

**Nutritional Status of Under Five Children among Manipuri  
Population of Bangladesh**



**A thesis**

**Submitted to University of Dhaka in conformity with the  
requirements for the degree of  
DOCTOR OF PHILOSOPHY  
IN  
NUTRITION AND FOOD SCIENCE**

**Submitted By  
SYED SHAFI AHMED**

**INSTITUTE OF NUTRITION AND FOOD SCIENCE  
UNIVERSITY OF DHAKA  
MAY 2016**

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**Reg: 02/2010 – 2011 (Old)**

**56/ 2015 – 2016 (New)**



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## **SUPERVISOR CERTIFICATE**

I hereby certify to the best of my knowledge that the research “**Nutritional Status of Under Five Children Among Manipuri Population Of Bangladesh**” has been carried out entirely by **SYED SHAFI AHMED**, the candidate as a research scholar under my direct supervision and guidance (this work has not been submitted elsewhere for a degree) and that the candidate has fulfilled the requirements of the regulations laid down for the Doctor of Philosophy of the University of Dhaka.

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Institute of Nutrition and Food Science,

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And

Currently Vice Chancellor,

Shahjalal University of Science & Technology, Sylhet

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Dr. Syed Shafi Ahmed

## ABSTRACT

**Background:** Under nutrition is a human disaster on a vast scale especially among children in rural communities globally.

**Objective:** To see the nutritional status of under five children of Manipuri population of Bangladesh.

**Methodology:** This cross-sectional study was conducted among Manipuri population of three villages of Kamalganj (Mangalpur, Madabpur and Tilakpur) under Moulvibazar district during the period October 2010 to December 2014 using a semi-structured questionnaire. Sampling technique was purposive and the data was collected by face to face interview. Z score was in each anthropometric parameter. Data was analyzed by using SPSS version 21 and compared with national data.

**Results:** Among the study children, 56.9% were of Bishnupriya, 26.9% were Meitei and 16.2% were of Meiteipangan sub-group of Manipuri population. Mean age was  $22 \pm 12.6$  months and 61.6% were male and 38.4% were female. Majority (88.2%) of the mothers was housewives and most of them are educated. Among the children 93% were completely immunized as per EPI schedule, 48.8% were exclusively breast feed and 67.3% started complementary feeding on time. Amongst study children, 19.3% were underweight, 27.5% were stunted and 8.96% were wasted. By specific blood nutrient parameters, 63.7% were found anaemic ( $Hb < 10$  gm/dl), 39.8% had serum ferritin level below 15ng/ml. The association between haemoglobin and serum ferritin was found statistically significant ( $p < 0.05$ ). Amongst study children, 29.92% had protein of below standard (6.2 gm/dl), 17.6% had serum albumin level below 3.5 gm/dl, 52.3% had serum iron level below 50  $\mu$ g/dl, 11.3% had serum Vitamin D level below 20 ng/ml and 26.79% had serum zinc level below 700  $\mu$ g/l. Protein, albumin and ferritin level were found having significant association with wasting (p-value 0.044, 0.001 and 0.05 respectively).

**Conclusion:** The study shows that the nutritional indicators of under 5 children of Manipuri population is reasonably good. The frequency of malnutrition in Manipuri children is lower than those obtained from national data. This study also finds higher frequency of anaemia and some micronutrient deficiency in Manipuri community of Bangladesh.

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# Introduction

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## **1.1 Introduction**

Nutrition is a dynamic process involving food values, food processing, digestion and assimilation of food for nourishing the body. Malnutrition results from inadequate food intake, increased nutrients needs, decreased nutrient absorption and/ or increased nutrient losses<sup>1</sup>.

The UN in its Millennium Development Goals (MDG) aims to eradicate extreme poverty and hunger in the period 1990 – 2015 and to halve the proportion of people who suffer from hunger and malnutrition<sup>2</sup>. Malnutrition is highly associated with infant and child mortality, which are the two indicators used for monitoring the progress to achieve another MDG goal to reduce infant and child mortality.

