of Delhi. Height was recorded at baseline and after 12 months. They found that height velocity among girls was better compared to boys between age of 3-4 years which was 7.36 ± 0.77 and 7.67 ± 1.21 respectively. Mean height velocity for boys between 4-5 years and for girls of same age was similar that is 7.18 ± 1.22 and 7.18 ± 1.03 respectively.⁴⁷

A community-based cross-sectional study was conducted in 2023 in Ahmedabad, Indi among 191 children under the age of five, who were living in urban slum area. Parents were interviewed using a pre-designed questionnaire, and malnutrition was evaluated based on the WHO-recommended Z-score categories. Two-thirds of the children were found to have normal weight for their age, while one-third were underweight. The nutritional status of the children was significantly influenced by factors such as age, birth weight, feeding practices, and immunization status. Specifically, one-fourth of the children were underweight, and this was statistically associated with factors including low birth weight, preterm delivery, improper feeding practices, and incomplete immunization.⁴⁸

A study done in 2020 using Indian National Family Health Survey (2015–2016) data, Principal component analysis (PCA) was applied to demographic and socio-economic determinants of childhood morbidity. In Southern India, children were found to experience better conditions for growth and nutrition compared to central, predominantly rural areas, particularly within the "tribal belt," where girls had lower average weight and height than boys. In contrast, north eastern districts provided more favourable conditions for child development, as evidenced by better average weight and lower rates of underweight and wasting. Malnutrition and poor

child growth metrics were concentrated in areas with high poverty, low maternal education, lower maternal BMI, and higher rates of teenage pregnancies and parity 4+. The study emphasized the utility of combining PCA and cluster analysis for district-level variation in child nutrition and identified regions at high risk of undernutrition, stunting, and wasting, contributing to policy recommendations to improve child nutrition in India.⁴⁹

A cross-sectional study conducted in 2017 examined 1,052 children aged 0-5 years from middle- and low-socioeconomic classes in an urban population, majority were male children (535, 50.9%). According to IAP guidelines, 513 children (48.8%) had normal weight, while 5 (0.5%) were classified as having very severe malnutrition. Based on WHO standards, 623 children (59.2%) were underweight, and 135 (12.8%) were severely malnourished. The nutritional status of the children showed a positive correlation with parental education and employment, higher birth weight, and increased family income, while higher birth order negatively impacted nutritional status. Children who were exclusively breastfed for six months and received appropriate complementary feeding afterward had better nutritional outcomes.⁵⁰

Studies on diet diversity, EBF, feeding practices and growth velocity

A study done on diet diversity, environmental factors and there with growth and development of under five children. They found that 49% met the recommended 4 food groups with mean DDS 3.28. 81% of mothers did not get nutrition knowledge, 77% did have access to improved toilets. This study suggested provision of nutrition training to mother access road network, piped water toilet facility growth.⁵¹

This study examined the association between dietary diversity and growth outcomes in children aged 6 to 23 months in India using data from the 2015-2016

National Family Health Survey. The study involved 67,278 mother-child pairs and found that 35.9% of children were stunted with z score <-2 , 23.8% wasted WAZ <-2 , 32% underweight with WAZ <-2 . study showed Inadequate dietary diversity who do increased the risk of stunting, wasting, and underweight. Children not consume dairy products, eggs, fruits, and vegetables were at risk of experience with malnutrition and hence fail to attain the required weight, height and BMI.⁵²

A cross-sectional study was conducted on 140 under-five children from cassava farming households in Ogun and Oyo states, South-West Nigeria. A study showed that 98.7% and 97.5% of children consumed grains, roots, and tubers, while 36.7% and 36.3% consumed legumes in Ogun and Oyo states, respectively. Additionally, 48.6% of the children met the minimum dietary diversity of four food groups, with an average dietary diversity score of 3.28. Logit regression analysis identified significant determinants of dietary diversity, including the child's age, mother's age, distance to the farm, and food expenditure.⁵³

A cross sectional study done in 2021 in one of the provinces of South Africa showed that 9% of underweight, 4% of wasting and 26% of stunting age of WAZ <-2 low diet diversity was associated with wasting (z score <-2) and stunting (z score <-2) which was statistically significant with $p<0.05$. Weight for height was not associated with diet diversity.⁵⁴

This descriptive cross-sectional study in Khyber Teaching Hospital, Peshawar, in the year 2021 found that 33% of children has WAZ <-2 , 44% had WHZ <-2 , 15% had WAZ <-2 . Delayed weaning (after 1 year) was practiced by 18.5% of mothers, 30.5% started weaning before 6 months, 78.5% of children were vaccinated. In this study 75% of fathers did not have satisfactory income.⁵⁵

An institution-based cross-sectional study was conducted from February to March 2021, involving 406 participants. The dietary diversity of children was assessed using a standardized tool, with statistical significance set at $P < 0.05$ and the association measured using AOR with a 95% CI. A total of 399 children participated, with 52.1% meeting the minimum dietary diversity. Grains, roots, and tubers were consumed by 79.2%, followed by dairy products and vitamin A-rich fruits and vegetables by 58.1% of participants. Children of mothers who worked as daily labourers were less likely to meet the minimum dietary diversity.⁵⁶

In the year 2020 longitudinal study was conducted among 110 participants to observe the association between one-year growth change and diet quality among preschool children in Adachi City, Tokyo, Japan. Body mass index for age z-score (BAZ) and height for age z-score (HAZ) were assessed using WHO guidelines. Dietary intake were measured using the brief-type self-administered diet history questionnaire for children (BDHQ3y), and a daily quality score based on the Japanese Food Guide Spinning Top (JFGST score) was generated. Regression analysis revealed no significant relationship between one-year growth change and diet quality. But intake of total energy was positively associated with BAZ of children.⁶

In the year 2020 a study was conducted among under-five children (N=573) from nine communities that are part of an ongoing experiment. Nutritional intervention was done by counselling mothers and by providing diet chart helped in reducing severe form of malnutrition.⁵⁷

In the year 2020 a study conducted among under five children in Mbieri in Imo state, Nigeria. To study food habits and anthropometry 14.1% of children were stunted 6.5% wasted, 7.8% were undernourished. This study found significant correlation between height and feeding practices. For weight and BMI positive correlation was found but not statistically significant.⁵⁸

In the year 2020 a conducted among 512 mother-child couples who were chosen randomly, children's age was ranging from 6 to 59 months. This study showed that 43% of children failed to attain expected height. DDS, animal food were correlated with WHZ score. Education of the mother was positively correlated with HAZ score.¹⁵

In the year 2020, a study was conducted among 379 preschool children in North West Province of South Africa. Linear and logistic regression analysis were utilised to find the relationship between DDS and nutritional indicators. The average age of the children was 4 0.7 years, and frequency of stunting was (29%) with WHZ score <-2, underweight (13%) with WHZ (<-2), and thinness (6%) with WHZ <-2. Out of 12 food categories, the mean DDS was 4.39 ± 1.55 , 61% and 39% of children low and medium diet diversity that is food groups <4 and 5-8 respectively. All children consumed 19% and 17% consumed egg and sea food respectively. Cereals (100%) followed by condiments, beverages, spices, sweets. Consumption of a diverse diet was related with a decreased risk of stunting [AOR = 0.25, 95% CI: 0.10 to 0.92] among four-year-olds, while 5-year-olds had a lower risk of being underweight [OR = 0.32, 95% CI: 0.57 to 0.07] in the univariate analysis.⁵⁹

In the year 2020 conducted a study on Mothers (n=100) and their children aged 2 to 5 years (n=100) living in Shakurpur, an urban slum (Delhi). To measure diet variety, the Minimum Dietary variety for Women questionnaire (MDD -W, 2016) was employed. Majority at mothers and children, consumed foods from five or more food categories. Almost half of both groups were not eating enough dietary variety. There was a correlation between mother dietary diversity and child dietary diversity ($\chi^2 = 14.577$, $p=0.000$). There was no association between adequacy of diet diversity

and nutritional status of children. Also, no association between mother's diet diversity and child's nutritional status.⁶⁰

Study of correlation between agricultural biodiversity, diet diversity, food security with wasting was conducted in 2020. They found diet diversity was correlated with the child, with one unit increase in DDS, WHZ score decreases by 0.13 (B= .126,95 % CI; - 1.02, -.034) maternal illiteracy as associated with wasting (B= .143, 95% CI; 14, 1.86).⁶¹

This cross-sectional study involved 317 mother-child pairs (children aged 0-59 months) selected using a two-stage simple random sampling technique. Information on socio-demographic factors, care practices, and anthropometric characteristics was obtained using semi-structured interviews. The median age of children was 24 months, with 50.8% male and 42.3% delivered at health facilities. Only 45.4% were exclusively breastfed, 28.8% were introduced to complementary foods too early, 45.4% were dewormed in the last six months, and only 43.9% had complete immunization. Attained WAZ(<-2), HAZ (<-2), WHA (<-2) were 42%, 41%, and 29.3%, respectively, poor anthropometric indices were associated with age less than 12 months, 1st birth order, female gender with $p < 0.05$. Deworming practice was protective against poor anthropometric indices with odds of 0.5114 $p < 0.05$. Household monthly income did not have any influence of anthropometry of children.

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In the year 2019 a cross-sectional survey was conducted in a semi-urban area in southwest Nigeria. There were 220 pre-schoolers included in the study. Maximum children were 5 years followed by 4 years then 3 years, least were 2 years. About 78.2% of children consumed >3 meals/day, 19.5% consumed 3 meals/ day, 2.3% <3

times a day. This study showed skipping meals was associated with wasting with $p < 0.04$.⁶³

In the year 2018 a study was done to know diet diversity and its association with nutritional status using z score which give idea about attained growth at given point of time, 42.7% of children failed to attain required weight, 38% require height and 27.6% require body mass (BMI). Diet diversity index was associated with height for age and weight for age in Wardha and not in Koraput. 24 hrs food score was associated with HAZ score and DDI with WAZ score.⁸

This cross-sectional descriptive study assessed the nutritional status of children under five using anthropometric measurements and a 24-hour dietary recall. Data were collected from mothers or caregivers through interviewer-administered questionnaires. The study found 7.6% and 6.5% of children were moderately and severely stunted, 1.1% and 5.4% were moderately and severely wasted, 10.9% and 7.6% were moderately and severely overweight, and 6.5% and 1.1% were moderately and severely underweight. Significant correlations were found between dietary intake, food habits, health, and nutritional status.⁶⁴

In the year 2016 Ambedkar NN et al., These SAM children were admitted to Cheluvamba Hospital, which is affiliated with Mysore Medical College and Research Institute in Mysore, Karnataka. A total of 103 SAM cases were tested against 100 controls. Age less than 2 years, more family members (55.3% had 5 to 8 members), birth spacing less than 2 years (39.8%), open air defecation (37.9%), and living in kuccha home (32%). Poor appetite (33%), prelacteal feed (19.4%), lack of exclusive breastfeeding (42.7%), discontinuing breastfeed before 2 years (74.8%), receiving complementary feed before 6 months (67%), bottle feeding (32%), calorie deficiency

(79.6%), protein deficiency (66%), and feeding difficulty (17.5%) were the dietary risk factors that were statistically significant.⁶⁵

In the year 2016 a study was done in Andaman & Nicobar Islands and many statuses in India. The incidence of stunting, underweight, and wasting was 28.6%, 24.3%, and 12.8%, respectively, although 78.2%, 27.4%, and 50.8% of the children consumed calories, protein, and fat at levels below RDA. This study showed a weak correlation between anthropometric failures and food failures (Pearson correlation ranging from 0.013 to 0.147) and (AUC 0.62), Authors inferred that may not be done to less food consumption alone improvement in household dietary diversity also would help in Indian setting.⁶⁶

In the year 2014, a study conducted among 423 children aged 2-4 years mean DDS was 4.19 ± 0.83 . 19.15 % consumed from ≤ 3 food groups. 6.15% consumed from ≥ 6 food groups mean FVS 9.37 ± 2.45 range 2-7. 99% consumed cereals, 92 fresh, 80% vitamin A rich foods, 76% eggs, DDS and FVS was not significantly correlated with growth indicators. Adequacy energy was correlated with WAZ ($r=0.437$, $p=0.000$) HAZ ($r=0.413$ $p=0.000$) WHZ ($r=0.466$ $p=0.000$).¹³

In the year 2011 a study was done among children aged between 6 and 18 months. Around 16% of the children in the study were underweight, and 8% were both stunted and wasted. The average score for dietary variety was 4.6. Diet diversity was positively correlated between WAZ, HAZ and WHZ scores for energy and protein intake with $p < 0.01$.⁶⁷

A descriptive cross-sectional survey of 226 mothers and their under-five children was conducted in rural communities in Imo State, Nigeria in the year 2017. The children's average age was 4.2 ± 0.7 years, with 51.8% males and 48.2% females.

Stunting, wasting, and underweight prevalence was 11.5%, 5.4%, and 2.7%, respectively prevalence of under nutrition stunting and wasting was similar among boys and girls. The mean DDS was 6.04 ± 4.18 , with cereals and vegetables were consumed more The prevalence of low, medium, and high DDS was 73.5%, 25.2%, and 1.3%, respectively. (HAZ), and family income was positively associated with DDS with $p < 0.05$.⁶⁸

Studies on Socio- economic and environmental factors and growth

A study was conducted in 2022 in 5 districts of Rwanda and included 2,788 children and their mothers/ guardian. This study concentrated on causes of stunting that is attained growth for height less than -2 z score. After mathematical modelling they suggested that concentrating only on provision of food intervention will address problem of stunting short/ medium term not long term. Hence multi-disciplinary approach to address socio-economic and environmental factors along with food security helps in the problem of stunting at short, medium and long term.⁶⁹

This study emphasized attained growth failure for all 3 aspects that is WAZ <-2, WHZ <-2, WHZ <-2 was 5.2% in 2014 and reduced to 2.7% in 2017/18. The resource for coexisting stunting, under nutrition and wasting found in this study were poor socioeconomic status, not formal education of mothers, mothers who were underweight.⁷⁰

In the year 2020, the research involved 354 children aged 0 to 5 years old. Weight, height, and the circumference of the mid upper arm were all measured. Stunting, wasting, and underweight are 35%, 6.4%, and 15.8% respectively. Malnutrition has been associated to socioeconomic position, mother literacy, and exclusive breast feeding in studies.⁷¹

A cross-sectional study in rural Ambala, Haryana, surveyed 600 children through a door-to-door approach, measuring their nutritional status using z scores. The study found that 30.7% of children were underweight, 46.2% were stunted, and 7.5% were wasted. Factors such as open defecation, access to unsafe water, and living in kuccha houses were associated with higher odds of underweight children with odds ratio of 1.34, 1.52 and 1.42 respectively. But it was not statistically significant with $p > 0.05$.⁷²

A cross-sectional study of 310 children under five in urban-slum areas of Hyderabad used probability proportionate to size sampling. Data on socio-demographics, health, and nutrition were collected via questionnaires and standard procedures. The study found 39.6% had anthropometric failure, with 20.7% with WAZ < -2 stunted, 26.8% WAZ < -2 (underweight), and 12% WHZ < -2 (wasted) respectively. Significant predictors of growth failure included father's illiteracy, low birth weight, lack of exclusive breastfeeding, and insufficient calorie intake with $p < 0.05$.⁷³

In the year 2020 the study was carried out in 16 randomly selected clusters across two districts in Maharashtra, India. A total of 2929 mothers and their 3,671 children under the age of five were included., exclusive breastfeeding up to six months of age was shown as a protective factor against underweight ($p < 0.05$) both in urban and rural area. Low maternal education was associated with child underweight with WAZ (< -2) or stunting HAZ (< -2) birth order > 2 was associated with stunting with HAZ (< -2) in rural area with $p < 0.05$.⁷⁴

A community-based cross-sectional study was conducted among under-five children in rural and urban Rishikesh with year 2019 a sample size of 400. Multistage

sampling and systematic random sampling were used to select households. This study showed attained weight, height and weight for height were less in 37.3%, 43.3% and 24.5% respectively. More children with HAZ score (<-2) were between 6 months – 23 months compared to 24-59 months difference was statistically significant with $p<0.05$. Educational status of father and mother were associated with wasting and stunting with $p<0.05$.⁷⁵

In the year 2019 data from the 2016 Ethiopia Demographic and Health Survey (EDHS) were utilised to identify the socio-demographic variables associated with children's attained growth that is weight and height. Hence nutritional status children aged between 18-23 months and 24-59 months were at risk of stunting compared to 6-11 months with odd of 7.814 and 6.59 respectively. Better weight at birth protects from stunting and wasting with odds of 0.54 and 0.06 respectively. Mother's education and BMI protects from stunting better income protects stunting and wasting.⁷⁶

A community-based cross-sectional study was conducted among under-five children in Bareilly, Uttar Pradesh, India in the year 2013, using multistage simple random sampling. The prevalence of underweight, wasting, and stunting was 33.11%, 46.88%, and 10.44%, respectively, with total malnutrition prevalence i.e. 57.11% of significant associations were found between malnutrition and children failed to attain optimal growth. Age <12 months and among ($p<0.000$) girls ($p<0.030$). As the socioeconomic status deteriorates growth also gets affected with $p<0.000$. Illiteracy among mothers also affects growth with $p=0.01$.⁷⁷

In the year 2017 multiple indicator cluster surveys (MICS) were conducted in Mongolia in 2000, 2005, and 2010 to determine the impact of socioeconomic and

environmental health variables on growth indicators/ nutritional status. HAZ and WAZ changed over the course of the decade. All three outcomes WAZ score, HAZ and WHZ significantly improved between 2000 and 2010 ($p < 0.001$). Socioeconomic factors had a greater impact on stunting and weight. This study suggested to incorporate some interventions in the nutrition related programmes, which would target poor households and households with illiterate mothers.⁷⁸

In the year 2012 study was conducted among 14,587 children. This study found that growth indicators for weight, height and BMI decreased in age groups 1-3 and 3-5 as compared to 0-1 years. Boys growth indicators were better than girls $p < 0.05$. Increased family size, illiteracy of mother, poverty had higher odds of having poor growth indicators with $p < 0.01$.⁷⁹

A systematic review of environmental risk factors associated with stunting in the year 2018, showed that access to improved sanitation protected against stunting (70.6%) 29.4% did not find such association safe drinking water reduced stunting in same studies 52% (17/33) did not show such association.⁸⁰

In the year 2022 a study was done in Nepal among approximately half of Muslim children were underweight i.e. did not attain the required weight for age. 0.9% were obese, 17.3% were wasted, and 63.1% were stunted i.e. did not attain required height for age. Children with >4 members in family, joint/extended family, living with someone other than parents, mothers with primary education and fathers with SLC and above education, school going children Mothers with secondary education and dads with primary education, school-aged children, no own land, and child history chronic disease were significantly associated with wasting with $p < 0.05$.

In the year 2020 studied prevalence of stunting, wasting and underweight using z score which also give information regarding the attained weight, height and body mass prevalence of 38.8% stunting, 27.5% underweight and 12.9% had wasting. Factors responsible in this study were household wealth (OR, 1.2; 95% CI, 1.1 – 1.3; $P < 0.01$), lack of maternal education : (OR, 1.8; 95% CI, 1.7-2.0; $P < 0.01$).⁸²

In year 2020 a community-based cross-sectional study in 16 randomly selected clusters across two districts of Maharashtra state covered 2929 mothers and their 3671 under-five children. The prevalence of stunting, wasting, and underweight (attained height, BMI and weight) was 45.9%, 17.1%, and 35.4%, respectively. Higher prevalence rates were observed in urban slums compared to rural areas. Factors associated with nutritional deficiencies included exclusive breastfeeding, birth order, maternal education, sex of the child, and family income ($p < 0.05$).⁸³

This descriptive epidemiological study was conducted in the Rafiq Nagar urban slum. Among mothers of 194 children under six years through personal interviews. According to WHO malnutrition grading, 59.8% of children were malnourished, and only 46.4% were fully immunized. Factors positively affecting nutritional status/ attained growth at a given point included parents' higher education, exclusive breastfeeding, proper weaning, immunization, and higher socioeconomic status. Malnutrition was most prevalent among 1-2-year-olds, highlighting the need for educating mothers on nutritional needs and the importance of complete immunization and proper feeding practices.⁸⁴

Studies on parent's anthropometry and growth

In the year 2021 a study was conducted using NFHS IV (2015-16) data to know the association between parental height with child stunting. This study showed

that maternal height was found as predictor of child's height with odds ratio 2.85 for very short mother wealth was also predictor of stunting with OR 2 for least quintile.⁸⁵

In the year 2020 a study conducted in Indonesia among 123 children aged 1 to 5 years old. The majority of respondents (53.7%) were female, 67% of participants had normal height, 97.6% normal weight, 65% of mother's height was > 55 cm, 62.6% of father's height was >165cm father's height was not associated with stunting ($p>0.01$) mother's height was stunting positively associated with $p<0.01$.⁸⁶

In the year 2015 a study conducted among 697 children with a median age of 18 months. 33% of the toddlers had a BMI more than the WHO 85th percentile, and 14% had a BMI greater than the WHO 95th percentile. If either the mother or father was overweight (BMI 25 kg/m²), the probability of a child having a BMI over the WHO 95th percentile was significantly increased, however association were observed between the parents' BMI and the family's socio-demographics.⁸⁷

A study done in 35 low and middle income countries in the year 2017-18 to know factors associated with poor growth study included children between 12-59 months. 38.8% failed to attain required height, 27.5% required weight and 12.9% required body mass. The reasons were short maternal height with child stunting (OR- 4.7, CI 4.5 – 5 $P<0.05$), lack of maternal education (OR, CI1.8-2 $p<0.001$), poverty (OR 1.795%, CI -1.6 -1.8 $p<0.01$), low maternal BMI (OR 1.6 95% CI 1.1 -1 $p<0.01$). Short parental height also associated with child stunting (OR 1, 95% CI 1.7 -2.2 $p<0.01$).⁸⁸

JUSTIFICATION

Growth is very important in children, which has to be monitored regularly so that any faltering of growth can be detected early. This can be done at one time and the attained growth can be assessed by comparing with reference values (WHO) by using “z” scores or percentiles. This method gives an idea regarding percentage of children in different age groups have attained normal growth or not. Even if children who have attained normal growth at a given point, may not grow normally if any adverse conditions, or children who have not attained appropriate growth at a given point of time may show catch up growth or normal growth if congenial environment is provided. If we measure actual gain in height or weight among children, we get increasing trend despite not growing at a required pace. Hence measurement of velocity of growth for weight, height and BMI is very important, so that timely appropriate action can be taken.

As growth is a dynamic process, which gets affected by various factors like genetics (parents’ anthropometry), nutrition, social and environmental factors, hence velocity of growth also will get affected by these factors. In the natural history of growth among under five children, there are certain periods where catch up growth occurs. According to a study 61% of children showed catch up growth between 24-36 months of age.⁸⁹ Such information helps programme managers to plan some interventions so as to help children attain their growth potential. At present under five children’s growth is assessed by measuring their weight at different time intervals by Anganwadi workers.³⁰ Height, Mid upper arm circumference, weight for height and BMI are not assessed. Sometimes constitutionally thin and short children are considered as malnourished despite having normal growth velocity. There is a need to

compare growth of children at two different time period at least 3 months apart, which gives an idea of growth velocity.

Hence the present study was done to assess the velocity of growth among under five children by using longitudinal study design. Present study also was done to find correlation between growth velocity (weight, height, BMI, Mid arm circumference, Head circumference) with diet, (both quantitative and qualitative components of diet). Many studies have considered only quantity of diet or quality of the diet. In this study, Dietary diversity indicators were used as qualitative measure of food consumption that reflects household access to a variety of foods, and is also a proxy for nutrient adequacy of the diet of individual and also macro and or micro nutrient adequacy of the diet. 24 hour recall method was used to know the quantity of calories and proteins consumed at the base line, 6 months and 12 months. As per literature quantity of calories and protein that children consume is important than variety of food consumed for catch up growth.⁹⁰ Along with diet correlation of growth velocity with parent's anthropometry, socio-demographic and environmental factors was also done. Hence it was possible to study various possible risk factors that affect the growth of children aged between 1-5 years.

Objectives

Primary Objective:

1. Assessment of growth velocity among children aged between 1-5 years residing in rural area

Secondary Objective:

1. To study the diet diversity, socio-economic and environmental determinants of growth velocity.
2. To study the association between growth velocity and anthropometry of parents.

MATERIALS AND METHODS

The present longitudinal study was conducted in the rural field practice area of medical college over a period of one year.

Study design – Longitudinal study

Source of Data: Primary health center (Vantmuri PHC)

Data Collection Period: September 2021 to August 2022

Study Population: Children aged between 1-5 years residing in the study area

As the study intends to know growth velocity among children aged 1-5 years and it is 1year longitudinal study hence children aged between 1-4 years are included at the beginning of the study.

Sample size: According to a study conducted, catch up growth at 3 years was 61%.⁸⁹

Sample size at 95% Confidence Interval, with 10% of 'P' as allowable error and 10% for attrition came to 270

$$n = \frac{Z^2 pq}{d^2} \quad p=61\% \quad Z= 1.96 \quad q=100-61 = 39$$

$$n = \frac{3.84 \times 61 \times 39}{6.1 \times 6.1}$$

$$n = \frac{9135.36}{37.21} \quad d= 10\% \text{ of } 61$$

245.5+ 10% of attrition

10%of 245.5=24.5

245.5+24.5

=270

Sampling technique:

Figure 1. Flow chart of selection of AWC

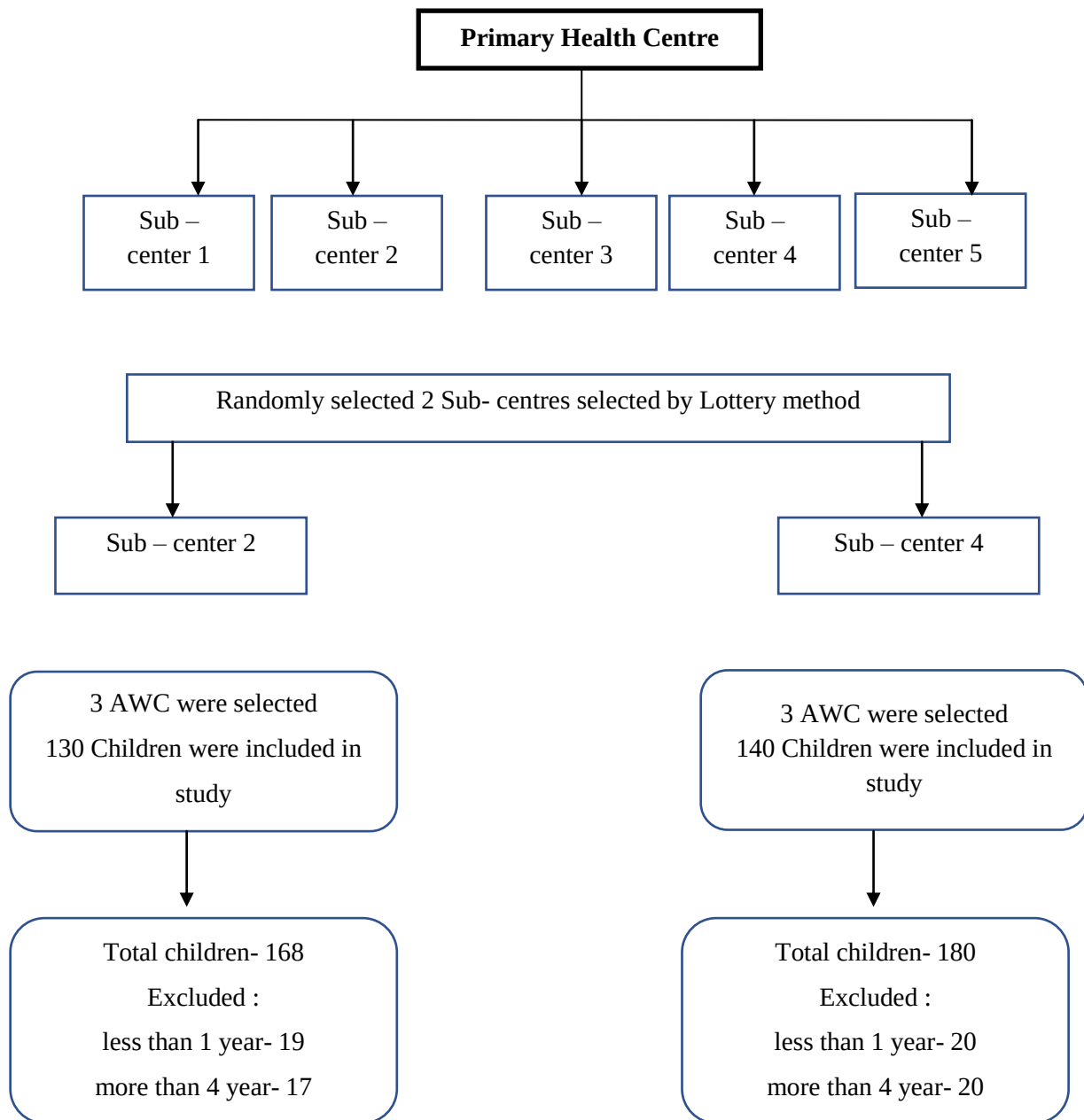


Figure 2 a: Map of Vantamuri PHC

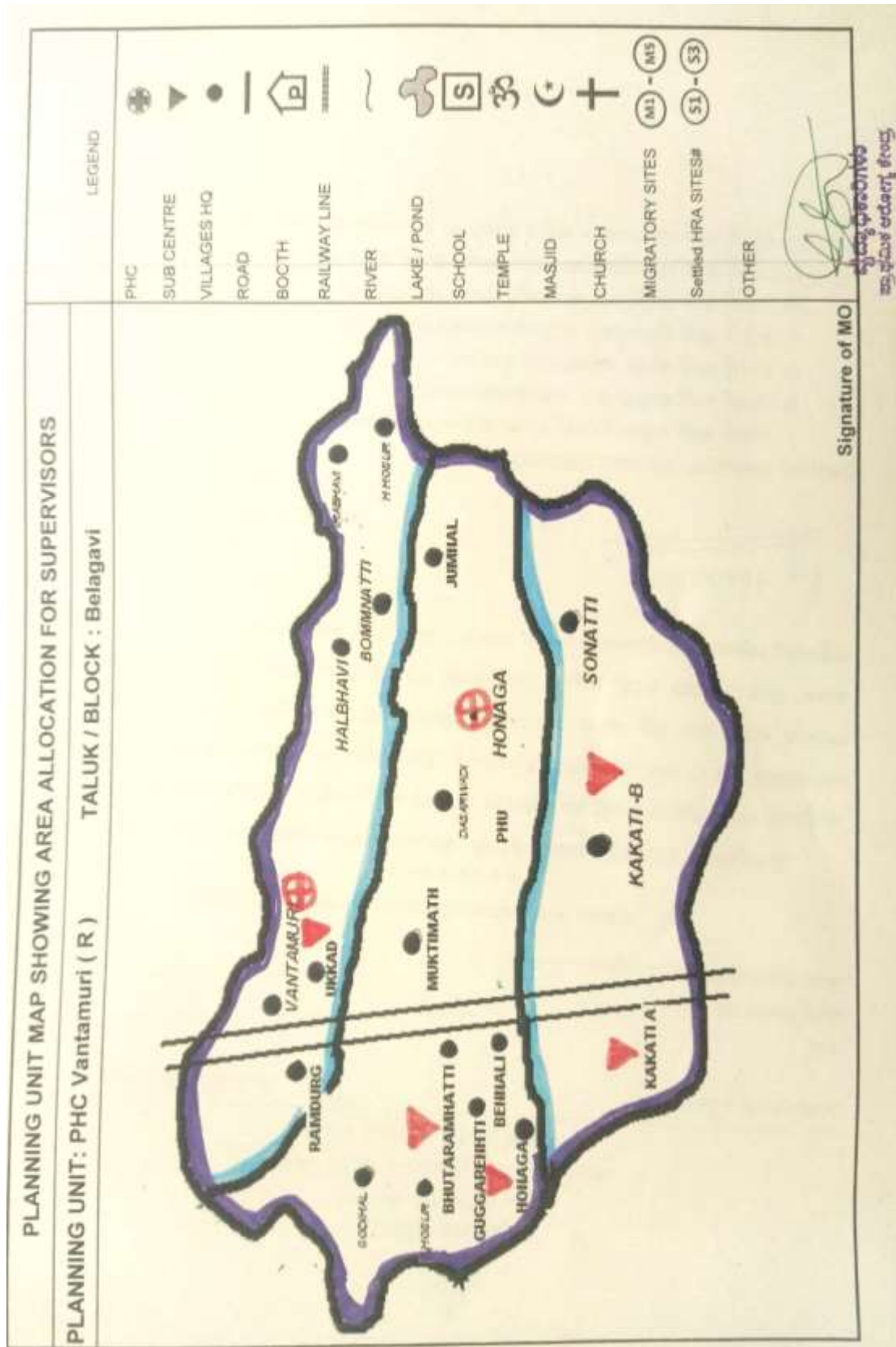


Figure 2 b: Map of Vantamuri PHC Subcenters showing anganwadi centers



Figure 2 c: Map of Bhutaramanahatti showing location of Anganwadi



There are five sub centres under PHC Vantamuri out of 5 sub centres, 2 Sub centres were randomly selected namely Vantamuri and Bhutaramanahatti three Anganwadis from Sub centre Vantamuri and another four was from Sub center four Bhutaramanahatti were selected.

All AW under the selected two sub centre's list of children aged between 1-4 years was prepared; children from AWs under the selected Sub centres were selected till required sample size was reached i.e., 270 children.

Inclusion:

All the children residing in study area aged between 1-4 years

Exclusion:

Children with diseases like type 1 Diabetes Mellitus, congenital heart diseases, cretinism (already diagnosed cases), and differently abled were excluded.

Permission – permission from Mukhya Sevika (ICDS) was taken before training of Anganwadi workers and data collection.

Data collection procedure

A cross-sectional study was conducted between August 2021 to September 2021 to collect the base line data about the study participants after obtaining consent from the mother.

Baseline data was collected about socio-demographic variables, environmental variables, diet of children, nutritional status of children using z scores WAZ, HA, BMI z score. Also anthropometry of parents was collected.

Growth velocity of selected children was done, through anthropometric measurements (height/ length, weight, head circumference and mid arm circumference) every month. At the end of one-year assessment was done to know the growth velocity among selected children. Children who were stunted and wasted was noted by using WHO “Z” score for weight for age, height for age and BMI.

Diet of the children was noted in the beginning of the study (on two occasions), after 6 months and at the end of one year of the study to know the change in the diet pattern (diet diversity) and its effect on growth velocity and hence nutritional status of the children.

Diet of the children was assessed using quantitative and qualitative method.

Calculation of Diet diversity indicator

Food Variety Score

- Calculation of Food variety score was done by considering individual food items consumed without considering which group of food it belongs.⁵⁹
- Quantitative method using 24hrs recall method. Qualitative method using FVS, DDS, DSS.

Diet diversity score

Diversity of food consumption was done by following 12 food group classifications as per FAO

- If the child consumes foods from -
 - Less than 4 groups is considered as low
 - 5-8 is considered as medium
 - 9-12 is considered as high

- Mean diet diversity score was calculated at different time period – beginning of the study, at 6 months and at 1 year.
- Maximum consumed food group and minimum consumed food group was calculated
- Association between food diversity and nutritional status was done at different age group for boys and girls by using Z score.⁵⁹

Dietary Serving Score

- Dietary serving score was calculated as follows⁹¹

Food groups	Number of servings recommended	Assigned score
Cereals/roots	4	4
Vegetables	2	4
Fruits	2	4
Legume/lentil	1	2
Meat/Fish/Egg	1	2
Milk/Dairy Products	2	4
Total	12	20

Intake of total calories and proteins was done by collecting information using 24hrs recall method (at the beginning, at 6 months and at 1 year. Each time it was done as 2 occasion and taken mean). This was used for quantitative analysis of food intake along with qualitative analysis.

For children who were breast fed along with complimentary feeding, additional 315 kcal and 4.95gms of protein (450 ml of breast milk) for breast feeding had been added for calories and protein consumed from complimentary feeding.

Immunization status of children- Immunization status of children was assessed using immunization card of the children.

The cross-sectional information was collected by the researcher and longitudinal information about anthropometry of the children, any morbidity among children was collected by Anganwadi workers, diet pattern at the end of 6 months and one-year was collected by the researcher by visiting the family (mother).

Training of Selected Anganwadi Workers:

1. Estimation of correct age of the child based on the date of birth.
2. Skills to measure appropriate weight, height/ length, mid arm circumference, chest and head circumference appropriately.
3. Hands on training was given till they learnt the skills.
4. Growth chart was provided for each child on which every month AWW recorded the anthropometric data.
5. Researcher cross verified 10% of the data collected by AWW.

If the child was absent or not available for measurement on the designated day, then within next three days measurement was taken.

For growth velocity calculation every quarterly measurement was used that is baseline, 3 months, 6 months, 9 months and 12months for weight, height and BMI.

As velocity of head circumference has its significance up to two years and in our study we included 1-5 years, hence assessment of head circumference was done using Z score in the beginning of the study and at the end of the study and also head circumference velocity in terms of percentile in different age at different time points was done.

Similarly mid-upper arm circumference was assessed in the beginning and at the end of the study using Z score and also its velocity at different time points was measured.

Statistical tool used:

Descriptive analysis: Descriptive analysis was carried out using mean and standard deviation for quantitative variables, frequency and proportion for categorical variables.

The association between categorical explanatory variables and quantitative outcome was assessed by comparing the mean values. The mean differences along with their 95% CI were used. For normally distributed Quantitative parameters the mean values were compared between study groups using Independent sample t- test (2 groups) / ANOVA (>2 groups). For non-normally distributed Quantitative parameters, Karl Pearson's correlation coefficient, dependent t test, Friedman's ANOVA, Pair comparison by Tukeys posthoc test.

P value < 0.05 was considered statistically significant. Data was analysed by using SPSS 20 version

Velocity of growth in children was assessed by measuring actual weight, height, MUAC, Head circumference

- Growth velocity for weight and height among different age group was done at 3 monthly intervals. BMI was calculated at baseline, 6 months and 12 months
- Growth velocity among boys and girls, was compared among malnourished and well nourished, children, BMI
- Association/ Correlation was calculated for growth velocity (height, weight, MUAC, head circumference) with

- FVS, DDS, DSS, total calories and protein intake
- Anthropometry of – Father and Mother(height, weight, BMI)
- Socio demographic variables
- Environmental variables

Ethical Clearance:

The work was authorized by the Institutional Ethics Committee for Human Subjects Research at JNMC, KLE University, Belgaum (Annexure) obtained 29th July 2021

Study variables ⁹²

Occupation ⁹²: The source of their income, as self-reported by the parents of beneficiaries, who would earn his or her living by means of it.

1. **Agricultural labourer:** Owns his land or on a contract basis or who works at any place including agricultural fields on a daily wage basis.
2. **Government employee:** parents of beneficiaries who is a permanent or contract worker in any government agencies.
3. **Private employee:** parents of beneficiaries who is a permanent or contract worker in any private companies or factories or NGOs.
4. **Business:** a person engaged in commercial or industrial business either an owner or executive
5. **Others:** daily wage labourers, drivers, carpenter, painter, cook

Type of family⁹³

1. **Nuclear:** the family consisting of married couple along with their dependent children.
2. **Joint:** It consist of number of married couples and their children who live in the same household

Socioeconomic status⁹⁴

The entire monthly income of the family in Rupees, as well as the family size, were acquired. The monthly income per capita in rupees was computed, and the family was categorized using a modified version of B. G. Prasad's classification.⁸⁸

The B.G Prasad's scale was introduced in 1961 considering the base of Consumer Price Index (CPI) for 1960 as 100.

Consumer Price Index for January 2021 was 118.2

Multiplication factor = $\frac{\text{current index value (118.2)}}{\text{Base index value in 2016 (100)}} = 1.182$

Base index value in 2016 (100)

The new income value is calculated using the following equation:

= Multiplication Factor $\times$ Old income value $\times 4.63 \times 4.93 \times 2.88$.

Revision of Prasad's socioeconomic status classification revised Revision of Prasad's socioeconomic status classification revised for the year 2021 (base year 2016=100)

Socio-economic status: class	Original classification of per capita income (Rs./month)	Revised classification for 2021 (Rs./month)
I (upper class)	100 and above	7770 and above
II (upper middle class)	50-99	3808-7769
III (middle class)	30-49	2253-3808
IV(lower middle class)	15-29	1166-2253
V (lower class)	<15	<1166

Educational Qualification:

Illiterate: parents of beneficiaries who cannot read or write with understanding in any language

Primary: parents of beneficiaries who had completed one to five years of schooling

Secondary: parents of beneficiaries who had completed six to ten years of schooling

PUC: parents of beneficiaries who had completed education up to PUC

Degree: parents of beneficiaries who had completed any graduation degree course or any post-graduation course

Height

The standing body height of children was measured to the nearest 0.5 cm using a commercial stadiometer. Children were instructed to stand erect, barefoot, with their feet together on the stadiometer's floorboard and their backs against its vertical backboard. The positioning required both heels to touch the base of the vertical board, which also made contact with the buttocks, scapulae, and head.

Measuring the Length of children

The Harpenden infantometer is a tool used to measure the length of new-borns and child. This device features a horizontal wooden board with two vertical planks at each end, positioned perpendicularly. One end has a fixed plank (headpiece), while the other end has a movable plank (footpiece) to adjust to the child length. A calibrated reading strip in the middle of the board allows the length of the baby to be read directly. The infantometer can measure lengths ranging from 0 to 100 cm with a precision of 1 mm.

Steps for Measuring Length

Preparation

Undo the child braids and remove any hair ornaments to ensure proper head positioning.

Remove the child diapers to make it easier to hold their legs together and straighten them.

Positioning the child

An assistant is required for the measurement process.

The assistant stands at the head end of the infantometer.

Positioning the Head

Place the child supine on the measuring board.

Ask the assistant to hold the child's head while you steady the legs.

Position the child's head in the Frankfort plane. This means the crown touches the headpiece and a vertical line from the ear canal to the lower border of the eye socket is perpendicular to the board.

Apply gentle traction to ensure the head is in contact with the fixed headpiece.

Positioning the Feet

Place the child on infantometer.

Hold down the baby's legs with one hand and move the footpiece with the other.

Align the child's shoulders and hips at right angles to the long axis of the body.

Apply gentle pressure on the knees to straighten the legs and prevent flexing.

Move the footboard to rest firmly against the child's feet, ensuring the soles are flat on the board and the toes point directly upwards.

Record the measurement to the nearest 0.1 cm from the digital counter on the measuring board.

Stadiometer is used for measuring standing height. Alternatively, height can be measured against a calibrated flat wall.

Method of Recording Height

Remove hair ornaments and footwear.

Positioning: Child stands with back against the stadiometer or wall, feet slightly apart at 60° angle, weight evenly distributed, and back of the head, shoulder blades, buttocks, calves, and heels touching the vertical board.

Head Position: Ensure the Frankfort plane is horizontal.

Measurement: Push tummy gently to help young children stand straight. Record the reading to the nearest 1 mm.

All the instruments used for weighing the children were tested with known weight before using it.



Figure 3- Stadiometer



Figure 4- Measuring tape



Figure 5- Infantometer

Weight

Body weight was recorded using a digital scale with an accuracy of 100 grams. Participants wore light clothing and stood barefoot at the center of the scale platform. For child, a Salter scale, a spring-type mechanical infant scale with a round dial, was used. This scale is designed for weighing infants up to 25 kg with a precision of 100 grams and is primarily used in growth monitoring and anthropometric surveys.^{95,96}

Child Weighing

Weighing Scale: Basket or pan type scales are used for infants up to 10 kg, measuring in 10 g increments.

Digital Scales: Portable and measure up to 5 g differences; should have a taring facility for clothing/diaper deduction.

Older Children Weighing

Platform Scales: Used for children who can stand, measuring in 100 g in cm.

Calibration: Regular calibration with known weights is essential.

Method of Recording Weight

Weighed with minimal clothing. Stand at the scale's centre, distribute weight evenly, and avoid holding onto anything. Preferably use the same scale for follow-up measurements.



Figure 6- Salter Scale



Figure 7- Weighing scale

BMI

Each participant's BMI was calculated by dividing body weight in kilograms by height in meters squared. The BMI classification followed guidelines established for the Indian population and was based on categorizations provided by the WHO Steering Committee, the International Association for the Study of Obesity, and the International Obesity Task Force.⁹⁵

Classification of BMI for parents

BMI kg/m²	Classification
≤18.49	Underweight
18.5–22.99	Normal weight
23 – 24.9	Overweight at risk
25 – 29.9	Pre-Obese
30- 34.9	Obese I
35 – 39.9	Obese II
≥40	Obese III

Mid Upper Arm Circumferences – For children aged between 6 months and 5 years, the measurement should be taken while they are sitting or standing on their mother's lap. The person measuring should stand on the side facing the arm that will be measured.⁴



Figure 8- Measuring tape for Mid upper arm circumference (Shaker's Tape)

Head Circumferences- The measurements included children between the ages of 6 months and 5 years, with positions for measurement being either seated or standing on a caregiver's lap. with the non-stretchable measuring tape covering the occiput at the rear and the supraorbital ridges at the front, representing the largest circumference of the head. ⁴



Figure 9- Measuring tape for Head Circumferences (SICA)

RESULTS

The present longitudinal study was carried out for a period of one year in rural area, to study the velocity growth among 270 children aged 1-5 years and the factors associated with it.

Result will be divided under following sections

Sections

- I. Descriptive tables**
- II. Tables related to growth velocity**
- III. Tables showing association/ correlation between growth velocity and diet, socioeconomic, environmental and parent's anthropometry**
- IV. Tables showing comparison of attained growth at different time period**

Section I: Descriptive tables

Table 1: Distribution of study participants according to Socio demographic profile (N=270)

Parameters	Frequency	Percentages
Age Group (In Months)		
13-24 months	105	38.89%
25-36 months	81	30.00%
>=37 months	84	31.11%
Gender		
Male	137	50.74%
Female	133	49.26%
Religion		
Hindu	241	89.26%
Muslim	28	10.37%
Jain	1	0.37%
Type of the Family		
Nuclear	121	44.81%
Joint	148	54.81%
Broken	1	0.37%
Education of Father		
Illiterate	73	27.75%
Primary	7	2.66%
Higher Primary	26	9.88%
Secondary	140	53.25%
Diploma	2	0.76%
Degree	15	5.70%
Education of Mother		
Illiterate	86	31.85%
Read and write	7	2.59%
Primary	9	3.33%
Higher primary	26	9.63%
Secondary	130	48.16%
Diploma	4	1.48%
Degree	7	2.59%
PG	1	0.37%

Occupation of Father		
Farmer	48	18.25%
Daily wage labourers	123	46.78%
Self-employed	53	20.15%
Govt. employee	15	5.71%
Pvt. Employee	23	8.74%
Unemployed	1	0.37%
Occupation of Mother		
Farmer	36	13.33%
Daily wage labourers	78	28.88%
Self-employed	1	0.37%
Govt. employee	5	1.85%
Pvt. Employee	6	2.22%
Home maker	144	53.35%
Socio Economic Class		
class I	2	0.74%
class II	1	0.37%
class III	50	18.52%
class IV	180	66.67%
class V	37	13.70%

Maximum numbers of children were between age group 13-24 months. Male children were slightly more (50.74%) compared to female children. Most of the children belonged to Hindu community i.e. 89.26%, and 54.81 % of families were joint followed by nuclear families (44.81%). Maximum number of fathers and mothers were educated up to secondary level followed by illiterates, Maximum number of fathers worked on daily wages (46.78%) followed by farming. Maximum number of mothers were homemakers (53.35%) followed by daily wage labourers (29.00%) respectively. Maximum children belonged to class IV socioeconomic class (66.67%) and minimum to class II (0.37%) and socioeconomic class I (0.74%).