Malnutrition among children is a major public health problem in developing countries including Bangladesh<sup>3,4</sup>, resulting from consumption of poor diet over a long period of time<sup>5</sup>. It has been reported that about 13 million infants and children, less than five years of age, die each year in developing countries and most of these deaths are attributed to under nutrition<sup>6</sup>. According to WHO criteria, 52% of young children in under-developed countries are considered normal, while 48% of them are malnourished and 10% of them are severely malnourished<sup>3</sup>. Although Bangladesh has already achieved a remarkable progress in reducing child malnutrition from 68% in the late 1980s to 41% in 2007<sup>7,8</sup> and under-five mortality<sup>9</sup>, still malnutrition is a common problem in this country<sup>10</sup>. It is one of the countries with very high burden of malnutrition. The underlying cause for 60% of the under-five deaths is malnutrition in Bangladesh<sup>11</sup>.

Malnutrition among children is a critical problem because its effects are long lasting and go beyond child-hood. It has both short- and long-term consequences. For instance, malnourished as compared to non-malnourished children are physically, emotionally and intellectually less productive and suffer more from chronic illnesses and disabilities. Malnutrition among children depends on complex interactions of various factors reflecting socio-demographic, environmental, reproductive, institutional, cultural, political and regional factors<sup>12</sup>.

Nutritional status is a result of complex interaction between food consumption, overall health status & care practices. Poor nutritional status is one of the most important health & welfare problems facing by Bangladesh. Young children & women of reproductive age are especially vulnerable to nutritional deficits & micronutrient deficiencies. At the individual level, inadequate or inappropriate feeding patterns lead to malnutrition. Numerous socioeconomic & cultural factors influence patterns of feeding & nutritional status<sup>2</sup>.

The UN has also reported that more than one-third of the world's population suffers from micronutrient deficiencies, particularly vitamin A, iodine, folate and Zn deficiencies. Malnutrition includes not only underweight due to insufficient energy and protein intakes, but also micronutrient deficiencies due to insufficient food intakes. These deficiencies can affect a child's physical and cognitive development and increase the risk of infection<sup>13</sup>. The economic costs of under nutrition include direct costs such as the increased burden on the health care system, and indirect costs of lost productivity. Adequate nutrition is essential for children's health and development<sup>14</sup>. Unless massive improvements in child nutrition are made, it will be difficult to achieve Millennium Development Goals.

Static and functional laboratory tests are primarily used to detect subclinical nutrient deficiency states. Some static biochemical tests measure levels of the nutrient in biological fluids and tissues on the assumption that such tests reflect the total body nutrient content or the nutrient tissue store most sensitive to depletion. Other functional biochemical tests assess the consequences of the nutrient deficiency by measuring changes in the activities of a specific enzyme (e.g., alkaline phosphatase for zinc) or in the concentrations of specific blood components dependent on a given nutrient (e.g., hemoglobin for iron; retinol binding protein for Vitamin A). Functional physiological tests assess the physiological performance of an individual *in vivo* and may include tests of immune competence, taste acuity, night blindness (via vision restoration time for Vitamin A), muscle function, and work capacity. Growth and developmental responses such as lactation, sexual maturation, and cognition, also can be assessed. None of these functional physiological tests are specific and hence must be used in conjunction with biochemical tests to identify the nutrient deficiency involved<sup>15</sup>.

Bangladesh has a large population of 166 million<sup>16</sup> with a small land area of 1,44,000 square kilometer, making it one of the most densely populated countries (920.1 per square kilometer) in the world<sup>9</sup>. Over population, poverty and illiteracy are pervasive in Bangladesh, causing population hazards like malnutrition<sup>17</sup>.



## **Manipuri ethnic community**

More than forty five different ethno-linguistic groups have been living in Bangladesh for many centuries. They are scattered mainly in hilly parts of Bangladesh, in the districts of Rangpur, Dinajpur, Rajshahi, Mymensingh, Sylhet and Chittagong Hill Tracts (CHTs). The prominent groups are Chakmas, Marmas, Murungs, Chaks, Bowms, Pankoos, Khiyangs, Khumis, Tripuras, and Lushais of the CHTs who are collectively known as Jumma because they cultivate their land in a specific way called *Jum* or shifting cultivation; and Hajongs, Khasis, Garos, Shantals, Oraons, Rajbangshi, Manipuri's etc in other districts<sup>18</sup>.

These people with distinctive social and cultural practices, languages and customs are commonly known as 'Adivasis' by themselves. Among them the Manipuri is one of the Adivasi communities living mainly in Sylhet and Moulvibazar districts of the country, having migrated from the Manipur state of India. They are dispersed in small pockets of settlements that are surrounded by areas inhabited by Bengali-speaking people<sup>19</sup>.

Manipuri population of Bangladesh essentially belong to Mongolian descent. The original homeland of this ethnic population is Manipur, once a sovereign state and now the northeastern zonal state of India. It is believed that they came to this country between 1819 and 1826 as a result of internal conflicts and repeated attack by Barmis. In the early days, Manipur had different names such as Kyangleipak, Kyangkleipang, Kyanglei, Meitrabak, and Mekhali and the Manipuris were known as Meitei. During the reign of Maharaj Garibniwaz (1709-1748), some missionaries arrived here from sylhet. There was an opinion that these missionaries named this land 'Manipur' and its principal inhabitants, Manipuris. The mahabharata has a mention of Manipur

and the missionaries but as it was discovered later, Manipur of Mahabharata and Manipur of Sylhet were not the same place. Historically, Manipuris are grouped into seven yek or salais. These are Ningthauja, Luwang, Khuman, Moirang, Angom, Chenglei and Khaba-Nganba. Each yek or salai is again divided into many Shageis. Subsequently, these yek or salais were converted to Vaisnavite sects. In this way Ningthauja yeks became Shandilya gotra, Khumans-Moudgalya, Moirangs-Atreya and Angirasya, Angom-Goutama, Luwang-Kashyapa, Chenglei-Bashistha and Angirasya and Khaba-Nganba-Bharadwaj and Naimisya. Ethnologically, Manipuris belong to the Kuki-Chin group of the Tibeto-Burman family of the Mongolian race. But a good admixture of Aryan and other blood groups also took place in the mainstream of Manipuri nation. Because of its special geographical location and as a result of several religious and political interactions, Manipur became the melting point of different ethnic groups and cultures from the time immemorial. This assimilation resulted in the formation of the modern Meitei people who are now widely known as Manipuri. According to the 1991 Population Census, there are about 25,000 Manipuris in Bangladesh. Of them about 13,000 are in Maulvi Bazar, 7,000 in Sylhet and 4,000 in Habiganj<sup>20</sup>.

Among these migrates, three sections of the population in Bangladesh all identify themselves as Manipuri. Among them *Meiteis* identify themselves as an ethnic minority but they never consider themselves as tribal, *Adivasi* or indigenous rather they are more interested to be introduced as part of the mainstream Hindu community of Bangladesh. But other sections (known as *Visnupria and Manipuri Muslim or Pangan*) do not hesitate to introduce themselves as *Adivasi* or indigenous. Every indigenous group has an ethnic identity and one very dominant characteristic of an indigenous group is its ethnicity. All of the native ethnic groups of the present state of Manipur had, at one time or another, been the cognate of the *Meitei* in Manipur. *Meiteis*

themselves were a melting pot of seven leading ethnic groups belonging to seven major principalities. The members of an ethnic group share a common ethnicity and ethnicity itself has its own historiography. It is like a cultural system which presses from generation to generation<sup>21,22</sup>.

### **Food Habit of Manipuris**

Historical evidence suggests that there was a change in the diet of the Manipuris, mainly due to introduction of Hinduism at the beginning of eighteenth century. The earlier reigns seem to have been one long feast with hecatombs of fat cattle and oceans of spirituous drinks, even culminating on more than one instance in fatalities due to an excessive appreciation of the good cheer. But the official adoption of Hinduism created many food type prohibitions. There are three religious groups in Manipuri communities.

I. Old Hinduism (Bishnu Priya)

II. Mitoi

III. Muslims (Mitoi Pangan) (Quite rare in Sreemongol)<sup>4</sup>

Old Hindus abide by many restrictions about consuming meat, eggs, oil and onion as an innate part of their faith. Manipuris are not anomalous as well in this regard. Mitoi people also abstain from consuming meat, eggs and onion. Mitoi people also do not consume cow's milk. Both use chives instead of onions<sup>23</sup>.