Table 2: Distribution of study participants according to environmental variables
(N=270)

Parameters	Frequency	Percentages
Type of House		
Pucca	267	98.89%
Semi-pucca	3	1.11%
Ownership of House		
Own	270	100.00%
No. of Rooms in House		
1 room	50	18.52%
2 rooms	94	34.81%
3 rooms	112	41.48%
4 rooms	14	5.19%
Overcrowding		
Present	126	46.67%
Absent	144	53.33%
Proper Ventilation in the House		
Yes	238	88.15%
No	32	11.85%
Electrification of the House		
Yes	270	100.00%
Type of Cooking Fuel Used		
LPG	269	99.63%
Electricity	1	0.37%
Toilet Facility Available in Your House		
Yes	258	95.56%
No	12	4.44%
Source of Drinking Water		
Tube well	2	0.74%
Tap water	268	99.26%

All the parents owned the houses and they had electric supply, and they were pucca houses (98.89%). About 41.48% had houses with three rooms followed by two rooms (34.81%), one room (18.52%) and four rooms (5.19%). All houses had less crowded (53.33%), houses were ventilation was proper in (88.15%), maximum family used LPG gas (99.63%) for cooking. Most of the houses had toilet facility i.e. (95.56%). A 99.26% were using tap water and 0.74% tube well

Table 3. Distribution of study participants based on variables related to birth and feeding practices

Parameters	Frequency	Percentage
Birth Order of children		
One	98	36.30%
Second	90	33.33%
Third	58	21.48%
Fourth	15	5.56%
Fifth	9	3.33%
Mean Birth Weight (Kg)	2.73 ± 0.36	Range 1.50 to 4.50
NICU Admission		
Yes	9	3.33%
No	261	96.67%
Duration of breast feeding		
5 months	236	87.41%
6 months	33	12.22%
7 months and above	1	0.37%
Breast feeding continued		
Yes	107	39.63%
No	163	60.37%

Most of the children's birth order was 1st (36.30%), followed by 2nd (33.33%) and followed 3rd (21.48%) 8.89% were either 4th and 5th order. Mean birth weight of the children was range 1.50 to 4.50. Most of the children were not admitted in the NICU i.e. 96.67%. all the children received immunization as per the age, and vitamin A prophylaxis, as per mother's information for all the children breast feeding started within one hour of birth. Maximum children received (87.41%) BF for 5 months, 12.22% for 6 months and 0.37% > 7 months received. About 39.63% children continued to receive breast milk at the time.

No illness requiring medication/ hospitalization reported during study period.

All the children had received immunization appropriate for the age and also all children received Vitamin A supplementations.

Table 4: Distribution of study participants based on the details of diet received (N=270)

Parameters	Frequency	Percentages
Type of Weaning Foods Given to Child		
Cow's Milk/ Buffalo's Milk	222	82.22%
Cereal Porridge	42	15.56%
Fruit Juice	1	0.37%
Vegetable soup	5	1.85%
Quantity of weaning food Given		
½ cup	23	8.52%
1 cup or more	247	91.48%
Frequency of Weaning Food given		
Twice	123	45.56%
Thrice	123	45.56%
Four times or more	24	8.89%
Number of meals given to Children / day		
One	1	0.37%
Two	7	2.59%
Three	32	11.85%
More	230	85.19%

Most of the children received cow's an buffalo's milk as 82.22%, 15.56% received cereal porridge in 1 cup quantity (91.48%). Frequency of weaning food given to children was twice as well as thrice i.e. 45.56% and 45.56 respectively. About 85.19% children received more than 4 meals per day. Starting of breast feeding soon after birth could not be collected for every child.

As per as vitamins concerned 64.81% received iron syrup, followed by 21.11% received multivitamin, 1.85% received vitamin D. Around 12.22% received treatment for minor ailments

Table 5 Distribution of study participants according to their nutritional status at the beginning of the study

Parameters	Frequency	Percentages
Weight For Age (Z- score)		
Underweight (<-2)	80	29.63%
Normal (-2 to 2)	190	70.37%
Height For Age (Z score)		
Stunting (<-2)	17	6.30%
Normal (-2 to 2)	221	81.85%
Tall (>2)	32	11.85%
BMI Status (Z score)		
Underweight (<-2) (Thinness)	208	77.04%
Normal (-2 to 2)	61	22.59%
Overweight (>2)	1	8.89%
Mid Upper Arm Circumference		
< 12.5	194	71.86%
12.5-13.5	52	19.25%
>13.5	24	8.89%
Head circumference For Age Group		
Small (<-2)	139	51.48%
Normal (-2 To 2)	130	48.15%
Big (>2)	1	0.37%

Underweight was observed among 29.26% of children, stunting was observed among 6.30% of children and thinness is 77.04%.

Maximum range of < 12.5 cm is 71.86% and minimum is >13.5 cm is 8.89%

Approximately 51.48% of children had a small head circumference i.e., 48.15% had normal (-2 to 2), and 0.37% had big head.

Table 6: Distribution of study participants according to calories and proteins consumed, required and deficient

Variables related to diet	Mean $\pm$ SD	Range
Total Calories Consumed	671.08 $\pm$ 154.91	341.0 to 1148.0
Required Calories	1143.33 $\pm$ 139.14	1050.0 to 1350.0
Calories Deficient	381.58 $\pm$ 157.21	0 to 863.0
Total Proteins consumed	20.58 $\pm$ 5.5	5.2 to 32.8
Required Protein	17.93 $\pm$ 1.39	17.0 to 20.0
No Protein Deficiency	-	-

The mean calorie consumed was 671.08 average required calories was 1143.33. Hence average calorie deficiency was 381.58 $\pm$ 157.21. The mean total protein intake was 20.58. The average required protein is 17.93. There was no deficiency of protein intake.

Table 7: Distribution of study participants according to frequency of consumption of different food groups

Food groups	Number	Percentage
Cereals Daily	270	100%
Pulses and Legumes		
Daily	235	87.04%
Alternate	26	9.63%
Once in week	7	2.59%
Once in month	1	0.37%
Never	1	0.37%
Green Leafy Vegetable		
Daily	186	68.89%
Alternate	58	21.48%
Once in week	23	8.52%
Once in month	2	0.74%
Never	1	0.37%
Other Vegetables		
Daily	50	18.52%
Alternate	79	29.26%
Once in week	105	38.89%
Fortnightly	3	1.11%
Once in month	8	2.96%
Rarely	19	7.04%
Never	6	2.22%
Fruits		
Daily	28	10.37%
Alternate	20	7.41%
Once in week	190	70.37%
Fortnightly	3	1.11%
Once in month	14	5.19%
Rarely	12	4.44%
Never	3	1.11%

Milk		
Daily	249	92.22%
Alternate day	1	0.37%
Once in week	8	2.96%
Fortnightly	1	0.37%
Once in month	3	1.11%
Rarely	3	1.11%
Never	5	1.85%
Beverages/Nuts and Seeds		
Daily	153	56.67%
Alternate Day	51	18.89%
Once in week	12	4.44%
Once in month	1	0.37%
Rarely	30	11.11%
Never	23	8.52%
Oils and Fats / ghee and butter		
Daily	1	0.37%
Alternate Day	3	1.11%
Once in week	86	31.85%
Fortnightly	2	0.74%
Once in month	3	1.11%
Rarely	31	11.48%
Never	144	53.33%
Sweets		
Alternate day	12	4.44%
Once in week	173	64.07%
Fortnightly	1	0.37%
Once in month	4	1.48%
Rarely	24	8.89%
Never	56	20.74%
Egg		
Alternate Day	20	7.41%
3 Once in week	125	46.30%

Fortnightly	2	0.74%
Once in month	7	2.59%
Rarely	34	12.59%
Never	82	30.37%
Meat		
Once in week	10	3.70%
Once in month	3	1.11%
Rarely	72	26.67%
Never	185	68.52%
Fish		
Once in week	14	5.19%
Once in month	11	4.07%
Rarely	70	25.93%
Never	175	64.81%

Cereals were consumed by all 270 participants daily. Majority of participants (87.04%) consume pulses and legumes daily, 9.63% consumed them on alternate days, 2.59% once a week. Green leafy vegetables were also a significant part of the diet, with 68.89% of participants consuming them daily. 21.48% consumed on alternate days, once a week (8.52%).

Consumption of other vegetables everyday by 18.52%, alternate day by 29.26%, and 38.89% once a week.

Fruits were consumed daily by 10.37% of the participants, while 7.41% ate them on alternate days. A large proportion (70.37%) consumed fruits once a week.

Milk being part of daily dietary component for 92.22% of participants, few consumed it on alternate days (0.37%), once a week (2.96%), fortnightly (0.37%), once a month (1.11%), rarely (1.11%), or never (1.85%).

More than half of the participants (56.67%) consumed beverages/ nuts and seeds daily, included them in their diet on alternate days (18.89%), once a week (4.44%), once a month (0.37%), rarely (11.11%), or never (8.52%).

More than 50% did not consume oils and fats about 30% consumed them once a week.

Sweets were consumed on alternate days by 4.44% of the participants, once a week by 64.07%, and never by 20.74%.

Eggs were included in the diet on alternate days by 7.41% of the participants and once a week by 46.30%, never (30.37%).

The consumption of meat is relatively low, with 3.70% of participants eating it once a week, 1.11% once a month, 26.67% rarely, and 68.52% never.

Fish is consumed once a week by 5.19% of the participants, once a month by 4.07%, rarely by 25.93%, and never by 64.81%.

Table 8: Distribution of study participants according to Diet Diversity indicators (Food Variety Score, Dietary Diversity Score and Dietary Serving Score)

Diet diversity Indicator	Number	Percentage
Food Variety Score (number of food items consumed)		
Two	3	1.11%
Three	23	8.52%
Four	15	5.56%
Five	72	26.67%
Six	83	30.74%
Seven	21	7.78%
Eight	49	18.15%
Nine	4	1.48%
Dietary Diversity Score (Number of food groups consumed)		
Number of food groups Consumed children	No.of children	Percentage of
Two	5	1.85%
Three	143	52.96%
Four	107	39.63%
Five	10	3.70%
Six	5	1.85%
Dietary Serving Score (Number of servings of different food groups consumed)		
Diet serving score	Number of children	Percentage of children
Seven	17	6.30%
Eight	45	16.67%
Nine	59	21.85%
Ten	56	20.74%
Eleven	34	12.59%
Twelve	52	19.26%
Thirteen	1	0.37%
Fourteen	6	2.22%

❖ **Note:** IN DDS Low (≤ 4), Medium (5-8) and High (9-12)

For the Food Variety Score, 3 children (1.11%) consumed two different food items, 23 children (8.52%) consumed three, 15 children (5.56%) consumed four, 72 children (26.67%) consumed five, 83 children (30.74%) consumed six, 21 children

(7.78%) consumed seven, 49 children (18.15%) consumed eight, and 4 children (1.48%) consumed nine different food items.

Regarding the Dietary Diversity Score, 5 children (1.85%) consumed foods from two different food groups, 143 children (52.96%) consumed from three, 107 children (39.63%) consumed from four, 10 children (3.70%) consumed from five, and 5 children (1.85%) consumed from six different food groups. Most children's DSS was nine (21.85%), followed by ten servings 20.74%, twelve servings was (19.26 %), and eight servings (16.67 %).

Table 9: Distribution of parents of study participants according to their Anthropometric variables

Anthropometry	Number	Percentage
Fathers' Height		
<155	50	19.01%
155 to 160	98	37.26%
>160	115	43.73%
Fathers' Weight		
<54.400	65	24.71%
54.400 to 60	97	36.88%
>60	101	38.40%
Fathers' BMI		
Underweight (<18.50)	21	7.98%
Normal (18.50-24.99)	169	64.26%
Overweight (25-29.99)	65	24.71%
Obese(≥ 30)	8	3.04%
Mothers' Height		
<145	64	23.70%
145 to 150	76	28.15%
>150	130	48.15%
Mothers' Weight		
<40	48	17.78%
40 to 45	94	34.81%
>45	128	47.41%
Mothers' BMI		
Underweight (<18.50)	84	31.11%
Normal (18.50-24.99)	161	59.63%
Overweight (25-29.99)	22	8.15%
Obese(≥ 30)	3	1.11%

- Note- 07 children had lost their father due to COVID/ other reasons

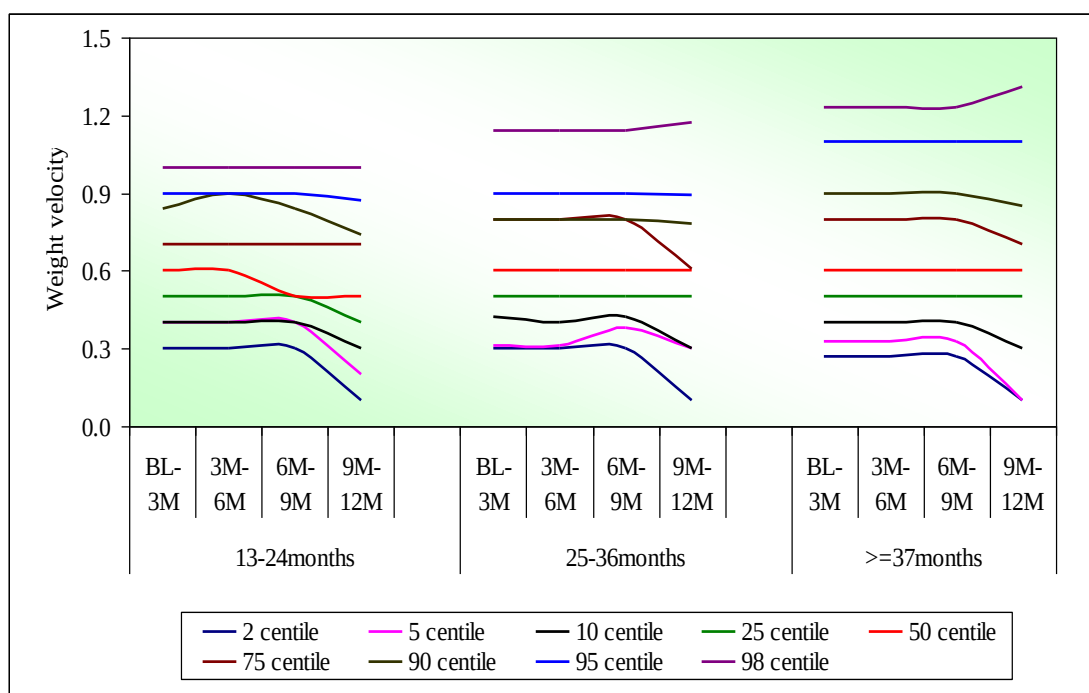
In father height was >160cm in 43.73% and <155cm in 19.01%. Father is weight was >60kg in 38.40% and <54.4 kg in 24.71%. Mother height was >150cm in 48.15% and <145cm in 23.70%. Mother weight was >45kg in 47.1% and <40kg in 23.70% .Maximum number of both father's and mother's BMI was normal i.e. 64.26% and 59.63% respectively, 24.71% of fathers and 8.15% of mothers were overweight, obesity was observed among 3.04% fathers and 1.11% of mothers

Section II: Growth velocity is assessed by using percentiles and actual increase in weight, height, BMI, MUAC, HC at different time points

Table 10: Weight velocity in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-3M	0.30	0.40	0.40	0.50	0.60	0.70	0.84	0.90	1.00
	3M-6M	0.30	0.40	0.40	0.50	0.60	0.70	0.90	0.90	1.00
	6M-9M	0.30	0.40	0.40	0.50	0.50	0.70	0.84	0.90	1.00
	9M-12M	0.10	0.20	0.30	0.40	0.50	0.70	0.74	0.87	1.00
25-36months	BL-3M	0.30	0.31	0.42	0.50	0.60	0.80	0.80	0.90	1.14
	3M-6M	0.30	0.31	0.40	0.50	0.60	0.80	0.80	0.90	1.14
	6M-9M	0.30	0.38	0.42	0.50	0.60	0.80	0.80	0.90	1.14
	9M-12M	0.10	0.30	0.30	0.50	0.60	0.61	0.78	0.89	1.17
>=37 months	BL-3M	0.27	0.33	0.40	0.50	0.60	0.80	0.90	1.10	1.23
	3M-6M	0.27	0.33	0.40	0.50	0.60	0.80	0.90	1.10	1.23
	6M-9M	0.27	0.33	0.40	0.50	0.60	0.80	0.90	1.10	1.23
	9M-12M	0.10	0.10	0.30	0.50	0.60	0.70	0.85	1.10	1.31

Figure 10: Weight velocity in terms of percentile in different age groups at different time points

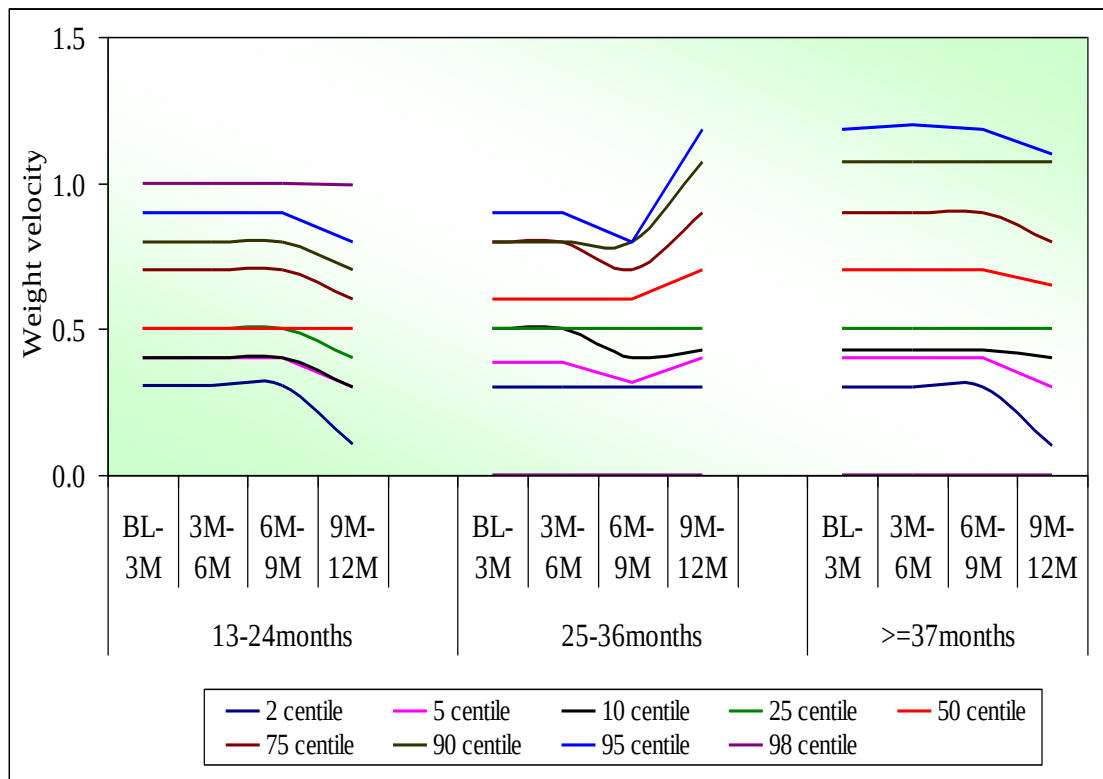


Among 13-24 months growth velocity remains same 95th and 98th percentile. From 50th percentile below there is decline. In 25-36 months below 25th percentile there is decline. and ≥ 37 months overall it is said that children below 25th percentile weight velocity decreases

Table 11: Weight velocity of boys in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-3M	0.30	0.40	0.40	0.50	0.50	0.70	0.80	0.90	1.00
	3M-6M	0.30	0.40	0.40	0.50	0.50	0.70	0.80	0.90	1.00
	6M-9M	0.30	0.40	0.40	0.50	0.50	0.70	0.80	0.90	1.00
	9M-12M	0.11	0.30	0.30	0.40	0.50	0.60	0.70	0.80	0.99
25-36months	BL-3M	0.30	0.39	0.50	0.50	0.60	0.80	0.80	0.90	.
	3M-6M	0.30	0.39	0.50	0.50	0.60	0.80	0.80	0.90	.
	6M-9M	0.30	0.32	0.40	0.50	0.60	0.70	0.80	0.80	.
	9M-12M	0.30	0.40	0.43	0.50	0.70	0.90	1.07	1.19	.
>=37 months	BL-3M	0.30	0.40	0.43	0.50	0.70	0.90	1.07	1.19	.
	3M-6M	0.30	0.40	0.43	0.50	0.70	0.90	1.07	1.20	.
	6M-9M	0.30	0.40	0.43	0.50	0.70	0.90	1.07	1.19	.
	9M-12M	0.10	0.30	0.40	0.50	0.65	0.80	1.07	1.10	.

Figure 11: Weight velocity of boys in terms of percentile in different age groups at different time points

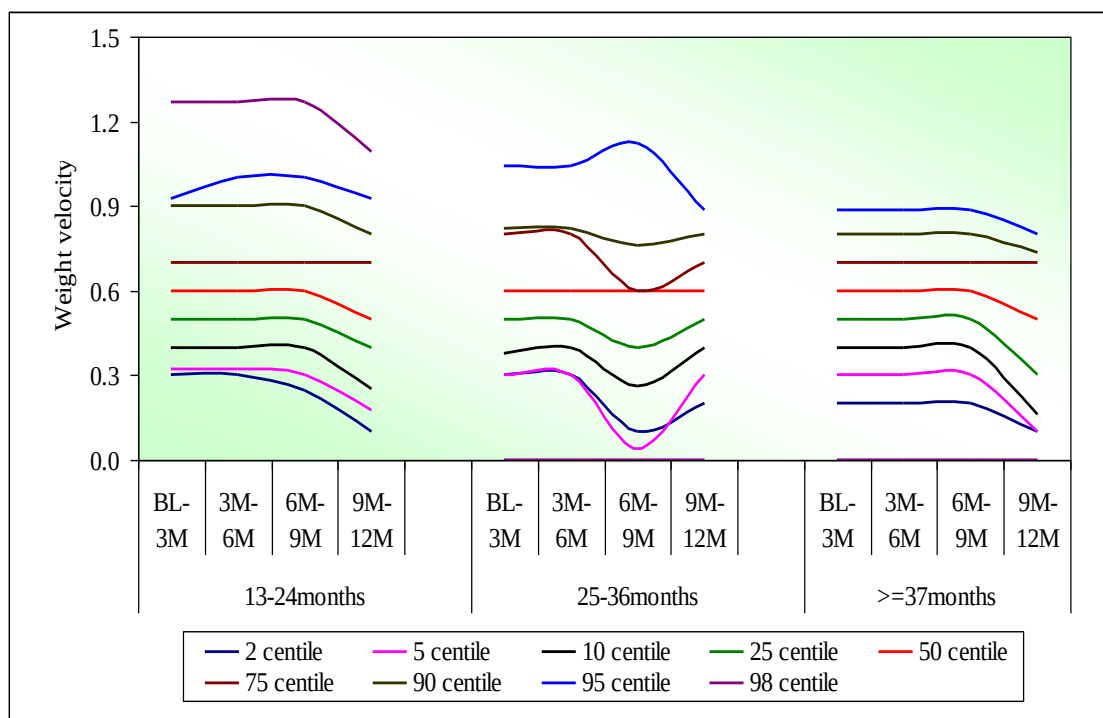


Weight velocity of boys in 13-24 months remains same in 98th percentile and below 95th percentile there is decline and 50th percentile again remains constants and below 25th percentile there is decline. Among 25-36 months 98th -50th percentile there is initial increase in weight velocity between 6 months- 12 months. Among ≥ 37 months except for 95th and 50th percentile there is decline in weight velocity.

Table 12: Weight velocity of girls in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-3M	0.30	0.32	0.40	0.50	0.60	0.70	0.90	0.93	1.27
	3M-6M	0.30	0.32	0.40	0.50	0.60	0.70	0.90	1.00	1.27
	6M-9M	0.25	0.30	0.40	0.50	0.60	0.70	0.90	1.00	1.27
	9M-12M	0.10	0.18	0.25	0.40	0.50	0.70	0.80	0.93	1.09
25-36months	BL-3M	0.30	0.30	0.38	0.50	0.60	0.80	0.82	1.04	.
	3M-6M	0.30	0.30	0.40	0.50	0.60	0.80	0.82	1.04	.
	6M-9M	0.10	0.04	0.26	0.40	0.60	0.60	0.76	1.12	.
	9M-12M	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.89	.
>=37 months	BL-3M	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.89	.
	3M-6M	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.89	.
	6M-9M	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.89	.
	9M-12M	0.10	0.10	0.16	0.30	0.50	0.70	0.74	0.80	.

Figure 12: Weight velocity of girls in terms of percentile in different age groups at different time points



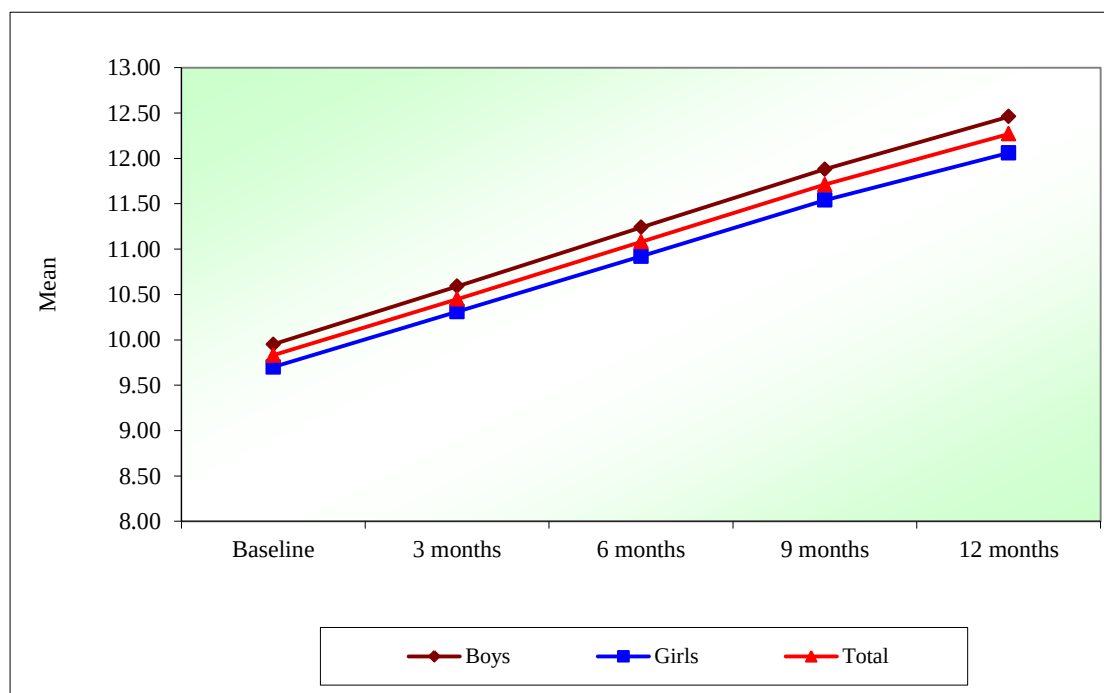
Weight velocity of girl's among 13-24months and ≥ 37 months is declining except for 50th percentile. Among 25-36 months there is increase in weight velocity from 6 months to 12 months period except for 98th and 50th percentile.

Table 13: Comparison of actual weight of boys and girls at different time points

Time points	Boys		Girls		Mean Diff.	t-value	p-value	95% CI for mean Diff.	
	Mean	SD	Mean	SD				Lower	Upper
Baseline	9.95	1.75	9.70	1.86	0.25	1.1576	0.2481	-0.18	0.69
3months	10.59	1.73	10.31	1.85	0.28	1.2953	0.1963	-0.15	0.71
6 months	11.24	1.74	10.92	1.85	0.31	1.4287	0.1542	-0.12	0.74
9 months	11.88	1.78	11.54	1.87	0.34	1.5321	0.1267	-0.10	0.78
12 months	12.46	1.85	12.06	1.92	0.40	1.7429	0.0825	-0.05	0.85

$p < 0.05$ (independents t test)

Figure 13: Comparison of actual weight (in kgs) of boys and girls at different time points

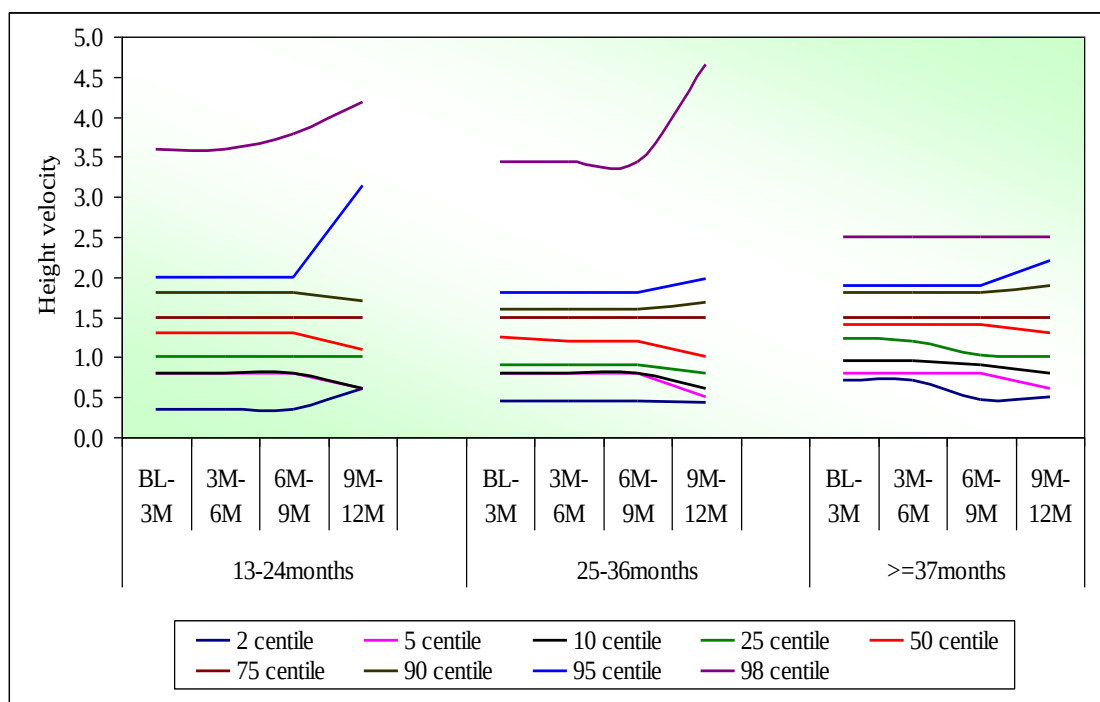


In our study baseline mean weight of boys is 9.95 kgs and girls 9.70 kgs mean difference is 0.25 it is not statistically significant ($p>0.05$). At baseline, 3 months, 6 months, 9months and 12 months also there was no significant difference between weight velocity among boys and girls. Though the weight at the baseline,3,6,9 and 12 month was more among boys than that of girls.

Table 14: Height velocity in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-3M	0.35	0.80	0.80	1.00	1.30	1.50	1.80	2.00	3.60
	3M-6M	0.35	0.80	0.80	1.00	1.30	1.50	1.80	2.00	3.60
	6M-9M	0.35	0.80	0.80	1.00	1.30	1.50	1.80	2.00	3.78
	9M-12M	0.60	0.60	0.60	1.00	1.10	1.50	1.70	3.15	4.19
25-36months	BL-3M	0.46	0.80	0.80	0.90	1.25	1.50	1.60	1.80	3.44
	3M-6M	0.46	0.80	0.80	0.90	1.20	1.50	1.60	1.80	3.44
	6M-9M	0.46	0.80	0.80	0.90	1.20	1.50	1.60	1.80	3.44
	9M-12M	0.43	0.51	0.60	0.80	1.00	1.50	1.68	1.98	4.65
>=37months	BL-3M	0.71	0.80	0.95	1.23	1.40	1.50	1.80	1.90	2.50
	3M-6M	0.71	0.80	0.95	1.20	1.40	1.50	1.80	1.90	2.50
	6M-9M	0.47	0.80	0.90	1.03	1.40	1.50	1.80	1.90	2.50
	9M-12M	0.50	0.60	0.80	1.00	1.30	1.50	1.90	2.20	2.50

Figure 14: Height velocity in terms of percentile in different age groups from different time points

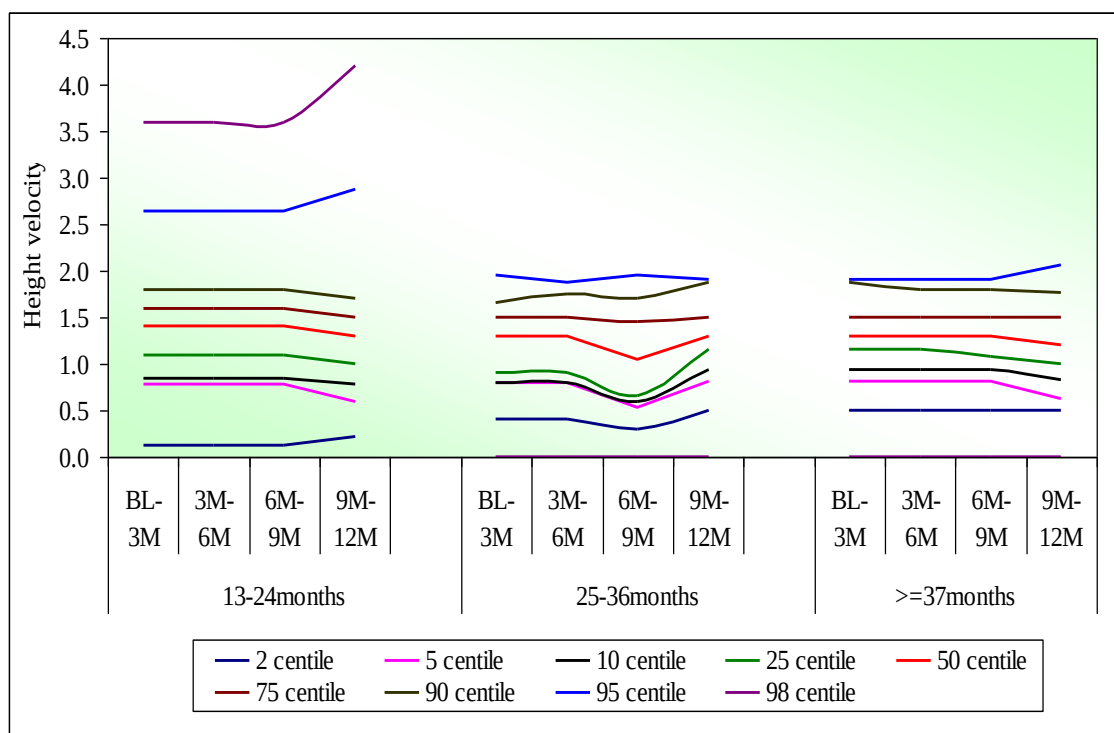


Height velocity increased in children aged 13-24 months who were between 90th , 95th percentile and 98th percentile and it was constant in remaining 2nd to 90th percentile and among 25-36 months children initial stable then there is decline except for 95th and 98th percentile . In ≥ 37 months 98th centile it is constant then 75th percentile shows slight increase in height velocity.

Table 15: Height velocity of boys in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-3M	0.13	0.78	0.84	1.10	1.40	1.60	1.80	2.64	3.60
	3M-6M	0.13	0.78	0.84	1.10	1.40	1.60	1.80	2.64	3.60
	6M-9M	0.13	0.78	0.84	1.10	1.40	1.60	1.80	2.64	3.60
	9M-12M	0.22	0.60	0.78	1.00	1.30	1.50	1.70	2.88	4.20
25-36months	BL-3M	0.40	0.80	0.80	0.90	1.30	1.50	1.65	1.95	.
	3M-6M	0.40	0.80	0.80	0.90	1.30	1.50	1.75	1.88	.
	6M-9M	0.30	0.53	0.60	0.65	1.05	1.45	1.70	1.95	.
	9M-12M	0.50	0.82	0.93	1.15	1.30	1.50	1.87	1.90	.
≥37months	BL-3M	0.50	0.82	0.93	1.15	1.30	1.50	1.87	1.90	.
	3M-6M	0.50	0.82	0.93	1.15	1.30	1.50	1.80	1.90	.
	6M-9M	0.50	0.82	0.93	1.08	1.30	1.50	1.80	1.90	.
	9M-12M	0.50	0.63	0.83	1.00	1.20	1.50	1.77	2.06	.

Figure 15: Height velocity of boys in terms of percentile in different age groups at different time points

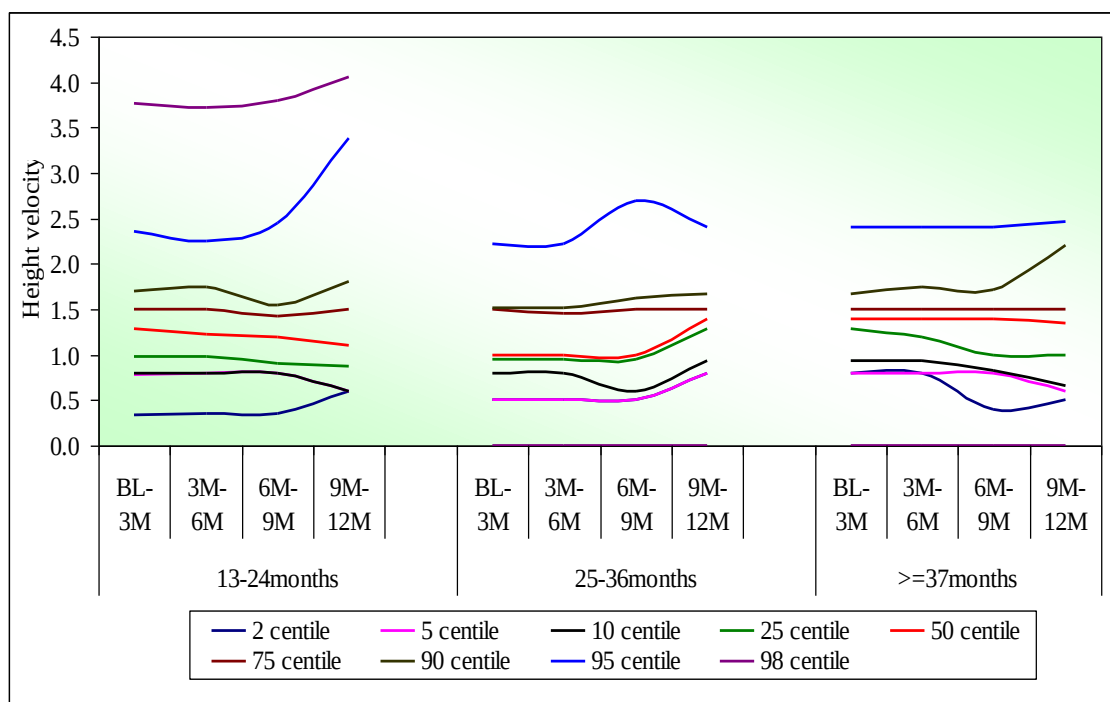


Height velocity of boys among 13-24 months children was more in 98th and 95th and 2nd percentile there is increase in height velocity in last quarter except for 95th percentile. Among 25-36 months children and ≥ 37 months almost remains same, expect for 95th percentile.

Table 16: Height velocity of girls in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-3M	0.34	0.78	0.80	0.98	1.28	1.50	1.70	2.35	3.76
	3M-6M	0.35	0.80	0.80	0.98	1.23	1.50	1.75	2.25	3.72
	6M-9M	0.35	0.80	0.80	0.90	1.20	1.43	1.55	2.45	3.80
	9M-12M	0.60	0.60	0.60	0.88	1.10	1.50	1.80	3.38	4.05
25-36months	BL-3M	0.50	0.50	0.80	0.95	1.00	1.50	1.52	2.22	.
	3M-6M	0.50	0.50	0.80	0.95	1.00	1.45	1.52	2.22	.
	6M-9M	0.50	0.50	0.60	0.95	1.00	1.50	1.62	2.70	.
	9M-12M	0.80	0.80	0.93	1.28	1.40	1.50	1.67	2.41	.
>=37months	BL-3M	0.80	0.80	0.93	1.28	1.40	1.50	1.67	2.41	.
	3M-6M	0.80	0.80	0.93	1.20	1.40	1.50	1.74	2.41	.
	6M-9M	0.40	0.80	0.83	1.00	1.40	1.50	1.71	2.41	.
	9M-12M	0.50	0.60	0.66	1.00	1.35	1.50	2.20	2.46	.

Figure 16: Height velocity of girls in terms of percentile in different age groups at different time points

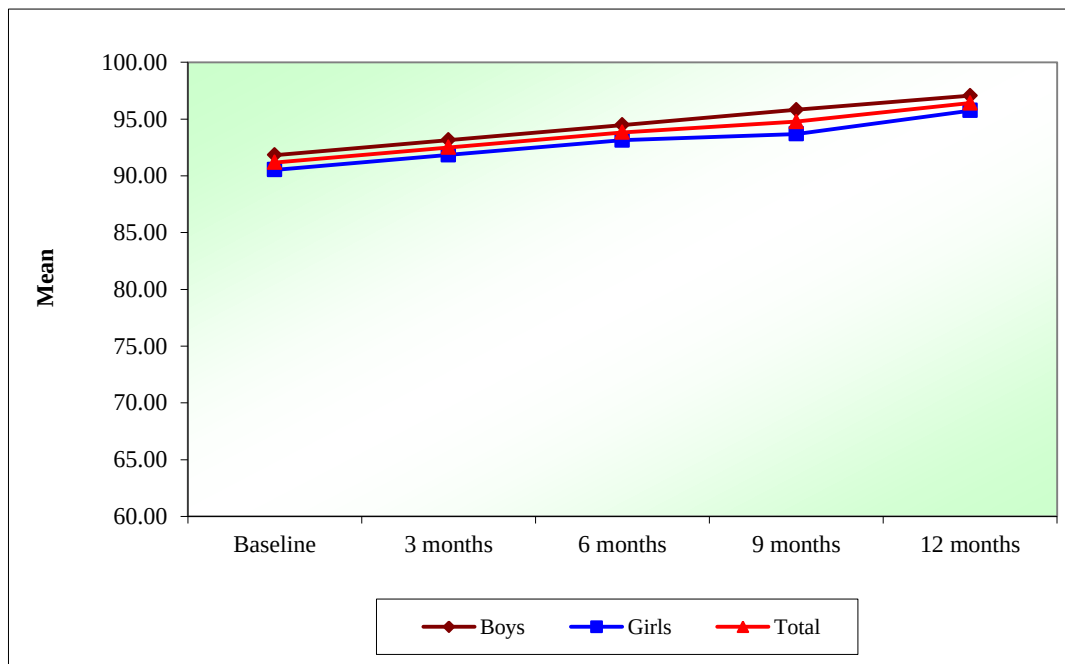


Height velocity of girls aged between 13-24 months increase in 2nd, 75th to 98th percentile in last two quarters. Among 25-36 months, height velocity increased between 3rd and 4th quarters. Among ≥ 37 months except for 98th percentiles it was either constant or declining.

Table 17: Comparison of actual height of boys and girls at different time points

Time points	Boys		Girls		Mean Diff.	t-value	p-value	95% CI for mean Diff.	
	Mean	SD	Mean	SD				Lower	Upper
Baseline	91.82	7.98	90.53	9.06	1.29	1.2467	0.2136	-0.75	3.34
3months	93.15	8.00	91.84	9.11	1.31	1.2616	0.2082	-0.74	3.37
6 months	94.48	8.04	93.14	9.20	1.33	1.2694	0.2054	-0.73	3.40
9 months	95.81	8.10	93.69	12.00	2.13	1.7095	0.0885	-0.32	4.57
12 months	97.06	8.20	95.74	9.53	1.32	1.2188	0.2240	-0.81	3.45

$p < 0.05$ (independents t test)

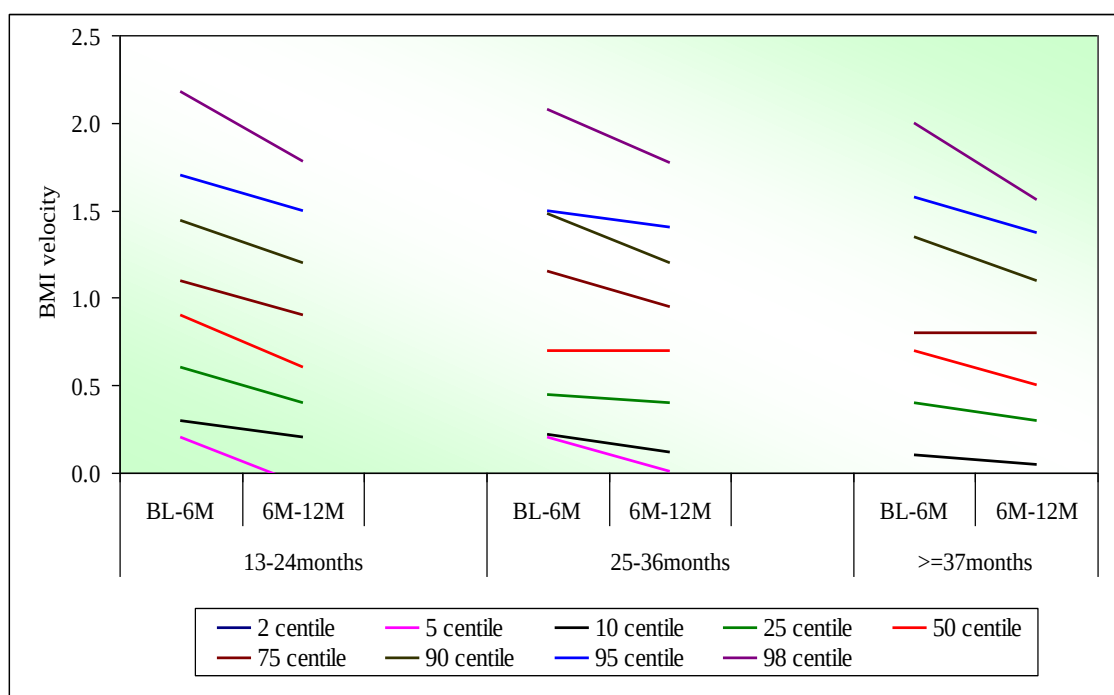
Figure 17: Comparison of actual height of boys and girls at different time points

In our study baseline mean height of boys was 91.82cm and girls 90.53cm, mean difference was 1.29 cm it was not statistically significant ($p > 0.05$). At baseline, 3 months, 6 months, 9months and 12 months also there was no significant difference between height velocity among boys and girls. Though the height of boys was more than that of girls.