Although fish is allowed, animal flesh is forbidden as well as eggs; onion and garlic. Manipuris are mainly vegetarian. Rice is the main staple food. But they have some different food habits to the mainstream people of Bangladesh. Dal and different leafy vegetables (including yennum which is used instead of onion) are favorite food items. Manipuri women tend to use less oil when

cooking curries in comparison to the majority style of cooking. Milk and butter are also popular. Manipuri people produce their own foods. Most of the houses have vegetable gardens where they produce vegetables for their personal needs. A few also produce vegetables for commercial purposes. Rice, dal, and oil seeds are also homegrown<sup>24</sup>.

So, as observed, their ethnic origin, culture, feeding practice, and profession are different from those of indigenous Bangladeshis. As these are very important determinants for nutrition, there may be an obvious difference in the nutritional status of under 5 years children of Manipuri population from that of Bengali children.



**Manipuri girl in village**



**Culture in Manipuri village**



**Manipuri dance**



**Clothes made by Manipuri girl**

# **Rationale of the study**

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## **1.2 Rationale of the study**

Nutritional status of children is a burning public health issue since it is multidimensional and has profound consequences on national and regional health, nutrition and population policy.

The Lancet series estimated that more than one-third under 5 child deaths and diseases burden is associated with under nutrition that can be tackled if proper intervention can be delivered at early two years of life. The effects of undernutrition among under 2 children continues as an intergenerational cyclic process. Stunting in the first two years of life leads to long term physical and cognitive damage including shorter adult height, lower educational achievements, reduced economic productivity and decreased offspring birth weight.

The Manipuri population of Bangladesh essentially belong to Mongolian descent. Their health conditions have remained practically unexplored and no studies about the health status of Manipuri population especially children under 5 years of age, the most vulnerable group.

The Manipuri, is one of the many ethnic communities in Bangladesh. The Manipuri community is concentrated in the lowland regions of Sylhet, Maulavibazar, Sunamgonj and Habiganj districts of Bangladesh.



Manipuri women were found to be involved in earning activities (mainly handloom). Manipuri people are vegetarian and they prefer less spicy foods. All of them drink fresh water. Cleanliness is their tradition. While these practices help them to maintain good health, they suffer from different common diseases. Similar to all other indigenous groups in Sylhet region, Manipuri people tend to be ignored from researches

Reports on nutritional status among the under two children in Bangladesh is many but among the Manipuri children is inadequate.

# Objectives of the study

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### **1.3 Objectives of the study**

#### **General objective:**

- To determine the nutritional status of under 5 children among Manipuri population of Bangladesh

#### **Specific objective:**

- To assess the anthropometric indices of under 5 children among Manipuri people
- To assess the anthropometric status of mothers of the subjects
- To compare the nutritional status among the subjects of different sub groups along with national prevalence.
- To assess the nutritional status of the subjects in terms of selected biochemical parameters.
- To find out the socio-demographic characteristics of the subjects

## 1.4 Background Information

Nutritional status is the balance between the intake of nutrients by an organism and the expenditure of these in the process of growth, reproduction and health maintenance. Because this process is highly complex and quite individualized, nutritional status assessment can be directed at a wide variety of aspects of nutriture<sup>20</sup>.

The assessment of nutritional status is commonly summarized by anthropometric measurement, biochemical or laboratory tests, clinical indicator and dietary assessment. This study focused on anthropometric and dietary technique<sup>21</sup>.

Anthropometric approaches are relatively non invasive methods that asses the size or body composition of an individual<sup>22</sup>.

In children, growth charts have been developed to allow researchers and clinicians to assess weight and height for age and as well as weight for height. For children low height for age considered stunting while low weight for height indicates wasting in addition to weight and height measures of mid upper arm circumference are used to estimate muscle mass<sup>23</sup>.

### INDICES OF NUTRITIONAL STATUSES<sup>25</sup>

Three standard indices of physical growth that describe the nutritional status of children are:

- Height-for-age (stunting)
- Weight-for-height (wasting)
- Weight-for-age (underweight)

Each of these indices provides different information about growth and body composition that can be used to assess nutritional status.

### **Height-for-age (stunting)**

Height-for-age measures linear growth. A child who is more than two standard deviations below the median (-2 SD) of the WHO reference population in terms of height-for-age is considered short for his or her age, or stunted. This condition reflects the cumulative effect of chronic malnutrition. If a child is below three standard deviations (-3 SD) from the reference median, then he or she is considered to be severely stunted. Stunting reflects a failure to receive adequate nutrition over a long period of time and is worsened by recurrent and chronic illness. Height-for-age, therefore, reflects the long-term effects of malnutrition in a population and does not vary appreciably according to recent dietary intake.

### **Weight-for-height (wasting)**

Weight-for-height describes current nutritional status. A child who is more than two standard deviations below (-2 SD) the reference median for weight-for-height is considered to be too thin for his or her height, or wasted. This condition reflects acute or recent nutritional deficit. As with stunting, wasting is considered severe if the child is more than three standard deviations below (-3SD) the reference median. Severe wasting is closely linked to mortality risk.

### **Weight-for-age (underweight)**

Weight-for-age is a composite index of weight-for-height and height-for-age. Thus, it does not distinguish between acute malnutrition (wasting) and chronic malnutrition (stunting). A child can be underweight for his age because he or she is stunted, because he or she is wasted, or both. Children whose weight-for-age is below two standard deviations (-2 SD) from the median of the reference population are classified as underweight. Children whose weight-for-age is below three standard deviations (-3 SD) from the median of the reference population are considered severely underweight. Weight-for-age is an overall indicator of a population's nutritional health.

Z-score means are also calculated as summary statistics representing the nutritional status of children in a population. These mean scores describe the nutritional status of the entire population without the use of a cut off. A mean Z-score of less than 0 (i.e., a negative mean value for stunting, wasting, or underweight) suggests that the distribution of an index has shifted downward and that most if not all children in the population suffer from undernutrition relative to the reference population.

### **Mid upper arm circumference (MUAC):**

If neither height nor weight can be measured or obtained, nutritional assessment can be estimated using the mid upper arm circumference. The subject should be standing or sitting. The nondominant arm should be used if possible. If MUAC is less than 12.5 cm, child is considered severely malnourished, if between 12.5 cm to 13.5 cm. then child is moderately malnourished and more than 13.5 cm is considered normal<sup>26</sup>. If MUAC changes by at least 10% then it is likely that weight and BMI have change by approximately 10% or more.

**Body mass index (BMI):<sup>25</sup>**

Nutritional status can be quantified by body mass (Quetelet) index

$$\text{BMI} = \frac{\text{Weight (kg)}}{(\text{Height in meter})^2}$$

The lower normal level is considered 18.5. In malnourished children height retardation lags behind that of weight, and relation between weight and height should always be compared with age using appropriate charts.

**Standard deviation score (SD score) or Z-score:<sup>27</sup>**

Z-score is defined as the deviation of an observed individual value from the median value of the reference population, divided by the standard deviation of the reference population.

$$\text{Z Score} = \frac{\text{Observed value} - \text{Median reference value}}{1\text{SD}}$$

It denotes the degree of dispersion away from the mean. It has been estimated that approximately two thirds (about 68.27%) of the observations lie within one standard deviation. A range of 2 SD around the mean is expected to include 95.4% of all observations.

**Socioeconomic factors and child nutrition**

Child nutrition or malnutrition is multifaceted. It is a manifestation of the combined effect of adequate or inadequate dietary intake and diseases, both of these are closely related to social and economic development. Affordability, education and good access to health services are major contributors of childhood nutrition. Child health is closely related to maternal health, as nutrition during pregnancy, birth condition, birth spacing & health status of mother impact the health of the child prior to, during and after birth. Nutrition related problem can be prevented by affordable health interventions are made

available to the mothers & children who need them. Cost effectiveness has been increased by providing package interventions that address multiple health issues through known & cost effective intervention. Optimal infant feeding were recently reviewed by WHO. This review led to a revision to its recommendation to exclusive breast feeding for about six months followed by continued breast feeding with adequate complementary food for upto two years and beyond<sup>26</sup>. There is a complex relationship between the child's age, timing of weaning events and gut function leading to food malabsorption<sup>27</sup>. So wrong food at wrong age and giving in insufficient quantity is one of the most important correctable causes. Healthy & well educated children contribute to the security, economic growth & civil stability of nation<sup>28</sup>.