Table 18: BMI velocity in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-6M	-0.35	0.20	0.30	0.60	0.90	1.10	1.44	1.70	2.18
	6M-12M	-0.50	-0.07	0.20	0.40	0.60	0.90	1.20	1.50	1.78
25-36months	BL-6M	-0.26	0.20	0.22	0.45	0.70	1.15	1.48	1.50	2.08
	6M-12M	-0.95	0.01	0.12	0.40	0.70	0.95	1.20	1.40	1.77
>=37months	BL-6M	-0.33	-0.10	0.10	0.40	0.70	0.80	1.35	1.58	2.00
	6M-12M	-0.40	-0.25	0.05	0.30	0.50	0.80	1.10	1.38	1.56

Figure 18: BMI velocity in terms of percentile in different age groups at different time points

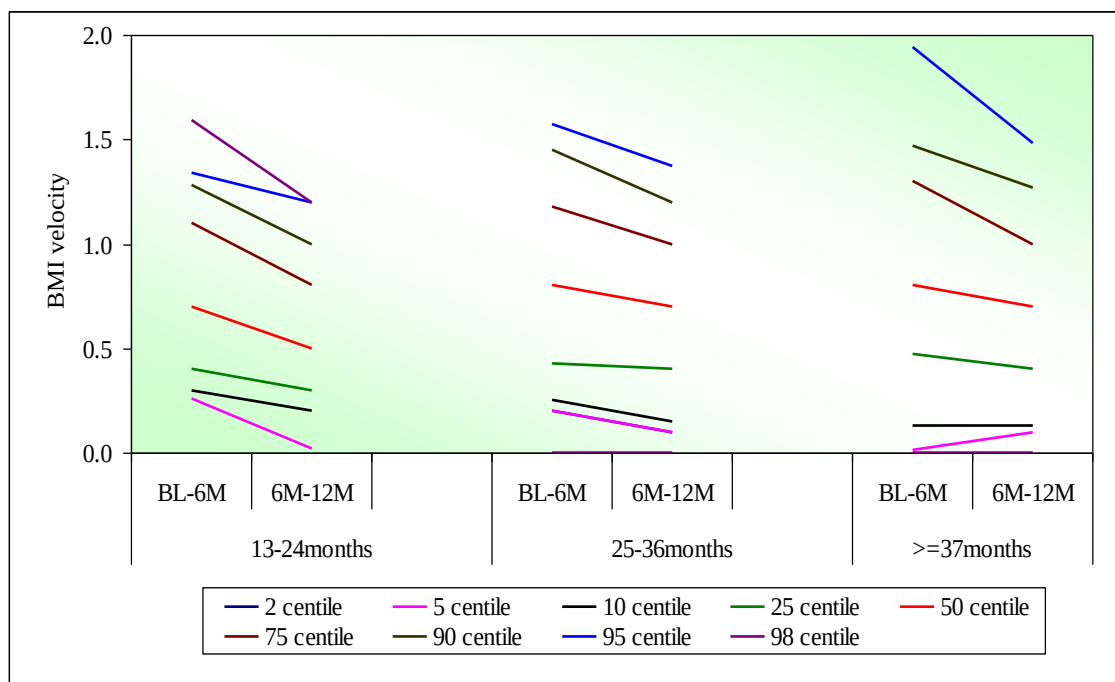


BMI velocity declined in all the age groups, except for >37 months but as the percentile increased the BMI velocity also increased.

Table 19: BMI velocity of boys in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-6M	-0.47	0.26	0.30	0.40	0.70	1.10	1.28	1.34	1.59
	6M-12M	-0.58	0.02	0.20	0.30	0.50	0.80	1.00	1.20	1.20
25-36months	BL-6M	0.20	0.20	0.25	0.43	0.80	1.18	1.45	1.58	.
	6M-12M	0.10	0.10	0.15	0.40	0.70	1.00	1.20	1.38	.
>=37months	BL-6M	-0.30	0.02	0.13	0.48	0.80	1.30	1.47	1.94	.
	6M-12M	-0.40	0.10	0.13	0.40	0.70	1.00	1.27	1.49	.

Figure 19: BMI velocity of boys in terms of percentile in different age groups at different time points

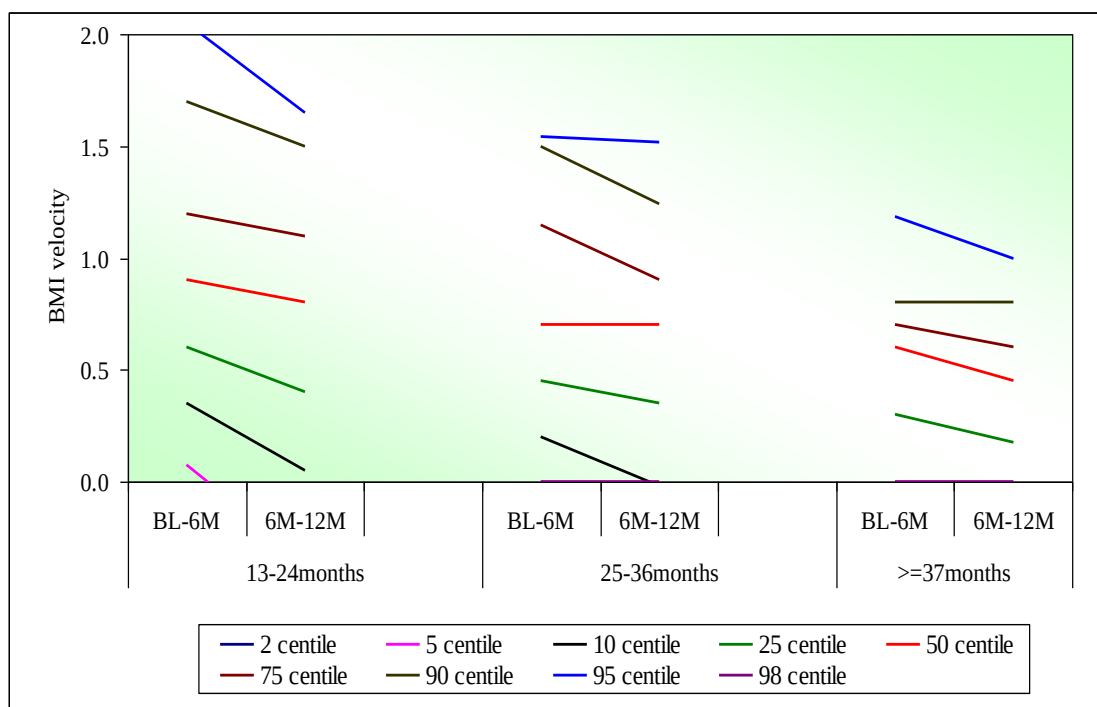


Overall there is decline in BMI velocity, in all the age groups.

Table 20: BMI velocity of girls in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-6M	-0.36	0.08	0.35	0.60	0.90	1.20	1.70	2.05	2.92
	6M-12M	-0.50	-0.35	0.05	0.40	0.80	1.10	1.50	1.65	2.52
25-36months	BL-6M	-0.90	0.00	0.20	0.45	0.70	1.15	1.50	1.54	.
	6M-12M	-1.40	-0.77	-0.02	0.35	0.70	0.90	1.24	1.52	.
>=37months	BL-6M	-0.40	-0.27	-0.04	0.30	0.60	0.70	0.80	1.19	.
	6M-12M	-0.40	-0.39	-0.10	0.18	0.45	0.60	0.80	1.00	.

Figure 20: BMI velocity of girls in terms of percentile in different age groups at different time points

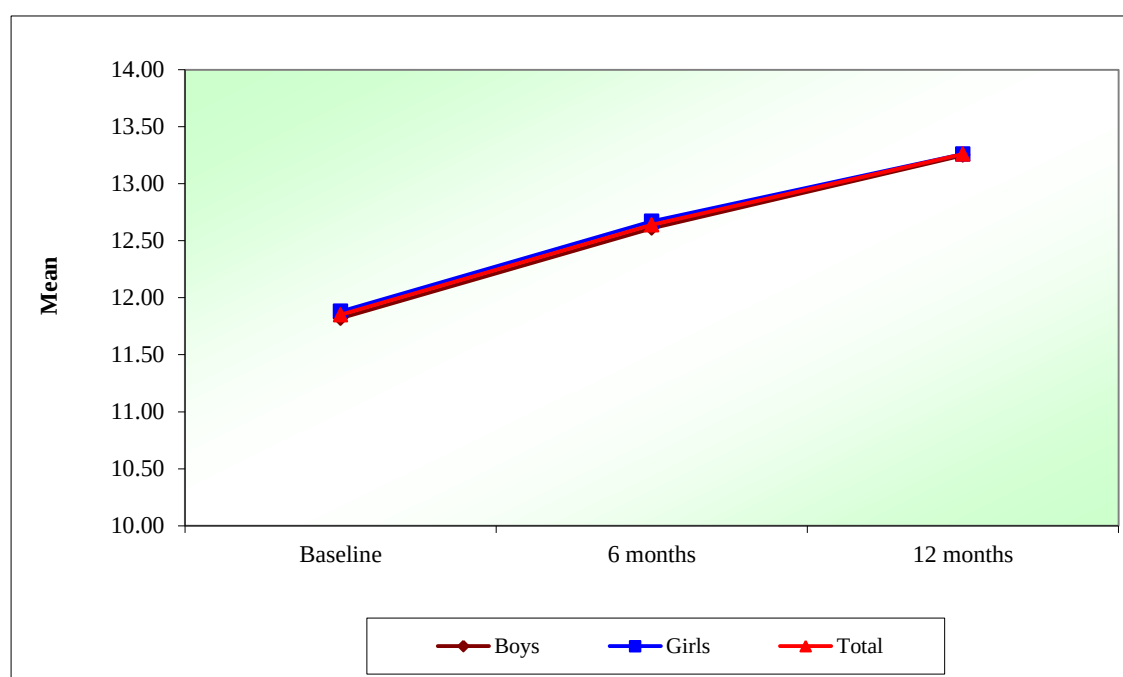


Overall there is decline in BMI velocity among all the age groups.

Table 21: Comparison of actual BMI of boys and girls at different time points

Time points	Boys		Girls		Mean Diff.	t-value	p-value	95% CI for mean Diff.	
	Mean	SD	Mean	SD				Lower	Upper
Baseline	11.82	1.62	11.88	2.03	-0.06	-0.2848	0.7760	-0.50	0.38
6 months	12.61	1.47	12.67	1.93	-0.06	-0.2646	0.7915	-0.46	0.35
12 months	13.25	1.43	13.26	1.94	-0.01	-0.0249	0.9802	-0.41	0.40

p<0.05 (independents t test)

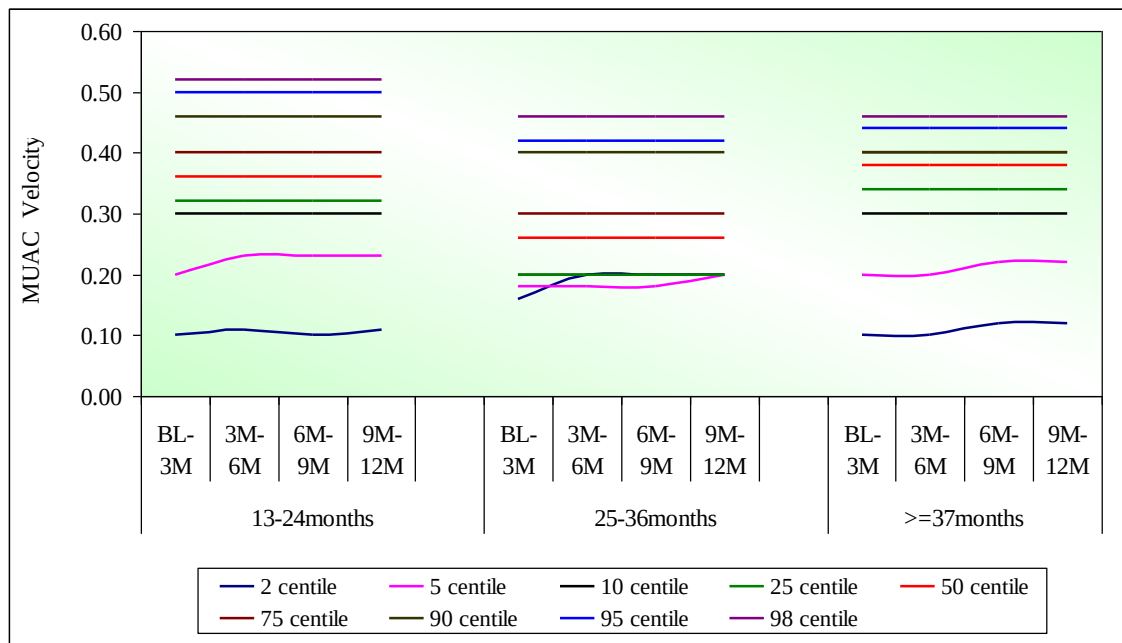
Figure 21: Comparison of actual BMI of boys and girls at different time points

In our study baseline mean BMI among boys was 11.82 kg/m² and girls 11.88 kg/m², mean difference was -0.06, at 6 months, and at 12 months mean difference was -0.01. BMI was more among girls than boys. But the difference was not statistically significant with p>0.05.

Table 22: Mid upper arm circumference velocity in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-3M	0.1	0.2	0.3	0.32	0.36	0.4	0.46	0.5	0.52
	3M-6M	0.11	0.23	0.3	0.32	0.36	0.4	0.46	0.5	0.52
	6M-9M	0.1	0.23	0.3	0.32	0.36	0.4	0.46	0.5	0.52
	9M-12M	0.11	0.23	0.3	0.32	0.36	0.4	0.46	0.5	0.52
25-36months	BL-3M	0.16	0.18	0.2	0.2	0.26	0.3	0.4	0.42	0.46
	3M-6M	0.2	0.18	0.2	0.2	0.26	0.3	0.4	0.42	0.46
	6M-9M	0.2	0.18	0.2	0.2	0.26	0.3	0.4	0.42	0.46
	9M-12M	0.2	0.2	0.2	0.2	0.26	0.3	0.4	0.42	0.46
>=37 months	BL-3M	0.1	0.2	0.3	0.34	0.38	0.4	0.4	0.44	0.46
	3M-6M	0.1	0.2	0.3	0.34	0.38	0.4	0.4	0.44	0.46
	6M-9M	0.12	0.22	0.3	0.34	0.38	0.4	0.4	0.44	0.46
	9M-12M	0.12	0.22	0.3	0.34	38	0.4	0.4	0.44	0.46

Figure 22: Mid upper arm circumference velocity in terms of percentile in different age groups at different time points

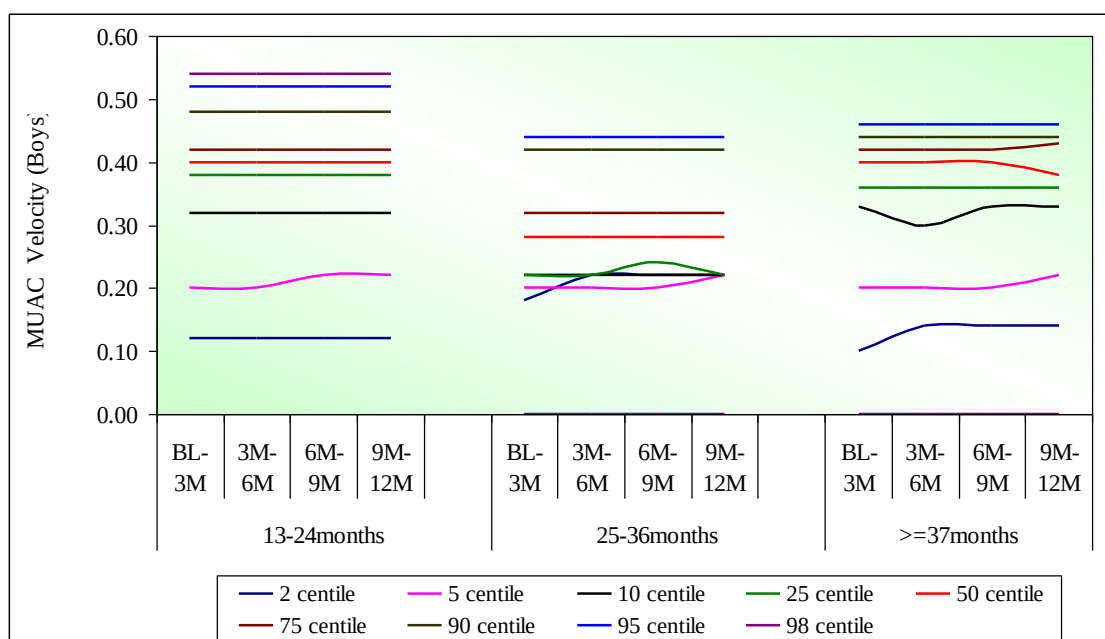


As the percentile increased MUAC also increased in all the 3 age groups. Between the 4 quarters velocity remained almost same except for 2nd and 5th percentile where there was slight increase.

Table 23: Mid upper arm circumference velocity of boys in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-3M	0.12	0.2	0.32	0.38	0.4	0.42	0.48	0.52	0.54
	3M-6M	0.12	0.2	0.32	0.38	0.4	0.42	0.48	0.52	0.54
	6M-9M	0.12	0.22	0.32	0.38	0.4	0.42	0.48	0.52	0.54
	9M-12M	0.12	0.22	0.32	0.38	0.4	0.42	0.48	0.52	0.54
25-36months	BL-3M	0.18	0.2	0.22	0.22	0.28	0.32	0.42	0.44	.
	3M-6M	0.22	0.2	0.22	0.22	0.28	0.32	0.42	0.44	.
	6M-9M	0.22	0.2	0.22	0.24	0.28	0.32	0.42	0.44	.
	9M-12M	0.22	0.22	0.22	0.22	0.28	0.32	0.42	0.44	.
≥37 months	BL-3M	0.1	0.2	0.33	0.36	0.4	0.42	0.44	0.46	.
	3M-6M	0.14	0.2	0.3	0.36	0.4	0.42	0.44	0.46	.
	6M-9M	0.14	0.2	0.33	0.36	0.4	0.42	0.44	0.46	.
	9M-12M	0.14	0.22	0.33	0.36	0.4	0.43	0.44	0.46	.

Figure 23: Mid upper arm circumference velocity of boys in terms of percentile in different age groups at different time points

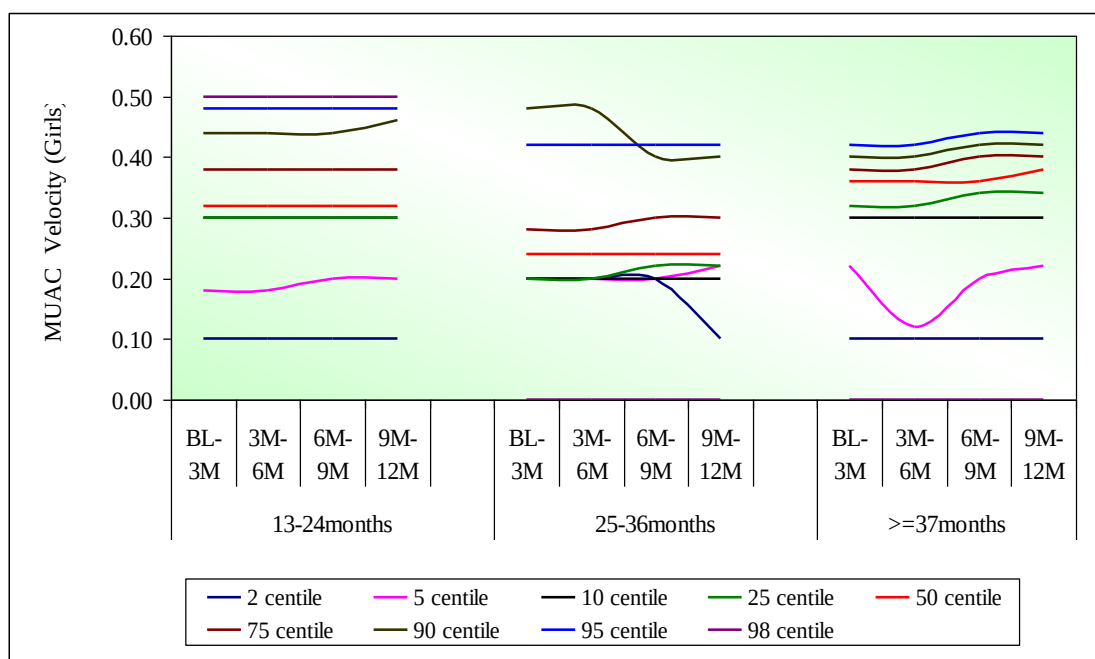


During 2nd quarter among 13-24 months there was increased velocity among 5th percentile. Otherwise remained constant in 25- 36 months except for 2nd and 5th percentile it's was constant. Among ≥37 months change was observed at 10th, 5th and 2nd percentile and 50th percentile.

Table 24: Mid upper arm circumference velocity of girls in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-3M	0.1	0.18	0.3	0.3	0.32	0.38	0.44	0.48	0.5
	3M-6M	0.1	0.18	0.3	0.3	0.32	0.38	0.44	0.48	0.5
	6M-9M	0.1	0.2	0.3	0.3	0.32	0.38	0.44	0.48	0.5
	9M-12M	0.1	0.2	0.3	0.3	0.32	0.38	0.46	0.48	0.5
25-36months	BL-3M	0.2	0.2	0.2	0.2	0.24	0.28	0.48	0.42	.
	3M-6M	0.2	0.2	0.2	0.2	0.24	0.28	0.48	0.42	.
	6M-9M	0.2	0.2	0.2	0.22	0.24	0.3	0.4	0.42	.
	9M-12M	0.1	0.22	0.2	0.22	0.24	0.3	0.4	0.42	.
≥ 37 months	BL-3M	0.1	0.22	0.3	0.32	0.36	0.38	0.4	0.42	.
	3M-6M	0.1	0.12	0.3	0.32	0.36	0.38	0.4	0.42	.
	6M-9M	0.1	0.2	0.3	0.34	0.36	0.4	0.42	0.44	.
	9M-12M	0.1	0.22	0.3	0.34	0.36	0.4	0.42	0.44	.

Figure 24: Mid upper arm circumference velocity of girls in terms of percentile in different age groups at different time points

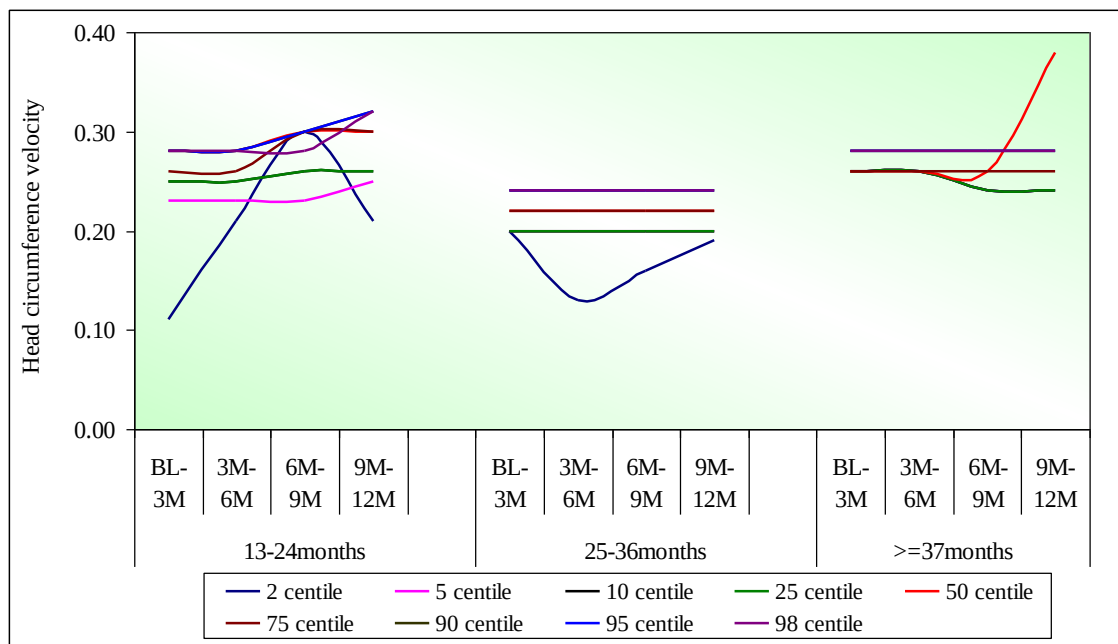


During 2nd quarter mid upper arm circumference velocity increased in 13-24 months. Remained constant in 25-36 and ≥ 37 months group except for 2nd, 5th and 90th percentile.

Table 25: Head circumference velocity in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-3M	0.11	0.23	0.25	0.25	0.28	0.26	0.28	0.28	0.28
	3M-6M	0.21	0.23	0.25	0.25	0.28	0.26	0.28	0.28	0.28
	6M-9M	0.3	0.23	0.26	0.26	0.3	0.3	0.3	0.3	0.28
	9M-12M	0.21	0.25	0.26	0.26	0.3	0.3	0.32	0.32	0.32
25-36months	BL-3M	0.2	0.2	0.2	0.2	0.22	0.22	0.24	0.24	0.24
	3M-6M	0.13	0.2	0.2	0.2	0.22	0.22	0.24	0.24	0.24
	6M-9M	0.16	0.2	0.2	0.2	0.22	0.22	0.24	0.24	0.24
	9M-12M	-0.19	0.2	0.2	0.2	0.22	0.22	0.24	0.24	0.24
>=37months	BL-3M	0.26	0.26	0.26	0.26	0.26	0.26	0.28	0.28	0.28
	3M-6M	0.26	0.26	0.26	0.26	0.26	0.26	0.28	0.28	0.28
	6M-9M	0.24	0.24	0.24	0.24	0.26	0.26	0.28	0.28	0.28
	9M-12M	0.24	0.24	0.24	0.24	0.26	0.26	0.28	0.28	0.28

Figure 25: Head circumference velocity in terms of percentile in different age groups at different time points

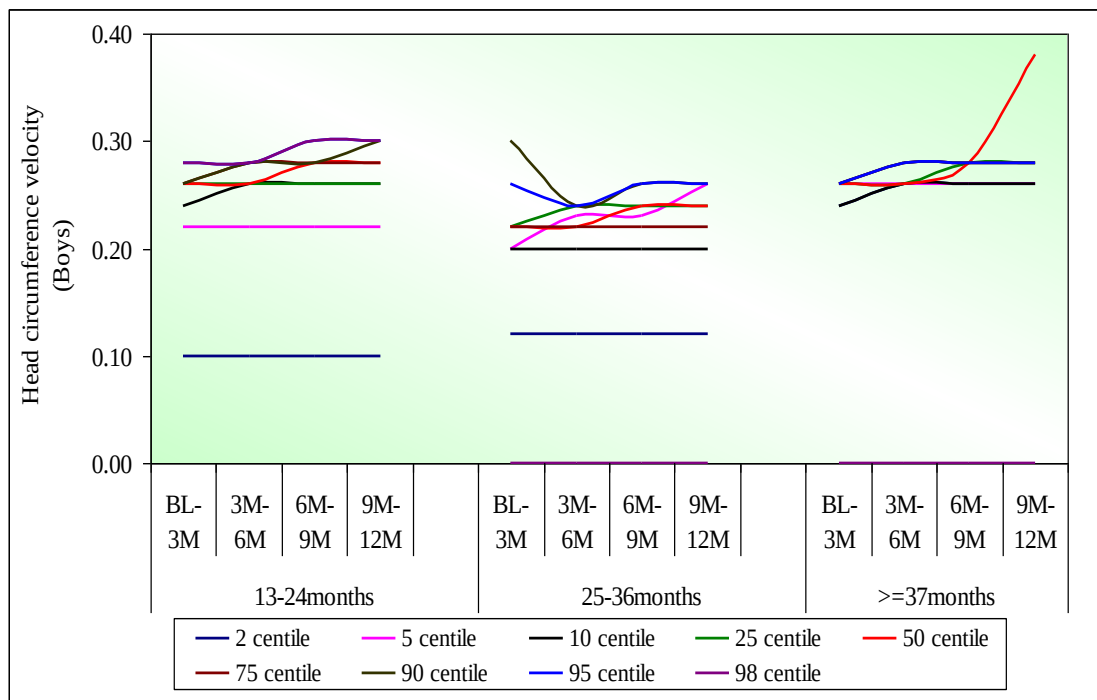


Velocity of Head circumference increased in 2nd and 3rd quarters among children aged between 13-24 months, in 25-36 months and ≥ 37 months its remained constant except for 10th percentile and 25th percentile.

Table 26: Head circumference velocity of boys in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24months	BL-3M	0.1	0.22	0.24	0.26	0.26	0.26	0.26	0.28	0.28
	3M-6M	0.1	0.22	0.26	0.26	0.26	0.28	0.28	0.28	0.28
	6M-9M	0.1	0.22	0.26	0.26	0.28	0.28	0.28	0.3	0.3
	9M-12M	0.1	0.22	0.26	0.26	0.28	0.28	0.3	0.3	0.3
25-36months	BL-3M	0.12	0.2	0.2	0.22	0.22	0.22	0.3	0.26	.
	3M-6M	0.12	0.23	0.2	0.24	0.22	0.22	0.24	0.24	.
	6M-9M	0.12	0.23	0.2	0.24	0.24	0.22	0.26	0.26	.
	9M-12M	0.12	0.26	0.2	0.24	0.24	0.22	0.26	0.26	.
>=37months	BL-3M	0.24	0.26	0.24	0.26	0.26	0.26	0.26	0.26	.
	3M-6M	0.26	0.26	0.26	0.26	0.26	0.28	0.28	0.28	.
	6M-9M	0.26	0.26	0.26	0.28	0.28	0.28	0.28	0.28	.
	9M-12M	0.26	0.26	0.26	0.28	0.28	0.28	0.28	0.28	.

Figure 26: Head circumference velocity of boys in terms of percentile in different age groups at different time points

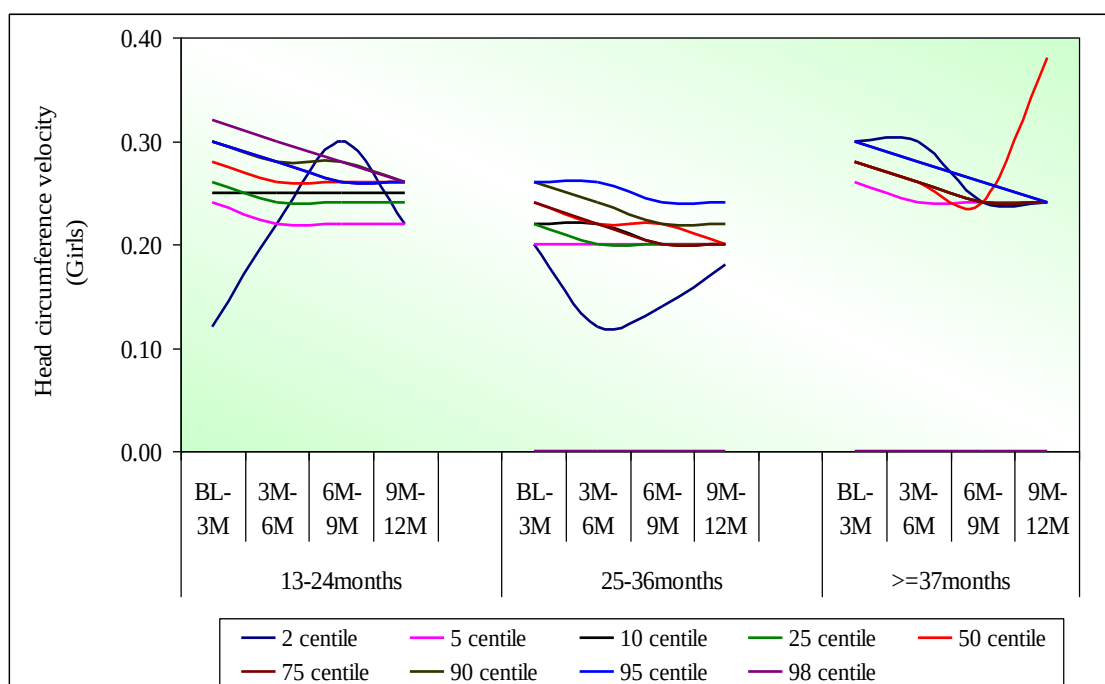


As the percentile increased head velocity increased in all the age groups.

Table 27: Head circumference velocity of girls in terms of percentile in different age groups at different time points

Age groups	Changes from	2 centile	5 centile	10 centile	25 centile	50 centile	75 centile	90 centile	95 centile	98 centile
13-24 months	BL-3M	0.12	0.24	0.25	0.26	0.28	0.3	0.3	0.3	0.32
	3M-6M	0.22	0.22	0.25	0.24	0.26	0.28	0.28	0.28	0.3
	6M-9M	0.3	0.22	0.25	0.24	0.26	0.26	0.28	0.26	0.28
	9M-12M	0.22	0.22	0.25	0.24	0.26	0.26	0.26	0.26	0.26
25-36 months	BL-3M	0.2	0.2	0.22	0.22	0.24	0.24	0.26	0.26	.
	3M-6M	0.12	0.2	0.22	0.2	0.22	0.22	0.24	0.26	.
	6M-9M	0.14	0.2	0.2	0.2	0.22	0.2	0.22	0.24	.
	9M-12M	0.18	0.2	0.2	0.2	0.2	0.2	0.22	0.24	.
>=37 months	BL-3M	0.3	0.26	0.28	0.28	0.28	0.28	0.3	0.3	.
	3M-6M	0.3	0.24	0.26	0.26	0.26	0.26	0.28	0.28	.
	6M-9M	0.24	0.24	0.24	0.24	0.24	0.24	0.26	0.26	.
	9M-12M	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	.

Figure 27: Head circumference velocity of girls in terms of percentile in different age groups at different time points



As the percentile increased head velocity increased in all the age groups except for 2nd percentile.

Table 28: Comparison of growth velocity scores of boys and girls from baseline to 12 months

Parameters	Velocity	Boys		Girls		Total		t-value	p-value
		Mean	SD	Mean	SD	Mean	SD		
Weight	BL-3M	0.64	0.19	0.61	0.19	0.63	0.19	1.1987	0.2317
	3M-6M	0.64	0.19	0.61	0.20	0.63	0.20	1.2591	0.2091
	6M-9M	0.64	0.19	0.61	0.20	0.63	0.19	1.1964	0.2326
	9M-12M	0.59	0.21	0.53	0.24	0.56	0.23	2.1501	0.0324
Height	BL-3M	1.33	0.45	1.31	0.61	1.32	0.53	0.3221	0.7476
	3M-6M	1.33	0.44	1.31	0.60	1.32	0.53	0.2931	0.7697
	6M-9M	1.33	0.45	1.29	0.62	1.31	0.54	0.6559	0.5124
	9M-12M	1.25	0.53	1.31	0.88	1.28	0.72	-0.6734	0.5013
BMI	BL-6M	0.79	0.46	0.78	0.54	0.79	0.50	0.1416	0.8875
	6M-12M	0.64	0.39	0.59	0.53	0.62	0.47	0.8785	0.3804

Velocity for weight, height and BMI was more among boys. but the difference was not statistically significant. Height velocity declined among boys in last quarter as compared to girls but not statistically significant

Table 29a: Comparison of growth velocity scores among different age groups from baseline to 12 months

Parameters	Velocity	13-24months		25-36months		>=37months		F-value	p-value
		Mean	SD	Mean	SD	Mean	SD		
Weight	BL-3M	0.60	0.18	0.64	0.18	0.65	0.21	2.3264	0.0996
	3M-6M	0.60	0.18	0.64	0.19	0.66	0.22	1.8745	0.1555
	6M-9M	0.59	0.18	0.64	0.18	0.65	0.21	2.7707	0.0644
	9M-12M	0.52	0.19	0.56	0.22	0.60	0.27	2.7231	0.0675
Height	BL-3M	1.34	0.56	1.24	0.63	1.38	0.35	1.4941	0.2263
	3M-6M	1.34	0.55	1.23	0.63	1.37	0.35	1.7136	0.1822
	6M-9M	1.34	0.58	1.24	0.63	1.35	0.37	1.1828	0.3080
	9M-12M	1.31	0.69	1.19	0.96	1.32	0.43	0.9530	0.3869
BMI	BL-6M	0.86	0.51	0.79	0.50	0.68	0.48	3.1446	0.0447*
	6M-12M	0.65	0.48	0.65	0.48	0.56	0.44	1.0556	0.3494

*p<0.05 (one way ANOVA)

Weight velocity was more in children who were 37 months and above followed by 25-36 month and least was in 13-24 months but statically not significant. Height velocity was more among children aged 37 months and above as compared to children aged 13-24 and 25-36 months difference was not statistically significant. BMI velocity was more from baseline to 6 months in 13-24 months.

Table 29b: Comparison of weight for age velocity with other growth velocity scores among malnourished and well-nourished participants from baseline to 12 months

Parameters	Velocity	<3		-2 to 2		>3		F-value	p-value
		Mean	SD	Mean	SD	Mean	SD		
Weight	BL-3M	0.78	0.20	0.60	0.17	0.64	0.21	15.2214	0.0001*
	3M-6M	0.78	0.20	0.60	0.17	0.65	0.22	14.9194	0.0001*
	6M-9M	0.78	0.20	0.60	0.17	0.63	0.21	14.6153	0.0001*
	9M-12M	0.69	0.18	0.53	0.22	0.57	0.24	7.8793	0.0005*
Height	BL-3M	1.50	0.98	1.29	0.43	1.31	0.43	2.1940	0.1135
	3M-6M	1.50	0.98	1.29	0.42	1.29	0.43	2.3561	0.0968
	6M-9M	1.50	0.98	1.29	0.44	1.27	0.46	2.3120	0.1010
	9M-12M	1.53	1.48	1.21	0.50	1.38	0.61	3.5189	0.0310*
BMI	BL-6M	1.20	0.60	0.69	0.42	0.89	0.54	18.4676	0.0001*
	6M-12M	0.95	0.57	0.55	0.40	0.67	0.52	11.8853	0.0001*

***p<0.05 (One way ANOVA)**

Table 29c: Comparison of height-for-age with other growth velocity scores among malnourished and well-nourished study participants from baseline to 12 months

Parameters	Velocity	<3		-2 to 2		>3		F-value	p-value
		Mean	SD	Mean	SD	Mean	SD		
Weight	BL-3M	0.65	0.30	0.63	0.19	0.52	0.17	2.0019	0.1371
	3M-6M	0.65	0.30	0.63	0.19	0.52	0.17	2.0427	0.1317
	6M-9M	0.65	0.30	0.63	0.19	0.52	0.17	1.9698	0.1415
	9M-12M	0.53	0.31	0.56	0.23	0.44	0.21	1.9125	0.1497
Height	BL-3M	1.15	0.24	1.33	0.54	1.26	0.44	0.3050	0.7373
	3M-6M	1.13	0.22	1.32	0.53	1.26	0.44	0.3521	0.7035
	6M-9M	1.08	0.22	1.32	0.55	1.26	0.44	0.4621	0.6305
	9M-12M	1.15	0.31	1.29	0.74	1.15	0.46	0.2979	0.7426
BMI	BL-6M	1.27	1.01	0.79	0.47	0.63	0.70	2.5656	0.0788
	6M-12M	0.97	0.94	0.62	0.45	0.45	0.65	2.0396	0.1321

(One way ANOVA)

Table 29d: Comparison of BMI status with other growth velocity scores among malnourished and well-nourished study participants from baseline to 12 months

Parameters	Velocity	<3		-2 to 2		>3		F-value	p-value
		Mean	SD	Mean	SD	Mean	SD		
Weight	BL-3M	0.69	0.20	0.53	0.14	0.55	0.15	24.0532	0.0001*
	3M-6M	0.69	0.20	0.53	0.14	0.55	0.15	24.9597	0.0001*
	6M-9M	0.69	0.20	0.53	0.14	0.55	0.15	22.9660	0.0001*
	9M-12M	0.63	0.22	0.43	0.22	0.48	0.17	24.1933	0.0001*
Height	BL-3M	1.37	0.61	1.22	0.31	1.30	0.46	1.8212	0.1638
	3M-6M	1.36	0.60	1.22	0.30	1.29	0.47	1.8501	0.1592
	6M-9M	1.36	0.62	1.20	0.32	1.31	0.47	1.9508	0.1442
	9M-12M	1.36	0.85	1.12	0.35	1.20	0.60	2.8376	0.0603
BMI	BL-6M	0.94	0.52	0.57	0.34	0.59	0.43	19.5154	0.0001*
	6M-12M	0.76	0.48	0.41	0.38	0.45	0.37	18.6798	0.0001*

***p<0.05 (One way ANOVA)**

Table 29b -29d -Weight for age velocity was better among malnourished children weight for age, height for age, BMI velocity was better among malnourished as compared to well-nourished only weight difference was significant and in all the time points height velocity in last quarter, BMI at baseline to 6 months and 12 months.

Table 29e: Comparison of mean weight at different time points among malnourished and nourished participants

				Malnourished vs. Nourished	Nourished vs. Over nourished	Malnourished vs Over nourished
WFA		Mean	SD	Mean Difference (p-value)	Mean Difference (p-value)	Mean Difference (p-value)
	Weight					
3M - B	Malnourished	0.70	0.22	0.11 p<0.001*	0.03 p= 0.719	0.08 p= 0.209
	Nourished	0.59	0.18			
	Over nourished	0.62	0.12			
6M - 3M	Malnourished	0.71	0.22	0.12 p<0.001*	0.036 p=0.669	0.08 p= 0.187
	Nourished	0.59	0.18			
	Over nourished	0.63	0.13			
9M- 6M	Malnourished	0.70	0.22	0.10 p<0.001*	0.04 p= 0.682	0.07 p=0.29
	Nourished	0.59	0.18			
	Over nourished	0.63	0.12			
12M - 9M	Malnourished	0.62	0.22	0.10 p= 0.005*	0.04 p=0.644	0.05 p= 0.644
	Nourished	0.52	0.23			
	Over nourished	0.57	0.15			
Total wt gain	Malnourished	2.73	0.86	0.43 p<0.001 *	0.15 p=0.647	0.28 p=0.266
	Nourished	2.30	0.72			
	Over nourished	2.45	0.49			

(Scheffe's multiple post-hoc procedure)

There was a significant difference in mean changes between Malnourished and Nourished groups across all time intervals. Between all the time intervals mean difference of Malnourished was higher than nourished , indicating increase in weight

over the time periods was significantly higher in Malnutrition than in Nourished (with $p < 0.05$). However there was no significant mean difference among (Nourished and Over nourished) and (Over nourished and Malnourished).

Table 29f: Comparison of mean height at different time points among malnourished and nourished participants

				Stunted vs Normal	Stunted vs Tall	Normal vs Tall
HFA	Height	Mean	SD	Mean Difference (p-value)	Mean Difference (p-value)	Mean Difference (p-value)
3M - B	Stunted	1.235	0.397	-0.108 p=0.729	-0.061 p=0.91	0.046 p=0.729
	Normal	1.343	0.599			
	Tall	1.297	0.398			
6M - 3M	Stunted	1.23	0.40	0.11 p=0.714	0.06 p=0.912	0.04 p=0.774
	Normal	1.34	0.60			
	Tall	1.29	0.38			
9M- 6M	Stunted	1.22	0.40	0.11 p=0.997	1.081 p=0.8	1.19 p=0.336
	Normal	1.33	0.60			
	Tall	0.14	10.77			
12M - 9M	Stunted	1.15	0.42	0.15 p=0.995	1.27 p=0.737	1.12 p=0.388
	Normal	1.30	0.82			
	Tall	2.42	10.82			
Total increase in Height	Stunted	4.83	1.59	0.485 p=0.7	0.314 p=0.871	0.17 p=0.85
	Normal	5.31	2.58			
	Tall	5.14	1.57			

(Scheffe's multiple post-hoc procedure)

There was no significant difference in mean changes in growth velocity and actual increase in height between the groups across at all time intervals with $p > 0.05$

Table 29g: Comparison of mean BMI at different time points among malnourished and nourished participants

	BMI	Mean velocity	SD	Median velocity	Mean Rank	Z	p-value
3M – B	Malnourished	0.44	0.27	0.41	146.24	-4.14	<0.001*** ^{MW}
	Nourished or Over nourished	0.29	0.18	0.30	99.48		
6M - 3M	Malnourished	0.41	0.26	0.39		5.16	<0.001*** T-test
	Nourished or Over nourished	0.27	0.16	0.28			
9M - 6M	Malnourished	0.38	0.25	0.36	145.3	-3.78	<0.001*** ^{MW}
	Nourished or Over nourished	0.26	0.15	0.26	102.61		
12M - 9M	Malnourished	0.30	0.26	0.29	145.26	-3.76	<0.001*** ^{MW}
	Nourished or Over nourished	0.15	0.27	0.18	102.74		
	Nourished or Over nourished	0.83	0.49	0.85	100.23		

(MW: Mann-Whitney U test)

Over the observed time intervals, the malnourished children exhibited a greater BMI gain than the nourished or over nourished group.

The mean rank for BMI change in the malnourished group was higher as compared to nourished or over nourished between all-time intervals.

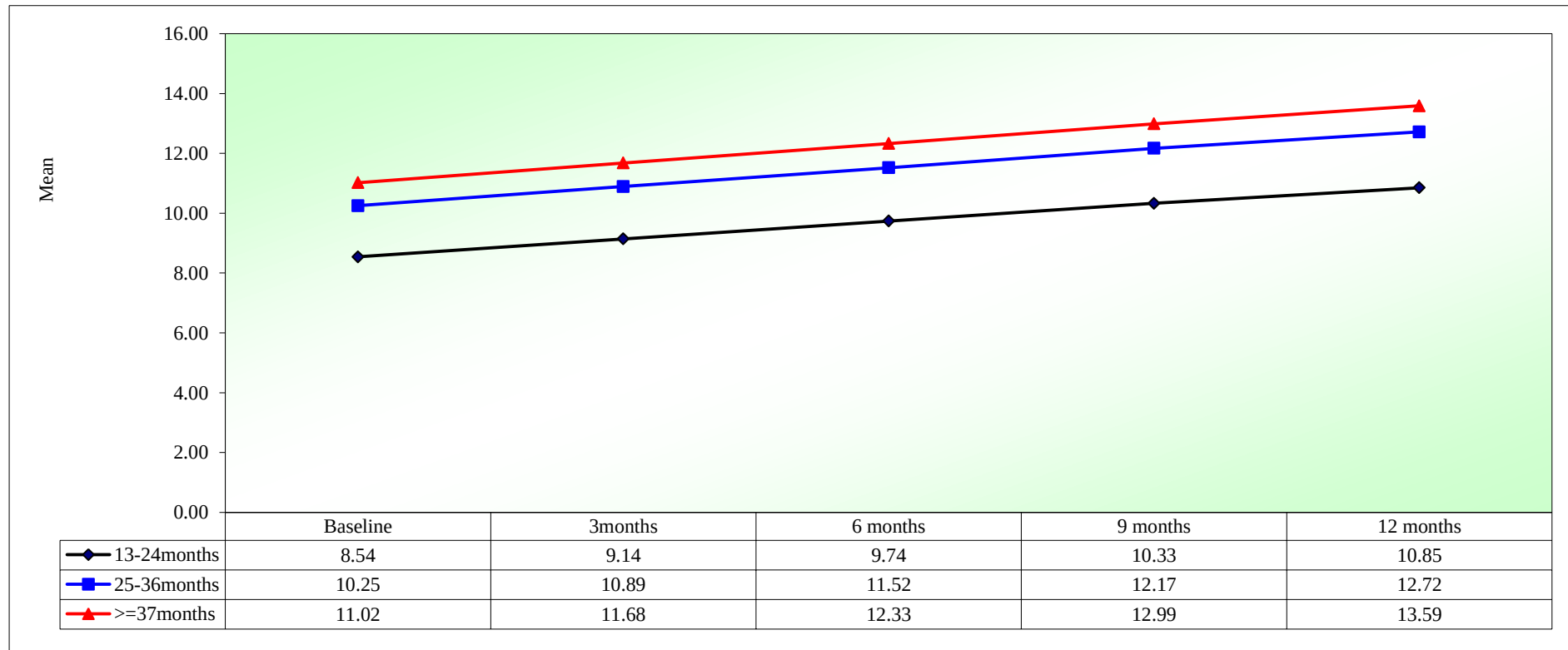
The Mann-Whitney U test revealed a statistically significant difference in BMI changes between the groups with $p < 0.001^{***}$ at each time interval.