### **Hemoglobin estimation**

Hemoglobin estimation is the most important test, & useful index of the overall state of nutrition. Beside anemia it also tells about protein & trace element nutrition.

### **Iron**

Iron is an essential element for almost all living organisms as it participates in a wide variety of metabolic processes, including oxygen transport, deoxyribonucleic acid (DNA) synthesis, and electron transport. However, as iron can form free radicals, its concentration in body tissues must be tightly regulated because in excessive amounts, it can lead to tissue damage. Disorders of iron metabolism are among the most common diseases of humans and encompass a broad spectrum of diseases with diverse clinical manifestations, ranging from anemia to iron overload, and possibly to neurodegenerative diseases.

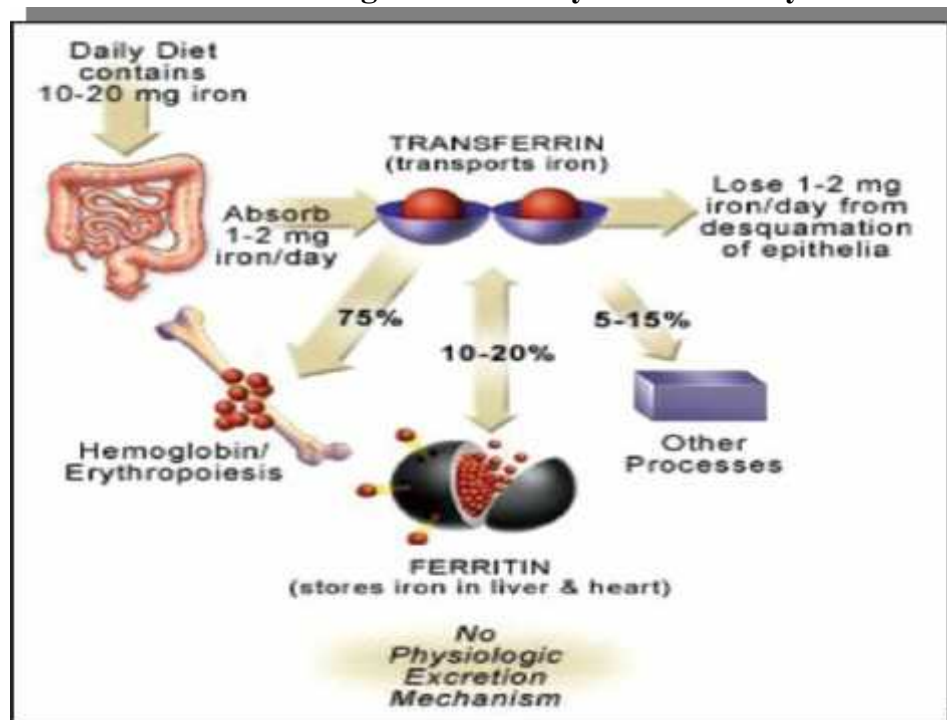


For many years, nutritional interest in iron focused on its role in hemoglobin formation and oxygen transport<sup>29</sup>. Nowadays, although low iron intake and/or bioavailability are responsible for most anemia in industrialized countries, they account for only about half of the anemia in developing countries, where infectious and inflammatory diseases (especially malaria), blood loss from parasitic infections, and other nutrient deficiencies (vitamin A, riboflavin, folic acid, and vitamin B12) are also important causes<sup>30</sup>.

### **Biochemistry and physiology**

Iron is recycled and thus conserved by the body. Iron is delivered to tissues by circulating transferrin, a transporter that captures iron released into the plasma mainly from intestinal enterocytes or reticuloendothelial macrophages. The binding of iron-laden transferrin to the cell-surface transferrin receptor (TfR) 1 results in endocytosis and uptake of the metal cargo. Internalized iron is transported to mitochondria for the synthesis of heme or iron-sulfur clusters, which are integral parts of several metalloproteins, and excess iron is stored and detoxified in cytosolic ferritin.