Table 30: Comparison of actual weight among different age groups at different time

Time points	13-24months		25-36months		>=37months		F-value	p-value	Pair comparison by Tukeys posthoc		
	Mean	SD	Mean	SD	Mean	SD			13-24 vs 25-36	13-24 vs >=37	25-36 vs >=37
Baseline	8.54	1.24	10.25	1.53	11.02	1.63	72.5725	0.0001*	p=0.0001*	p=0.0001*	p=0.0020*
3months	9.14	1.22	10.89	1.51	11.68	1.56	79.7755	0.0001*	p=0.0001*	p=0.0001*	p=0.0010*
6 months	9.74	1.22	11.52	1.51	12.33	1.53	84.3497	0.0001*	p=0.0001*	p=0.0001*	p=0.0010*
9 months	10.33	1.26	12.17	1.54	12.99	1.53	86.2795	0.0001*	p=0.0001*	p=0.0001*	p=0.0010*
12 months	10.85	1.30	12.72	1.59	13.59	1.59	84.6432	0.0001*	p=0.0001*	p=0.0001*	p=0.0010*

*p<0.05 (one way ANOVA)

Figure 28: Comparison of actual weight among different age groups at different time



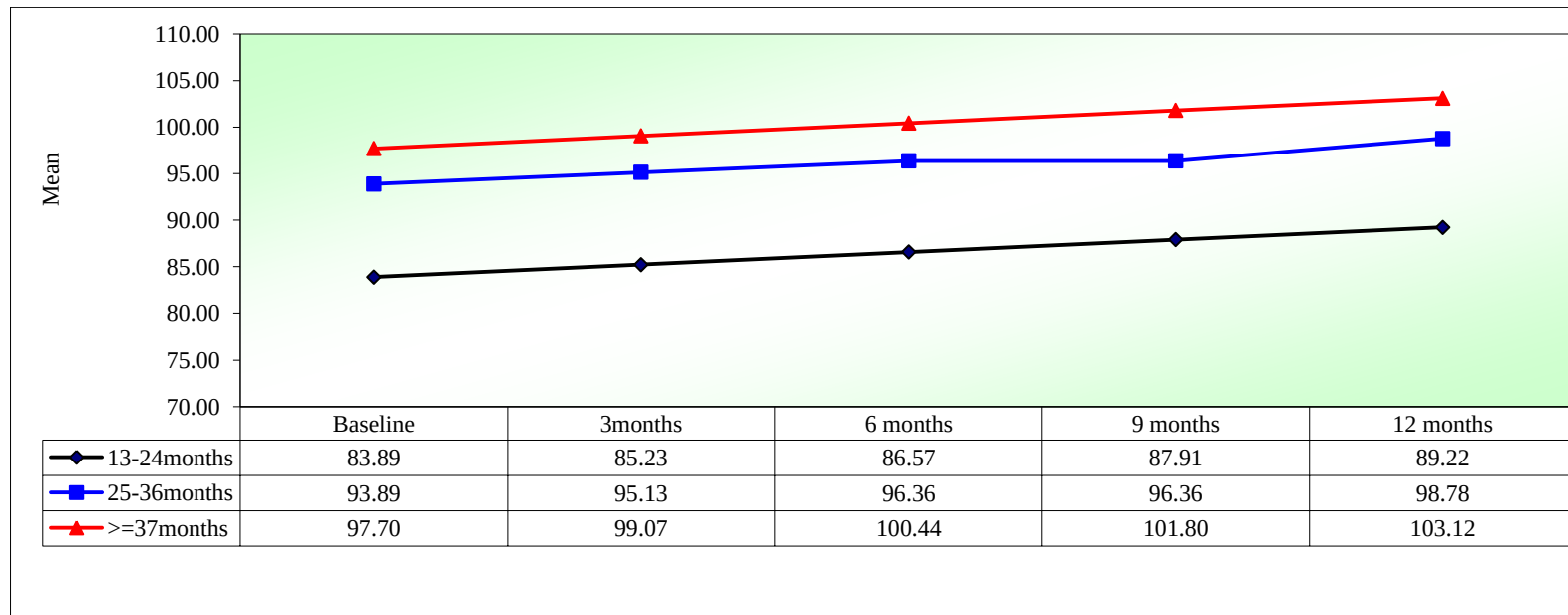
There is gain in weight in all the 3 groups from baseline to 1 year. The difference of weight at baseline, 3 months, 6 months, 9 months and 12 months significant difference with $p < 0.05$. Weight gain between 13-24 months, 25-36 months and ≥ 37 months is statistically significant.

Table 31: Comparison of actual height among different age groups at different time

Time points	13-24months		25-36months		>=37months		F-value	p-value	Pair comparison by Tukeys posthoc		
	Mean	SD	Mean	SD	Mean	SD			13-24 vs 25-36	13-24 vs >=37	25-36 vs >=37
Baseline	83.89	5.87	93.89	6.10	97.70	6.30	132.0416	0.0001*	p=0.0001*	p=0.0001*	p=0.0001*
3months	85.23	5.95	95.13	6.11	99.07	6.35	129.6323	0.0001*	p=0.0001*	p=0.0001*	p=0.0001*
6 months	86.57	6.09	96.36	6.20	100.44	6.42	125.4062	0.0001*	p=0.0001*	p=0.0001*	p=0.0001*
9 months	87.91	6.28	96.36	11.89	101.80	6.53	65.4845	0.0001*	p=0.0001*	p=0.0001*	p=0.0001*
12 months	89.22	6.50	98.78	6.62	103.12	6.67	111.2314	0.0001*	p=0.0001*	p=0.0001*	p=0.0001*

*p<0.05 (one way ANOVA)

Figure 29: Comparison of actual height among different age groups at different time



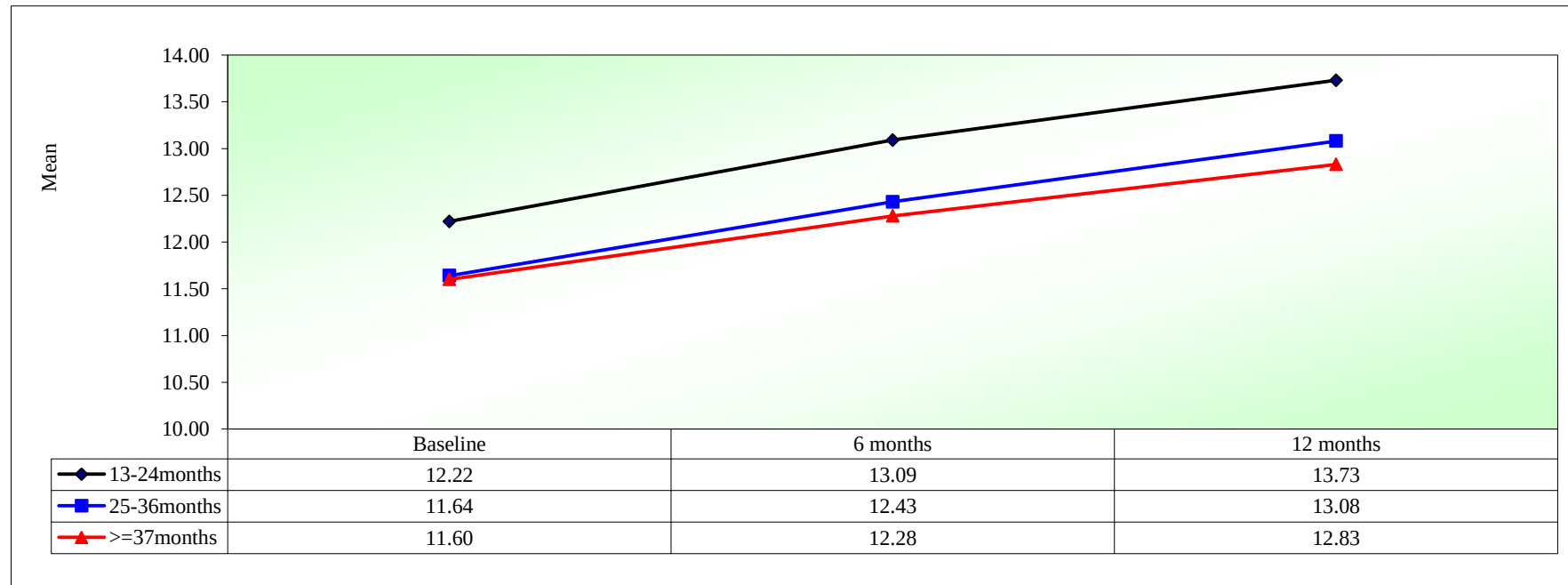
Mean height at 13-24 months , 25-36 months and ≥ 37 months was 83.89 in the beginning, 93.89 and 97.70, at 3 month was 85.23, 95.13 and 99.07, at 6 months was 86.57, 96.36 and 100.44, at 9 months 87.91, 96.36 and 101.80 and at the 12 months 89.22, 98.78 and 103.12 and this was statically significant with $p < 0.05$. And Tukeys posthoc test shows that the significant difference between 13-24 months vs 25-36 months, 13-24 months vs ≥ 37 months and 25-36 months vs ≥ 37 months is statistically significant. But the mean increase in total height is 5.46 cm more than 37 months, 4.89cm in 25-36 months and 5.33cm in 13-24 months.

Table 32: Comparison of actual BMI among different age groups at different time

Time points	13-24months		25-36months		>=37months		F-value	p-value	Pair comparison by Tukeys posthoc		
	Mean	SD	Mean	SD	Mean	SD			13-24 vs 25-36	13-24 vs >=37	25-36 vs >=37
Baseline	12.22	2.06	11.64	1.51	11.60	1.76	3.5813	0.0292*	p=0.0750	p=0.0490*	p=0.9890
6 months	13.09	1.93	12.43	1.38	12.28	1.59	6.3261	0.0021*	p=0.0240*	p=0.0030*	p=0.8340
12 months	13.73	1.91	13.08	1.40	12.83	1.56	7.5100	0.0007*	p=0.0210*	p=0.0010*	p=0.6350

*p<0.05 (one way ANOVA)

Figure 30: Comparison of actual BMI among different age groups at different time



Mean BMI at 13-24 months , 25-36 months and ≥ 37 months was 12.22 in the beginning, 11.64 and 11.60, at 6 months was 13.09, 12.43 and 12.28 and at 12 months 13.73, 13.08 and 12.83 this was statistically significant with $p < 0.05$. And Tukeys posthoc test shows that the significant difference between 13-24 months vs 25-36 months, 13-24 months vs ≥ 37 months and 25-36 months vs ≥ 37 months is statistically significant. But the mean increase in total BMI is 1.23 more than 37 months followed by 1.44 in 25-36 months and 1.51 in 13-24 months.

Section III- Tables showing association/ correlation between growth velocity and diet, socioeconomic, environmental variables and parent's anthropometry

Table 33: Association between Growth velocity (Height, Weight & BMI) and Exclusive Breast Feeding (N=270)

Parameter	Exclusive Breast Feeding (Mean± SD)		P value (IST)
	<6 months (N=236)	Up to months 6 (N=34)	
Weight velocity (/month)	0.33 ± 0.01	0.33 ± 0.04	0.006
Height velocity (/month)	0.33 ± 0.003	0.33 ± 0	0.705
BMI velocity (/month)	0.26 ± 0.05	0.26 ± 0.05	0.507

Weight velocity per month was more among children who received exclusive breast feeding up to 6 months as compared to those who received <6 months the difference was statistically significant with $p < 0.05$. There was no significant difference for height and BMI velocity with duration of exclusive breast feeding.

Table 34: Association between DDS with WAZ, HAZ, BMI Z score at different time point

N status	Time points	Baseline DDS						Chi-square	p-value
		Poor	%	Medium	%	Total	%		
Weight-for-age	Baseline								
	Under nourished	76	95.00	4	5.00	80	29.63	0.0670	0.7960
	Normal	179	94.21	11	5.79	190	70.37		
	6 months								
	Under nourished	72	94.74	4	5.26	76	28.15	0.0170	0.8960
	Normal	183	94.33	11	5.67	194	71.85		
	12 months								
	Under nourished	60	96.77	2	3.23	62	22.96	0.8330	0.3620
	Normal	195	93.75	13	6.25	208	77.04		
Height-for-age	Baseline								
	Stunted	17	100.00	0	0.00	17	6.30	3.5210	0.1720
	Normal	206	93.21	15	6.79	221	81.85		
	Tall	32	100.00	0	0.00	32	11.85		
	6 months								
	Stunted	25	100.00	0	0.00	25	9.26	2.2110	0.3310
	Normal	222	93.67	15	6.33	237	87.78		
	Tall	8	100.00	0	0.00	8	2.96		
	12 months								
	Stunted	38	100.00	0	0.00	38	14.07	3.0090	0.2220
	Normal	212	93.39	15	6.61	227	84.07		
	Tall	5	100.00	0	0.00	5	1.85		
BMI status	Baseline								
	Thin	195	93.75	13	6.25	208	77.04	0.8530	0.6530
	Normal	59	96.72	2	3.28	61	22.59		
	Over weight	1	100.00	0	0.00	1	0.37		
	6 months								
	Thin	145	92.95	11	7.05	156	57.78	1.5990	0.4500
	Normal	109	96.46	4	3.54	113	41.85		
	Over weight	1	100.00	0	0.00	1	0.37		
	12 months								
	Thin	99	94.29	6	5.71	105	38.89	0.0650	0.9680
	Normal	155	94.51	9	5.49	164	60.74		
	Over weight	1	100.00	0	0.00	1	0.37		
	Total	255	94.44	15	5.56	270	100.00		

There was no significant association between DDS with weight-for-age, height-for-age and BMI at different time point.

Table 35: Correlation between weight scores with DDS, FVS and DSS at baseline, 6 months and 9 months' time points

Variables	Time points	Summery	Weight scores at				
			Baseline	3 month	6 months	9 months	12 months
DDS	Baseline	r-value	0.1142	0.1235	0.1300	0.1361	0.1401
		p-value	0.0610	0.0430*	0.0330*	0.0250*	0.0210*
	6 months	r-value	0.0843	0.0838	0.0828	0.0809	0.0807
		p-value	0.1670	0.1700	0.1750	0.1850	0.1860
	12 months	r-value	0.0521	0.0475	0.0436	0.0383	0.0340
		p-value	0.3930	0.4370	0.4760	0.5310	0.5780
FVS	Baseline	r-value	0.1004	0.1062	0.1102	0.1134	0.1156
		p-value	0.1000	0.0820	0.0710	0.0630	0.0580
	6 months	r-value	0.0421	0.0382	0.0332	0.0291	0.0208
		p-value	0.4910	0.5320	0.5870	0.6340	0.7340
	12 months	r-value	0.0122	0.0042	-0.0049	-0.0123	-0.0258
		p-value	0.8420	0.9450	0.9350	0.8410	0.6720
DSS	Baseline	r-value	0.0223	0.0252	0.0267	0.0296	0.0248
		p-value	0.7150	0.6800	0.6630	0.6280	0.6840
	6 months	r-value	0.0011	-0.0064	-0.0148	-0.0209	-0.0311
		p-value	0.9850	0.9170	0.8090	0.7330	0.6110
	12 months	r-value	-0.0414	-0.0524	-0.0639	-0.0730	-0.0884
		p-value	0.4980	0.3910	0.2960	0.2320	0.1470

***p<0.05 (Karl Pearson's correlation coefficient)**

Compared to baseline, DDS was positively correlated with weight velocity scores at 3,6,9 and 12 months . FVS and DSS did not have any positive correlation.

Table 36: Correlation between height velocity scores with DDS, FVS and DSS at baseline, 6 months and 9 months' time points

Variables	Time points	Summery	Height scores at				
			Baseline	3 month	6 months	9 months	12 months
DDS	Baseline	r-value	0.1046	0.1077	0.1101	0.0698	0.1115
		p-value	0.0860	0.0770	0.0710	0.2530	0.0670
	6 months	r-value	0.0937	0.0884	0.0833	0.0698	0.0711
		p-value	0.1240	0.1470	0.1720	0.2530	0.2440
	12 months	r-value	0.0334	0.0272	0.0211	-0.0136	0.0084
		p-value	0.5850	0.6570	0.7300	0.8240	0.8910
FVS	Baseline	r-value	0.1082	0.1037	0.0986	0.0269	0.0849
		p-value	0.0760	0.0890	0.1060	0.6600	0.1640
	6 months	r-value	0.0933	0.0862	0.0788	0.0224	0.0635
		p-value	0.1260	0.1580	0.1970	0.7140	0.2980
	12 months	r-value	0.0441	0.0392	0.0340	-0.0153	0.0234
		p-value	0.4710	0.5210	0.5780	0.8020	0.7020
DSS	Baseline	r-value	-0.0034	-0.0033	-0.0030	-0.0500	-0.0063
		p-value	0.9560	0.9570	0.9610	0.4130	0.9180
	6 months	r-value	0.0768	0.0809	0.0849	0.0201	0.0924
		p-value	0.2080	0.1850	0.1640	0.7420	0.1300
	12 months	r-value	-0.0579	-0.0521	-0.0459	-0.0381	-0.0332
		p-value	0.3430	0.3940	0.4530	0.5330	0.5870

$p < 0.05$ (Karl Pearson's correlation coefficient)

There was no positive correlation between height velocity scores with DDS, FVS and DSS at baseline, 3months, 6 months, 9 months and 12 months

Table 37: Correlation between BMI scores with DDS, FVS and DSS at baseline, 6 months and 9 months and 12 months time points

Variables	Time points	Summery	BMI scores at		
			Baseline	6 months	12 months
DDS	Baseline	r-value	-0.0087	-0.0124	-0.0102
		p-value	0.8860	0.8390	0.8670
	6 months	r-value	-0.0240	-0.0217	-0.0111
		p-value	0.6940	0.7230	0.8560
	12 months	r-value	0.0149	0.0162	0.0194
		p-value	0.8080	0.7910	0.7510
FVS	Baseline	r-value	-0.0263	-0.0126	0.0100
		p-value	0.6670	0.8370	0.8710
	6 months	r-value	-0.0663	-0.0724	-0.0731
		p-value	0.2770	0.2360	0.2310
	12 months	r-value	-0.0355	-0.0509	-0.0654
		p-value	0.5610	0.4050	0.2840
DSS	Baseline	r-value	0.0253	0.0355	0.0429
		p-value	0.6780	0.5610	0.4830
	6 months	r-value	-0.1060	-0.1417	-0.1671
		p-value	0.0820	0.0200	0.0060
	12 months	r-value	0.0260	-0.0051	-0.0410
		p-value	0.6710	0.9330	0.5030

p<0.005 (Karl Pearson's correlation coefficient)

There was no ccorrelation between BMI scores with DDS, FVS and DSS at baseline, 6 months and 12 months

Table 38: Correlation between Mid upper arm circumference scores with DDS, FVS and DSS at baseline, 6 months and 9 months' time points

Variables	Time points	Summery	Mid upper arm circumference scores at				
			Baseline	3 month	6 months	9 months	12 months
DDS	Baseline	r-value	-0.1441	-0.1506	-0.1573	-0.1571	-0.1475
		p-value	0.0180*	0.0130*	0.0100*	0.0100*	0.0150*
	6 months	r-value	0.0038	-0.0092	-0.0128	-0.0328	-0.0393
		p-value	0.9500	0.8800	0.8340	0.5920	0.5200
	12 months	r-value	0.0425	0.0273	0.0307	0.0210	0.0159
		p-value	0.4870	0.6550	0.6160	0.7310	0.7950
FVS	Baseline	r-value	0.0519	0.0632	0.0593	0.0588	0.0602
		p-value	0.3950	0.3010	0.3310	0.3360	0.3240
	6 months	r-value	0.0277	0.0223	0.0063	-0.0152	-0.0283
		p-value	0.6510	0.7150	0.9190	0.8030	0.6430
	12 months	r-value	0.0096	0.0184	0.0150	0.0035	-0.0007
		p-value	0.8750	0.7630	0.8060	0.9550	0.9910
DSS	Baseline	r-value	0.0037	-0.0003	-0.0059	-0.0172	-0.0195
		p-value	0.9520	0.9960	0.9230	0.7790	0.7500
	6 months	r-value	-0.0971	-0.1125	-0.1394	-0.1577	-0.1643
		p-value	0.1110	0.0650	0.0220*	0.0090*	0.0070*
	12 months	r-value	-0.0380	-0.0499	-0.0669	-0.0830	-0.0929
		p-value	0.5340	0.4140	0.2740	0.1740	0.1280

***p<0.05 (Karl Pearson's correlation coefficient)**

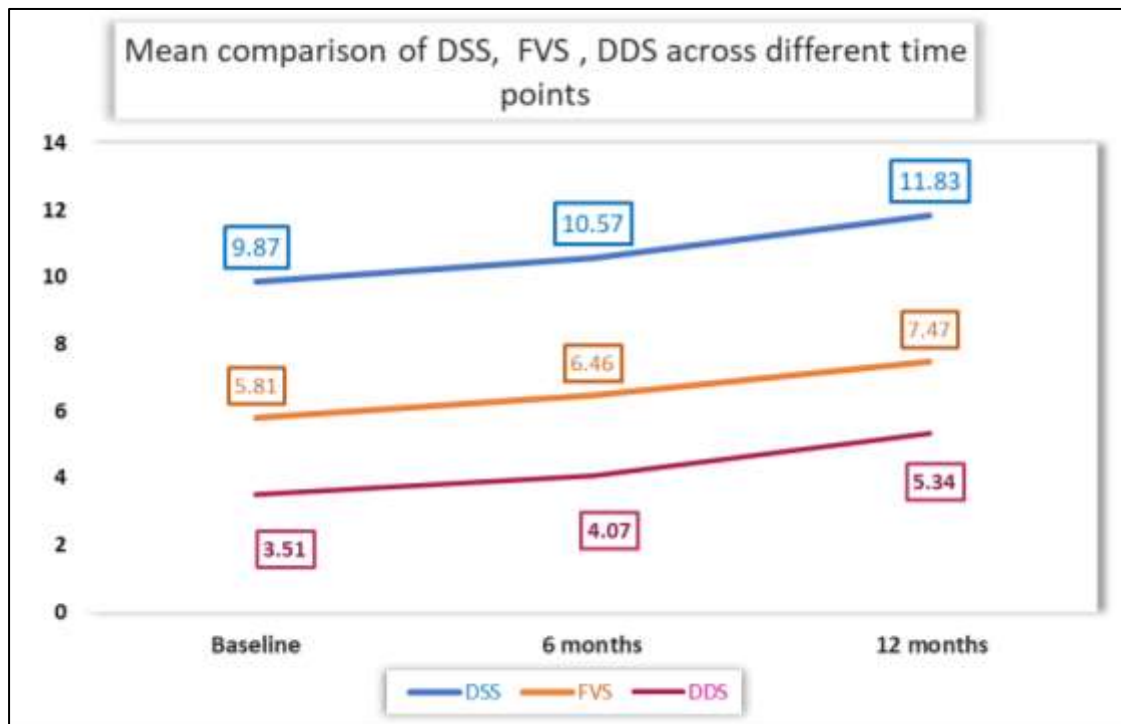
There was negative correlation between Mid upper arm circumference scores with DDS at baseline, 3, 6, 9 and 12 months which was statistically significant. DSS was negatively correlated with MUAC at 6, 9 and 12 months which was statistically significant.

Table 39: Correlation between head circumference scores with DDS, FVS and DSS at baseline, 6 months and 9 months' time points

Variables	Time points	Summery	Head circumference scores at				
			Baseline	3 month	6 months	9 months	12 months
DDS	Baseline	r-value	-0.0747	-0.0766	-0.0644	-0.0604	-0.0477
		p-value	0.2210	0.2100	0.2910	0.3220	0.4350
	6 months	r-value	-0.0436	-0.0316	-0.0156	-0.0022	0.0046
		p-value	0.4760	0.6060	0.7980	0.9710	0.9400
	12 months	r-value	0.0036	0.0147	0.0279	0.0393	0.0454
		p-value	0.9530	0.8100	0.6480	0.5200	0.4570
FVS	Baseline	r-value	-0.1152	-0.1002	-0.0730	-0.0489	-0.0198
		p-value	0.0590	0.1010	0.2320	0.4240	0.7460
	6 months	r-value	-0.1530	-0.1557	-0.1515	-0.1443	-0.1304
		p-value	0.0120*	0.0100*	0.0130*	0.0180*	0.0320*
	12 months	r-value	-0.1326	-0.1329	-0.1319	-0.1292	-0.1191
		p-value	0.0290*	0.0290*	0.0300*	0.0340*	0.0510
DSS	Baseline	r-value	-0.1493	-0.1406	-0.1269	-0.1108	-0.0879
		p-value	0.0140*	0.0210*	0.0370*	0.0690	0.1500
	6 months	r-value	0.0348	0.0235	0.0169	0.0044	-0.0052
		p-value	0.5690	0.7010	0.7820	0.9430	0.9330
	12 months	r-value	-0.0495	-0.0588	-0.0589	-0.0626	-0.0594
		p-value	0.4180	0.3360	0.3350	0.3050	0.3310

***p<0.05 (Karl Pearson's correlation coefficient)**

There was negative correlation between head circumference scores with FVS at base line, 3,6,9 and 12 months. There was negative correlation with DSS at baseline, 3 and 6 months. These differences were statistically significant with $p < 0.05$.

Figure 31: Comparison of mean of DDS, FVS, DSS across the time

The mean DSS was 9.87 in the beginning of the study increased to 10.57 at 6 months, and at the end of 12 months it increased to 11.83. Mean FVS at the beginning was 5.81, 6.46 at 6 months and at the end of 12 months was 7.47. Mean DDS at the beginning was 3.51, 4.07 at 6 months and at the end of 12 months it increased to 5.34.

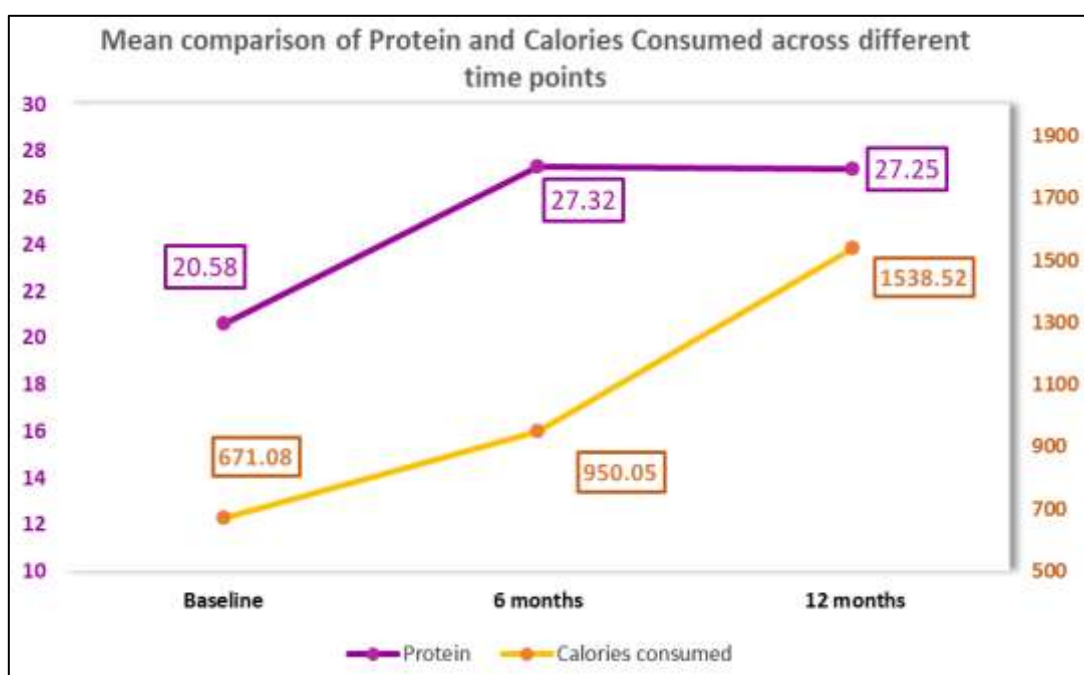
Table 40: Association between Quantity of weaning food vs Nutritional status
(Using “Z” scores)

		Adequate	Not-Adequate	Total	Chi-square	p-value
Weight-for-age	Baseline- Z score					
	≤ -2	23	57	80	13.5050	.000*
	-2 to 2	101	89	190		
	6 months – Z score					
	≤ -2	29	47	76	2.5700	0.1090
	-2 to 2	95	99	194		
	12 months – Z score					
	≤ -2	22	40	62	3.5340	0.0600
	-2 to 2	102	106	208		
Height-for-age	Baseline					
	≤ -2	3	14	17	10.5150	.005*
	-2 to 2	100	121	221		
	>2	21	11	32		
	6 months					
	≤ -2	4	21	25	10.5440	.005*
	-2 to 2	115	122	237		
	>2	5	3	8		
	12 months					
	≤ -2	15	23	38	1.0900	0.5800
	-2 to 2	106	121	227		
	>2	3	2	5		
BMI status	Baseline					
	≤ -2	95	113	208	0.9190	0.6320
	-2 to 2	29	32	61		
	>2	0	1	1		
	6 months					
	≤ -2	67	89	156	2.3340	0.3110
	-2 to 2	57	56	113		
	>2	0	1	1		
	12 months					
	≤ -2	50	55	105	1.0130	0.6030
	-2 to 2	74	90	164		
	>2	0	1	1		
MUAC Status	Baseline					
	12.5-13.5	114	132	246	0.1920	0.6610
	>13.5	10	14	24		
	6 months					
	12.5-13.5	90	88	178	4.5210	.033*
	>13.5	34	58	92		
	12 months					
	12.5-13.5	33	24	57	4.1680	.041*
	>13.5	91	122	213		

HC Status	Baseline					
	≤ -2	58	81	139	3.0330	0.2190
	-2 to 2	65	65	130		
	>2	1	0	1		
	6 months					
	≤ -2	34	59	93	5.0120	.025*
	-2 to 2	90	87	177		
	12 months					
	≤ -2	16	25	41	1.3930	0.4980
	-2 to 2	106	120	226		
	>2	2	1	3		
	Total	124	146	270		

In our study weight-for-age at baseline, height-for-age at baseline and 6 months, MUAC at 6 and 12 months and HC at 6 months were associated with adequacy of weaning food. This difference was statistically significant with $p < 0.05$.

Figure 32: Comparison of mean protein and calories consumed across different time points



The mean protein intake was 20.58gm in the beginning of the study increased to 27.32gms at 6 months, remains almost same at the end of 12 months. Whereas mean calories consumption was 671.08 in the beginning of the study, increased to 950.05 at the end of 6 months and at the end of 12 months it increased to 1538.52.

Table 41: Association between No. of rooms in house vs Nutritional status among study participants

		One rooms	Two rooms	Three rooms	Four rooms	Total	Chi-square	p-value
Weight-for-age	Baseline							
	≤ -2	18	32	29	1	80	5.9960	0.1120
	-2 to 2	32	62	83	13	190		
	6 months							
	≤ -2	17	28	30	1	76	4.1280	0.2480
	-2 to 2	33	66	82	13	194		
	12 months							
	≤ -2	16	23	22	1	62	5.1070	0.1640
	-2 to 2	34	71	90	13	208		
Height-for-age	Baseline							
	≤ -2	3	11	3	0	17	9.1190	0.1670
	-2 to 2	42	73	93	13	221		
	>2	5	10	16	1	32		
	6 months							
	≤ -2	5	15	5	0	25	11.0510	0.0870
	-2 to 2	44	77	102	14	237		
	>2	1	2	5	0	8		
	12 months							
	≤ -2	8	19	9	2	38	9.4130	0.1520
	-2 to 2	42	74	99	12	227		
	>2	0	1	4	0	5		
BMI status	Baseline							
	≤ -2	36	66	95	11	208	11.1620	0.0830
	-2 to 2	13	28	17	3	61		
	>2	1	0	0	0	1		
	6 months							
	≤ -2	22	49	78	7	156	15.7730	.015*
	-2 to 2	27	45	34	7	113		
	>2	1	0	0	0	1		
	12 months							
	≤ -2	14	31	56	4	105	14.4140	.025*
	-2 to 2	35	63	56	10	164		
	>2	1	0	0	0	1		
MUAC Status	Baseline							
	12.5-13.5	43	82	108	13	246	7.3200	0.0620
	>13.5	7	12	4	1	24		
	6 months							
	12.5-13.5	27	53	86	12	178	15.2970	.002*
	>13.5	23	41	26	2	92		
	12 months							
	12.5-13.5	10	15	27	5	57	3.9320	0.2690
	>13.5	40	79	85	9	213		

HC Status	Baseline							
	≤ -2	22	47	62	8	139	20.7260	.002*
	-2 to 2	28	47	50	5	130		
	>2	0	0	0	1	1		
	6 months							
	≤ -2	10	38	42	3	93	7.6230	0.0540
	-2 to 2	40	56	70	11	177		
	12 months							
	≤ -2	5	14	20	2	41	8.5200	0.2020
	-2 to 2	45	80	90	11	226		
	>2	0	0	2	1	3		
	Total	50	94	112	14	270		

Irrespective of number of rooms the nutrition status of children improved over 1 year. BMI was less at 6 months and 12 months among children who lived in houses with 3 rooms. MUAC also was less at 6 months and head circumference at baseline among children who lived in houses with 3 rooms this difference was statistically significant

Table 42: Association between overcrowding and Nutritional status / attained growth of study participants (using 'Z' scores)

		Present	Absent	Total	Chi-square	p-value
Weight-for-age	Baseline					
	≤ -2	30	50	80	3.8380	0.0580
	-2 to 2	96	94	190		
	6 months					
	≤ -2	32	44	76	0.8840	0.3470
	-2 to 2	94	100	194		
	12 months					
	≤ -2	25	37	62	1.3010	0.2540
	-2 to 2	101	107	208		
Height-for-age	Baseline					
	≤ -2	6	11	17	4.2850	0.1170
	-2 to 2	100	121	221		
	>2	20	12	32		
	6 months					
	≤ -2	8	17	25	2.7590	0.2520
	-2 to 2	115	122	237		
	>2	3	5	8		
	12 months					
	≤ -2	14	24	38	3.3570	0.1870
	-2 to 2	111	116	227		
	>2	1	4	5		
BMI status	Baseline					
	≤ -2	95	113	208	1.3800	0.5020
	-2 to 2	30	31	61		
	>2	1	0	1		
	6 months					
	≤ -2	75	81	156	1.5330	0.4650
	-2 to 2	50	63	113		
	>2	1	0	1		
	12 months					
	≤ -2	55	50	105	3.5660	0.1680
	-2 to 2	70	94	164		
	>2	1	0	1		
MUAC Status	Baseline					
	<11.5-13.5	114	132	246	0.1180	0.7320
	>13.5	12	12	24		
	6 months					
	<11.5-13.5	88	90	178	1.6120	0.2040
	>13.5	38	54	92		

HC Status	12 months					
	<11.5-13.5	35	22	57	6.3050	.012*
	>13.5	91	122	213		
	Baseline					
	≤ -2	59	80	139	3.0170	0.2210
	-2 to 2	66	64	130		
	>2	1	0	1		
	6 months					
	≤ -2	39	54	93	1.2760	0.2590
	-2 to 2	87	90	177		
	12 months					
	≤ -2	18	23	41	3.5580	0.1690
	-2 to 2	105	121	226		
	>2	3	0	3		
	Total	126	144	270		

Overcrowding was associated with lesser MUAC at 12 months. The difference was statistically significant with $p < 0.05$.

Table 43: Association between SES class and growth velocity (increase in weight, height, BMI) from baseline to 12 months

Parameters	Velocity	Class I-3		Class 4		Class 5		F-value	p-value
		Mean	SD	Mean	SD	Mean	SD		
Weight	BL-3M	0.67	0.20	0.61	0.18	0.65	0.21	2.2738	0.1049
	3M-6M	0.67	0.21	0.61	0.19	0.65	0.21	2.0212	0.1345
	6M-9M	0.67	0.20	0.61	0.19	0.65	0.21	2.2498	0.1074
	9M-12M	0.62	0.27	0.53	0.21	0.60	0.21	4.0588	0.0183*
Height	BL-3M	1.38	0.57	1.32	0.56	1.22	0.29	1.0022	0.3684
	3M-6M	1.38	0.57	1.32	0.55	1.22	0.29	0.9939	0.3715
	6M-9M	1.38	0.57	1.31	0.57	1.22	0.29	0.8774	0.4171
	9M-12M	1.33	0.69	1.29	0.79	1.15	0.37	0.6917	0.5016
BMI	BL-6M	0.84	0.52	0.75	0.50	0.89	0.44	1.6655	0.1911
	6M-12M	0.68	0.46	0.57	0.47	0.75	0.42	2.8649	0.0587

***p<0.05 (one way ANOVA)**

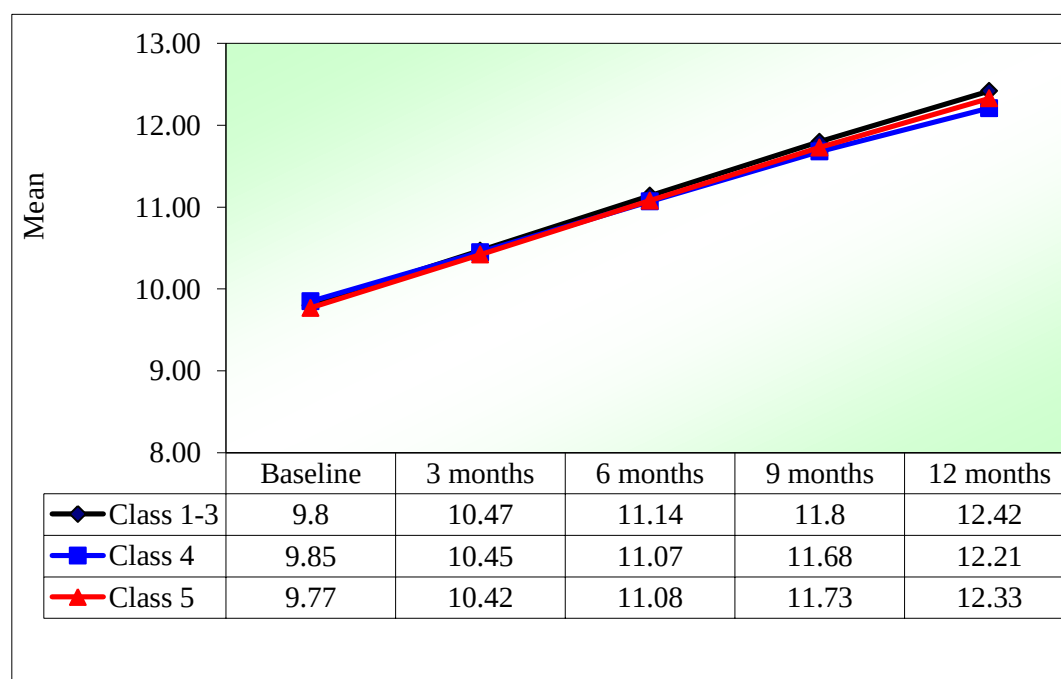
In our study among study participants belonging to class I-III mean growth velocity for weight was better compared to class IV and class V, this difference was statistically significant with $p<0.05$. Though height velocity was better among study participants belonging to class I-III, but statistically not significant. BMI velocity was better among study participants belonging to class IV and V, but statistically not significant with $p>0.05$.

Table 44: Association between of SES class with actual weight gain among study participants at different time points

Time points	Class I-III		Class IV		Class V		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD		
Baseline	9.80	1.96	9.85	1.77	9.77	1.78	0.0329	0.9676
3months	10.47	1.94	10.45	1.75	10.42	1.81	0.0062	0.9938
6 months	11.14	1.94	11.07	1.75	11.08	1.87	0.0293	0.9711
9 months	11.80	1.96	11.68	1.77	11.73	1.95	0.0997	0.9051
12 months	12.42	2.06	12.21	1.82	12.33	2.04	0.2933	0.7460

p<0.05 (one way ANOVA)

Figure 33: Association between of SES class with actual weight among study participants at different time points



In our study comparison of SES with weight velocity the mean weight of class I-III, class IV and class V were 9.80, 9.85 and 9.77 in the beginning respectively, at 3 months it was 10.47, 10.45 and 10.42, at 6 months it was 11.14, 11.7 and 11.08, at 9 months 11.8, 11.68 and 11.73 and at 12 months 12.42, 12.21 and 12.33 this difference was not statistically significant with $p > 0.05$. But the total mean weight gain was 2.62 kgs in class I-III followed by 2.56 kgs in class IV and least gain was observed that was 2.36 kgs in class V.

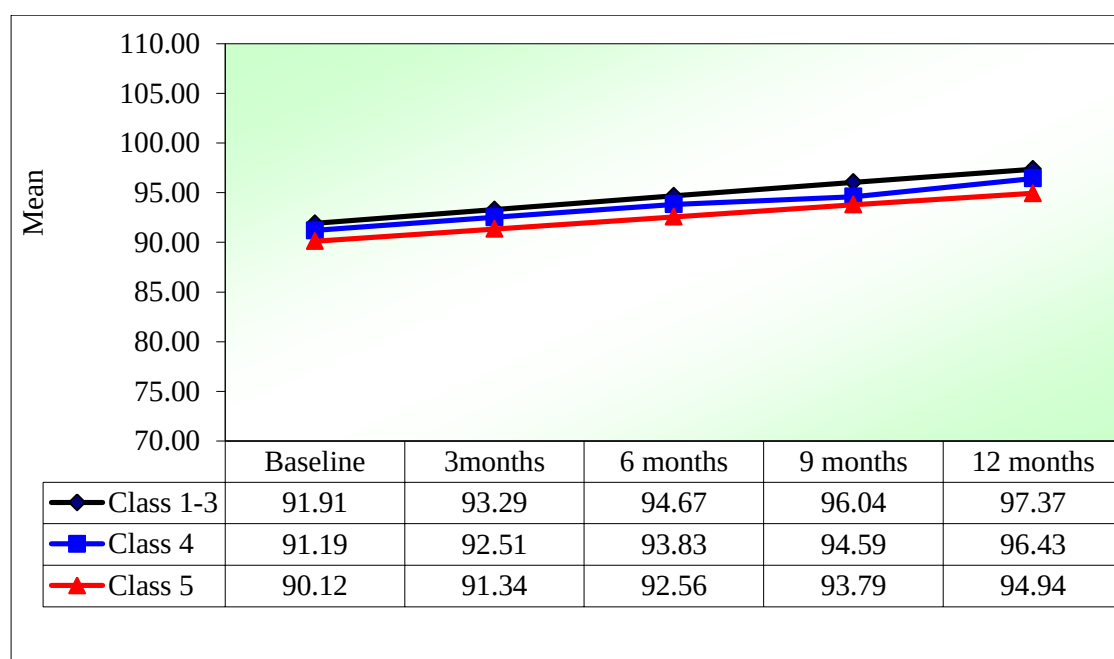
Table 45: Association between SES class with actual gain in height of study participants at different time points

Time points	Class I-III		Class IV		Class V		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD		
Baseline	91.91	8.47	91.19	8.71	90.12	7.89	0.4741	0.6230
3months	93.29	8.50	92.51	8.74	91.34	7.93	0.5590	0.5725
6 months	94.67	8.57	93.83	8.80	92.56	7.99	0.6439	0.5260
9 months	96.04	8.67	94.59	11.06	93.79	8.05	0.6051	0.5468
12 months	97.37	8.83	96.43	9.05	94.94	8.18	0.8151	0.4437

p<0.05

(one way ANOVA)

Figure 34: Association between of SES class with actual height of study participants at different time points



In our study mean height of children belonging to class I-III was more compared to class IV- V, at baseline, 3 months , 6 months, 9 months and 12 months.

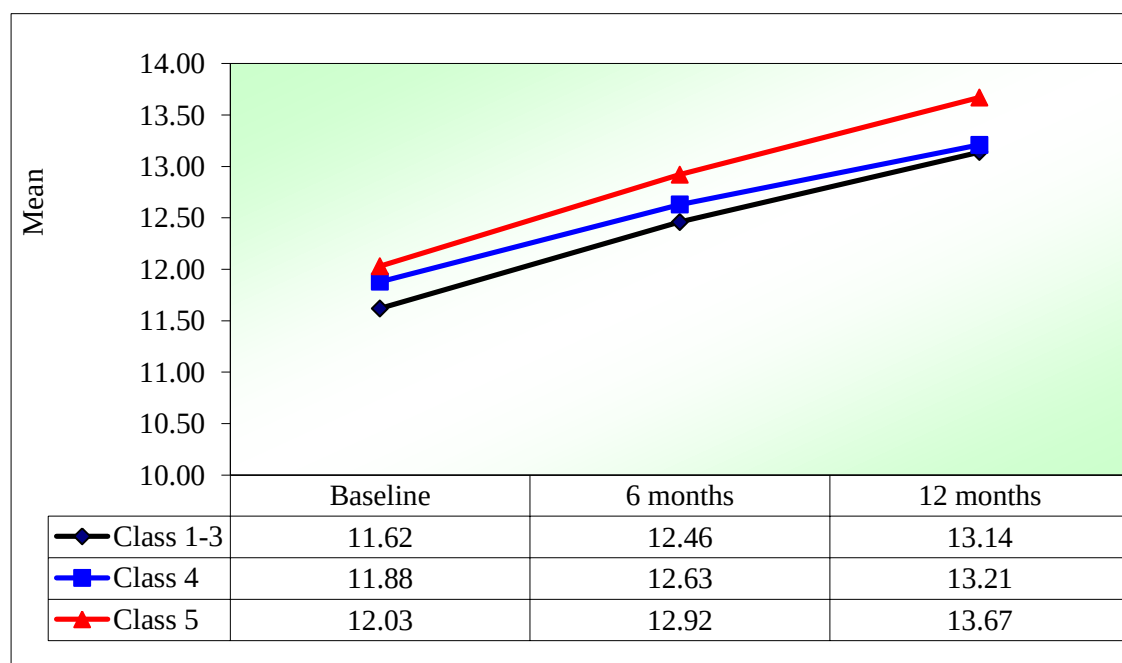
Total increase in height was 5.46 cm in class I-III, 5.24 cm in class IV , 4.82 cm in class V but the difference was not statistically significant with $p>0.05$.

Table 46: Association between of SES class with actual BMI of study participants at different time points

Time points	Class I-III		Class IV		Class V		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD		
Baseline	11.62	1.93	11.88	1.85	12.03	1.64	0.6100	0.5441
6 months	12.46	1.77	12.63	1.73	12.92	1.49	0.7922	0.4539
12 months	13.14	1.73	13.21	1.73	13.67	1.48	1.2840	0.2786

P<0.05 (one way ANOVA)

Figure 35: Association between of SES class with actual BMI of study participants at different time points



In our study though BMI of children belonging to class V was better as compared to class IV and class I-III at baseline, 3 months, 6 months, 9 months and 12 months. But the difference was not statistically significant with $p>0.05$.

Table 47: Association between educational qualifications of father and growth velocity of children from baseline to 12 months

Parameters	Velocity	Illiterates		Primary		Secondary & PUC		Degree & higher		F-value	p-value
		Me an	SD	Me an	SD	Me an	SD	Me an	SD		
Weight	BL-3M	0.63	0.24	0.58	0.15	0.63	0.17	0.67	0.20	1.1339	0.3358
	3M-6M	0.64	0.24	0.58	0.15	0.63	0.18	0.67	0.20	1.2240	0.3014
	6M-9M	0.63	0.24	0.58	0.15	0.63	0.18	0.66	0.20	0.9460	0.4188
	9M-12M	0.55	0.30	0.51	0.18	0.57	0.19	0.56	0.24	0.6780	0.5662
Height	BL-3M	1.27	0.36	1.26	0.59	1.34	0.58	1.53	0.58	1.2482	0.2927
	3M-6M	1.27	0.36	1.26	0.59	1.33	0.57	1.53	0.58	1.3520	0.2579
	6M-9M	1.27	0.37	1.26	0.59	1.33	0.59	1.46	0.65	0.7581	0.5185
	9M-12M	1.25	0.52	1.17	0.58	1.28	0.83	1.56	0.73	1.1732	0.3204
BMI	BL-6M	0.84	0.55	0.72	0.49	0.79	0.47	0.68	0.49	0.7766	0.5079
	6M-12M	0.64	0.51	0.59	0.46	0.63	0.44	0.46	0.47	0.7613	0.5167

p<0.05

(one way ANOVA)

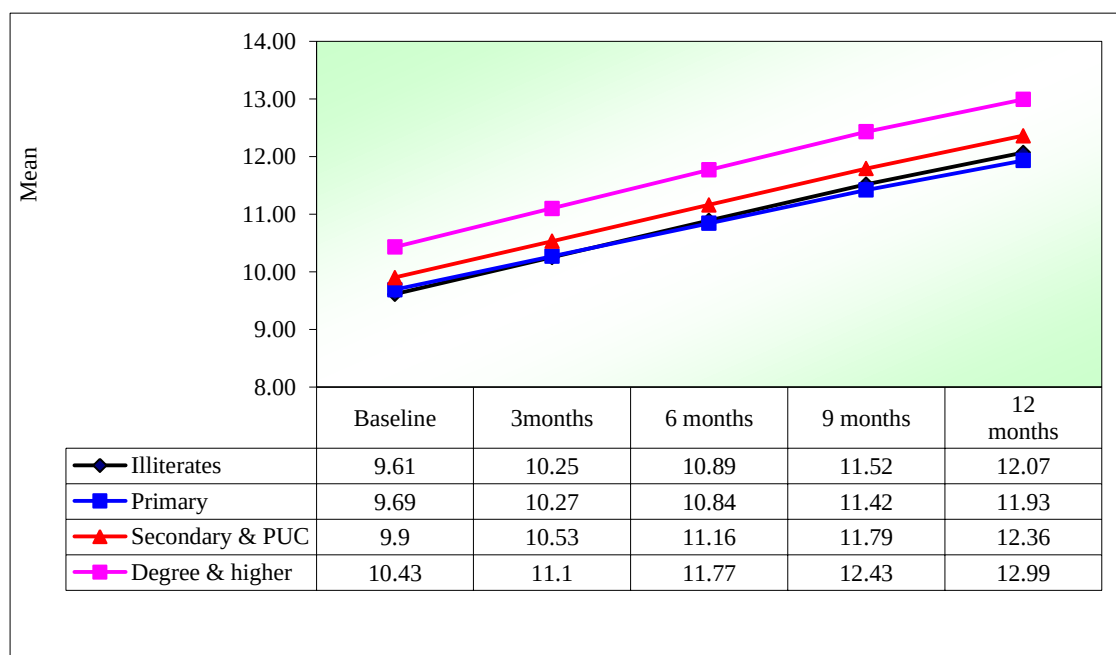
weight velocity, height velocity was better among study participants whose fathers had studied degree and above and its was less among those who had studied up to primary the difference was not statistically significant. BMI velocity was better among participants whose fathers were illiterate but the difference was not statistically significant.

Table 48: Association between educational qualifications of father and actual mean weight of study participants at different time

Time points	Illiterates		Primary		Secondary & PUC		Degree & higher		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Baseline	9.61	1.62	9.69	1.90	9.90	1.86	10.43	1.94	1.1147	0.3436
3months	10.25	1.59	10.27	1.89	10.53	1.85	11.10	1.93	1.2631	0.2874
6 months	10.89	1.59	10.84	1.90	11.16	1.85	11.77	1.94	1.4321	0.2338
9 months	11.52	1.64	11.42	1.91	11.79	1.87	12.43	1.98	1.5532	0.2012
12 months	12.07	1.74	11.93	1.97	12.36	1.92	12.99	2.00	1.5975	0.1903

P<0.05 (one way ANOVA)

Figure 36: Association between educational qualifications of father and actual mean weight of study participants at different time



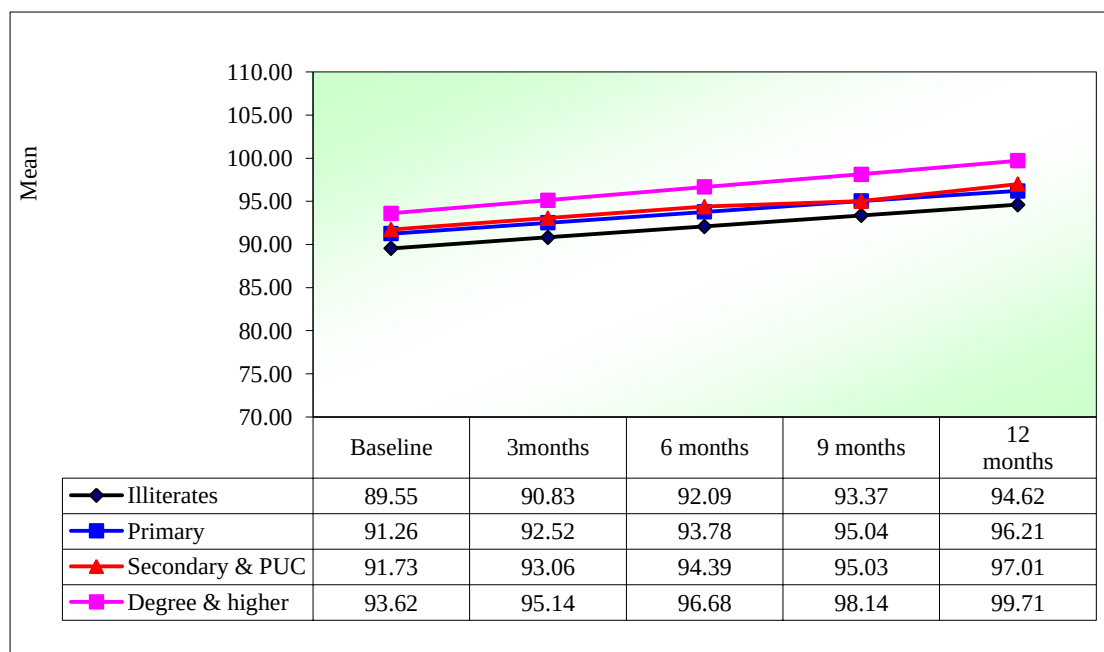
Mean weight of study participants whose fathers were educated up to degree and above was more at baseline, 3 months, 6 months, 9 month, 12 month followed by higher secondary and PUC primary and illiterates, but the difference was not statistically significant with $p>0.05$

Table 49: Association between educational qualifications of father and actual mean height of study participants at different time

Time points	Illiterates		Primary		Secondary & PUC		Degree & higher		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Baseline	89.55	8.16	91.26	8.58	91.73	8.71	93.62	8.11	1.5768	0.1953
3months	90.83	8.22	92.52	8.77	93.06	8.70	95.14	8.10	1.7099	0.1653
6 months	92.09	8.29	93.78	8.99	94.39	8.72	96.68	8.12	1.8440	0.1395
9 months	93.37	8.37	95.04	9.24	95.03	11.47	98.14	8.22	1.1236	0.3400
12 months	94.62	8.46	96.21	9.50	97.01	8.93	99.71	8.32	2.0389	0.1088

P<0.05 (one way ANOVA)

Figure 37: Association between educational qualifications of father and actual mean height of study participants at different time



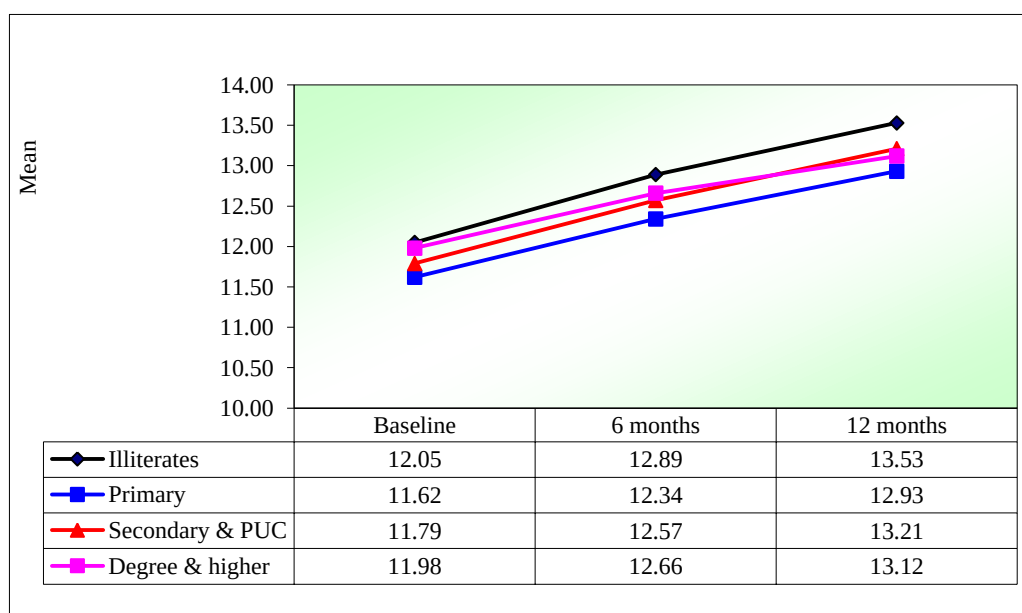
Mean height of study participants whose fathers were educated up to degree and above was more at baseline, 3 months, 6 months, 9 month, 12 month followed by higher secondary and PUC, primary and lastly illiterates, difference was not statistically significant with $p>0.05$

Table 50: Association between educational qualifications of fathers and actual mean BMI of study participants at different time points

Time points	Illiterates		Primary		Secondary & PUC		Degree & higher		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Baseline	12.05	1.77	11.62	1.60	11.79	1.87	11.98	2.29	0.5629	0.6400
6 months	12.89	1.55	12.34	1.54	12.57	1.78	12.66	2.00	0.9702	0.4072
12 months	13.53	1.46	12.93	1.62	13.21	1.82	13.12	1.77	1.1452	0.3313

P<0.05 (one way ANOVA)

Figure 38: Association between educational qualifications of fathers and mean BMI of study participants at different time points



Mean BMI was more among study participants who's fathers were illiterates at baseline, 6 months and 12 months (12.05, 12.89 , 13.53 respectively) as compared to study participants who's fathers were educated up to primary level and above this difference was not statistically significant with $p>0.05$.

Table 51: Association between educational qualifications of mothers and growth velocity of children from baseline to 12 months

Parameters	Velocity	Illiterates		Primary		Secondary & PUC		Degree & higher		F-value	p-value
		Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Weight	BL-3M	0.61	0.23	0.64	0.20	0.62	0.17	0.71	0.17	0.9426	0.4205
	3M-6M	0.62	0.23	0.64	0.20	0.63	0.17	0.72	0.17	1.0024	0.3923
	6M-9M	0.61	0.23	0.64	0.20	0.62	0.17	0.70	0.18	0.8276	0.4797
	9M-12M	0.54	0.29	0.57	0.21	0.56	0.18	0.58	0.22	0.3167	0.8133
Height	BL-3M	1.29	0.50	1.26	0.54	1.35	0.57	1.45	0.27	0.6293	0.5967
	3M-6M	1.28	0.48	1.27	0.54	1.35	0.57	1.44	0.23	0.6168	0.6047
	6M-9M	1.30	0.52	1.25	0.54	1.34	0.57	1.35	0.40	0.3119	0.8167
	9M-12M	1.26	0.61	1.20	0.63	1.29	0.84	1.56	0.39	0.7753	0.5087
BMI	BL-6M	0.79	0.56	0.83	0.48	0.76	0.48	0.81	0.27	0.2164	0.8850
	6M-12M	0.60	0.52	0.68	0.45	0.61	0.45	0.56	0.30	0.3293	0.8042

***p<0.05 (one way ANOVA)**

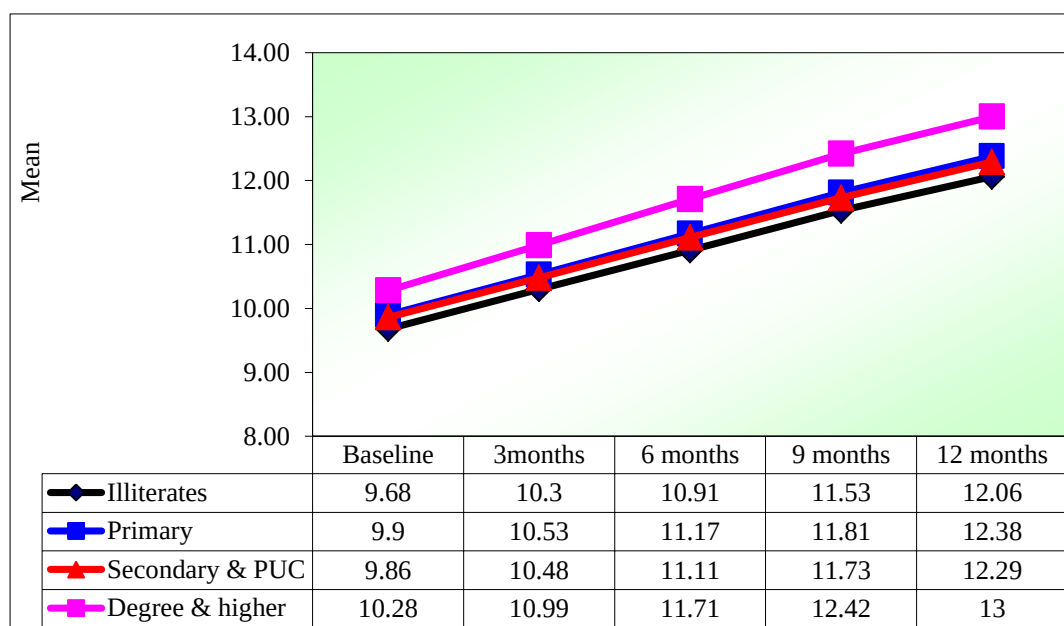
Weight and height of study participants whose mothers had studied degree and higher was better compared to mothers who were illiterate, studied up to primary, secondary and PUC.

Table 52: Association between educational qualifications of mothers and actual mean weight of study participants at different time points

Time points	Illiterates		Primary		Secondary & PUC		Degree & higher		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Baseline	9.68	1.68	9.90	1.97	9.86	1.84	10.28	1.81	0.4681	0.7048
3months	10.30	1.66	10.53	1.96	10.48	1.82	10.99	1.85	0.6182	0.6038
6 months	10.91	1.66	11.17	1.97	11.11	1.82	11.71	1.90	0.7870	0.5021
9 months	11.53	1.70	11.81	2.00	11.73	1.84	12.42	1.98	0.9334	0.4250
12 months	12.06	1.80	12.38	2.06	12.29	1.88	13.00	2.05	0.9907	0.3977

P<0.05 (one way ANOVA)

Figure 39: Association between educational qualifications of mothers and actual mean weight of study participants at different time points



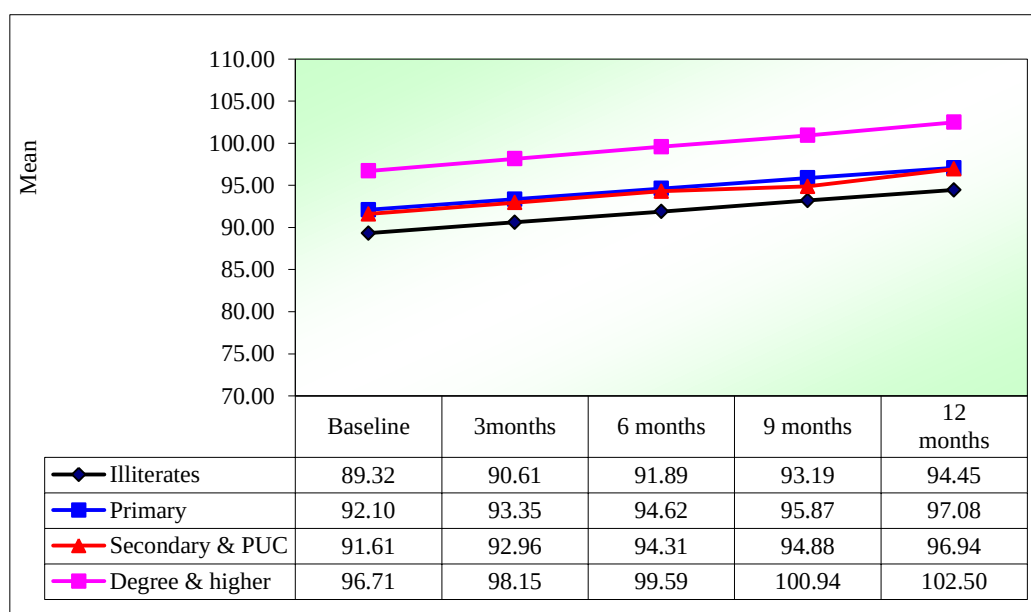
Mean weight of study participants whose mothers had education up to degree and above was more at baseline, 3 months, 6 months, 9 months, 12 months (10.28, 10.99, 11.71, 12.42 and 13 respectively) as compared to less educated mothers this difference was not statistically significant with $p > 0.05$.

Table 53: Association between educational qualifications of mothers and actual mean height of study participants at different time points

Time points	Illiterates		Primary		Secondary & PUC		Degree & higher		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Baseline	89.32	8.16	92.10	8.77	91.61	8.55	96.71	7.61	3.3990	0.0184*
3months	90.61	8.22	93.35	8.85	92.96	8.53	98.15	7.76	3.4897	0.0163*
6 months	91.89	8.32	94.62	8.96	94.31	8.56	99.59	7.92	3.5687	0.0147*
9 months	93.19	8.43	95.87	9.10	94.88	11.60	100.94	8.16	2.3350	0.0743*
12 months	94.45	8.57	97.08	9.29	96.94	8.75	102.50	8.34	3.6091	0.0139*

*p<0.05 (one way ANOVA)

Figure 40: Association between educational qualifications of mothers and actual mean height of study participants at different time points



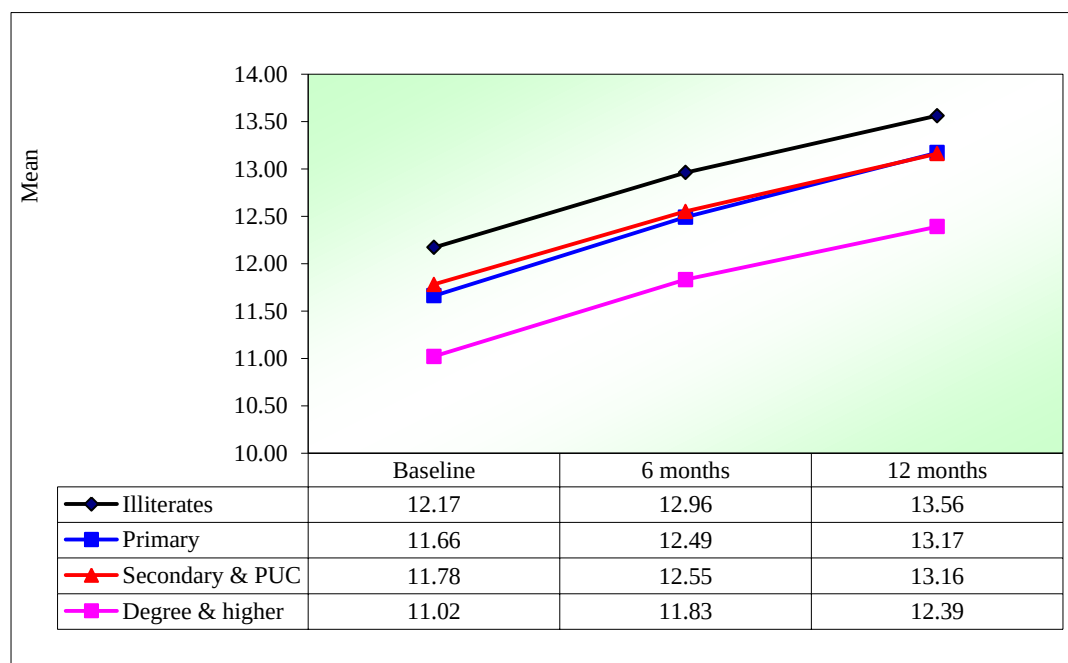
Mean height of study participants whose mothers had education up to degree and above was more at baseline, 3 months, 6 months, 9 months, 12 months (96.71, 98.15, 99.59, 100.94 and 102.50 respectively) as compared to less educated mothers this difference was statistically significant with $p < 0.05$.

Table 54: Association between educational qualifications of mother and actual mean BMI of study participants at different time points

Time points	Illiterates		Primary		Secondary & PUC		Degree & higher		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Baseline	12.17	1.65	11.66	1.65	11.78	1.99	11.02	1.72	1.8965	0.1305
6 months	12.96	1.44	12.49	1.55	12.55	1.89	11.83	1.58	2.1658	0.0924
12 months	13.56	1.40	13.17	1.61	13.16	1.89	12.39	1.51	2.1513	0.0942

P<0.05 (one way ANOVA)

Figure 41: Association between educational qualifications of mother and actual mean BMI of study participants at different time point



Mean BMI of study participants whose mothers were illiterates was more at baseline, 6 months and 12 months as compared to mothers who were better educated. But the difference was not statistically significant $p>0.05$.

Table 55: Association between occupation of fathers with growth velocity scores of study participants from baseline to 12 months

Parameters	Velocity	Unemploy ed		Governme nt employed		Private employed		Self employed		F- value	p-value
		Me an	SD	Me an	SD	Me an	SD	Me an	SD		
Weight	BL-3M	0.64	0.22	0.66	0.22	0.65	0.16	0.61	0.20	0.9724	0.4062
	3M-6M	0.64	0.22	0.66	0.22	0.65	0.16	0.61	0.20	0.8441	0.4708
	6M-9M	0.64	0.22	0.66	0.22	0.65	0.16	0.61	0.20	0.9443	0.4197
	9M-12M	0.58	0.22	0.55	0.24	0.58	0.17	0.53	0.26	1.0989	0.3501
Height	BL-3M	1.27	0.48	1.36	0.32	1.43	0.71	1.27	0.42	1.7854	0.1503
	3M-6M	1.26	0.48	1.36	0.32	1.43	0.70	1.27	0.42	1.7558	0.1560
	6M-9M	1.27	0.49	1.38	0.35	1.42	0.74	1.26	0.42	1.6735	0.1730
	9M-12M	1.20	0.57	1.25	0.34	1.43	1.04	1.22	0.54	1.6435	0.1797
BMI	BL-6M	0.87	0.47	0.79	0.53	0.76	0.46	0.77	0.53	0.6503	0.5834
	6M-12M	0.71	0.42	0.57	0.51	0.60	0.44	0.60	0.49	0.8057	0.4917

***p<0.05 (one way ANOVA)**

Weight velocity of study participants whos fathers were unemployed was less compared to those in government service and self-employed, but the difference was not statistically significant with $p > 0.05$. Height velocity of study participants who's fathers were in government and private job was better, but the difference was not statistically significant.

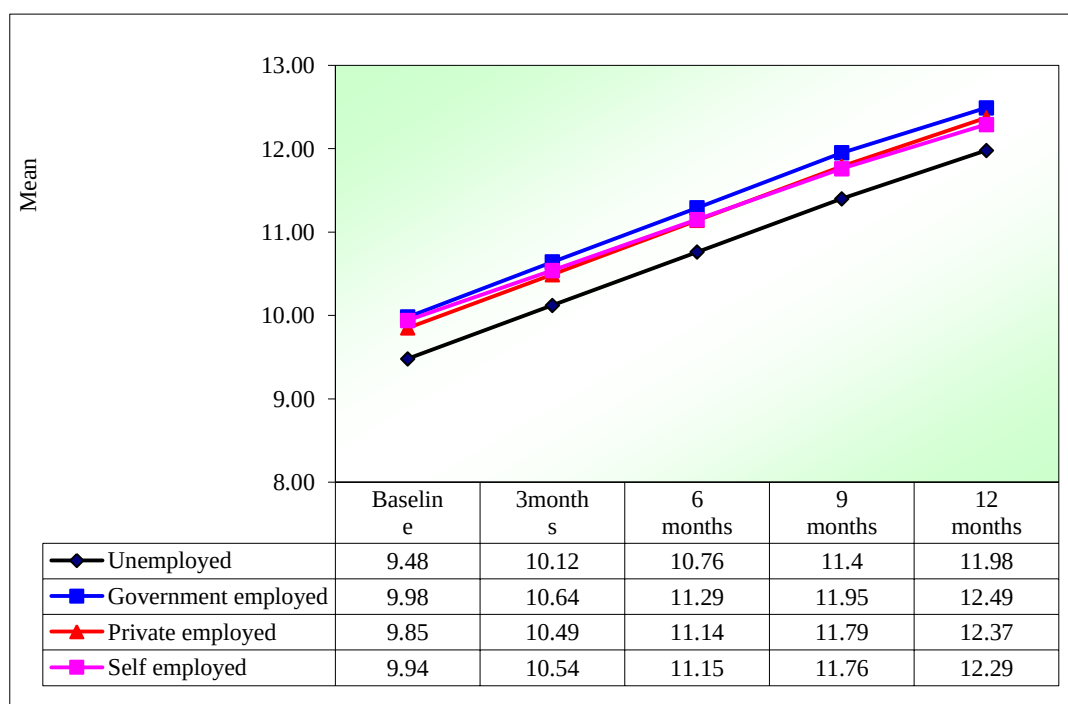
Table 56: Association between occupations of father and actual mean weight of study participants at different time points

Time points	Unemployed		Government employed		Private employed		Self employed		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Baseline	9.48	1.52	9.98	2.38	9.85	1.82	9.94	1.83	0.8241	0.4816
3months	10.12	1.47	10.64	2.36	10.49	1.83	10.54	1.82	0.7511	0.5226
6 months	10.76	1.46	11.29	2.35	11.14	1.84	11.15	1.83	0.6944	0.5562
9 months	11.40	1.48	11.95	2.36	11.79	1.88	11.76	1.87	0.6314	0.5953
12 months	11.98	1.55	12.49	2.38	12.37	1.92	12.29	1.95	0.5368	0.6574

P<0.05

(one way ANOVA)

Figure 42: Association between occupations of father and actual mean weight of study participants at different time points



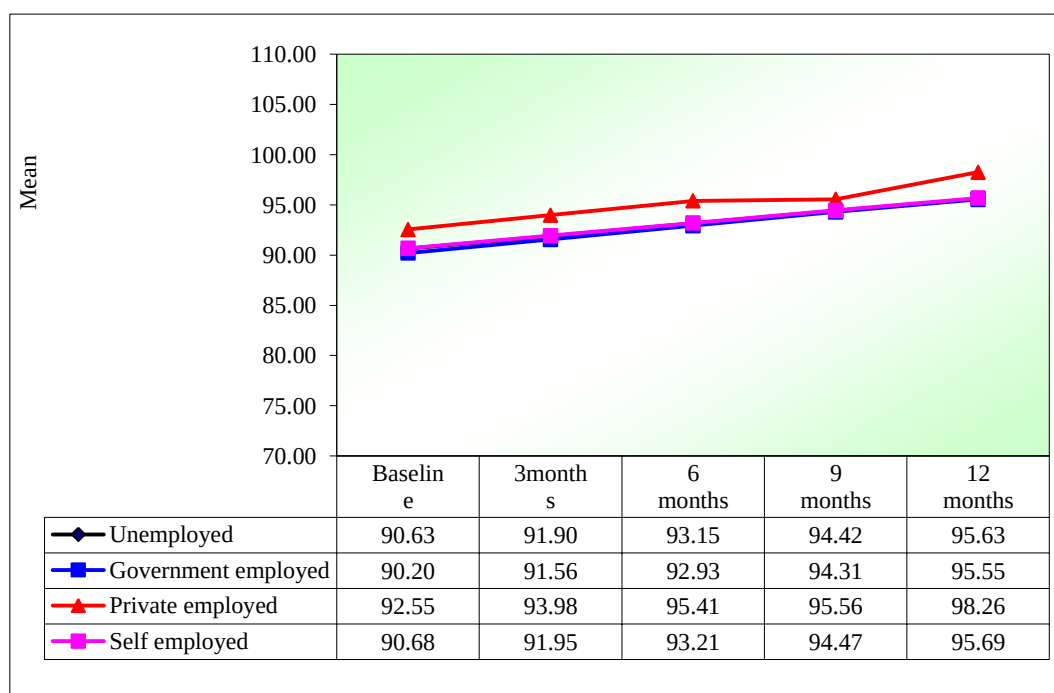
In our study mean weight of study participants whose fathers were self-employed was better, followed by government and private job as compared to unemployed. baseline mean weight of study participants of unemployed, government, private and self-employed was 9.48kgs, 9.98 kgs, 9.85 and 9.94kgs, at 3months it was 10.12, 10.64, 10.49 and 10.54, at 6 months it was 10.76, 11.29, 11.14 and 11.15, at 9 months it was 11.4, 11.95, 11.79 and 11.76 and at 12 months 11.98, 12.49, 12.37 and 12.29. These differences were statistically not significant. But the total mean gain in weight was 2.52 kg for private employed, 2.51 kg government employed, 2.35 kg self-employed and 2.5 kg in unemployed .

Table 57: Association between occupations of fathers and actual mean height of study participants at different time points

Time points	Unemployed		Government employed		Private employed		Self employed		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Baseline	90.63	7.43	90.20	11.34	92.55	8.39	90.68	8.68	0.9530	0.4155
3months	91.90	7.45	91.56	11.32	93.98	8.36	91.95	8.75	1.1003	0.3495
6 months	93.15	7.50	92.93	11.30	95.41	8.39	93.21	8.85	1.2452	0.2938
9 months	94.42	7.57	94.31	11.29	95.56	13.23	94.47	8.97	0.2162	0.8851
12 months	95.63	7.70	95.55	11.25	98.26	8.72	95.69	9.07	1.5928	0.1915

***p<0.05 (one way ANOVA)**

Figure 43: Association between occupations of fathers and actual mean height of study participants at different time points



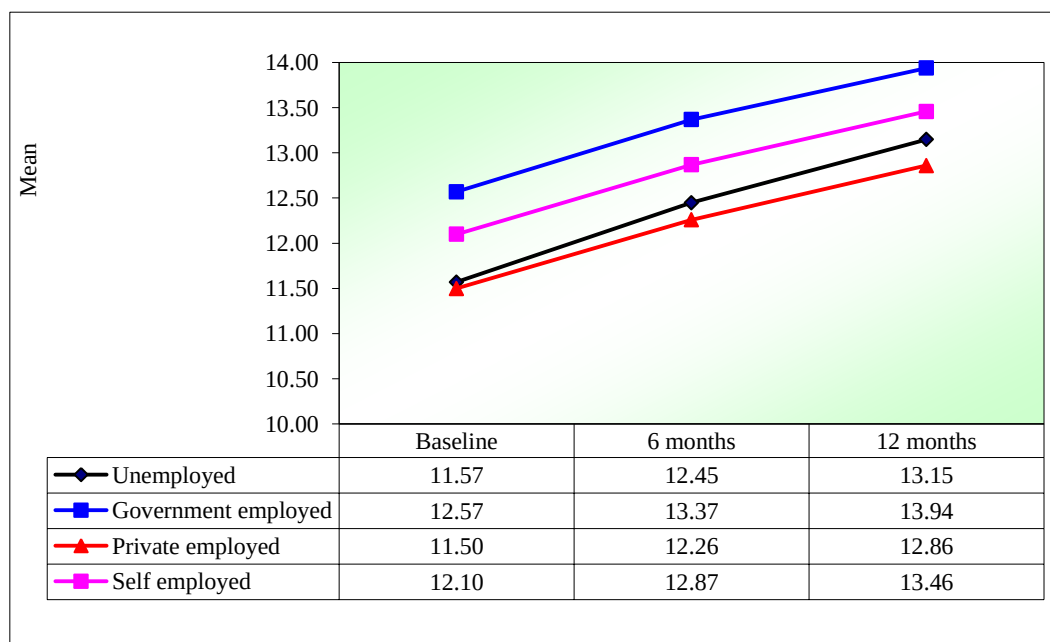
In our study mean height of study participants whose fathers were self-employed was better from baseline till 12 months as compared to others. But the total mean difference of height was 5.71 cm, observed among study participants whose fathers were in private job, followed by 5.35cm in government job, 5.01 was in self-employed and least that was 5cm among participants whose fathers were unemployed. But the difference was statistically not significant with $P>0.05$.

Table 58: Association between occupation of fathers and actual mean BMI of study participants at different time points

Time points	Unemployed		Government employed		Private employed		Self employed		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Baseline	11.57	1.58	12.57	3.88	11.50	1.56	12.10	1.68	2.9756	0.0321*
6 months	12.45	1.45	13.37	3.57	12.26	1.50	12.87	1.55	3.2496	0.0224*
12 months	13.15	1.45	13.94	3.21	12.86	1.60	13.46	1.57	2.9526	0.0331*

* $p < 0.05$ (one way ANOVA)

Figure 44: Association between occupations of father with actual mean BMI of study participants at different time points



Mean BMI of study participants whose father's were employed in Government service was more at baseline (12.57), 6 months (13.37) and 12 months (13.94) followed by those self employed baseline (12.10), 6 months (12.87) and 12 months (13.46) Least was among private employed, this difference was statistically significant with $p < 0.05$.

Table 59: Association between occupation of mothers and growth velocity scores of study participants from baseline to 12 months

Parameters	Velocity	Unemployed		Government employed		Private employed		Self employed		F-value	p-value
		Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Weight	BL-3M	0.62	0.18	0.78	0.04	0.72	0.25	0.62	0.22	1.6556	0.1770
	3M-6M	0.62	0.18	0.78	0.04	0.72	0.25	0.63	0.23	1.5010	0.2147
	6M-9M	0.62	0.18	0.78	0.04	0.72	0.25	0.61	0.22	1.6498	0.1783
	9M-12M	0.57	0.21	0.58	0.04	0.64	0.33	0.53	0.27	0.8313	0.4777
Height	BL-3M	1.35	0.58	1.46	0.09	1.43	0.31	1.24	0.42	1.0249	0.3821
	3M-6M	1.35	0.58	1.46	0.09	1.43	0.31	1.23	0.39	1.0928	0.3526
	6M-9M	1.35	0.59	1.46	0.09	1.27	0.53	1.23	0.44	1.0707	0.3620
	9M-12M	1.30	0.79	1.42	0.18	1.63	0.45	1.20	0.57	0.8813	0.4513
BMI	BL-6M	0.76	0.50	1.09	0.25	0.86	0.39	0.82	0.52	0.9375	0.4230
	6M-12M	0.62	0.46	0.73	0.19	0.66	0.46	0.61	0.50	0.1226	0.9467

***p<0.05 (one way ANOVA)**

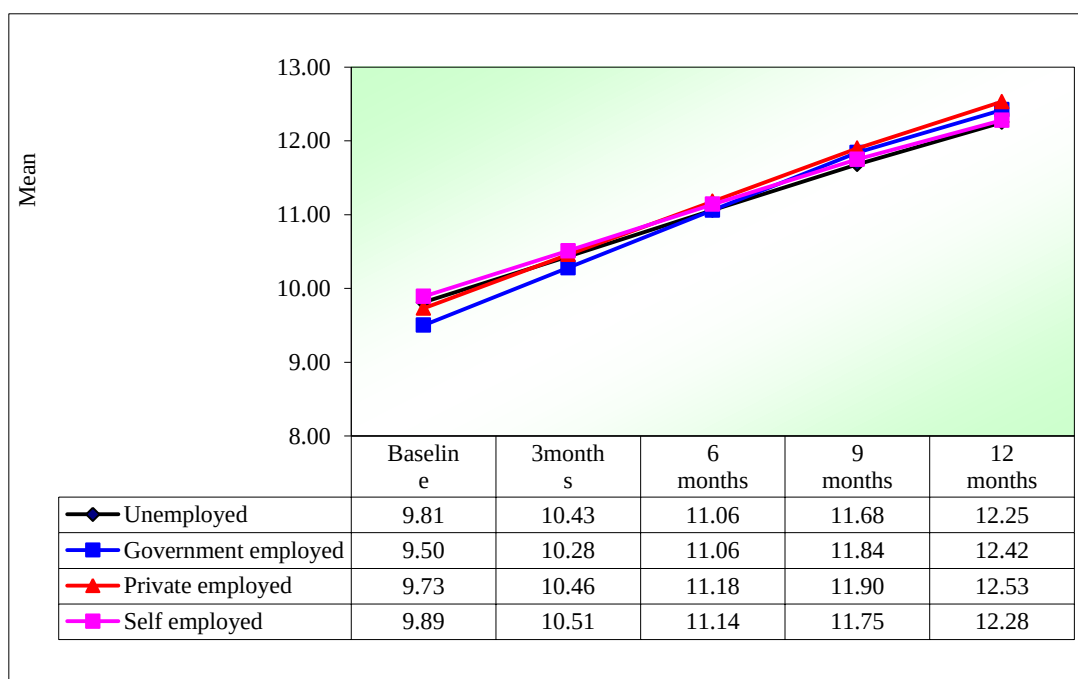
In our study weight velocity, height velocity and BMI velocity was more among participant's whose mothers were employed in government sector, followed by private sector. The difference was not statistically significant with $P>0.05$.

Table 60: Association between occupation of mother with actual mean weight of children at different time points

Time points	Unemployed		Government employed		Private employed		Self employed		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Baseline	9.81	1.77	9.50	2.55	9.73	1.52	9.89	1.87	0.1032	0.9581
3months	10.43	1.75	10.28	2.56	10.46	1.64	10.51	1.88	0.0500	0.9852
6 months	11.06	1.75	11.06	2.58	11.18	1.79	11.14	1.90	0.0414	0.9888
9 months	11.68	1.76	11.84	2.60	11.90	1.95	11.75	1.96	0.0568	0.9822
12 months	12.25	1.82	12.42	2.61	12.53	2.10	12.28	2.03	0.0571	0.9821

p<0.05 (one way ANOVA)

Figure 45: Association between occupation of mother with actual mean weight at different time points



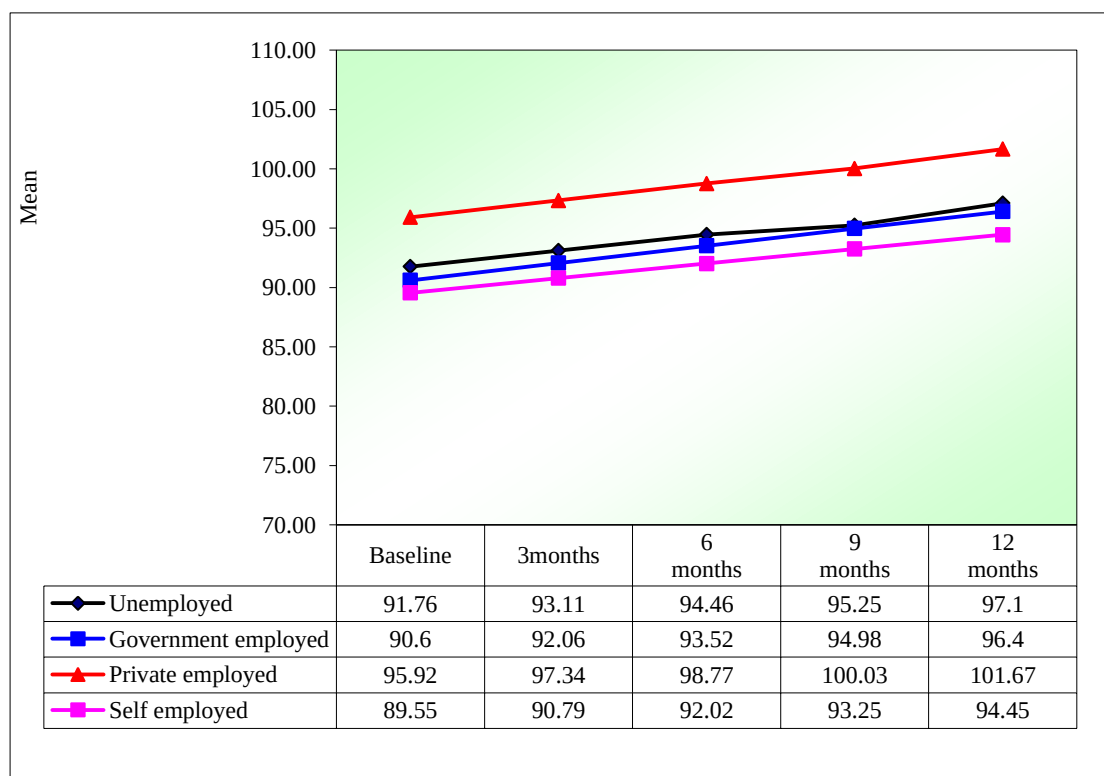
Weight of participants whose mothers were self-employed was more at the beginning of the study. At the end of the study the actual weight of participants whose mothers were employed in private sector was better, followed by government employed, self-employed and least was in unemployed. But the difference was not statistically significant with $P>0.05$.

Table 61: Association between occupation of mother with actual mean height at different time points

Time points	Unemployed		Government employed		Private employed		Self employed		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Baseline	91.76	8.51	90.60	6.15	95.92	10.69	89.55	8.41	1.8760	0.1340
3months	93.11	8.53	92.06	6.15	97.34	10.83	90.79	8.46	2.0171	0.1119
6 months	94.46	8.59	93.52	6.16	98.77	10.98	92.02	8.52	2.1512	0.0942
9 months	95.25	10.9	94.98	6.17	100.03	11.24	93.25	8.62	1.2454	0.2937
12 months	97.10	8.86	96.40	6.19	101.67	11.41	94.45	8.65	2.3800	0.0700

$p < 0.05$ (one way ANOVA)

Figure 46: Association between occupations of mother with actual mean height at different time points



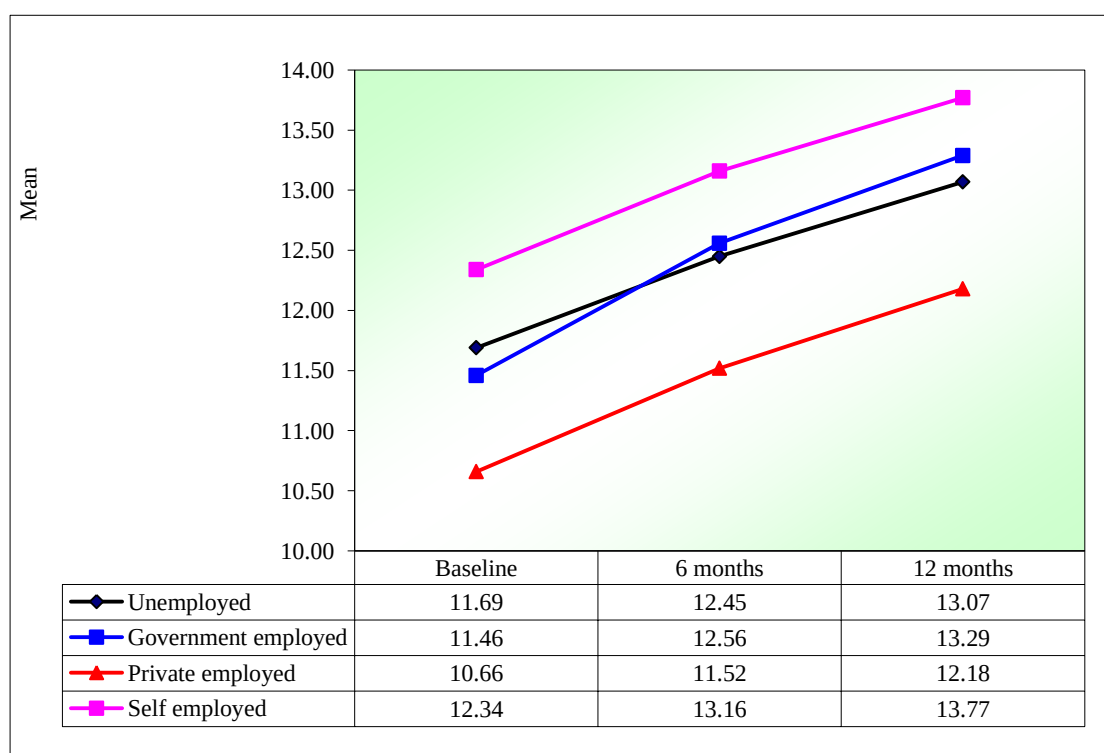
Height of participants whose mothers were employed in private form was better followed by unemployed; government employed and last self-employed. The difference was not statistically significant with $P>0.05$. Total increase in height was 5.94cm in private employed, 5.8 cm in government employed, 5.34 cm in unemployed and 4.9 cm in self-employed mother's children.