### Schematic diagram of iron cycle in the body



### Human Requirements

During early infancy, iron requirements are met by the little iron contained in the human milk. The need for iron rises markedly 4-6 months after birth and amounts to about 0.7-0.9 mg/day during the remaining part of the first year. Between 1 and 6 years of age, the body iron content is again doubled. Iron requirements are also very high in adolescents, particularly during the period of growth spurt. Girls usually have their growth spurt before menarche, but growth is not finished at that time. In boys there is a marked increase in hemoglobin mass and concentration during puberty. In this stage, iron requirements increase to a level above the average iron requirements in menstruating women<sup>31</sup>.

## **Vitamin D**

Vitamin D refers to a group of fat-soluble secosteroids responsible for enhancing intestinal absorption of calcium, iron, magnesium, phosphate and zinc. In humans, the most important compounds in this group are vitamin D<sub>3</sub> (also known as cholecalciferol) and vitamin D<sub>2</sub> (ergocalciferol)<sup>32</sup>.

## **Function**

Following dietary intake or synthesis in the epidermis of skin after UVB exposure, both forms of vitamin D enter the circulation and are transported to the liver by the vitamin D-binding protein. Exposure to sunlight or dietary intake of vitamin D increases serum levels of 25-hydroxyvitamin D<sup>33</sup>. While the kidney is the main source of 1 $\alpha$ -hydroxylase activity, extra-renal production of 1, 25- dihydroxyvitamin D has also been demonstrated in a variety of tissues, including skin, parathyroid gland, breast, colon, prostate, as well as cells of the immune system and bone cells<sup>34</sup>. Most of the physiological effects of vitamin D in the body are related to the activity of 1,25-dihydroxyvitamin D.

## **Deficiency**

Rickets and osteomalacia are the classical vitamin D deficiency diseases. In children, vitamin D deficiency causes rickets, a disease characterized by a failure of bone tissue to properly mineralize, resulting in soft bones and skeletal deformities. Rickets was first described in the mid-17th century by British researchers<sup>35</sup>. In the late 19th and early 20th centuries, German physicians noted that consuming 1–3 teaspoons/day of cod liver oil could reverse rickets<sup>36</sup>. The fortification of milk with vitamin D beginning in the 1930s has made rickets a rare disease in the United States, although it is still reported periodically, particularly among African American infants and children<sup>37</sup>.

## **Recommended intake**

Vitamin D intake can be measured in two ways: in micrograms (mcg) and International Units (IU). One microgram of vitamin D is equal to 40 IU of vitamin D. The sunshine vitamin - vitamin D - can be produced in the body with sun exposure or consumed in food or supplements. For 0-50 years: 5 micrograms or 200 IU per day.

## **Sources of Vitamin D**

*Food* very few foods in nature contain vitamin D. The flesh of fatty fish (such as salmon, tuna, and mackerel) and fish liver oils are among the best sources. Small amounts of vitamin D are found in beef liver, cheese, and egg yolks. Vitamin D in these foods is primarily in the form of vitamin D<sub>3</sub> and its metabolite 25(OH)D<sub>3</sub><sup>38</sup>. Some mushrooms provide vitamin D<sub>2</sub> in variable amounts<sup>39</sup>. Mushrooms with enhanced levels of vitamin D<sub>2</sub> from being exposed to ultraviolet light under controlled conditions are also available.

Fortified foods provide most of the vitamin D in the American diet<sup>40</sup>. For example, almost all of the U.S. milk supply is voluntarily fortified with 100 IU/cup, In Canada, milk is fortified by law with 35–40 IU/100 mL, as is margarine at  $\geq 530$  IU/100 g.

### **Sun exposure**

Most people meet at least some of their vitamin D needs through exposure to sunlight<sup>41</sup>. Ultraviolet (UV) B radiation with a wavelength of 290–320 nanometers penetrates uncovered skin and converts cutaneous 7-dehydrocholesterol to previtamin D<sub>3</sub>, which in turn becomes vitamin D<sub>3</sub>.