Table 62: Association between occupation of mother with actual mean BMI of children at different time points

Time points	Unemployed		Government employed		Private employed		Self employed		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Baseline	11.69	1.85	11.46	1.97	10.66*	1.48	12.34*	1.73	3.3348	0.0200*
6 months	12.45	1.74	12.56	1.85	11.52*	1.35	13.16*	1.54	4.1730	0.0066*
12 months	13.07	1.75	13.29	1.75	12.18*	1.36	13.77*	1.50	4.1164	0.0071*

* $p < 0.05$ (one way ANOVA)

Figure 47: Association between occupations of mother with actual mean BMI at different time points



Mean BMI among children whose mothers were self-employed was more at baseline (12.34), 6 month (13.16) and 12 months (13.77) as compared to mothers employed in government, private sector and illiterates. But increase in BMI at the end of 12 months was more among children whose mothers were government employee or in private employed. Least increase was observed among children of unemployed mother. This difference was statistically significant with $P < 0.05$. Total increase in BMI at the end of 12 months was better in participants whose (1.83) mother's were government employed, followed by private employed (1.52), self-employed (1.43) and unemployed (1.38).

Table 63: Correlation between weight of fathers and mothers with weight for age of study participants

Wt for age	Fathers weight		Mother weight	
	Spearman R	p-value	Spearman R	p-value
Baseline	0.1364	0.0270*	-0.0304	0.6193
6 months	0.2191	0.0003*	0.0044	0.9426
12 months	0.1816	0.0031*	0.0269	0.6594

***p<0.05 (Spearman's rank correlation)**

Our study showed that there was positive correlation between father's weight with weight of children at baseline, 6 months and 12 months which is statistically significant with $p<0.05$. No such correlation was found with mother's weight

Table 64: Correlation between height of fathers and mothers with height for age of study participants

Ht for age at	Fathers height		Mother height	
	Spearman R	p-value	Spearman R	p-value
Baseline	0.1336	0.0300*	0.0601	0.3250
6 months	0.1617	0.0085*	0.0884	0.1474
12 months	0.2093	0.0006*	0.1088	0.0742

***p<0.05 (Spearman's rank correlation)**

Our study showed that there was positive correlation between father's height with height of children at baseline, 6 months and 12 months which is statistically significant with $p<0.05$. No such correlation was found with mother's height

Table 65: Correlation between BMI of fathers and mothers with BMI of study participants

BMI at	Fathers BMI		Mother BMI	
	Spearman R	p-value	Spearman R	p-value
Baseline	0.0309	0.6179	0.0347	0.5698
6 months	0.1018	0.0996	0.0409	0.5033
12 months	0.1415	0.0217*	0.0901	0.1400

***p<0.05 (Spearman's rank correlation)**

Our study showed that there was positive correlation between father's BMI with BMI of children at 12 months which was statistically significant with $p<0.05$. No such correlation was found with mother's BMI

Section IV- Tables showing comparison of attained growth at different time period

Table 66: Comparison of weight scores of study participants at different time points

Times	Mean	SD	Mean Diff.	SD Diff.	t-value	p-value	95% CI for mean Diff.	
							Lower	Upper
Baseline	9.83	1.80	-0.63	0.19	-53.4097	0.0001*	-0.65	-0.60
3 month	10.45	1.79						
3 month	10.45	1.79	-0.63	0.20	-52.8596	0.0001*	-0.65	-0.61
6 months	11.08	1.80						
6 months	11.08	1.80	-0.63	0.19	-53.0154	0.0001*	-0.65	-0.60
9 months	11.71	1.83						
9 months	11.71	1.83	-0.56	0.23	-40.1675	0.0001*	-0.58	-0.53
12 months	12.27	1.89						

***p<0.05 (dependent t test)**

Table 67: Comparison of height score of study participants at different time points

Times	Mean	SD	Mean Diff.	SD Diff.	t-value	p-value	95% CI for mean Diff.	
							Lower	Upper
Baseline	91.18	8.54	-1.32	0.53	-40.9043	0.0001*	-1.39	-1.26
3 month	92.50	8.57						
3 month	92.50	8.57	-1.32	0.53	-41.1980	0.0001*	-1.38	-1.25
6 months	93.82	8.64						
6 months	93.82	8.64	-0.94	6.10	-2.5456	0.0115*	-1.68	-0.21
9 months	94.77	10.25						
9 months	94.77	10.25	-1.65	6.14	-4.4063	0.0001*	-2.38	-0.91
12 months	96.41	8.89						

***p<0.05 (dependent t test)**

Table 68: Comparison of BMI score of study participants at different time points

Times	Mean	SD	Mean Diff.	SD Diff.	t-value	p-value	95% CI for mean Diff.	
							Lower	Upper
Baseline	11.85	1.83	-1.40	0.95	-24.3785	0.0001*	-1.52	-1.29
6 months	13.26	1.70						
6 months	13.26	1.70	-83.16	9.95	-137.2599	0.0001*	-84.35	-81.96
12 months	96.41	8.89						

***p<0.05 (dependent t test)**

Table 66-68- Our study showed that gain in weight, height and BMI at 3 months, 6 months, 9months and 12 months interval was more and the difference was statistically significant with p<0.05.

Table 69: Comparison nutritional status / attained growth of study participants for weight using weight-for-age z scores at baseline, 6 months and 12 months'

Weight for age	Baseline	%	6 months	%	12 months	%	Chi-square	p-value
≤-2	80	29.63	76	28.15	62	22.96	37.0021	0.0001*
-2	86	31.85	102	37.78	95	35.19		
-1	75	27.78	67	24.81	78	28.89		
0	25	9.26	22	8.15	32	11.85		
1	4	1.48	3	1.11	3	1.11		
Total	270	100.00	270	100.00	270	100.00		

***p<0.05 (Friedman's ANOVA)**

In our study the prevalence of under nutrition (<-2) was which reduced to 22.96% at the end of 12 months this difference was statistically significant with p<0.05.

Table 70: Comparison nutritional status / attained growth of study participants for height using height -for-age z scores at baseline, 6 months and 12 months'

Height for age	Baseline	%	6 months	%	12 months	%	Chi-square	p-value
≤-2	17	6.29	25	9.26	38	14.07	283.7395	0.0001*
-2	19	7.04	44	16.30	55	20.37		
-1	58	21.48	62	22.96	64	23.70		
0	54	20.00	59	21.85	55	20.37		
1	49	18.15	48	17.78	41	15.19		
2	41	15.19	24	8.89	12	4.44		
3	32	11.85	8	2.96	5	1.85		
Total	270	100.00	270	100.00	270	100.00		

***p<0.05 (Friedman's ANOVA)**

In our study stunting increased from 6.29% in the beginning of the study to 14.07% at the end of 12 months. 11.85% were tall which decreased to 1.85% at the end of 12 months. Participants with height between -2 to 2 increased from 81.85% to 84.0%. This difference was statistically significant with $p<0.05$

Table 71: Comparison attained growth of study participants for BMI using of BMI -for-age z scores at baseline, 6 months and 12 months'

BMI	Baseline	%	6 months	%	12 months	%	Chi-square	p-value
≤ -2	208	77.04	156	57.77	105	38.89	340.4677	0.0001*
-2	33	12.22	61	22.59	71	26.30		
-1	21	7.78	33	12.22	58	21.48		
0	5	1.85	15	5.56	26	9.63		
1	1	0.37	4	1.48	7	2.59		
2	1	0.37	0	0.00	2	0.74		
3	1	0.37	1	0.37	1	0.37		
Total	270	100.00	270	100.00	270	100.00		

***p<0.05 (Friedman's ANOVA)**

In our study the BMI improved over a period of time children who were thin i.e. BMI < -2 were 77.04% in the beginning the study which decreased to 57.77% at 6 months and 38.89% at 12 months. This difference was statistically significant with $p < 0.05$

Table 72: Comparison of nutritional status / attained growth of study participants for MUAC at baseline, 6 months and 12 months'

MUAC	Baseline	%	6 months	%	12 months	%	Chi-square	p-value
<12.5	194	71.85	77	28.52	10	3.70	388.1072	0.0001*
12.5-13.5	52	19.26	101	37.41	47	17.41		
>13.5	24	8.89	92	34.07	213	78.89		
Total	270	100.00	270	100.00	270	100.00		

***p<0.05 (Friedman's ANOVA)**

In our study the MUAC improved over a period of time participants who were having MUAC <12.5 were 71.85% in the beginning the study which decreased to 28.52% at 6 months and 3.70% at 12 months. Participants with MUAC > 13.5 increased from 8.89% to 78.89% at the end of 12 months. This difference was statistically significant with p<0.05

Table 73: Comparison of nutritional status / attained growth of study participants for Head circumference using z scores at baseline, 6 months and 12 months'

HC	Baseline	%	6 months	%	12 months	%	Chi-square	p-value
≤-2	139	51.48	93	34.44	41	15.19	316.2895	0.0001*
-2	59	21.85	73	27.04	54	20.00		
-1	37	13.70	60	22.22	82	30.37		
0	26	9.63	33	12.22	59	21.85		
1	6	2.22	11	4.07	27	10.00		
2	2	0.74	0	0.00	4	1.48		
3	1	0.37	0	0.00	3	1.11		
Total	270	100.00	270	100.00	270	100.00		

***p<0.05 (Friedman's ANOVA)**

In our study the HC improved over a period of time, participants whose HC was <-2 were 51.48% in the beginning of the study, which decreased to 34.44% at 6 months and 15.19% at 12 months. This difference was statistically significant with p<0.05

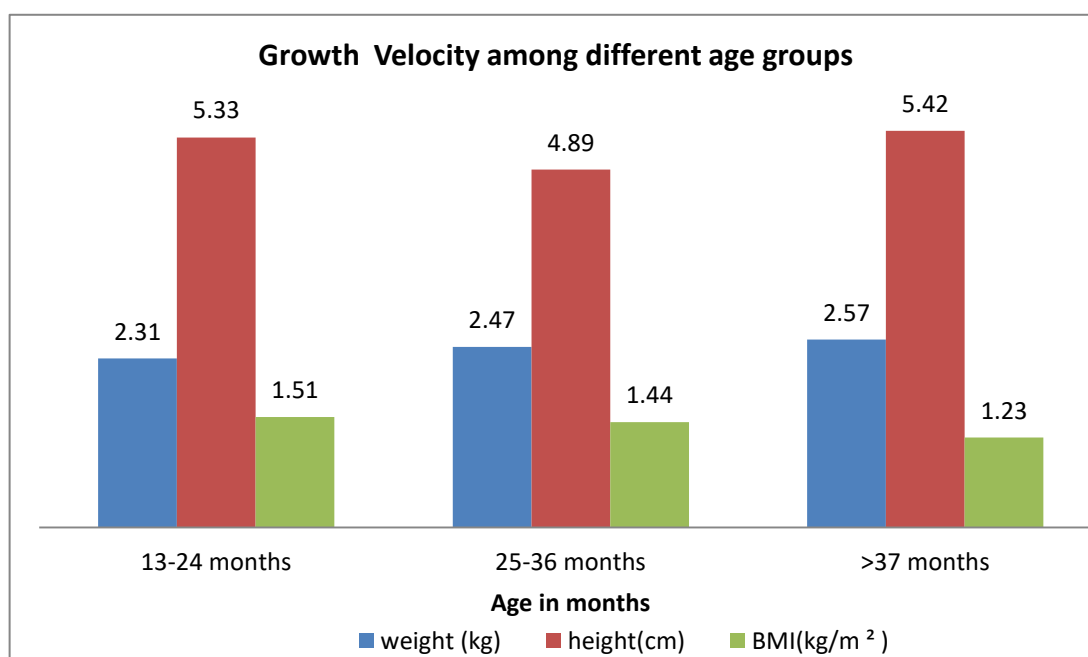
Table 74a: Comparison of age wise attained growth of study participants with nutritional status using z score at different time points

Weight-for-age						
Z-score	13-24 age in months		25-36 age in months		≥37 age in months	
	Aug-21	Aug-22	Aug-21	Aug-22	Aug-21	Aug-22
<-2	19 (18.09%)	19 (18.09%)	25(30.86%)	16(19.75%)	36(42.85%)	27(32.14%)
-2 to 2	86 (81.91%)	86 (81.91%)	56(69.13%)	65(80.24%)	48(57.14%)	57(67.85%)
Height-for-age						
<-2	4(3.80%)	13(12.38%)	3(3.70%)	10(12.34%)	10(11.90%)	15(17.44%)
-2 to 2	81(77.14%)	90(85.71%)	68(83.95%)	68(83.95%)	72(85.71%)	69(80.23%)
>2	20(19.04%)	2(1.90%)	10(12.34%)	3(3.70%)	2(2.38%)	2(2.32%)
BMI						
<-2	75(71.42%)	35(33.33%)	68(83.95%)	32(39.50%)	65(77.38%)	38(45.23%)
-2 to 2	29(27.61%)	69(65.71%)	13(38.27%)	49(60.49%)	19(22.61%)	46(54.76%)
>2	1(0.95%)	1(0.95%)	-	-	-	-
Mid-upper arm circumference						
<12.5	85(80.95%)	3(2.85%)	54(66.66%)	2(2.46%)	54(64.28%)	3(3.57%)
12.5-13.5	11(10.47%)	22(20.95%)	24(29.62%)	11(13.58%)	20(23.80%)	16(19.04%)
>13.5	9(8.57%)	80(76.19%)	3(3.70%)	68(83.95%)	10(11.90%)	65(77.38%)
Head circumference						
<-2	40(38.09%)	13(12.38%)	50(61.72%)	16(19.75%)	49(58.33%)	12(14.28%)
-2 to 2	65(61.90%)	92(87.61%)	30(37.03%)	63(77.77%)	35(41.66%)	71(84.52%)
>2	-	-	1(1.23%)	2(2.46%)	-	1(1.19%)

Age wise attained growth of study participants showed that weight-for-age z score less than -2, was improved in 25-36 months and ≥ 37 months group, but in the age groups 13-24 months, no such improvement seen. Whereas stunting increased at end of the study, in all age groups, BMI also improved in all the age groups. Where thinness (BMI <-2) decreased and BMI -2 to 2 improved over 1 year. MUAC showed lots of improvements. Head circumference showed also improvement in all the age groups.

Table 74b: Actual increase in weight, height and BMI in different age group

	Age in months		
	13-24 months	25-36 months	>37 months
weight (kg)	2.31	2.47	2.57
height(cm)	5.33	4.89	5.42
BMI(kg/m ²)	1.51	1.44	1.23

Figure 48: Actual increase in weight, height and BMI in different age groups

Actual increase in weight was more in children aged > 37 months which was 2.57 kgs, followed by 25-36 months (2.47 kgs) least was in children aged 13-24 months (2.31 kgs). Actual increase in height was observed in >37 months (5.42 cm) followed by 13-24 months (5.33 cm), least was in 25-36 months (4.89 cm). Increase in BMI was observed in 13-24 months (1.51 kgs/m²), followed by 25-36 months (1.44 kgs/m²), least was in >37 months (1.23 kgs/m²).

DISCUSSION

This was a longitudinal study done in a rural area for a period of one year among children aged 1-5 years. Who were registered at anganwadi.

Descriptive Tables Number -1 to 9

In our study Maximum number (38.89%) of children were between age group 13-24 months. Male children were slightly more (50.74%) compared to female children. Most of the children belonged to Hindu community i.e. 89.26% and 54.81 % of families were joint followed by nuclear families (44.81%). Almost half of the fathers and mothers were educated up to secondary level followed by illiterates, Maximum number of fathers worked on daily wages (46.67%) followed by farming. More than half of mothers were homemakers (53.16%), followed by daily wage labourers around 1/3rd (29.00%). 2/3rd children belonged to class IV socioeconomic class (66.67%) and very few to class II (0.37%) and class I (0.74%).

Similar findings in a study where participants aged 12-23 months were (33.5%-52.3%), 24-47 months (46%-34.5%), 24-35 months and least were in 48-59 months (20.5-36%) group.^{97, 40,69} Majority of children belonged to Hindu community (97.5%)(48.79%)^{75,33} In one study conducted in Ghana and South West Nigeria 4/5th of children belonged to Christian community.^{30,63} as these countries have more Christian population. Similar to our findings one study done in Nepal revealed that 62.8% of families were joint and followed by nuclear families.⁸¹ Unlike our study, a study done in Maharashtra and Hyderabad showed that, 58.90% and 62.7% of families were nuclear followed by joint families.^{33, 79} The difference would be these studies were done in Urban area. Unlike our study, a study done in Hyderabad found

that more than 50% of fathers (58%) and mothers (64%) of children were illiterate,⁷⁹ a study done in Nepal, 32.4% and 20.8% of fathers and mothers were illiterate respectively.⁸¹ In a study done in Hyderabad more than 2/3rd of fathers were daily wage labourer (66%), 1/4th of them were cultivators/ farmers, 2/5th of mothers were labourers (44.8%) followed by housewives i.e. 1/4th (28.7%).⁶⁴ In a study done in Nepal 4/5th of mothers were home makers (86%) and 1/4th of fathers were labourer/ daily wages (25.6%)⁸¹ a study done in Maharashtra maximum children were belonged to class V (67.09%) and minimum to class IV (26.15%) and class III (4.61%)³³ which is similar to our in a study done in Nepal maximum children belonged to less than Rs10000 (35.7%) per month income followed by Rs10000-19999 (30.1%).⁸¹

Parents of study participants owned the houses and had electric supply; they were pucca houses (98.89%). About 2/5th had houses with three rooms followed by two rooms (34.81%), 1/5th had one room (18.52%) and very few had four rooms (5.19%). More than 50% houses had no overcrowding. About 4/5th of houses had proper ventilation (88.15%), Almost all the families used LPG gas (99.63%) for cooking. Most of the houses had toilet facility i.e. (95.56%). Almost all (99.26%) were using tap water and 0.74% water from tube well.

In a study done in Mumbai urban slums, more than 4/5th houses were kuccha.⁸⁴ Similar to our study, a study done in Coimbatore district and rural area of north India, about 70% of houses were semi pucca and pucca house respectively.^{14,73} In Coimbatore district, rural area of north India 82.5% , 99.7% practiced open air defecation.⁵⁶ In some studies done in Mumbai Urban slum more than 50% used tap water and rural area of north India and Coimbatore district more than 96.3% used tap water.^{84,14,73}

In our study more than 1/3rd of the children's birth order was 1st (36.30%), followed by 2nd (33.33%) and followed 3rd (21.48%) least 8.89% were either 4th and 5th order. Mean birth weight of the children ranged 1.50 kg to 4.50 kg. Most of the children were not admitted in the NICU (96.67%). All the children received immunization as per the age, and vitamin A prophylaxis, as per mother's information all the children received. More than 4/5th of children (87.41%) received EBF for 5 months, 12.22% for 6 months and very few > 7 months. About 39.63% children continued to receive breast milk at the time of survey.

Unlike our study a study done in Nigeria, birth order 2nd was more i.e. 2/5th, followed by 3rd i.e. 1/4th (20.4%), followed by, 3rd (25.2%), 4th (10.2%) and 5th and above (5.3%).⁶⁸ The difference could be due to the culture difference. Study is done in Coimbatore district, South Africa, Ghana and Bangladesh more than 92.7%, birth order was ≤ 2 and 46%, and 37.1% were first respectively.^{14, 59, 30, 71} A study done in Mumbai Urban slum 63% were partially immunized the difference could be place of study i.e. as this study was done in slum. In a study conducted across 35 low- and middle-income countries, it was found that 46.6% of infants received exclusive breastfeeding within the first 24 hours after delivery. Among these infants, 53.4% were breastfed for less than six months, and the breastfeeding duration for more than 50% of the children was less than two years.^{84, 82} additionally, over half of the children received breast milk. The full vaccination rate was 54.7%, and 48.7% of infants began breastfeeding within one hour of birth.⁸² A similar study in the Coimbatore district showed that among 83% of infants breastfeeding was initiated within one hour of birth. Furthermore, 64.6% of infants were exclusively breastfed for less than six months, and 92.7% of children continued breastfeeding for more than a year.¹⁴ In an urban slum in southern India, a related study revealed that 55.6% of

children were not immunized according to their age, 40% did not initiate breastfeeding within one hour of birth, and 70% of children were exclusively breastfed for the initial months of life.⁷⁰

In our study more than 4/5th of children received cow's and buffalo's milk as weaning food (82.22%), 15.56% received cereal. Frequency of weaning food given to children was twice and thrice in about 45% of children. As far as present diet is concerned more than 4/5th (85.19%) children received more than 4 meals per day. As far as vitamins and minerals were concerned 64.81% received iron syrup, followed by 21.11% received multivitamin, 1.85% received vitamin D. Around 12.22% received treatment for minor ailments

Similar to our study a study done in 35 low-and middle- income countries, more than 3/5th of children (63.2%) received vitamin A supplement.⁸² In a study done in urban slum of southern India, Abuja, Nigeria 38.4% and 28.8% of children aged ≥ 6 months of age of received complementary feeding.^{70,62} Similar to our study done in Mysore 50% of children received liquids as weaning food.⁶⁵

In our study underweight was observed among 29.26% of children, stunting was observed among 6.30% of children and thinness in 77.04%. About 72% of children's MUAC was < 12.5 cm and about 9% it was >13.5 cm. Approximately 50% of children had a small head circumference and 48.15% had normal (-2 to 2), and 0.37% had big head.

In studies done at various places and countries wasting ranged from 1.9%-29.3%,stunting ranged between 8.1%- 58.7 %, and underweight 7.7-42 %

73,82,14,70,60,67,75,88,44,41,8,62,77,33,3,52,68,72,32,66,54,63

The mean calorie consumed in the beginning of the study was 671.08, average required calories was 1143.33. Hence average calorie deficiency was 381.58 ± 157.21 . The mean total protein intake was 20.58gms. The average required protein was 17.93. Hence there was no deficiency of protein intake.

A study indicated that calorie consumption was below 50% of the recommended dietary allowance (RDA).¹⁴ A study done in India 2/3rd of the children had low calorie consumption and 1/3rd had low protein intake.⁶⁶ A study by Prasad et al. reported an average calorie intake of approximately 900 calories per day among urban Eastern Indians, which was below the recommended 1143.33 calories.⁹⁸ The MENA study noted an average caloric intake of around 800-900 calories, highlighting a regional trend of insufficient calorie consumption.⁹⁹ A study by Radhika et al. found that protein intake in urban South Indians was generally adequate, with an average intake of 19.7 grams per day, but varied significantly based on socioeconomic status and dietary preferences.¹⁰⁰ A study by Misra et al. similarly reported average protein intakes of 18-20 grams per day, meeting or exceeding the recommended levels in urban Indian contexts, though disparities existed across different demographic groups.¹⁰¹

In our study cereals were consumed daily by all 270 participants in our study. 2/3rd included pulses and legumes in their daily diet, about 1/10th of them consuming on alternate day. Green leafy vegetables were part of daily intake for 2/3rd of participants, while 1/5th consumed them on alternate day and 1/10th weekly. Other vegetables were consumed daily to weekly by varying proportions, whereas fruit consumption ranged from daily (10.37%) to weekly (2/3rd). Milk was a daily dietary component for most of the participants, whereas oils and fats were consumed weekly

by about 1/3rd. Sweets were consumed weekly by 2/3rd of participants, while meat and fish were infrequently consumed by 1/3rd and 2/3rd never consumed.

A study conducted in South Africa found that the most commonly consumed food groups were grains, roots, tubers; dairy products; other fruits and vegetables, and flesh foods. There were significant differences in the consumption of dairy products ($P = 0.024$), flesh foods ($P = 0.012$), and other fruits and vegetables ($P = 0.032$) across different age groups. The least consumed food groups included eggs, vitamin A-rich fruits and vegetables, legumes, and nuts. Among 4-year-olds, dairy products were the least frequently consumed. Three-year-old children consumed fewer vitamin A-rich fruits and vegetables, flesh foods, legumes, and nuts compared to older children.⁵⁴ Similar to our study, by Prasad et al. found that in urban Eastern India, cereals constituted a major part of the diet for most individuals, reported a slightly higher daily fruit consumption rate of 15%.⁹⁸ Similarly, an ecological study in the Middle East and North Africa region showed that cereals were the primary food group, contributing significantly to daily caloric intake, dairy products were a significant part of the diet, Sweets were consumed weekly by 67% of participants, where sugar and sweeteners showed an increasing trend over several decades.⁹⁹ Similar to the findings of Misra et al., which highlighted moderate consumption of oils and fats, meat and fish were infrequently consumed by 33% of participants, with 67% never consuming fish in urban Indian diets.¹⁰¹ Radhika et al. reported a lower daily intake of green leafy vegetables (45%) among urban South Indians.¹⁰⁰

In our study about 15% of children consumed <5 food variety (irrespective of food groups), 20% consumed more than seven food variety, majority consumed 5-6 food variety. More than 90% of children consumed food items from less than 4 food groups. As far as DSS is concerned about 1/5th of children consumed 8, 10, 12

servings, ideal DDS as per recommendation being 20, none of the children consumed 20 servings.

A study conducted in South Africa found that more than half of the children had a low dietary diversity score, while 42% had adequate scores. Among different age groups, 3-year-olds showed a higher prevalence of low dietary diversity (2/3rd) compared to 4-year-olds (50%).⁵⁴ In another South African study, the dietary diversity scores ranged from 1 to 10 out of 12 food groups, with an average score of 4.39 ± 1.55 , 2/3rd of children were classified as low DDS group, while 1/3rd were in the medium DDS category.⁵⁹ In Tobago, a study revealed that the highest number of food items consumed by children in a 24-hour period was seventeen. In contrast to two-thirds of the children in one study consumed various food items, the mean Food Variety Score (FVS) was 9.37 ± 2.45 , ranging from 2 to 17.¹³ A study found that dietary diversity was often limited among children in low- and middle-income countries, majority of children consumed a restricted range of food groups, which was associated with insufficient intake of essential nutrients.¹⁰² A study conducted by Kennedy et al. found higher dietary diversity scores among children, with a significant number achieving scores of 9-12. Sub-Saharan African countries often have more diversified agricultural systems compared to regions like Karnataka, which might influence the variety of food items available to children.¹⁰³ A study by Moursi et al. conducted in Madagascar, also reported low dietary diversity scores among children.¹⁰⁴ They found that only a small percentage of children achieved a high DDS, have shown that higher dietary diversity is linked to better nutritional status and hence optimum attained growth.¹⁰⁵

In our study father's height was >160cm among 2/5th of children and <155cm in 1/5th. Father's weight was >60kg in 2/5th and <54.4 kg in 1/5th. More than 2/5th of Mother height was >150cm and more than 1/5th has height <145cm. About 50% of Mother's weight was >45kg and 1/5th had weight <40kg. More than 50% of both father and mother had normal BMI. More than 1/5th 24.71% of fathers and ten 1/10th of mothers were overweight, very few father and mothers were obese.

Similar to our study finding, in other studies fathers height >169.0 cm in 25.3%, 165.1-169.0 cm in 33.5%, 161.1-165.0 cm in 37.7%, 157.1-161.0 cm in 43.6% and ≤157.0cm 49.1% and mothers height was >156.0 cm in 23.6%, 153.1-156.0cm in 30.7%, 150.1-153.0cm 38.1%, 147.1-150.0 cm 43.4% and ≤147.0 cm in 53.5%⁸⁵ A study done in Indonesia father height <165cm in 37.4% and >165 cm 62.6%, mother's height <155cm in 35% and >155cm in 65%.⁸⁶ A study by Kimani-Murage et al. in Kenya also highlighted the correlation between parental and child anthropometric measures. They found that parental overweight and obesity were associated with higher risks of child overweight.¹⁰⁶

Growth Velocity among study participants – Table number 10-33

In our study, weight velocity remained same among 13-24 months old children who were at 95th and 98th percentile, from 50th percentile below there was decline. In 25-36 months and ≥ 37 months below 25th percentile there was decline in weight velocity. Height velocity increased in children aged 13-24 months who were at 95th percentile and 98th percentile and it was almost constant in remaining i.e. 2nd to 90th percentile. Among 25-36 months children initially it was stable then there was decline and again increased in 95th and 98th percentile. In ≥ 37 months height velocity increased in 75th -95th percentile there was decline from 50th centile to 2nd centile.

BMI velocity declined in all the age groups but as the percentile increased from 2nd to 98th, the BMI velocity also increased. In our study 13-24 months age showed higher BMI velocity compared to ≥ 37 months and least was in 25-36 months. The reason for this being velocity of growth for height was more in ≥ 37 months by followed by 25-36 months. Between the 4 quarter MUAC velocity remained same except for 2nd and 5th centile which showed slight increase higher the percentile better the MUAC was observed. As the percentile increased HC was also increased in all the age groups. Velocity for weight, height and BMI was more among boys. Height velocity declined among boys in last quarter as compared to girls but not statistically significant. Weight velocity was more in children those who were 37 months and above followed by 25-36 month and least was in 13-24 months but statically not significant. Height velocity was more among children aged 37 months and above as compared to children aged 13-24 and 25-36 months difference was not statistically significant. BMI velocity was more from baseline to 6 months in 13-24 months as compared to other and 2 age groups it was statically significant with $p < 0.05$.

A study conducted in northwest Iran found that in the early months after birth, girls exhibited higher weight and length velocities. However, their growth velocity slightly decreased, after 12 months, girls in the 95th percentile experienced a higher growth velocity. Another study done in northwest Iran it was observed that boys consistently showed greater growth across all percentiles from birth to four years of age compared to girls. A study conducted in Maku found that boys had a higher growth velocity than girls during the first year of life. However, by 12 months of age, the growth velocities of boys and girls became equal, and no significant differences were observed up to the age of five years.^{26,25,24} A study by Mei et al. indicated that children in higher weight percentiles tend to maintain their weight velocity more

consistently than those in lower percentiles .¹⁰⁷ This is similar to our study the pattern of growth among children aged 25-36 months, where height velocity initially stabilizes, declines, and then increases in the higher percentiles, can be attributed to growth spurts often seen in this age group, as described by Karlberg.¹⁰⁸ In our study increase in BMI was more in children aged ≥ 37 months similar to our study, a study by Freedman et al. who noted that higher BMI percentiles are associated with greater BMI velocity, particularly in younger children.¹⁰⁹ A study by de Onis et al. indicating MUAC as a reliable measure of nutritional status in younger children as it tends to be constant from the age 1 year to 5years.¹¹⁰ Similar trends were noted in the WHO child growth standards, which showed consistent weight velocity in higher percentiles and declines in lower percentiles for children up to 24 months. Similarly height velocity tends to be higher in children with better nutritional status, children in higher percentiles exhibit increased height velocity, which also reported higher BMI velocity in younger children due to rapid early growth phases .and consistent MUAC growth and increased head circumference velocity in higher percentiles due to better nutritional status .^{111,112}

In our study baseline mean weight of boys was 9.95 and girls 9.70, mean difference was 0.25kg, the difference was not statistically significant ($p>0.05$). Even at baseline, 3 months, 6 months, 9months and 12 months there is no significant difference between weight velocity among boys and girls. Though the weight at the baseline,3,6,9 and 12 month, boys weight was more than that of girls. In our study baseline mean height of boys was 91.82cm and girls 90.53cm, mean difference was 1.29cm it was not statistically significant ($p<0.05$). A baseline, 3 months, 6 months, 9months and 12 months there was no significant difference between heights velocity among boys and girls. Though the height at the baseline,3,6,9 and 12 months, though

boys height was more than that of girls but growth velocity difference statistically not significant. In our study baseline mean BMI of boys was less (11.82) than girls (11.88), mean difference was -0.06, at baseline and 6 months and mean difference was -0.01 at 12 months so there is no difference in BMI velocity among boys and girls with $P>0.05$.

A study done in Iran examined the growth curves for boys and girls, finding that boys had a higher mean weight from birth up to two years of age. This weight difference, present from birth, increased progressively until the age of two.⁴² A study done in Ethiopia the height and weight velocity of the children by age. A marked decrease in the growth velocity is observed from the first year to the second year of the child.²⁰ A study found that while boys often had slightly higher weights, the differences were not statistically significant. In a study on early childhood growth patterns, where boys typically exhibited higher height measurements, but the differences in growth velocities among boys and girls were not significant. A longitudinal study examined BMI trajectories and found minimal differences between genders during early childhood. A study reported non-significant differences in MUAC and head circumference growth velocities between genders.^{113,114,115}

This study was done in West Bengal state of India, it was a longitudinal study from preschool age to maturity, 536 were followed up the height of boy was more compare to girls. Height velocity decreased from 1 year to 5 years. At 1 year From 12.8 to at 5 years 6.20 for boys and at 1 year from 11.26 to at 5 years 6.14 for girls. 12.18 among one year to 6.14 at 5 years.⁴⁵ A study done in south Indian children's age between 3-18 years to assess mean height velocity showed height velocity was more between 3-4 years (6.47 ± 1.85) as compared to 4-5 years (6.13 ± 1.74) for boys, girls mean height velocity was more compared to boys mean height velocity and it

was more between 3-4 years (7.96 ± 2.60) and 4-5 years it was (6.60 ± 2.17). the mean height velocity was 3.8 cm for boys who were at 3rd percentile and increased to 10 cm for boys who were at 97th percentile for girls age between 3-4 years it 4.3 cms at 3rd percentile which increased 12.8 cm and 97th percentile for boys aged between 4-5 years mean height velocity at 3rd percentile was 3.7 which increased 9.4 who were at 97th percentile for girls aged between 4-5 years mean height velocity was 4.2cm at 3rd percentile which increased to 10.8 cm for girls who were at 97th percentile. ⁴⁶ In a study done to assess mean height velocity among North Indian healthy school children, mean height velocity was assessed at baseline at 12 months they found that mean height velocity among girls was better compared to boys between age of 3-4 years which was 7.36 ± 0.77 and 7.67 ± 1.21 respectively mean height velocity for boys age between 4-5 years and for girls of same age was 7.18 ± 1.22 and 7.18 ± 1.03 respectively for both boys and girls mean height velocity increased from 3rd percentile to 97th percentile, for boys it was 3.64 at 3rd percentile 7.2 cm at 50th percentile 9.26 cm at 97th percentile for girls mean height velocity 5.19cm at 3rd percentile 7.15 cm at 50th percentile and 9.36cm at 97th percentile boys mean height velocity who were 5 years was 4.84 cm at 3rd percentile, 7.19cm at 50th percentile and 11.22 cm at 97th percentile mean height velocity girls who has 5 years 4.57 cm at 3rd percentile, 6.70cm at 50th percentile and 9.23cm at 97th percentile. At age of 5 boys who were at 97th percentile showed better height compared to girls. ⁴⁷

Immunization partial were at higher risk of malnourished (AOR) 4.81 as compared to immunized LBW has higher risk of been malnourished (AOR) 2.42. Children less than 2 years at higher risk of been malnourished compared to more than 2 years which (AOR) 1.5. ⁴⁸

Specific characteristics that distinguished regional clusters, it was found that, in addition to female education and urbanization, access to mass media, the use of clean cooking fuels, improved sanitation, and safe drinking water were the most significant determinants of child well-being. Conversely, factors such as low maternal BMI, household poverty, high fertility rates (evidenced by a large proportion of higher-order births), a predominantly Hindu population, maternal age at birth below 20 years, and lack of immunization were identified as significant contributors to lower child height and weight, as well as a higher prevalence of nutritional deficiencies among children under five years of age.⁴⁹ The study revealed that malnutrition was most prevalent among children aged 4 to 5 years, while the lowest prevalence was observed in the 0 to 6-month age group. Female children were more affected by malnutrition compared to male children. The educational and employment status of parents showed a positive influence on the nutritional status of the child. Additionally, birth weight and family income were identified as significant factors impacting children's nutritional well-being.⁵⁰

Mean weight velocity of malnourished children was 0.70 kgs per quarter compare to nourished children (0.59 kgs at the end of first quarter which was statistically significant. Similar finding in remaining 3 quarters. There was no difference between mean height velocity at all 4 quarters among malnourished and nourished children.

BMI of malnourished children was better compared to nourished children at all 4 quarters which was statistically significant with $p < 0.01$.

Association between Diet Diversity and growth velocity- Table Number- 34-40

Our study showed that weight velocity per month was more among children who received exclusive breast feeding up to 6 months as compared to those who received <6 months the difference was statistically significant with $p < 0.05$. There was no significant association between duration of breast feeding and height and BMI velocity. There was no significant association between adequacy of weaning food DDS with weight-for-age, height-for-age and BMI at different time point. Compared to baseline, DDS was positively correlated with weight velocity scores at 3,6,9 and 12 months . FVS and DSS did not have any positive correlation. There was no positive correlation between height velocity scores with DDS, FVS and DSS at baseline, 6 months and 9 months and 12 months. There was no statically significant ccorrelation between BMI scores with DDS, FVS and DSS at baseline, 6 months and 9 months and 12 months. There was negative ccorrelation between Mid upper arm circumference scores with DDS at baseline, 3, 6, 9 and 12 months which was statically significant. DSS was negatively correlated with MUAC at 6, 9 and 12 months which was statically significant. There was negative ccorrelation between head circumference scores with FVS at base line, 3,6,9 and 12 months. The reason could be protein intake was inadequate from baseline and these differences were statically significant with $p < 0.05$. In our study weight-for-age at baseline, height-for-age at baseline and 6 months, MUAC at 6 and 12 months and HC at 6 months were associated with adequacy of weaning food. This difference was statistically significant with $p < 0.05$.

A study by Kramer et al. which found that exclusive breastfeeding was associated with optimal weight gain in infancy, while height growth rates remain unaffected. Which is similar to our study a study by Onyango et al. (1998), who

reported that dietary diversity scores were not strong predictors of growth outcomes. Study by Arimond and Ruel, who found that dietary diversity is an important indicator of micronutrient adequacy, it does not always correlate with anthropometric measures of nutritional status.^{116,117,118} Arimond and Ruel found no significant association between dietary diversity and height-for-age in a cross-sectional study ($p>0.05$).¹¹⁹ Kennedy et al. reported no significant correlation between FVS and BMI in a longitudinal study ($p>0.05$).¹²⁰ Black et al. in a cohort study reported that weight-for-age at baseline is significantly associated with adequate weaning practices ($p<0.05$).¹²¹ Dewey and Adu-Afarwuah in a randomized controlled trial found height-for-age improvements significantly associated with better weaning food adequacy at 6 months ($p<0.05$).¹²² Which are similar to our study findings Bhutta et al. reported that MUAC improvements at 6 and 12 months are associated with better weaning food adequacy ($p<0.05$).¹²³

Association between environmental and socio-demographic variables and growth velocity- Table Number: 41 to 62

Our study showed irrespective of number of rooms the nutrition status of children improved over 1 year. BMI was less at 6 months and 12 months among children who lived in houses with 3 rooms. MUAC also was less at 6 months and head circumference at baseline among children who lived in houses with 3 room this difference was statistically significant with $P<0.05$. Overcrowding was associated with lesser MUAC at 12 months, this difference was statistically significant with $p<0.05$. In our study among study participants belonging to class I-III mean growth velocity for weight was better compared to class IV and class V, this difference was statically significant with $p<0.05$. Though height velocity was better among study participants belonging to class I-III, but the difference was not statistically significant

with $P > 0.05$. BMI velocity was better among study participants belonging to class IV and V, but statistically not significant with $p > 0.05$, the reason could be height velocity was better in Class I-III.

A longitudinal study by Pongou et al. found that overcrowding was significantly associated with reduced MUAC at 12 months ($p < 0.05$).¹²⁴ A study by Victora et al. in a multi-country cohort study reported that higher socioeconomic status (SES) groups showed better growth velocity for weight ($p < 0.05$).¹²⁵ A study by Grantham-McGregor et al. reported better height, MUAC, and HC velocity in higher SES groups, but not statistically significant.¹²⁶ A study by Ruel and Alderman found no significant difference in BMI velocity across SES groups ($p > 0.05$).¹²⁷ The study by Grellety and Golden which found that overcrowded living conditions negatively affect child growth parameters. A study by Victora et al. which emphasized the strong influence of SES on child nutrition and growth outcomes.^{128,129}

Our study showed weight velocity of study participants whose fathers were unemployed was less compared to those in government service and self-employed, but the difference was not statically significant with $p > 0.05$. Height velocity of study participants whose fathers were in government and private job was better, but the difference was not statically significant. In our occupation of mother was not associated with growth velocity for weight, height and BMI with $P > 0.05$.

A study conducted in India showed that children of employed mothers had better nutritional status compared to those of unemployed mothers, though the differences were not always statistically significant. Children of mothers employed in higher occupational status jobs exhibited better growth metrics. Another study from

Bangladesh found that children of fathers employed in skilled jobs had better height-for-age z-scores compared to those of fathers in unskilled jobs, though this difference was not statistically significant ($p > 0.05$). The study by Vollmer et al. (2017) in Kenya indicated that children of mothers working in the formal sector had better nutritional outcomes compared to those of mothers in informal or no employment. However, the differences in height and weight were not statistically significant.

134,135,136

Our study showed that weight, Height velocity of study participants whose father had studied up to degree and higher was better, compared to study participants whose fathers had studied up to secondary, primary and illiterates. BMI velocity was better among study participants whose fathers were illiterates..

A study by Makoka which underscores the positive impact of parental education, particularly paternal education, on child health outcomes.¹³⁰ A study by Semba et al. highlighted the critical role of maternal education in promoting child growth and nutrition.¹³¹ This was in contrast to our study a study done in Bangladesh indicated that higher parental education was generally associated with improved infant and young child feeding practices, which are crucial for child growth.¹³² A study done by Denmark highlighted the positive effects of maternal education on child health outcomes, suggesting that educated mothers are more likely to engage in health-promoting behaviors and utilize healthcare services effectively.¹³³

Correlation between parent's anthropometry and growth velocity Table Number- 63 to 65

Our study showed that there was positive correlation between father's weight with weight of children at baseline, 6 months and 12 months which is statistically

significant with $p < 0.05$. No such correlation with mother's weight. Our study showed that there was positive correlation between father's height with height of children at baseline, 6 months and 12 months which was statistically significant with $p < 0.05$. No such correlation with mother's height. Our study showed that there was positive correlation between father's BMI with BMI of children at 12 months which was statistically significant with $p < 0.05$. No such correlation with mother's BMI

A study in China reported a significant positive association between paternal weight and child weight. The study found that children with heavier fathers had higher weights at various stages of early childhood.¹³⁷ Research from Brazil highlighted a strong positive correlation between paternal height and child height. The study showed that children with taller fathers were more likely to have better height-for-age z-scores (HAZ) at multiple time points these findings are similar to our study.¹³⁸ A study conducted in the United States found that paternal BMI was significantly associated with the BMI of their children at 12.¹³⁹ Unlike our study, a study from India showed significant correlations between maternal weight and child weight at various stages of infancy and early childhood, suggesting that maternal nutritional status directly influences child growth.¹⁴⁰ Similarly, research in Nepal found that maternal height was significantly associated with child height, with shorter maternal stature being linked to an increased risk of stunting in children.¹⁴¹ A study from Ethiopia indicated that maternal BMI was significantly correlated with child BMI, highlighting the role of maternal health in determining child nutritional status.¹⁴²

Comparison of attained growth of study participants at different time period
Table Number- 66 to 74b

In our study the prevalence of under nutrition reduced from 31.85% to 22.96% at the end of 12 months this difference was statistically significant with $p < 0.05$, Stunting increased from beginning of the study till the end of 12 months from 6.29% to 14.07%, this difference was statistically significant with $p < 0.05$. In our study BMI improved over a period of time children who were thin i.e. BMI Z score < -2 were 77.04% in the beginning the study, which decreased to 57.77% at 6 months and 38.89% at 12 months. This difference was statistically significant with $p < 0.05$. In our study MUAC improved over a period of time, children who were malnourished i.e. MUAC < 12.5 were 71.85% in the beginning the study which decreased to 28.52% at 6 months and 3.70% at 12 months. This difference was statistically significant with $p < 0.05$. In our study the HC improved over a period of time children who were had Z score for HC < -2 were 51.48% in the beginning the study which decreased to 34.44% at 6 months and 15.19% at 12 months. This difference was statistically significant with $p < 0.05$

A study conducted in Ethiopia reported a decrease in under nutrition prevalence from 37% to 29% over one-year period following nutritional interventions.¹⁴³ Similarly, a study in India showed a reduction in under nutrition among children from 28% to 20% over 12 months due to community-based nutritional programs.¹⁴⁴ Similar to our study a study done Bangladesh indicated an increase in stunting rates despite overall improvements in weight and BMI, the reason could be chronic malnutrition.¹⁴⁵ A study done in Kenya, showed a reduction in the prevalence of thinness (BMI < -2) from 64% to 34% over a one-year intervention period.¹⁴⁶

Similar to our study conducted in Malawi, where nutritional interventions led to improvement in MUAC, prevalence of MUAC <12.5 reduced from 60% to 15% over one year.¹⁴⁷ A study in Peru, which noted a significant increase in HC growth rates among children who received improved diet.¹⁴⁸ In our study initially AW distributed dry ration, after 6 months children started attending AWS, cooked food was served which improved total calorie intake.

During catch up growth period what matters is the total calories and protein consumed than food variety. Catch up growth was better in malnourished children when favorable conditions was provided, like improved quantity of diet with more calories and adequate protein.⁸³

SUMMARY

Over the course of one year, this longitudinal study was conducted in a rural area to examine growth velocity of 270 children aged between 1-5 years and to identify associated factors. The largest proportion of children fell within the 13-24 months age bracket, with males slightly outnumbering females (50.74%).

A significant number of fathers and mothers had received secondary education or were illiterate. The majority of fathers worked in daily wage jobs (46.67%) or were engaged in farming, while most mothers were homemakers (53.16%) or worked as daily wage laborers (29.00%). The socioeconomic distribution showed that a majority of children belonged to class IV (66.67%), with minimal representation in classes II (0.37%) and I (0.74%). First-born children constituted the highest proportion (36.30%), followed closely by second-born (33.33%), and third-born (21.48%), with smaller percentages for fourth and fifth births (8.89%). Nutritional assessments revealed that 29.26% of children were underweight, 6.30% were stunted, and 77.04% were categorized as thin. Regarding physical measurements, 71.86% of children had a mid-upper arm circumference of less than 12.5 cm, while 51.48% had a smaller than average head circumference, and 48.15% fell within the normal range (-2 to 2 SD). A small percentage (0.37%) had a larger head circumference.

The study found an average calorie intake of 671.08, which was significantly lower than the recommended 1143.33 calories, resulting in an average calorie deficit of 381.58 ± 157.21 . Protein intake averaged at 20.58, slightly above the required 17.93, with an average protein deficit of 1.02 ± 2.4 . In terms of dietary diversity, most children consumed three (52.96%) or four (39.63%) different food items, while only a small fraction achieved a high dietary diversity score (1.48%). The majority (88.9%)

consumed food from 5-8 different food groups, indicating a medium level of dietary diversity.

Anthropometric data related to parents showed that a substantial proportion of fathers (43.73%) were taller than 160 cm, whereas 19.01% were shorter than 155 cm. For mothers, 48.15% were taller than 150 cm, and 23.70% were shorter than 145 cm. The majority of both fathers (64.26%) and mothers (59.63%) had a normal BMI, while a notable percentage of fathers (24.71%) and fewer mothers (8.15%) were overweight. Obesity was observed in 3.04% of fathers and 1.11% of mothers. Growth velocity analysis revealed that children aged 13-24 months maintained consistent growth rates at the 95th and 98th percentiles. However, a decline in growth velocity was observed below the 50th percentile in the 25-36 months age group and below the 25th percentile for children aged 37 months and above.

A significant portion of both fathers and mothers had attained secondary education or were illiterate. Fathers were predominantly engaged in daily wage labor (46.67%) or farming, while mothers were mainly homemakers (53.16%) or engaged in daily wage labor (29.00%). Socioeconomically, most children belonged to class IV (66.67%), with minimal representation in classes II (0.37%) and I (0.74%). In terms of physical measurements, 71.86% of children had a mid-upper arm circumference of less than 12.5 cm, while 51.48% had a smaller than average head circumference, and 48.15% fell within the normal range (-2 to 2 SD). A small percentage (0.37%) had a larger head circumference.

The study found that average calorie intake was 671.08, significantly lower than the recommended 1143.33 calories, resulting in an average calorie deficit of 381.58 ± 157.21 . Protein intake averaged 20.58, slightly above the required 17.93,

with an average protein deficit of 1.02 ± 2.4 . Regarding dietary diversity, most children consumed three (52.96%) or four (39.63%) different food items, while only a small fraction achieved a high dietary diversity score (1.48%). The majority (88.9%) consumed food from 5-8 different food groups, indicating moderate dietary diversity. Anthropometric data concerning parents indicated that a substantial proportion of fathers (43.73%) were taller than 160 cm, with 19.01% shorter than 155 cm. For mothers, 48.15% were taller than 150 cm, and 23.70% were shorter than 145 cm. Most fathers (64.26%) and mothers (59.63%) had a normal BMI, though a significant proportion of fathers (24.71%) and fewer mothers (8.15%) were overweight. Obesity rates were 3.04% among fathers and 1.11% among mothers. The analysis of growth velocity revealed that children aged 13-24 months maintained consistent growth rates at the 95th and 98th percentiles. However, there was a decline in growth velocity below the 50th percentile for those aged 25-36 months and below the 25th percentile for children aged 37 months and above.

In our study, significant differences were observed in weight growth velocity among children from socioeconomic classes I-III compared to those in classes IV and V ($p < 0.05$). Differences in height, mid-upper arm circumference, and head circumference velocities were noted between children whose fathers had higher education levels versus those with lower education levels, although these were not statistically significant ($p > 0.05$). Similar findings were observed for children whose mothers had higher education levels. There were no statistically significant associations found between maternal occupation and growth velocities related to weight, height, BMI, mid-upper arm circumference, and head circumference in our study. Our study found a significant positive correlation between fathers' weight and the weight of children at baseline, 6 months, and 12 months ($p < 0.05$). However, no

such correlation was observed with mothers' weight. Similarly, there was a statistically significant positive correlation between fathers' height and children's height at baseline, 6 months, and 12 months ($p < 0.05$), whereas no such correlation existed with mothers' height. Furthermore, a positive correlation was observed between fathers' BMI and children's BMI at 12 months, which was statistically significant ($p < 0.05$), but no such correlation was found with mothers' BMI. Over the course of 12 months, our study showed a significant decrease in the prevalence of under nutrition, from 31.85% to 22.96% ($p < 0.05$). Conversely, stunting increased significantly from 6.29% to 14.07% during the same period ($p < 0.05$).

Moreover, improvements were observed in BMI categories over time: the percentage of children classified as thin (BMI < -2) decreased from 77.04% at the beginning of the study to 38.89% at 12 months ($p < 0.05$). Similarly, there were significant improvements in mid-upper arm circumference (MUAC) and head circumference (HC) measurements among children who were initially malnourished, with MUAC < 12.5 decreasing from 71.85% to 3.70% and HC < -2 decreasing from 51.48% to 15.19% by the end of 12 months ($p < 0.05$).

CONCLUSION

Weight and height velocity decreased among those who were less than 25th centile for weight and height. Weight and height velocity was better among those aged ≥ 37 months. BMI velocity was better among 13-24 months. Growth velocity for weight was better among children who received EBF for ≥ 6 months this was statistically significant with $p < 0.006$. Adequacy of weaning food was associated with growth velocity for weight, height, MUAC and HC. There was association between number of rooms, overcrowding and proper ventilation with growth velocity for BMI and MUAC. Fathers height, weight and BMI was positively correlated with child's height, weight and BMI velocity.

Our study also showed that with improvement in total calorie and adequacy of protein intake the attained growth for weight at various time period also improved. MUAC and head circumference also improved. But stunting increased over a period of time.

Malnourished children showed better weight height and BMI velocity as compared to normal children. When their nutrition improved in quality and quantity. Our study showed that catch up growth for weight was better in undernourished children as compared to normal and over nourished children. Stunted children failed to show catch up growth for height.

Growth velocity for weight, height, BMI, MUAC and HC was better among children who were at higher percentile in the beginning of the study. Hence it is important to maintain better nutritional status of children right from Intra uterine life.

Our study was longitudinal study planned to know the growth velocity of children <5 years and effect of diet and other socio demographic variables, environmental variables and also anthropometry of parents on growth velocity.

Further studies can concentrate on studying growth velocity of children with growth faltering as compared to children with normal growth velocity.

Our study showed that malnourished children's catch up growth for weight was better than well-nourished children, but not much difference in height velocity, hence BMI velocity was better among malnourished children as compared to normal children, this difference was statistically significant.

STRENGTHS OF THE STUDY

- One of the few comprehensive longitudinal studies to assess the growth velocity among children aged between 1-5 years.
- Study included various factors that could influence growth velocity i.e. diet, (both quantity and quality), socio demographic variables environmental variables and anthropometry of parents.
- Growth velocity was measured over a period of one year at 3 months interval for one year.
- As the study was conducted during COVID pandemic, where anganwadis were closed for some time, and started to function later helped the study to show actual effect of diet at baseline, 6 months and 12 months on attained growth of under five children.
- Comparison of growth velocity for weight, height and BMI was done among different age groups among boys and girls and also among malnourished and nourished children.

LIMITATIONS

- As it was a longitudinal study, anganwadi children belonging to two sub-centers were included
- As the study was done during COVID pandemic the nutritional status of children could be different at baseline as compared to normal situation
- As the quality and quantity of diet was compromised in the beginning of the study, due to COVID pandemic hence other determinants of growth velocity could not have shown their effect.
- Assessment of micronutrient intake was not done mean adequacy ratio(MAR) and nutrient adequacy ratio (NAR)
- Head circumference has significance up to 2 years only and MUAC remained constant up to 5 year hence Z scores for HC and MUAC at the beginning and at the end of the study was used to assess attained growth at the end of 1 year along with velocity
- Could not include children aged between 1-12 months

FURTHER IMPLICATION

- Multi centre mixed method study could be planned, to start with longitudinal study to assess growth velocity for six months. Based on the result of longitudinal study an interventional study could be planned for children showing poor growth velocity.

RECOMMENDATIONS

- Reemphasis on education regarding
 - Exclusive breast feeding should be done, which helps in improving growth velocity.
 - Correct weaning practices with single, double, triple and quadruple mix type of weaning food containing adequate calorie and proteins is needed for better growth velocity
- Inclusion of more food variety which improves appetite, Diet Diversity score more than 4 with adequate Diet Serving Score is very much required to meet macro and micro nutrient requirements hence helps in better growth velocity.
 - Hence mothers have to be sensitized regarding the same
 - Menu provided at anganwadi should include variety of food belonging to diverse food groups (Diet Diversity)
 - Informal education at anganwadi should include popular cartoons /character advertising for food varieties – vegetables, fruits etc.
- Improvement in socio economic condition indirectly helps in better environmental condition, better nutrition, education which should be aimed at long term goal of achieving better growth among children.
- More than 60% never consumed meat/ fish about 1/4th didn't consume eggs. Hence other sources of good quality proteins need to be supplemented in the diet at home and at anganwadi.

- Higher the percentile, better growth velocity, hence malnutrition should be avoided right from antenatal period till adolescent period.
- Malnourished children show catch up growth if adequate calories and proteins are provided hence growth monitoring should be done not only for weight but also height and BMI.

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ANNEXURES

ANNEXURE A - DATA COLLECTION INSTRUMENT

Study Topic: “Growth Velocity and its association with diet among children aged between 1-5 years residing in rural area of Belagavi- A Longitudinal Study”

Sub-Center Name:_____

Anganwadi Name/ Number:_____

Sl. No: _____

A. SOCIO DEMOGRAPHIC DETAILS:

1. Name : _____

2. Age (in months) : _____

3. Sex

1. Male

2. Female

4. Religion

1. Hindu

2. Muslim

3. Christian

4. Jain

5. others, specify_____

5. Type of the family

1. Nuclear

2. Joint

3. Broken

6. Education of father

1. Illiterate

2. Read and write

3. 1 – 4 Standard
 4. 5 – 8 Standard
 5. 9 – 12
 6. Diploma
 7. Degree
 8. PG
7. Education of mother:
1. Illiterate
 2. Read and write
 3. 1 – 4 Standard
 4. 5 – 8 Standard
 5. 9 – 12
 6. Diploma
 7. Degree
 8. PG
8. Occupation of Father
1. Farmer
 2. Laborer
 3. Self-employed
 4. Govt. employee
 5. Pvt. Employee
 6. Unemployed
9. Occupation of Mother
1. Farmer
 2. Laborer
 3. Self-employed
 4. Govt. employee
 5. Pvt. Employee
 6. Home maker

B. SOCIO-ECONOMIC HISTORY

10. Total monthly income : Rs _____
11. Number of family members : _____
12. Per capita income : Rs _____/ month
13. Socio economic class : I/II/III/IV/V

C. ANTHROPOMETRIC MEASUREMENTS OF PARENTS

1. **Father** a) Height : _____ b) Weight : _____
_____ BMI: _____
2. **Mother** a) Height: _____ b) Weight: _____
_____ BMI: _____

D. HOUSING

- 1 Type of house:
1. Pucca
 2. Semipucca
 3. Kacchar
- 2 Ownership of the House
1. Own
 2. Rented
 3. Others (_____)
- 3 Number of rooms in house
1. II
 2. IV
 3. V
 4. VI
- 4 Overcrowding:
1. Present
 2. Absent

5 Proper ventilation in the house

1. Yes
2. No

6 Electrification of the house

1. Yes
2. No.

7 Type of cooking fuel mostly used

1. Fire wood
2. Kerosene
3. Biogas
4. LPG
5. Electricity
6. Others (Spfy:_____)

8 Toilet facility is available in your house

1. Yes
2. No

9 Source of drinking water

1. Sanitary well
2. Unsanitary well
3. Tube well
4. Tap water
5. Water kiosk
6. packed water
7. Others (_____)

E. CHILD HISTROY

- 1 Birth Order: 1/ 2/ 3/ 4/5
- 2 Birth Weight: _____ grams
- 3 NICU administration:
 1. Yes
 2. No
 3. If Yes Mention reason _____
- A) Any illness in the past 15 days?
 1. Yes
 2. No
 3. If Yes Specify _____
- B)). Required hospital admission?
 1. Yes
 2. No
- C) if Yes mention
 1. No of days _____
 2. Diagnosis _____
- 4 Any repeated illness?
 1. ARI
 2. Diarrhea
 3. Skin Infection
 4. Others mention _____
 5. No
- 5 Immunization (As per the age)
 1. Completed
 2. Incomplete
 3. unimmunized
- 6 Vitamin A prophylaxis (As per the age)
 1. Given
 2. Not given

- 7 Breast feeding started _____ hours after birth.
- 8 Exclusive BF up to _____ months.
- 9 Weaning started at _____ months
- 10 Continued breast-feeding
 1. Yes
 2. No
- 11 What weaning foods were given to the child
 1. Cow's Milk/ Buffalo's Milk
 2. Cereal Porridge
 3. Fruit Juice
 4. Vegetable soup
 5. any other Mention: _____
- 12 How much quantity was given? _____
- 13 Have you started giving any other food
 1. Yes
 2. No
 3. If Yes specify: _____
- 14 Frequency of weaning food
 1. Once
 2. Twice
 3. Thrice
 4. increased from 1 to >3
- 15 Does your child receive any of the following?
 1. Multivitamins
 2. Vitamin D
 3. Iron
 4. Others Mention _____
- 16 Is your child on any medication?
 1. Yes
 2. No
 3. If Yes Mention _____

F. FOOD HABITS

- 1 Is your child allergic to any foods?
 1. Yes
 2. No

- 2 How many meals does your child eat each day?
 1. 1
 2. 2
 3. 3
 4. >4

- 3 Does your child consume regular food given in the anganwadi?
 1. Yes
 2. No
 3. Does not apply

- 4 Does your child have any of the following problems?
 1. Poor appetite
 2. Food fads
 3. Ability to chew the food
 4. Ability to swallow food
 5. None of these

G. Anthropometric Measurements: Calculated every month

Anthropometric Measurements	Cross-sectional	Date

Date:

Weight

Height

Mid Arm Circumference

Chest circumference

Anthropometric Measurements	Cross-sectional data	12rd Fallow Up	N/W/S
	Date:	Date:	
Weight (kgs)		N/U	N/W
Height (cm)		N/S	N/S
BMI(kg/m ²)		N/W	N/W

N- Normal, U-Undernourished, W-Wasted, S-Stunted

H. Diet History**(Collected baseline, 6 months and 12 months)****A) DIET HISTORY:**

	Food items	Quantity	Calories	Protein
Morning				
Breakfast				
Afternoon				
Lunch				
Evening Snacks				
Night Supper				

Breast feeding: continued / discontinued

Total Calories Consumed:

Required Calories:

Calories Deficient:

I.FOOD FREQUENCY QUESTIONNAIRE

(Collected baseline, 6 months and 12 months)

1 Does your child consume the following food items? If yes, mention the quantity and frequency.

Food groups	Daily	Alternate day	Once in week	Fortnightly	Once in month	Rarely	Never
Cereals and grains ಸಿರಿಧಾನ್ಯಗಳುಮತ್ತುಧಾನ್ಯಗಳು (rice, ragi, wheat, jowar)							
Pulses and legumes ಬೇಳೆಕಾಳುಗಳುಮತ್ತುದ್ವಿದ ಳಧಾನ್ಯಗಳು (green gram, horse gram, toor dhal, moogdhal)							
Green leafy vegetables (palak, rajgiri etc)							
Other vegetables							
Fruits							
Milk							
Tea							
Coffee							
Nuts and seeds (Badam, cashew nut, Dates, walnuts)							
Butter							
Ghee							
Sweets							

If, non- vegetarian:

Food groups	Daily	Alternate day	Once in week	Fortnightly	Once in month	Rarely	Never
Egg							
Meat							
Fish							
Chicken							

QUESTIONNAIRE – For Longitudinal Data

Study Topic: “Growth Velocity and its association with diet among children aged between 1-5 years residing in rural area of Belagavi- A Longitudinal Study”

Sub-Center Name: _____

Anganwadi Name _____

Sl. No: _____

A. SOCIO DEMOGRAPHIC DETAILS:

1] Name : _____

2] Age : ____ years

3] Sex i) Male ii) Female

B. Anthropometric Measurements (Longitudinal study):**Anthropometric Measurements**

Date Date: Date: Date: Date Date Date Date Date Date Date Date

Height

Weight

Head
Circumference

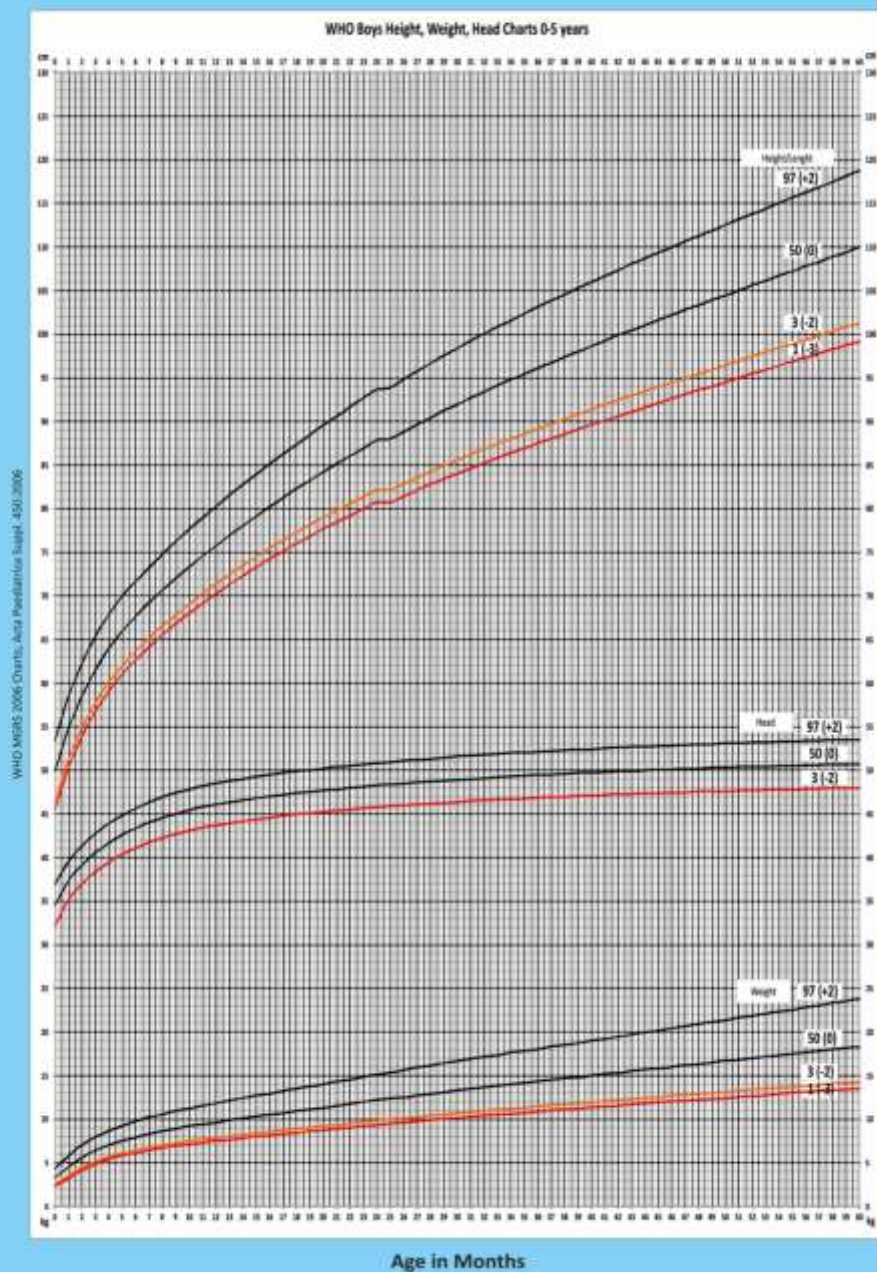
Chest
Circumference

Mid arm
Circumference

0 to 5 Years : WHO Boys Length/Height, Weight and Head Circumference Charts
(Z Scores are in Parenthesis)

Name : _____

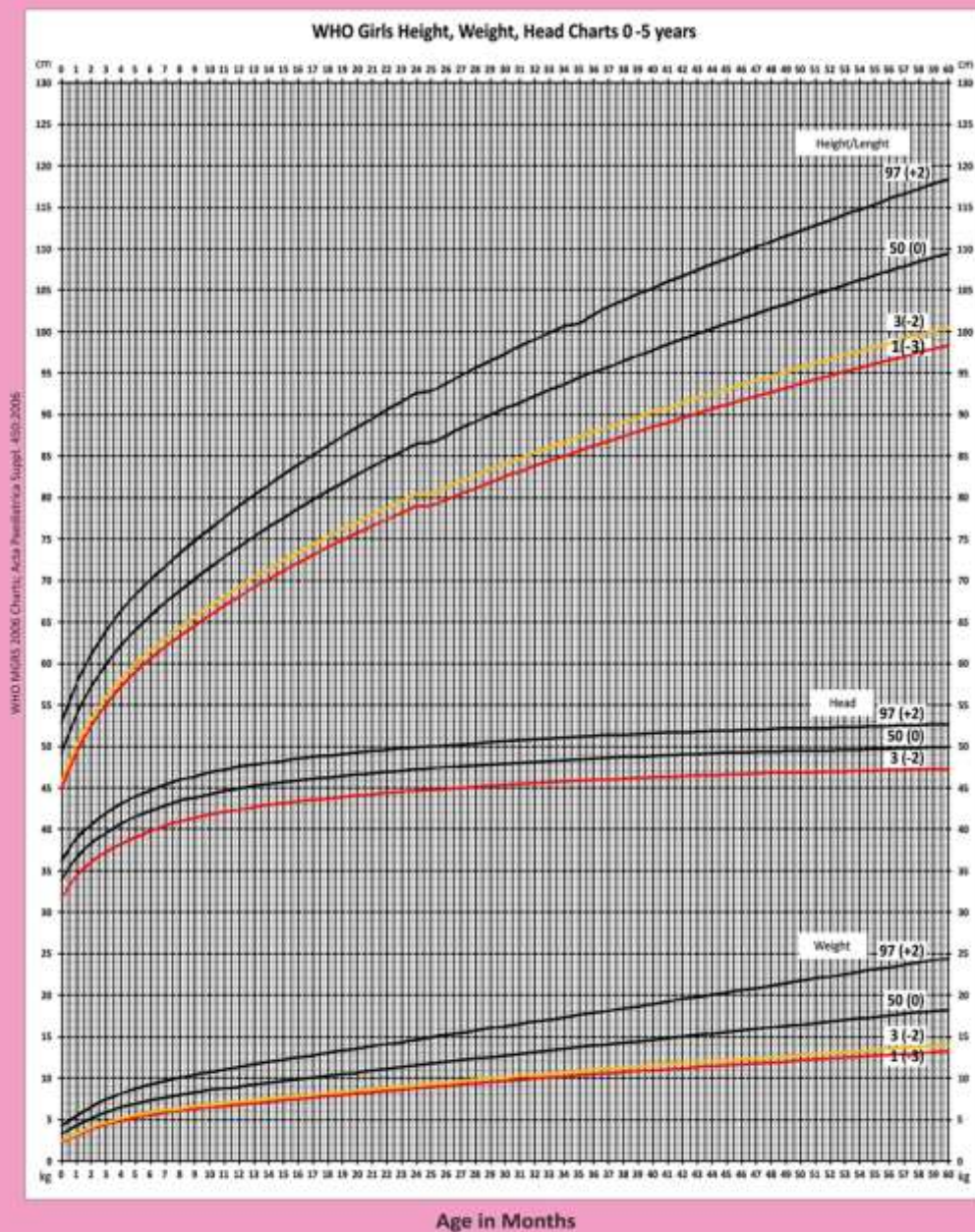
DOB : _____



0 to 5 Years : WHO Girls Length/Height, Weight and Head Circumference Charts
(Z Scores are in Parenthesis)

Name : _____

DOB : _____



**ANNEXURE B - INFORMED CONSENT & PATIENT INFORMATION
SHEET**

Study Topic: “Growth Velocity and its association with diet among children aged between 1-5 years residing in rural area of Belagavi- A Longitudinal Study”

Principle investigator:

Guide:.....

Introduction:

Growth is the progressive increase in the size of a child. Growth is a continuous orderly process and follows a particular pattern over a period of time termed as sigmoid curve. In this study we are assessing growth pattern in each child is unique. Through this study we are studying the growth pattern among children aged between 1-5 years. So, we are inviting to enroll your child in this study.

You will be asked some questions regarding your child age order of birth whether term delivery, institutional delivery. Child’s diet and socio-economic condition of the family. After this child’s weight, height, head circumference, mid upper arm circumference will be noted every 3 months and follow up for 1 year.

Withdrawal from the study: Your participation in this study will be voluntary. You are free to decide whether to participate or not in the study. In case you decide not to participate in the study, you will be able to withdraw your participation.

Possible Benefits: You will be benefited by health education given during the study regarding growth velocity. You will come know regarding your child’s growth velocity and necessary advice will be given at the end of the study.

Possible Risk: There will not be any risk involved in the study. The questionnaire filled by you will only be used for the sake of information regarding growth velocity.

Privacy and Confidentiality: Your identity will not be revealed. All the information collected will be coded so that no one will know your identity. The data collected from you will be kept confidential and only aggregated data will be published.

Financial Incentives: You will not receive any payment for participating in this study.

Authorization of Publication: Results of this study may be published for scientific purposes and/or presented to scientific groups; however, your identity will not be revealed.

Question: If you have any questions about the study, you can contact Miss Manasa Hiremath, PhD Scholar, Department of Community Medicine, J.N. Medical College Belagavi, Mobile No 9035352447 or you may contact Dr. Padmaja R. Walvekar Professor, Department of Community Medicine, J.N. Medical college, Belagavi-590010.

If you have any question about your right as a study participant, you can contact Chairperson, Institutional Ethical Committee, KAHAR, Belagavi @ 0831-2473777 Extension 4052.

Legal Rights:

By signing this consent form, you are not waving any of your legal rights.

CONSENT STATEMENT FROM PARENTS

I voluntarily give consent to my ward to participate in this study. My signature below indicates that I have decided to allow my ward to participate in this study I have read the information provided above (or the information provided above has been read to me) and I was given the opportunity to ask question and that they have been answered to my satisfaction.

Further, I am aware that the results of this research will be published without disclosing any identification of the participants.

Name of Parent(s)

Signature or left thumb impression

Name of Witness

Signature of Witness

Name of Researcher:

Signature of Researcher:

ಅಧ್ಯಯನದ ವಿಷಯ: “ಬೆಳಗಾವಿಯ ಗ್ರಾಮೀಣ ಪ್ರದೇಶದಲ್ಲಿ ವಾಸಿಸುವ 1-5 ವರ್ಷದೊಳಗಿನ ಮಕ್ಕಳಲ್ಲಿ ಬೆಳವಣಿಗೆಯ ವೇಗ ಮತ್ತು ಆಹಾರದೊಂದಿಗೆ ಅದರ ಸಂಬಂಧ- ಒಂದು ಉದ್ದದ ಅಧ್ಯಯನ”

ತತ್ತ್ವ ತನಿಖಾಧಿಕಾರಿ:

ಮಾರ್ಗದರ್ಶಿ:.....

ಪರಿಚಯ:

ಬೆಳವಣಿಗೆಯು ಮಗುವಿನ ಗಾತ್ರದಲ್ಲಿ ಪ್ರಗತಿಸ್ಥಿತಿ ಹೆಚ್ಚಳವಾಗಿದೆ. ಬೆಳವಣಿಗೆಯು ನಿರಂತರ ಕ್ರಮಬದ್ಧ ಪ್ರಕ್ರಿಯೆಯಾಗಿದೆ ಮತ್ತು ಸಿಗ್ಮಾಯಿಡ್ ಕರ್ವ್ ಎಂದು ಕರೆಯಲ್ಪಡುವ ಒಂದು ನಿರ್ದಿಷ್ಟ ಅವಧಿಯಲ್ಲಿ ನಿರ್ದಿಷ್ಟ ಮಾದರಿಯನ್ನು ಪಾಳು ಮಾಡುತ್ತದೆ. ಈ ಅಧ್ಯಯನದಲ್ಲಿ ನಾವು ಬೆಳವಣಿಗೆಯ ಮಾದರಿಯನ್ನು ನಿರ್ಣಯಿಸುತ್ತಿದ್ದೇವೆ ಏಕೆಂದರೆ ಪ್ರತಿ ಮಗುವಿನ ಬೆಳವಣಿಗೆಯ ಮಾದರಿಯು ವಿಶಿಷ್ಟವಾಗಿದೆ. ಈ ಅಧ್ಯಯನದ ಮೂಲಕ ನಾವು 1-5 ವರ್ಷ ವಯಸ್ಸಿನ ಮಕ್ಕಳಲ್ಲಿ ಬೆಳವಣಿಗೆಯ ಮಾದರಿಯನ್ನು ಅಧ್ಯಯನ ಮಾಡುತ್ತಿದ್ದೇವೆ. ಆದ್ದರಿಂದ, ನಿಮ್ಮ ಮಗುವನ್ನು ಈ ಅಧ್ಯಯನಕ್ಕೆ ದಾಖಲಿಸಲು ನಾವು ಆಹ್ವಾನಿಸುತ್ತಿದ್ದೇವೆ. ಜನನ ಹವಾಮಾನ ಅವಧಿಯ ವಿತರಣಾ ಸಾಂಸ್ಥಿಕ ವಿತರಣೆಯ ನಿಮ್ಮ ಮಗುವಿನ ವಯಸ್ಸಿನ ಕ್ರಮಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ ನಿಮಗೆ ಕೆಲವು ಪ್ರಶ್ನೆಗಳನ್ನು ಕೇಳಲಾಗುತ್ತದೆ. ಮತ್ತು ಮಗುವಿನ ಆಹಾರ ಮತ್ತು ಕುಟುಂಬದ ಸಾಮಾಜಿಕ-ಆರ್ಥಿಕ ಸ್ಥಿತಿ ಮತ್ತು ಈ ಮಗುವಿನ ತೂಕ, ಎತ್ತರ, ತಲೆ ಸುತ್ತಳತೆ, ಮಧ್ಯ ತೋಳಿನ ಸುತ್ತಳತೆ ಪ್ರತಿ ಗಮನಿಸಲಾಗುವುದು 3 ತಿಂಗಳು ಮತ್ತು 1 ವರ್ಷದವರೆಗೆ ಅನುಸರಿಸಿ.

ಅಧ್ಯಯನದಿಂದ ಹಿಂತೆಗೆದುಕೊಳ್ಳುವಿಕೆ: ಈ ಅಧ್ಯಯನದಲ್ಲಿ ನಿಮ್ಮ ಭಾಗವಹಿಸುವಿಕೆ ಸ್ವಯಂಪ್ರೇರಿತವಾಗಿರುತ್ತದೆ. ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಬೇಕೆ ಅಥವಾ ಬೇಡವೇ ಎಂದು ನಿರ್ಧರಿಸಲು ನೀವು ಸ್ವತಂತ್ರರು. ಒಂದು ವೇಳೆ ನೀವು ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸದಿರಲು ನಿರ್ಧರಿಸಿದರೆ, ನಿಮ್ಮ ಭಾಗವಹಿಸುವಿಕೆಯನ್ನು ಹಿಂಪಡೆಯಲು ನಿಮಗೆ ಸಾಧ್ಯವಾಗುತ್ತದೆ.

ಸಂಭಾವ್ಯ ಪ್ರಯೋಜನಗಳು: ಬೆಳವಣಿಗೆಯ ವೇಗಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ ಅಧ್ಯಯನದ ಸಮಯದಲ್ಲಿ ನೀಡಲಾದ ಆರೋಗ್ಯ ಶಿಕ್ಷಣದಿಂದ ನಿಮಗೆ ಲಾಭವಾಗುತ್ತದೆ. ನಿಮ್ಮ ಮಗುವಿನ ಬೆಳವಣಿಗೆಯ ವೇಗದ ಬಗ್ಗೆ ನಿಮಗೆ ತಿಳಿಯುತ್ತದೆ ಮತ್ತು ಅಧ್ಯಯನದ ಕೊನೆಯಲ್ಲಿ ಅಗತ್ಯ ಸಲಹೆಗಳನ್ನು ನೀಡಲಾಗುವುದು.

ಸಂಭವನೀಯ ಅಪಾಯ: ಅಧ್ಯಯನದಲ್ಲಿ ಯಾವುದೇ ಅಪಾಯವಿರುವುದಿಲ್ಲ. ನೀವು ಭರ್ತಿ ಮಾಡಿದ ಪ್ರಶ್ನಾವಳಿಯನ್ನು ಬೆಳವಣಿಗೆಯ ವೇಗಕ್ಕೆ ಸಂಬಂಧಿಸಿದ ಮಾಹಿತಿಗಾಗಿ ಮಾತ್ರ ಬಳಸಲಾಗುತ್ತದೆ.

ಗೌಪ್ಯತೆ ಮತ್ತು ಗೌಪ್ಯತೆ: ನಿಮ್ಮ ಗುರುತು ಬಹಿರಂಗಗೊಳ್ಳುವುದಿಲ್ಲ. ಸಂಗ್ರಹಿಸಿದ ಎಲ್ಲಾ ಮಾಹಿತಿಯನ್ನು ಕೋಡ್ ಮಾಡಲಾಗುವುದು ಇದರಿಂದ ನಿಮ್ಮ ಗುರುತು ಯಾರಿಗೂ ತಿಳಿಯುವುದಿಲ್ಲ. ನಿಮ್ಮಿಂದ ಸಂಗ್ರಹಿಸಿದ ಡೇಟಾವನ್ನು ಗೌಪ್ಯವಾಗಿಡಲಾಗುತ್ತದೆ ಮತ್ತು ಒಟ್ಟು ಡೇಟಾವನ್ನು ಮಾತ್ರ ಪ್ರಕಟಿಸಲಾಗುತ್ತದೆ.

ಹಣಕಾಸು ಪ್ರೋತ್ಸಾಹಕಗಳು: ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಲು ನೀವು ಯಾವುದೇ ಪಾವತಿಯನ್ನು ಸ್ವೀಕರಿಸುವುದಿಲ್ಲ.

ಪ್ರಕಟಣೆಯ ಅಧಿಕಾರ: ಈ ಅಧ್ಯಯನದ ಫಲಿತಾಂಶಗಳನ್ನು ವೈಜ್ಞಾನಿಕ ಉದ್ದೇಶಗಳಿಗಾಗಿ ಪ್ರಕಟಿಸಬಹುದು ಮತ್ತು / ಅಥವಾ ವೈಜ್ಞಾನಿಕ ಗುಂಪುಗಳಿಗೆ ಪ್ರಸ್ತುತಪಡಿಸಬಹುದು; ಆದಾಗ್ಯೂ, ನಿಮ್ಮ ಗುರುತು ಬಹಿರಂಗಗೊಳ್ಳುವುದಿಲ್ಲ.

ಪ್ರಶ್ನೆ: ನೀವು ಅಧ್ಯಯನದ ಬಗ್ಗೆ ಯಾವುದೇ ಪ್ರಶ್ನೆಗಳನ್ನು ಹೊಂದಿದ್ದರೆ, ನೀವು ಸಮುದಾಯ ine ಷಧ ವಿಭಾಗದ ಪಿಎಚ್‌ಡಿ ಪ್ರೊಫೆಸರ್ ವಿಭಾಗದ ಮಾನಸ ಹಿರೆಮಠ್ ಅವರನ್ನು ಸಂಪರ್ಕಿಸಬಹುದು. ಜೆ.ಎನ್.ಮೆಡಿಕಲ್ ಕಾಲೇಜು ಬೆಲಗವಿ ಮೊಬೈಲ್ ಸಂಖ್ಯೆ 9035352447 ಅಥವಾ ನೀವು ಸಂಪರ್ಕಿಸಬಹುದು ಡಾ. ಪದ್ಮಜಾ ಆರ್. ವೇವ್ಕರ್ ಸಮುದಾಯ ine ಷಧ ವಿಭಾಗದ ಪ್ರಾಧ್ಯಾಪಕರು, ಜೆ.ಎನ್. ವೈದ್ಯಕೀಯ ಕಾಲೇಜು, ಬೆಲಗವಿ -591010.ಒನ್ ಮೊಬೈಲ್ ನಂ. .ಅಧ್ಯಯನದ ಪಾಲ್ಗೊಳ್ಳುವವರಾಗಿ ನಿಮ್ಮ ಹಕ್ಕಿನ ಬಗ್ಗೆ ನಿಮಗೆ ಯಾವುದೇ ಪ್ರಶ್ನೆ ಇದ್ದರೆ, ನೀವು ಸಂಪರ್ಕಿಸಬಹುದು ಅಧ್ಯಕ್ಷರು, ಸಾಂಸ್ಥಿಕ ನೈತಿಕ ಸಮಿತಿ, ಕಹೇರ್, ಬೆಲಗವಿ @ 0831-2473777 ವಿಸ್ತರಣೆ 4052. ಕಾನೂನು ಹಕ್ಕುಗಳು: ಈ ಒಪ್ಪಿಗೆ ಫಾರ್ಮ್ ಸಹಿ ಮಾಡುವ ಮೂಲಕ, ನಿಮ್ಮ ಯಾವುದೇ ಕಾನೂನು ಹಕ್ಕುಗಳನ್ನು ನೀವು ಅಲೆಯುತ್ತಿಲ್ಲ.

ಒಪ್ಪಿಗೆ ಪತ್ರ

ಪೋಷಕರಿಂದ ಸಮಾಲೋಚನೆ ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಲು ನಾನು ಸ್ವಯಂಪ್ರೇರಣೆಯಿಂದ ನನ್ನ ವಾರ್ಡ್‌ಗೆ ಒಪ್ಪಿಗೆ ನೀಡುತ್ತೇನೆ. ಕೆಳಗಿನ ನನ್ನ ಸಹಿ ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಲು ನನ್ನ ವಾರ್ಡ್‌ಗೆ ಅವಕಾಶ ನೀಡಲು ನಿರ್ಧರಿಸಿದ್ದೇನೆ ಎಂದು ಸೂಚಿಸುತ್ತದೆ ನಾನು ಮೇಲೆ ಒದಗಿಸಿದ ಮಾಹಿತಿಯನ್ನು ಓದಿದ್ದೇನೆ (ಅಥವಾ ಮೇಲೆ ಒದಗಿಸಿದ ಮಾಹಿತಿಯನ್ನು ನನಗೆ ಓದಲಾಗಿದೆ) ಮತ್ತು ನನಗೆ ಪ್ರಶ್ನೆ ಕೇಳಲು ಅವಕಾಶ ನೀಡಲಾಯಿತು ಮತ್ತು ಅವುಗಳು ನನ್ನ ತೃಪ್ತಿಗೆ ಉತ್ತರಿಸಿದೆ. ಇದಲ್ಲದೆ, ಭಾಗವಹಿಸುವವರ ಯಾವುದೇ ಗುರುತನ್ನು ಬಹಿರಂಗಪಡಿಸದೆ ಈ ಸಂಶೋಧನೆಯ ಫಲಿತಾಂಶಗಳನ್ನು ಪ್ರಕಟಿಸಲಾಗುವುದು ಎಂದು ನನಗೆ ತಿಳಿದಿದೆ

ಪೋಷಕರ ಹೆಸರು (ರು) ಸಹಿ ಅಥವಾ ಎಡ ಹೆಬ್ಬರಳು

ಸಾಕ್ಷಿಯ ಹೆಸರು

ಸಾಕ್ಷಿಯ ಸಹಿ

ಸಂಶೋಧಕರ ಹೆಸರು:

ಸಂಶೋಧಕರ ಸಹಿ:

अभ्यासाचा विषय: "बेळगावच्या ग्रामीण भागात राहणाऱ्या १ ते ५ वर्षे वयोगटातील मुलांमध्ये वाढीचा वेग आणि त्याचा आहाराशी संबंध - एक अनुदैर्घ्य अभ्यास"

मुख्य तपासक:

मार्गदर्शक:.....

परिचय:

वाढ म्हणजे मुलाच्या आकारात होणारी प्रगती. वाढ ही एक सतत सुव्यवस्थिति प्रक्रिया आहे आणि त्याला सगिर्मॉड वक्र असे म्हणतात. या अभ्यासात आम्ही वाढीच्या पद्धतीचे मूल्यांकन करत आहोत कारण प्रत्येक मुलाच्या वाढीचा नमुना अद्वितीय असतो. या अभ्यासाद्वारे आम्ही 1 ते 5 वर्षे वयोगटातील मुलांमधील वाढीच्या पद्धतीचा अभ्यास करत आहोत. म्हणून आम्ही तुमच्या मुलाला या अभ्यासात सहभागी होण्यासाठी आमंत्रित करत आहोत.

तुम्हाला तुमच्या मुलाच्या वयाचा क्रम, जन्म कालावधी, संस्थात्मक डलिव्हरी त्यासोबत मुलाचा आहार आणि कुटुंबाची सामाजिक-आर्थिक स्थिती इत्यादी बाबत काही प्रश्न विचारले जातील. या मुलाचे वजन, उंची, डोक्याचा घेर, मधल्या वरच्या हाताचा घेर दर 3 महिन्यांनी लक्षात घेतला जाईल आणि 1 वर्षासाठी पाठपुरावा केला जाईल.

अभ्यासातून माघार घेणे: या अभ्यासात तुमचा सहभाग ऐच्छिक असेल. अभ्यासात भाग घ्यायचा की नाही हे ठरवण्यासाठी तुम्ही स्वतंत्र आहात. तुम्ही अभ्यासात सहभागी न होण्याचा निर्णय घेतल्यास, तुम्ही तुमचा सहभाग मागे घेण्यास सक्षम असाल.

संभाव्य फायदे: वाढीच्या वेगाबाबत अभ्यासादरम्यान दिलेल्या आरोग्य शिक्षणाचा तुम्हाला फायदा होईल. तुमच्या मुलाच्या वाढीचा वेग तुम्हाला कळेल आणि अभ्यासाच्या शेवटी आवश्यक सल्ला दिला जाईल.

संभाव्य जोखीम: अभ्यासात कोणताही धोका असणार नाही. तुम्ही भरलेली प्रश्नावली केवळ वाढीच्या वेगाच्या माहितीसाठी वापरली जाईल.

गोपनीयता : तुमची ओळख उघड केली जाणार नाही. संकलित केलेली सर्व माहिती कोड केली जाईल जेणेकरून कोणालाही तुमची ओळख कळणार नाही. तुमच्याकडून संकलित केलेला डेटा गोपनीय ठेवला जाईल आणि केवळ एकत्रित डेटा प्रकाशित केला जाईल.

आर्थिक प्रोत्साहन: या अभ्यासात सहभागी होण्यासाठी तुम्हाला कोणतेही पेमेंट मिळणार नाही.

प्रकाशनाची अधिकृतता: या अभ्यासाचे परणाम वैज्ञानिक हेतूसाठी प्रकाशित केले जाऊ शकतात आणि वैज्ञानिकगटांना सादर केले जाऊ शकतात; तथापि, तुमची ओळख उघड केली जाणार नाही.

प्रश्न: तुम्हाला अभ्यासाविषयी काही प्रश्न असल्यास, तुम्ही **मिस. मानसा एम. हिरेमठ**, पीएचडी स्कॉलर, डिपार्टमेंट ऑफ कम्युनिटी मेडिसिन, जे. एन. मेडिकल कॉलेज बेळगावी, मोबाईल नंबर 9035352447 यांच्याशी संपर्क साधू शकता क्वि तुम्ही **डॉ. पद्मजा आर. वाळवेकर**, प्रोफेसर, कम्युनिटी मेडिसिन विभाग, जे. एन. मेडिकल कॉलेज, बेळगावी-590010. मोबाईल क्र. यांच्याशी संपर्क साधू शकता.

अभ्यास सहभागी म्हणून तुमच्या अधिकाराबाबत तुम्हाला काही प्रश्न असल्यास, तुम्ही संपर्क करू शकता

अध्यक्ष, संस्थात्मक नैतिक समिती, काहेर, बेळगावी @ ०८३१-२४७३७७७ वसितार ४०५२.

कायदेशीर हक्क:

या संमतीफॉर्मवर स्वाक्षरी करून, तुम्ही तुमचे कोणतेही कायदेशीर अधिकार गमावत नाही.

पालकांकडून संमतीचे विधान

या अभ्यासात सहभागी होण्यासाठी मी स्वेच्छेने माझ्या प्रभागाला संमती देत आहे . खाली दिलेली माझी स्वाक्षरी सूचिती करते की मी माझ्या प्रभागाला या अभ्यासात भाग घेण्यास परवानगी देण्याचे ठरवले आहे. मी वर दिलेली माहिती वाचली आहे (कवि वर दिलेली माहिती मला वाचून दाखवण्यात आली आहे). मला प्रश्न विचारण्याची संधी देण्यात आली आहे आणि त्यांनी मला माझ्या प्रश्नांची समाधानकारक उत्तर दिली आहेत.

मला माहिती आहे की या संशोधनाचे परिणाम सहभागींची कोणतीही ओळख उघड न करता प्रकाशित केले जातील.

पालकांचे नाव..... स्वाक्षरी कवि डाव्या अंगठ्याचा ठसा.....

साक्षीदाराचे नाव.....साक्षीदाराची स्वाक्षरी.....

संशोधकाचे नाव..... संशोधकाची स्वाक्षरी.....

ANNEXURE C - ETHICAL CLEARANCE LETTER



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Ref.No.KAHER/EC/21-22/019

29th July 2021

To,
Ms. Manasa M Hiremath
Full time Ph.D. Research Scholar,
2020-21Batch, Faculty of Science,
KAHER, Belagavi.

Dear Research Scholar,

The KAHER Ethics Committee on Human Subjects for Ph.D. Research Project met on the 7th and 8th June, 2021 to consider your application for approval of the research project "Growth velocity and its association with diet among under five children residing in rural area of Belagavi- A longitudinal study."

As there are no ethical issues involved in your proposed research project, the committee has provided approval for this research project.

You are requested to report to Ethical Committee of the following:

1. Any deviation from or change of the protocol.
2. Any changes in study documents.

(Dr. Sheetal U. Harakuni)

Member-Secretary
Ethical Committee (Human) for Ph. D. Research
KAHER, Belagavi.

(Dr. B.C. Kotintot)

Chairman
Ethical Committee (Human) for Ph. D. Research
KAHER, Belagavi.

CC to:

- Special Officer to Hon. Vice Chancellor, KAHER, Belagavi
- The Registrar, KAHER, Belagavi.
- The Director Research Foundation, KAHER, Belagavi.
- The Director Academic Affairs, KAHER, Belagavi.

ANNEXURE D – PUBLICATIONS



ORIGINAL ARTICLE**Prevalence of under nutrition among under five children and correlation between anthropometry of parents and anthropometry of children***Manasa Hiremath¹, Padmaja Walvekar^{2*}, Sulakshana Baliga³**¹Department of Community Medicine, KAHER's Jawaharlal Nehru Medical College, Belagavi-590010 (Karnataka) India***Abstract**

Background: There is interplay of genetic and environmental factors in determining the weight, height and body structure of children. Hence it is important to know the role of genetic factor in determining height, weight and Body Mass Index (BMI) of children. **Aim and Objectives:** To know the prevalence of malnutrition among under five children; to assess correlation between anthropometry of parents and anthropometry of under five children; and to assess the quality and quantity of diet consumed by under five children. **Material and Methods:** Present study was a cross sectional study, done among 270 children aged between 1-4 years registered at Anganawadi. Information on sociodemographic variables and anthropometry of under five children and their parents was collected after taking parents' consent. Percentages and correlation coefficient were used to find correlation between anthropometry of parents and children (height, weight and BMI), level of significance was taken at $p < 0.05$. **Results:** Our study showed that 22.96% of children were under nourished, 1.48% stunted and 84.7% wasted. As per the mid arm circumference, mean was 12.02 ± 1.27 , 8.1% were severely malnourished and 29.3% moderately. Parents' height was positively correlated with height of children and it was statistically significant with $p < 0.05$. Parents' weight and fathers' BMI also showed positive correlation but it was not statistically significant. Mothers' BMI was not correlated with BMI of children. **Conclusion:** Our study found that about 23% of children were under nourished. Parent's height was positively correlated with children's height.

Keywords: Stunting, Wasting, Under Nutrition, Z Score

Introduction

Growth in a child is a continuous orderly process and follows a particular pattern over a period of time termed as sigmoid curves wherein there are periods of rapid growth and slower growth. Growth pattern of each child is unique and every child undergoes through three different types of physical patterns of growth – ectomorphs, endomorphs and the mesomorphs [1]. Child growth is an indicator of nutritional status and we can attribute malnutrition as the underlying cause for under five mortality. India is one among few countries where severe stunting and wasting is seen

among children. Plotting growth chart is a useful tool for early identification of factors affecting growth. One-time measurement, however, does not indicate, if the rate of growth of the child has been normal in the recent past, but it is an easy method to assess present nutritional status of children. The position on the growth chart becomes evidently abnormal only when the factors regarding growth are profound or have persisted for a long time [1]. Anthropometric examination is a mandatory tool in any research to assess growth, health and nutritional condition in childhood. Physical

measurements like weight, height, mid- upper arm circumference have been extensively used to define health and nutritional status of communities. According to National Family Health Survey-5 (NFHS-5) data (conducted in the year 2019-20) about 35.4 %, 19.5% and 8.4% children under -5 years were stunted, wasted, severely wasted respectively and 32.9% children were underweight [2]. Despite correcting diet through many nutritional programmes, malnutrition still is one of the major public health problems [3]. The nutrient density of the diet provided to children many a times is inadequate to meet their nutritional needs, hence by increasing the diversity of foods given to the children, such as meat, poultry, fish, eggs, fruits and vegetables helps to improve micronutrient intake and reduce its deficiency [1]. It is a known fact that nutrition is key determinant of good health and is critical for survival, good quality of life and well-being.

There is interplay of genetic, nutritional and environmental factors in determining the weight, height and body structure of children [4]. Hence it is important to know the role of genetic factor in determining height, weight and BMI of children. Some studies have shown that maternal nutritional status has a direct relation to the child's nutritional status [5]. Some other studies have shown association between parents' height with height of children in the absence of prolonged deficit of nutrition [6]. Some studies have shown positive correlation with parents' BMI [7]. Though shorter parents' height was correlated with stunting, it was not statistically significant as per study in Malaysia [8]. Sometimes constitutionally short and thin children may get classified as stunted and wasted. Hence the present study was done to know the nutritional status of under five children and

also to know the correlation between anthropometry of parents and anthropometry of children which will help in identifying whether weight and height of children has any positive correlation with height, weight and BMI of father and mother, that is genetic component.

Material and Methods

This was a cross-sectional study conducted at 5 sub-centers of primary health center, under the field practice area of Department of Community Medicine during the time period August to September 2021. According to NFHS V (2019-20) data, prevalence of under nutrition was 32.9% [3]. Sample size was calculated by using the formula:

$$n = \frac{Z\alpha^2 pq}{d^2}$$

at 95% Confidence Interval (CI), with 6% allowable absolute error and 10% attrition comes to 270.

Sampling technique

There are five subcentres in the study area, out of five two subcenters were selected randomly. List of children aged between 1-4 years, registered at selected anganawadi was obtained; anganwadis under the selected sub-centers were selected randomly until required sample size was reached i.e., 270 children – 130 children from four anganawadi from one sub centre and 140 from five anganawadi from another sub centre.

Inclusion and exclusion criteria

All children aged between 1-4 years (13-48 months) residing in study area and registered in anganawadi were included following clearance from the Institutional Ethics Committee (letter no. KAH/EC/21-22/019 dated 29/07/2021).

Children with diseases like type 1 diabetes mellitus, congenital heart diseases, cretinism (already diagnosed cases), and differently-abled children were excluded.

Data collection procedure

Predesigned and pretested questionnaire was used to collect information regarding sociodemographic variables, anthropometric measurements (height/length, weight and mid arm circumference) of children and height and weight measurement of parents was done, after obtaining consent from parents. To measure the length of children who were less than 2 years, infantometer was used while for older children stadiometer was used. To measure the weight, electronic weighing machine was used and calibrated frequently. In the present study, information regarding diet of the children was also collected using both qualitative and quantitative methods. Quantitative method by using 24-hour recall method and qualitative method using diet diversity and food variety score. For assessment of diet diversity as per Food and Agricultural Organization (FAO) guidelines, 12 food groups were considered and for food variety score food items were considered irrespective of the food group [9]. Calculation of food variety score was done by considering individual food items consumed without considering which group of food it belonged. Diversity of food consumption was done by following 12 food group classifications as per FAO

If the child consumed –

- less than 4 groups of food, it was considered as low
- 5-8 was considered as medium
- 9-12 was considered as high

Nutritional status of children (under nutrition, stunting and wasting) was calculated using WHO "Z" score for weight for age, height for age and weight for height [10].

Statistical analysis

Data were coded and entered in Microsoft Excel and analyzed by using Co Guide statistics software, V.1.01BDSS Corp, released 2020. Descriptive analysis was carried out using percentages. As the distribution was not normal, correlation coefficient was used to find correlation between parents' anthropometry and anthropometry of children where $p < 0.05$ was considered statistically significant.

Results

In our study among 270 participants, 137 (50.74%) were boys and 133 (49.26%) were girls. Mean age of participants was 29.06 ± 10.43 months. In our study, 105 (38.89%) of them were 12-24 months, 81 (30%) were 25-36 months, and 84 (31.11%) were more than 37 months (Table 1).

Table 1: Age and sex distribution of study participants (n = 270)

Characteristics	Number (Percentage)
Age Group (Months)	
12-24	105 (38.89%)
25-36	81 (30.00%)
≥ 37	84 (31.11%)
Gender	
Male	137 (50.74%)
Female	133 (49.26%)

In the present study, 75 (27.78%) of the participants' fathers were illiterate, 50 (18.52%) were farmers and 126 (46.67%) were labourers. Eighty-six (31.85%) mothers were illiterate and 36 (13.38%) participants' mothers were farmers, 78 (29.0%) were labourers and 143 (53.16%) were homemakers. Our study showed that 62 (22.96%) children were under-nourished, 4 (1.48 %) were stunted, and in 83 (30.7%) children, height was more than 2 with Z score > 2 and 227 (84.7%) wasted with Z score < 2. As per the mid arm circumference, 22 (8.1%) were severely malnourished while 79 (29.3%) were moderately malnourished with mean mid arm circumference being 12.02 ± 1.27 (Table 2).

Table 2: Distribution of study participants based on their nutritional status n=270

Z Score	Number (Percentage)
Weight-for-age	
Undernutrition (<-2)	62 (22.96%)
Normal (-2 To 2)	207 (76.67%)
(>2)	1 (0.37%)
Height-for-age	
Stunting (<-2)	4 (1.48%)
Normal (-2 To 2)	183 (67.78%)
(>2)	83 (30.74%)
Weight-for-height	
Wasting (<-2)	227 (84.7%)
Normal (-2 to 2)	43 (15.93%)
BMI for age	
Undernutrition (<-2)	256 (94.81%)
Normal (-2 to 2)	14 (5.19 %)

Our study showed that, mean calorie deficiency among children was 381.58 ± 157.21 Kcal (Range 0-863 Kcal) and mean protein deficiency was 1.02 ± 2.4 (Range 0-11.9 g). As far as diet diversity is concerned, all children consumed cereals, 248 (92%) consumed milk, 234 (87%) consumed pulses and legumes and 186 (69%) consumed green leafy vegetables daily. One hundred and twenty-four (46%) children consumed eggs with 67 (25%) having meat and 5% having fish weekly. Out of 270 children, 81 (30%) never consumed egg and 172 (64%) meat. Diet diversity score was 3 among 143 (53%), 4 among 105 (39%) and 5 and above among 13 (5%) children.

In our study, 50 (19%) father's height was less than 155 cm and 115 (44%) was more than 160 cm. On the other hand, 64 (23.70%) mother's height was less than 145 cm and 130 (48%) mother's height was more than 150 cm. Among fathers, about 65 (25%) weighed less than 55 kg and about 142 (52%) mothers weighed less than 45 kg. In our study, 21 (7.98%) fathers' and 84 (31.11%) mothers' BMI was < 18.5 kg/m² while 65 (24.71%) fathers' and 25 (9.26%) mothers' BMI was > 25 kg/m² (Table 3). Parents' height was positively correlated with height of their children and was statistically significant ($p < 0.05$). Weight of the mothers was positively correlated with the weight of their children but was statistically not significant ($p > 0.05$). In our study, there was no correlation found between parents' BMI with BMI of children.

Table 3: Anthropometric measurements of parents of study participants

Anthropometry	Number (Percentage)
Father height group	
<155	50 (19.01%)
155 to 160	98 (37.26%)
>160	115 (43.73%)
Father weight group	
<54.400	65 (24.71%)
54.400 to 60	97 (36.88%)
>60	101 (38.40%)
Father BMI group	
Underweight (<18.50)	21 (7.98%)
Normal (18.50-24.99)	169 (64.26%)
Overweight (25.00-29.99)	65 (24.71%)
Obese (≥ 30)	8 (3.04%)
Mother height group	
<145	64 (23.70%)
145 to 150	76 (28.15%)
>150	130 (48.15%)
Mother weight group	
<40	48 (17.78%)
40 to 45	94 (34.81%)
>45	128 (47.41%)
Mother BMI group	
Underweight (< 18.50)	84 (31.11%)
Normal (18.50 - 24.99)	161 (59.63%)
Overweight (25.00 - 29.99)	22 (8.15%)
Obese (≥ 30)	3 (1.11%)

Table 4: Correlation between parent's heights with child's height

Anthropometry	Child's height	<i>p</i>
	<i>r</i>	
Father's height v/s child's height	0.160	0.009*
Mother's height v/s child's height	0.138	0.023*

Table 5: Details of calories and proteins consumed, required and range among study children

Macro nutrients	Mean consumed	Required	Range
Calories	671 $\pm$ 254	970 $\pm$ 160	341 - 1148
Proteins	12.26 $\pm$ 6.63	17 $\pm$ 2.39	5.2 - 28.8

Table 6: Details of diet diversity indicators among study children

Variables - Diet diversity	Mean $\pm$ SD	Range
Food variety score	5.46 $\pm$ 2.45	3 - 9
Diet diversity score	3.87 $\pm$ 0.83	2 - 7
Diet serving score	10.57 $\pm$ 1.62	7-14

Discussion

As per NFHS-5 data (2020-21) for India, 32.1% of under-five children were undernourished, 35.5% were stunted and 19.3% were wasted. As per NFHS-5 data for the state of Karnataka, under nutrition was found in 32.9%, stunting in 35.4% and wasting in 19.5% of children [2].

As per the study done in Pune, Maharashtra, 6.32% children were undernourished, 5% were stunted and 4.47% were wasted [11]. A study done in 16 states in India showed that, 24.3% of children were under weight, 28.6% were stunted and 12.8% were wasted [12]. Similar to our study, various studies [13-14] have shown 24.8% as prevalence of underweight. A study done in Maharashtra showed the prevalence of wasting as 16%, stunting 40.46% and underweight 38.15% and the proportion of wasting was higher among boys [15]. A study done in two districts of western Maharashtra showed the prevalence of wasting as 17.1%, stunting of 45.9% and underweight 35.4% [16]. In a study done at a city of Maharashtra, maximum children were between 3.6- 4.5 years, 55% were females and 74.07% of children had mild malnutrition [16]. In our study, we found stunting among 1.48% and wasting among 84.07% children. This could be attributed to the fact that many children were -2SD for weight for age and height for age, and with one attack of infection, they could slip to -3SD, and also stunting was less compared to under nutrition which must have led to more number of children with low weight for height (wasting). As the study was conducted during COVID time, compromised nutrition of the children could have caused acute malnutrition hence weight was more affected than height.

A study done in Indonesia showed that maternal height was strongly associated with stunting with $p < 0.05$ [17]. A study done in Pakistan showed that mother's BMI was significantly associated with child's weight with $p < 0.05$ [7]. In our study, mothers' BMI were not correlated with children's BMI, the reason could be more children with BMI less than 18.5 compared to mothers' BMI and more children with HAZ score > 2 and stunting was only 1.48%. Hence, weight for height and BMI of children was more, reason could be weight gets affected early and height has genetic component also and gets affected in case of chronic malnutrition. According to a study done in Malaysia, paternal height was significantly associated with stunting and paternal BMI was also associated with wasting of children with $p < 0.05$ [8]. A study done in 35 low- and middle-income countries showed that short parental height had 1.9 times higher odds of having stunted children with $p < 0.05$ [18].

A study done in South West Nigeria to find out the adequacy of diet among under five children found that 98.7% and 97.5% of children consumed grains with roots and tubers while 36.7% and 36.3% consumed legumes, in Ogun and Oyo states respectively. The study also found that only 48.6% of children met the minimum cut-off point of 4 food groups and dietary diversity mean score was 3.28. The study found child's age, mothers' age, distance to farm, and expenditure on food were significant determinants of children's dietary diversity. In a study done in Nigeria, prevalence of stunting, wasting and underweight among under five children were found to be 11.5%, 5.4% and 2.7%, respectively. Mean dietary diversity for all

food groups was 6.04 ± 4.18 . Cereals and vegetables had higher mean values. They found that dietary diversity was significantly associated with HAZ ($\chi^2 = 10.63$; $p = 0.03$), while total family income remained significantly and positively associated with dietary diversity score ($p < 0.05$) [19].

A study done in Tehran showed that, prevalence of overweight and obesity was 20% and 6.8% respectively among preschool children, and they were more among girls compared to boys [20].

A study done in South Africa found prevalence of stunting to be 29%, underweight to be 13% and thinness 6%. Mean dietary diversity was 4.39 ± 1.55 out of 12-food groups, 61% had low and 39% medium dietary diversity. Similar to our study, cereals were consumed by all and accounted for the main food group consumed, while fish and other seafood (17%) were the least consumed. Consumption of a diversified diet was associated with lower odds of being stunted (AOR = 0.25, 95% CI: 0.10 to 0.92) [21]. Diet of the children in the present study showed deficiency of mean calories and protein intake, also mean dietary diversity was less than 4, diet serving mean score was less than 10 and food variety also ranged from 2 – 9, which shows that both quantity and quality of the diet was less than recommended, which affected the weight of the children hence affecting weight for height and BMI of the children. A controlled trial done at Karad, Maharashtra showed that addition of nutrition supplements along with regular food in the form of Krishna mix, helped in improving the nutritional status of children [22].

As the present study was conducted during COVID period, Anganawadis distributed raw food grains to the families of under five children and as

most of the parents were working in unorganized sector and belonged to class IV and V socio-economic class, did not earn well, probably the food meant for children could have been shared by other members of the family which affected the diet diversity which was less than four in our study and caused malnutrition, diet serving score and food variety score was also less than recommended score. Weight gets affected first in the presence of shortage of food, hence the weight and weight for height and BMI also got affected in the present study.

Need of the hour is to provide nutrition education to mothers, who can increase the diversity of food by buying pulses, vegetables and fruits out of the money saved from free ration through public distribution system [23].

Conclusion

In our study, under nutrition and stunting was less and wasting was high when compared to other studies done in India and NFHS-5 data (India and Karnataka). Parental height was positively correlated with children's height ($p < 0.05$). Parental weight and father's BMI was positively correlated but statistically not significant; mother's BMI was not correlated with child's BMI. Diet diversity was better for cereals, milk, pulses, and green leafy vegetables. Mean diet diversity score was 3 and less than 3 among 50% of children, which might cause monotony in the diet affecting the quantity of food intake. Our study recommends improvement in the quality and quantity of the diet of the children which would prevent under nutrition in children as weight of the child is determined by the diet they consume unlike height which depends on the genetic composition of the parents along with diet, hence improvement in the quality and

quantity of the diet of the family helps in reducing under nutrition in children as well as adolescent girls and mothers as prenatal nutritional condition of mother has positive correlation with nutritional status of child.

Limitations

As the study was conducted during COVID pandemic, routine Anganawadi services were not provided to children as far as supplementary nutri-

tion is concerned, which might have had its effect on nutritional status of children including family members. When nutrition is affected even growth potential of under five children also might have been affected.

Acknowledgement

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Original Article

Effect of quality and quantity of diet on nutritional status of under-five children residing in the rural area: A longitudinal study

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ABSTRACT

Introduction: Variety and adequacy of intake of food are required to meet the nutritional needs of the children. Due to poverty/illiteracy, poor families depend on a single food group that is, cereals. Due to the pandemic also, the nutrition of the growing children is affected. **Objective:** To know the effect of quantity and quality of diet on the nutritional status of under-five children. **Methodology:** This study had 270 children aged between 1 and 4 years registered at Anganwadi as study participants. Information on sociodemographic variables, quantity of calories and proteins consumed, quality of diet, and anthropometry of children was collected. Percentages and paired *t*-tests were used to find the difference between nutritional status and diet at different intervals, which was found to be statistically significant ($P < 0.05$). **Results:** In our study, we found that as the quantity and quality of diet improved nutritional status, especially weight for age, body mass index (BMI) for age Z score also improved. There was a significant difference between calories consumed at the baseline, 6 months and 1 year with $P < 0.05$. Protein intake was significant between baseline and six months with $P < 0.005$. **Conclusion:** Our study found a high percentage of undernutrition and wasting in the under-five population when diet was not sufficient in quality and quantity. As the quality and quantity of diet improved nutritional status also improved.

Keywords: Children, diet diversity, diet serving score, wasting, under-five, undernutrition

Introduction

Diet is an important factor in achieving adequate growth and development in children. Diet diversity with nutrient-rich foods is important to meet the dietary needs that help in normal growth during their initial years of life.^[1] The study of the growth velocity of children and its association with diet diversity indicators helps policymakers, pediatricians, and family physicians to start

corrective measures. Also, based on the food grains grown locally, and staple food consumed some modifications in cooking practices can be advised to the mother.^[2]

As per the National Family Health Survey 5 (NFHS) data, only one-fifth of non-breastfed children aged between 6 and 23 months received adequate diet.^[3] Despite the Integrated and Child Development Programme, malnutrition is a major public health problem among under-five children.^[4]

So, longitudinal studies of growth and its relation with the quantity and quality of diet throw more light on the process of growth, which helps policymakers to implement required recommendations. Hence, the present study was planned to know

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the effect of quality and quantity of diet on the nutritional status of under-five children.

Materials and Methods

Study Design: Longitudinal study

Source of Data: Rural field practice area of the Department of Community Medicine

Data Collection Period: August 2021 to August 2022

Study Population: Children (1-4 years)

Sample size was calculated using $n = Z\alpha^2 pq/d^2$

considering 66.9% of children consuming low-diet diversity,^[4] at a 95% confidence interval, with 6% allowable error and 20% attrition

Sample size = 270

Sampling technique: Out of five sub-centers, randomly two sub-centers were selected.

A list of children aged between 1 and 4 years registered at selected Anganwadi (AW) was obtained; randomly AWs under the selected sub-centers were selected until the required sample size was reached, that is, 270 children, six Anganwadis were included from two sub-centres.

Ethical clearance: Obtained from the Institutional Ethics Committee letter no. EC/21-22/019 dated 29/07/2021.

Inclusion criterion

All children aged between 1 and 4 years residing in the study area and registered in Anganwadi.

Exclusion

Children with diseases such as type 1 diabetes mellitus, congenital heart diseases, cretinism (already diagnosed cases), and differently-abled children.

Data collection procedure

A predesigned proforma was prepared and after obtaining the consent of parents, the data were collected on sociodemographic variables, anthropometry of children, and diet of children. Length of children above 2 years was measured using a stadiometer and for those who were less than 2 years using an infantometer; weight was measured using a Salter scale. The nutritional status of under-five children was assessed using the Epi Anthro software and a "Z" score was used to know the nutritional status of children (weight for age, height for age, weight for height, body mass index [BMI] for age) were calculated.^[6] Longitudinal data were collected at the interval of 6 months and 1 year.

Information regarding the 24-h recall method to know the adequacy of diet in terms of calories and proteins consumed was performed on two occasions and a means score was considered. To know the quality of diet, food variety score, and diet diversity (food groups consumed daily, once in 3-7 days and once in fortnight/month) performed for these 12 food groups were considered as per the Food and Agriculture Organization classification,^[7] to identify diet serving score frequency of serving the food was also collected. This was performed at the beginning of the study at 6-month intervals and at 1-year intervals to know the pattern of diet and its effect on the nutritional status of children.

Calculation of diet diversity indicator

Food variety score

- Calculation of the Food Variety Score was performed by considering individual food items consumed without considering the group of food.
- Diet diversity score (DDS)

Dietary Diversity Score	12-food group
Low	≤ 4
Medium	5-8
High	9-12

Dietary Serving Score (DSS)

- The dietary serving score was calculated as follows^[8]

Food groups	Number of servings recommended	Assigned score
Cereals/roots	Four	Four
Vegetables	Two	Four
Fruits	Two	Four
Legume/bean	One	Two
Meat/fish/egg	One	Two
Milk/dairy products	Two	Four
Total	Twelve	Twenty

Statistical analysis

Data were coded and entered in Microsoft Excel and data were analyzed using the Co Guide statistics software, V.1.01. BDSS Corp. Released 2020. Version 1.0, India: BDSS Corp. Descriptive analysis was carried out using percentages and a paired *t*-test was used. The level of significance of < 0.05 was considered.

Results

In this study, among 270 participants, 137 (50.74%) were boys and 133 (49.26%) were girls. The mean age of participants was 29.06 ± 10.43 years. Also, 105 (38.89%) of them were 12-24 months, 81 (30%) were 25-36 months, and 84% (31.11%) were more than 37 months. In the present study, 27.78% of the participant's father was illiterate. Also, 18.52% were farmers, 46.67% were laborers, and 20.37% of mothers were illiterate. Next, 13.38% participant's mothers were farmers, 29.0% were laborers, and 53.16% were homemakers [Table 1].

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Table 1: Descriptive analysis of sociodemographic parameters in the study population (n=270)

Socio demographic variables	Number	Percentage
Age groups		
15-24 months	105	38.89%
25-36 months	83	30.00%
37-48 months	84	31.11%
Gender		
Male	137	50.74%
Female	133	49.26%
Religion		
Hindu/Others	242	89.63%
Muslim	28	10.37%
Type of the family		
Nuclear	122	45.18%
Joint	148	54.81%
Socio economic class		
Class I-III	53	19.63%
Class IV-V	217	80.37%
Education of father		
Illiterate/read and write	75 (27.78%)	93 (34.45%)
Primary	34 (12.59%)	35 (12.96%)
Secondary and above	161 (59.63%)	142 (52.59%)
Occupation of father		
Farmer	50 (18.52%)	36 (13.38%)
Daily wage Labourer	127 (46.67%)	78 (29.00%)
Self employment	55 (20.37%)	1 (0.37%)
Government employee/private employee	38 (14.08%)	11 (4.09%)
Home maker		143 (53.16%)

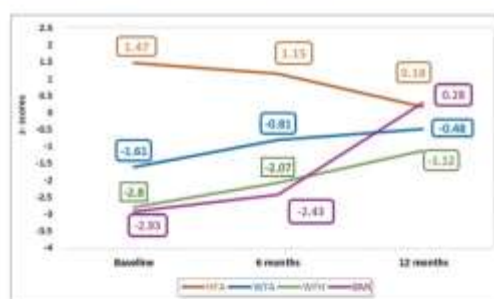
In the present study, weight for age Z score was <-2 in 29.3% of children, which reduced to 11.9% after 6 months and 4.1% at 12 months. The difference was statistically significant ($P < 0.001$). Height for age Z score was <-3 in 1.5% of children in the beginning and at the end of 6 months and 3.7% at the end of 12 months. The difference was statistically significant ($P < 0.001$). Weight for height and BMI Z score showed the maximum difference between beginning, 6 months, and 12 months [Table 2].

This study showed that the mean Z score for weight for age, weight for height and BMI increased from the baseline to 6 months to 1 year. This difference was statistically significant [Table 3].

In this study, it was observed that the mean height for age decreased at 6 months and 1 year as compared to the baseline mean value, whereas the weight for age, weight for height and BMI Z scores improved at 6 months and 12 months [Graph 1].

In this study, it was observed that the mean calorie intake improved at 6 months and also at 12 months as compared to the baseline mean value, whereas the protein intake improved from the baseline to 6 months and almost remained the same at 12 months [Graph 2].

In this study, it was observed that the mean diet serving score, food variety score, and diet diversity score improved at 6 months and 12 months as compared to the baseline mean value [Graph 3].



Graph 1: Comparison (mean) of HFA, WFA, WFH and BMI across different time points

In this study, calories consumed by children improved at 6 months and also at 1 year, protein consumption improved at 6 months and remained almost the same at the end of 1 year. Diet diversity, food variety and diet serving score also improved from the baseline to 6 months and 1 year [Table 4, Graphs 4 and 5].

Out of the total, 100% of children consumed cereals, 92% milk, 87% pulses, 69% green leafy vegetables, and 19% vegetables daily. Also, 70% consumed fruits once a week, 46% consumed eggs weekly, and 4% consumed meat once a fortnight. More children started consuming other vegetables, fruits, sweets, and eggs as compared to the baseline either daily or alternate days [Graphs 4 and 5].

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Table 2: Comparison of z scores for WAZ, HAZ, BMI at baseline, 6 months and 1 year

Variables	Baseline (n=270)	6 months (n=270)	12 months (n=270)	P
Weight for age group				
<2 (underweight)	79 (29.3%)	32 (11.9%)	11 (4.1%)	<0.001
-2 to 2 (normal)	191 (70.7%)	238 (88.1%)	259 (95.9%)	
Height for age group				
<-3 (stunted)	4 (1.5%)	4 (1.5%)	10 (3.7%)	<0.001
-2 to 2 (normal)	175 (64.8%)	211 (78.1%)	247 (91.3%)	
≥3 (tall)	91 (33.7%)	55 (20.4%)	13 (4.8%)	
Weight for height group				
≤-3 (wasted)	227 (84.1%)	106 (39.3%)	21 (7.8%)	<0.001
-2 to 2 (normal)	43 (15.9%)	164 (60.7%)	249 (92.2%)	
BMI status group				
≤-3 (thin)	256 (94.8%)	153 (56.7%)	7 (2.6%)	<0.001
-2 to 2 (normal)	14 (5.2%)	117 (43.3%)	256 (94.8%)	
≥3 (over weight)	0 (0%)	0 (0%)	7 (2.6%)	

Table 3: Comparison of nutritional status of children (Z score) at baseline, 6 months and 1 year

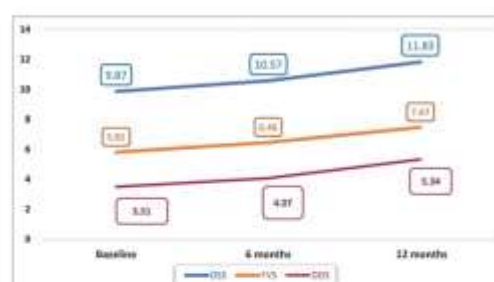
Anthropometry	Baseline	6 months	12 months	P		
				Baseline vs. 6 months	Baseline vs. 12 months	6 months vs. 12 months
Weight for age Z score	-1.61±1.21	-0.83±1.25	-0.48±1.06	<0.001	<0.001	<0.001
Height for age Z score	1.47±1.51	1.15±1.45	0.18±1.36	<0.001	<0.001	<0.001
Weight for height Z score	-2.8±0.52	-2.07±0.93	-1.12±0.97	<0.001	<0.001	<0.001
BMI Z score	-2.93±0.3	-2.43±0.76	0.28±1.2	<0.001	<0.001	<0.001

Table 4: Comparison of quality and quantity of diet at baseline, 6 months and 1 year

Quality and quantity-diet	Baseline	6 months	12 months	P		
				Baseline vs. 6 months	Baseline vs. 12 months	6 months vs. 12 months
Total calories consumed	671.08±154.91	930.05±141.7	1538.52±165.78	<0.001	<0.001	<0.001
Total protein consumed	20.58±5.5	27.32±5.59	27.25±5.77	<0.001	<0.001	0.954
FVS	5.81±1.53	6.46±1.45	7.47±1.37	<0.001	<0.001	<0.001
DDS	3.51±0.69	4.07±0.83	5.34±0.9	<0.001	<0.001	<0.001
DSS	9.87±1.65	10.57±1.62	11.83±1.67	<0.001	<0.001	<0.001



Graph 2: Comparison of calories and proteins consumed across different time points



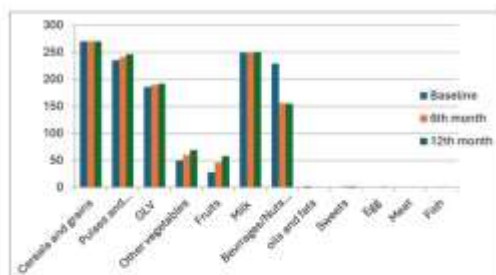
Graph 3: Comparison of DSS, FVS, and DDS across different time points

Discussion

Similar to the NFHS-5 data, this study also showed that undernutrition was about 30%,¹⁹ stunting was less as compared to the NFHS data, and more children had a height higher than normal, the reason for the difference could be because of genetic factors that might have decided the height of children and as

chronic malnutrition affects height, not acute malnutrition. Because of COVID-19, study subjects faced acute malnutrition. Because of the higher prevalence of children whose height was more than normal and undernutrition being 30%, wasting and BMI were more compared to the NFHS 5 data for India and Karnataka. Another study showed that underweight was more

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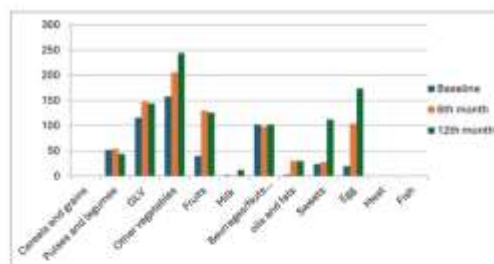


Graph 4: Daily consumptions of food groups at the baseline, 6th month, and 12th month

in this study (38.3%) and the rate of stunting (41.3%) was more than the NFHS 5 data for India. In this study, wasting was less than that is, 18.4%, the reason for this finding could be because more children were stunted than wasted. Similar findings were found in other studies.^[9-12] A study performed in Rohtak showed the prevalence of wasting was 13.8%, stunting was 31.2%, and underweight was 21.4%. The proportion of wasting was higher among boys.^[13] As the prevalence of stunting, undernutrition and wasting vary depending on various underlying causes, there is a need for specific action for its prevention.

A study performed in Nigeria showed that stunted children were more likely to have a low Diet Diversity Score.^[14] A study performed in South Africa showed that height for age had significant positive correlations with the Food Variety Score and Diet Diversity Score.^[15] According to a study, a positive association was found between a child's age and DDS that is, older children met better Mean Diet Diversity as compared to young children.^[16] The present study showed that when diet was deficient in quantity in the form of consumption of calories, and proteins, and low in quality that is FVS, DDS less than 4 and DSS less than 10, weight got affected more than height.

A study performed in north-central Ethiopia showed that a positive and generally linear trend in the mean HAZ is observed as DDI increased indicating that low dietary diversity increases the risk of undernutrition.^[16] Another study performed in Ghana showed that animal-source food scores were positively correlated with children's WHZ.^[17] Similar findings were observed in a study performed in Tobago, Woreda, and California.^[18,19] Our study showed that by increasing the quantity and quality of diet, a change in weight was observed; hence, the prevalence of undernutrition decreased over a period of 1 year. Height did not change like weight; the reason could be that in the beginning of the study, not many children were stunted, the reason could be acute malnutrition during the COVID-19 period. Anganwadis provided raw ration to the families of children, and later started preparing energy-dense foods for children after they received permission to open the Anganwadis. Hence, catch-up growth was observed in our study participants as far as weight was concerned when their diet was improved in quantity and quality.



Graph 5: Alternate day consumptions of food groups at the baseline, 6th month, and 12th month

In a study performed on Filipinos showed that as far as diet diversity is concerned, the consumption of cereals was 100%, oil/fat was 97%, and tubers was 88.71%.^[20] Various studies have shown that more people prefer food with high protein and energy compared to vegetables and fruits and their low consumption leads to micronutrient deficiency.^[20,21] The present study showed that at the baseline, more children consumed cereals, pulses, milk, and nuts (oil) on a daily basis. The consumption of foods of animal origin, fruits, and vegetables other than green leafy was less.

In this study, the mean difference in food variety score between the baseline and at the end of 12 months was 1.66, the difference in diet diversity score was 1.83, and the difference in dietary serving score was 1.96. The dietary diversity score should be more than 4 and the dietary serving score more than 10 for the optimum growth of under-five children.^[6] As the mean DDS was less than 4 at the beginning of our study and the mean DSS was less than 10, many children had lesser WAZ, BAZ scores. As FVS, DDS and DSS improved, total calories and proteins consumed also increased and hence the nutritional status of under-five children also improved. At a given point, the growth of a child may be normal or better than standard reference values but the velocity of growth may be affected if an adequate diet is not provided. Similarly, a malnourished child may grow well if adequate nutrition is provided. A monotonous diet affects the nutritional status of under-five children.^[22] Though many factors are responsible for the growth of children, diet plays an important role in maintaining optimum growth.

The present study is a longitudinal study that considers the assessment of quality as well as the quantity of diet and its effect on the nutritional status of under-five children, where the follow-up of diet and anthropometry are performed. Many studies have been performed taking into consideration either the quality or quantity of the diet using a cross-sectional design.

Conclusion

Our study showed that during the COVID lockdown period as Anganwadis were closed, raw food was given to the families of children. It affected the quantity and quality of diet consumed by

children. This acute shortage of food during the pandemic had an effect on weight more than the height of children. Many parents' income was based on daily wages, affecting the economic status of the family. In the present study, one-third of the participant's height was more than 2 standard deviation (SD) and one-third of participants had weight less than -2 SD; hence, the weight for height and BMI for age was more affected among under-five children. An increase in the quality and quantity of diet provided by Anganwadis under the Integrated Child Development Services Programme helped in increasing the weight of the children compared to height. Hence, Z scores of weight for age, weight for height and BMI scores also improved over a period of 1 year.

Recommendations

The diet of children should be improved by increasing food variety at home and Anganwadi which increases the interest of children in eating.

A diet diversity score of more than 4, with the inclusion of fruits and vegetables, meets the micronutrient deficiency in the diet. Food groups containing animal sources meet the requirement of essential amino acids and good-quality proteins. Hence, nutrition education of mothers and Anganwadi workers regarding diet diversity is very important.

As per the recommendations by the Food and Agriculture Organization, the number of food servings should be 12, and the diet serving score should be 20 for optimum growth of children, which ensures the adequacy of quantity (calories and proteins) and the quality of the diet. So, training of Anganwadi workers and mothers will help in providing an appropriate diet for children.

As the present study was performed during the COVID pandemic, providing raw ration to the family did not help to provide adequate nutrition to children. Programme managers can use different approaches to supply adequate diets to the vulnerable population during any emergency.

Limitations

As it was a longitudinal study, children were selected from six Anganwadis belonging to two sub-centres only.

Bias could have occurred while collecting data on the nutrition of children.

Genetics and sociodemographic variables also play an important role in determining the nutritional status of children along with nutrition; the present study emphasized the quality and quantity of diet in determining the nutritional status of children.

As the study was performed during the COVID pandemic, Anganwadis could not provide cooked food to children until they started functioning.

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Conflicts of interest

There are no conflicts of interest.

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ANNEXURE E - ONLINE CERTIFICATES, CONFERENCES AND PAPER PRESENTATI







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**UNIVERSITY DEPARTMENT OF
EDUCATION FOR HEALTH PROFESSIONALS**

This is to certify that

Dr./Mr./Mrs. Ms. Manasa M. Hiremath

has participated in the workshop entitled

Molecular Biology of Infectious Diseases

on 26th July 2022 organised by KAHER, BSRC

Belagavi as a Delegate / Resource Person.


Dr. Sunila Patil
Director, UDEHP


Dr. V. A. Kothiwale
Registrar





KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Declared as Deemed-to-be-University u/s 3 of the UGC Act, 1956)
Accredited 'A+' Grade by NAAC (2nd Cycle) Placed in Category 'A' by MHRD (GoI)

Department of Epidemiology and Biostatistics

CERTIFICATE

Workshop on

Sample Size Estimation, Systematic Review and Meta-Analysis using EXCEL/SPSS

held from 4th to 6th January 2021

This is to certify that Ms. Manasa M. Hiremath
has participated as a Delegate in the workshop


Dr. N. K. Tyagi
Professor & Head,
Department of Epidemiology & Biostatistics, KAHER, Belagavi


Dr. V. A. Kothiwale
Registrar,
KAHER, Belagavi



**3rd International Conference on
Maternal, Newborn and Child Health**
Translating Research Evidence to Practice

Certificate

This is to certify that

Ms Manasa M Hiremath

JNMC Women's and Children's Health Research Unit, Belagavi

*has participated as Faculty / Moderator / Delegate
in the 3rd International Conference on Maternal, Newborn and Child Health
held on November 11 - 13, 2022 at J N Medical College Belagavi*

Organized by

Women's and Children's Health Research Unit

Jawaharlal Nehru Medical College

KLE Academy of Higher Education and Research Belagavi, Karnataka, India

Dr Shivaprasad S Goudar
Professor of Physiology, J N Medical College &
Director Research, KAHER, Belagavi

Dr (Mrs) N S Mahantashetti
Officiating Vice-Chancellor, KAHER &
Principal, JNMC, Belagavi

Dr V A Kothiwale
Registrar, KAHER,
Belagavi

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COMPLETION REPORT - PART 1 OF 2 COURSEWORK REQUIREMENTS*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

Name: Manasa Hremath (ID: 9729796)
Institution Affiliation: University of North Carolina at Chapel Hill (ID: 429)
Institution Email: manasahremath1996@gmail.com
Institution Unit: MPH
Phone: 09035352447

Curriculum Group: CITI Good Clinical Practice
Course Learner Group: GCP for Clinical Trials with Investigational Drugs, Biologics and Devices Course
Stage: Stage 1 - Basic Course

Record ID: 40160887
Completion Date: 19-Jan-2021
Expiration Date: 19-Jan-2024
Minimum Passing: 80
Reported Score*: 94

REQUIRED AND ELECTIVE MODULES ONLY

	DATE COMPLETED	SCORE
The CITI Good Clinical Practice Course for Clinical Trials Involving Drugs and Biologics (ID: 14613)	04-Jan-2021	3/3 (100%)
Overview of New Drug Development (ID: 14621)	04-Jan-2021	5/5 (100%)
Overview of ICH GCP (ID: 14622)	04-Jan-2021	5/5 (100%)
ICH—Comparison Between ICH GCP E6 and U.S. FDA Regulations (ID: 14625)	19-Jan-2021	4/4 (100%)
Conducting Investigator-Initiated Studies According to FDA Regulations and GCP (ID: 14614)	13-Jan-2021	3/3 (100%)
Investigator Obligations in FDA-Regulated Research (ID: 14615)	19-Jan-2021	4/5 (80%)
Managing Investigational Agents According to GCP Requirements (ID: 14617)	13-Jan-2021	5/5 (100%)
Informed Consent in Clinical Trials of Drugs and Biologics (ID: 14618)	13-Jan-2021	4/4 (100%)
Monitoring Clinical Trials of Drugs by Industry Sponsors (ID: 14619)	13-Jan-2021	4/5 (80%)
Audits and Inspections of Clinical Trials of Drugs and Biologics (ID: 14620)	13-Jan-2021	4/5 (80%)
Detecting and Evaluating Adverse Events (ID: 14623)	13-Jan-2021	4/4 (100%)
Reporting Serious Adverse Events in Investigations of Drugs and Biologics (ID: 14624)	13-Jan-2021	4/4 (100%)
Completing the CITI GCP Course (ID: 14626)	13-Jan-2021	No Quiz
The CITI Good Clinical Practice Course for Clinical Investigations of Devices (ID: 14633)	13-Jan-2021	3/3 (100%)
Overview of U.S. FDA Regulations for Investigational Devices (ID: 14637)	13-Jan-2021	4/5 (80%)
Investigator Obligations in FDA-Regulated Clinical Investigations of Devices (ID: 14635)	13-Jan-2021	5/5 (100%)
Conducting Investigator-Initiated Clinical Investigations of Devices (ID: 14634)	13-Jan-2021	5/5 (100%)

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

Verify at: www.citiprogram.org/verify/?kt0208753-3ffe-48b3-93a2-73c773114635-40160887

Collaborative Institutional Training Initiative (CITI Program)

Email: support@citiprogram.org

Phone: 888-529-5929

Web: <https://www.citiprogram.org>

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)
COMPLETION REPORT - PART 2 OF 2
COURSEWORK TRANSCRIPT**

** NOTE: Scores on this Transcript Report reflect the most current quiz completions, including quizzes on optional (supplemental) elements of the course. See list below for details. See separate Requirements Report for the reported scores at the time all requirements for the course were met.

- **Name:** Manasa Hiremath (ID: 9729796)
 - **Institution Affiliation:** University of North Carolina at Chapel Hill (ID: 420)
 - **Institution Email:** manasahiremath1996@gmail.com
 - **Institution Unit:** MPH
 - **Phone:** 09035352447
-
- **Curriculum Group:** CITI Good Clinical Practice
 - **Course Learner Group:** GCP for Clinical Trials with Investigational Drugs, Biologics and Devices Course
 - **Stage:** Stage 1 - Basic Course
 - **Description:** This GCP training contains all of the attested CITI Program modules from the **GCP for Clinical Trials with Investigational Drugs and Biologics (ICH Focus) Version 2**. This ICH E6 GCP Investigator Site Training meets the Minimum Criteria for ICH GCP Investigator Site Personnel Training identified by TransCelerate BioPharma as necessary to enable mutual recognition of GCP training among trial sponsors.
-
- **Record ID:** 40160687
 - **Report Date:** 19-Jan-2021
 - **Current Score**:** 94

REQUIRED, ELECTIVE, AND SUPPLEMENTAL MODULES	MOST RECENT	SCORE
The CITI Good Clinical Practice Course for Clinical Trials Involving Drugs and Biologics (ID: 14613)	04-Jan-2021	3/3 (100%)
The CITI Good Clinical Practice Course for Clinical Investigations of Devices (ID: 14633)	13-Jan-2021	3/3 (100%)
Overview of U.S. FDA Regulations for Investigational Devices (ID: 14637)	13-Jan-2021	4/5 (80%)
Overview of New Drug Development (ID: 14621)	04-Jan-2021	5/5 (100%)
Overview of ICH GCP (ID: 14622)	04-Jan-2021	5/5 (100%)
Investigator Obligations in FDA-Regulated Clinical Investigations of Devices (ID: 14635)	13-Jan-2021	5/5 (100%)
Conducting Investigator-Initiated Clinical Investigations of Devices (ID: 14634)	13-Jan-2021	5/5 (100%)
ICH—Comparison Between ICH GCP E6 and U.S. FDA Regulations (ID: 14625)	19-Jan-2021	4/4 (100%)
Conducting Investigator-Initiated Studies According to FDA Regulations and GCP (ID: 14614)	13-Jan-2021	3/3 (100%)
Investigator Obligations in FDA-Regulated Research (ID: 14615)	19-Jan-2021	4/5 (80%)
Managing Investigational Agents According to GCP Requirements (ID: 14617)	13-Jan-2021	5/5 (100%)
Informed Consent in Clinical Trials of Drugs and Biologics (ID: 14618)	13-Jan-2021	4/4 (100%)
Monitoring Clinical Trials of Drugs by Industry Sponsors (ID: 14619)	13-Jan-2021	4/5 (80%)
Audits and Inspections of Clinical Trials of Drugs and Biologics (ID: 14620)	13-Jan-2021	4/5 (80%)
Detecting and Evaluating Adverse Events (ID: 14623)	13-Jan-2021	4/4 (100%)
Reporting Serious Adverse Events in Investigations of Drugs and Biologics (ID: 14624)	13-Jan-2021	4/4 (100%)
Completing the CITI GCP Course (ID: 14626)	13-Jan-2021	No Quiz

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

Verify at: www.citiprogram.org/verify/7fd0208753-3f8e-46b3-93a2-73c7731f4635-40160687

Collaborative Institutional Training Initiative (CITI Program)
 Email: support@citioprogram.org
 Phone: 888-529-5929
 Web: <https://www.citiprogram.org>



Completion Date 19-Jan-2021
Expiration Date 19-Jan-2024
Record ID 40160887

This is to certify that:

Manasa Hiremath

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

CITI Good Clinical Practice

(Curriculum Group)

GCP for Clinical Trials with Investigational Drugs, Biologics and Devices Course

(Course Learner Group)

1 - Basic Course

(Stage)

Under requirements set by:

University of North Carolina at Chapel Hill

CITI
Collaborative Institutional Training Initiative

This GCP training contains all of the attested CITI Program modules from the GCP for Clinical Trials with Investigational Drugs and Biologics (ICH Focus) Version 2. This ICH E6 GCP Investigator Site Training meets the Minimum Criteria for ICH GCP Investigator Site Personnel Training identified by TransCelerate BioPharma as necessary to enable mutual recognition of GCP training among trial sponsors.

Verify at www.citiprogram.org/verify/?wf2cb1fa6-3eba-468c-b7a4-bb0830fc2e19-40160887



Completion Date 02-Jan-2021
Expiration Date 02-Jan-2024
Record ID 40160886

This is to certify that:

Manasa Hiremath

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Human Research

(Curriculum Group)

Group 1 Biomedical Research:

(Course Learner Group)

1 - Basic Course

(Stage)

Under requirements set by:

University of North Carolina at Chapel Hill

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w03fc4a44-efce-4acf-8352-2f9e88ffcbd6-40160886



NIDA Clinical Trials Network

Certificate of Completion

is hereby granted to
Manasa Hiremath
 to certify your completion of the six-hour required course on:
GOOD CLINICAL PRACTICE

MODULE:

Introduction
 Institutional Review Boards
 Informed Consent
 Confidentiality & Privacy
 Participant Safety & Adverse Events
 Quality Assurance
 The Research Protocol
 Documentation & Record-Keeping
 Research Misconduct
 Roles & Responsibilities
 Recruitment & Retention
 Investigational New Drugs

STATUS:

N/A
 Passed
 Passed
 Passed
 Passed
 Passed
 Passed
 Passed
 Passed
 Passed
 Passed

Course Completion Date: 19 February 2021

CTN Expiration Date: 19 February 2024

Tracee Williams, Training Coordinator
 NIDA Clinical Coordinating Center

Good Clinical Practice, Version 5, effective 03-Mar-2017

This training has been funded in whole or in part with Federal funds from the National Institute on Drug Abuse, National Institutes of Health, Department of Health and Human Services, under Contract No. HHSN27201201000024C.

From
Manasa M Hiremath
PhD Scholar
KAHER Belagavi

Date- 19-07-2021

To,
Girija Shilainarvarmath
Mukayya Sevika
ICDS Belagavi

Respected Madam,

I am pursuing PhD at KAHER Belagavi title of the mine study is "Growth Velocity And Its Association With Diet Among Under Five Children Residing In Rural Area Of Belagavi- A Longitudinal Study". I need to collect information regarding growth velocity of Anganwadi children of Vantamuri PHC. I also need to train Anganwadi workers regarding measurements of weight, height, mid upper arm circumference, head circumference of children attending anganwadi so as to record the same every month. I need your permission to train anganwadi workers and also to collect information regarding children attending anganwadi .

Thanking You,

Yours Sincerely


Manasa M H

permitted .

19-7-2021
G.S. Shilainarvarmath