### **Dietary supplements**

In supplements and fortified foods, vitamin D is available in two forms, D<sub>2</sub> (ergocalciferol) and D<sub>3</sub> (cholecalciferol) that differ chemically only in their side-chain structure. Vitamin D<sub>2</sub> is manufactured by the UV irradiation of ergosterol in yeast, and vitamin D<sub>3</sub> is manufactured by the irradiation of 7-dehydrocholesterol from lanolin and the chemical conversion of cholesterol<sup>42</sup>.

### **Zinc**

Zinc is required by enzymes involved in DNA and protein synthesis and is essential for cell growth and repair. Zinc may also have antioxidant and antiatherogenic properties<sup>43,44</sup>.

Zinc is involved in numerous aspects of cellular metabolism. It is required for the catalytic activity of approximately 100 enzymes<sup>45</sup> and it plays a role in immune function<sup>46</sup>, protein synthesis, DNA synthesis, cell division<sup>47</sup> and wound healing<sup>48</sup>. Zinc also supports normal growth and development during pregnancy, childhood, and adolescence and is required for proper sense

of taste and smell<sup>49,50</sup>. A daily intake of zinc is required to maintain a steady state because the body has no specialized zinc storage system<sup>51</sup>.

### Recommended Intakes

The current RDAs for zinc are listed below: For infants aged 0 to 6 months, the FNB established an AI for zinc that is equivalent to the mean intake of zinc in healthy, breastfed infants<sup>52</sup>.

### Recommended Allowance<sup>53</sup>

Age	Male	Female
0–6 months	2 mg*	2 mg*
7–12 months	3 mg	3 mg
1–3 years	3 mg	3 mg
4–8 years	5 mg	5 mg

\* Adequate Intake (AI)

### Sources of Zinc

Oysters contain more zinc per serving than any other food, but red meat and poultry provide the majority of zinc in the American diet. Other good food sources include beans, nuts, certain types of seafood (such as crab and lobster), whole grains, fortified breakfast cereals, and dairy products. Phytates-which are present in whole-grain breads, cereals, legumes, and other foods-bind zinc and inhibit its absorption<sup>54</sup>.

### Zinc Deficiency

Zinc deficiency is characterized by growth retardation, loss of appetite, and impaired immune function. In more severe cases, zinc deficiency causes hair loss, diarrhea, delayed sexual maturation, impotence, hypogonadism in males, and eye and skin lesions<sup>55,56</sup>. Weight loss, delayed healing of wounds,

taste abnormalities, and mental lethargy can also occur<sup>57</sup>. Many of these symptoms are non-specific and often associated with other health conditions; therefore, a medical examination is necessary to ascertain whether a zinc deficiency is present. Zinc nutritional status is difficult to measure adequately using laboratory tests<sup>58</sup> due to its distribution throughout the body as a component of various proteins and nucleic acids<sup>59</sup>.

### **Protein**

Protein is a vital part of a healthy diet for children. This substance, though important for all people, is especially necessary for developing and growing bodies. Protein is used as a source of energy, especially when carbohydrates and fats are at insufficient levels in the diet. In addition, a child needs adequate protein to support the body's production of its own proteins. Children may develop a serious protein deficiency called protein energy malnutrition. In much of the world this is caused by lack of access to a variety of foods. According to the World Health Organization (WHO), more than 30% of the world's infant population is malnourished<sup>60</sup>. Protein-calorie malnutrition results in 2 similar but distinct diseases, marasmus and kwashiorkor.

### **Marasmus**

Is defined simply as chronic deprivation of energy needed to maintain body weight. Its extreme form is characterized by severe weight loss and cachexia.<sup>1</sup> Marasmus is further characterized by subnormal body temperature, decreased pulse and metabolic rate, loss of skin turgor, constipation, and starvation diarrhea, consisting of frequent, small, mucus-containing stools<sup>61</sup>.

### **Kwashiorkor**

Is a somewhat more complex disease. It is characterized by edema, low capillary-filtration rate, hypoalbuminemia, and dermatitis.

Derived from an African term meaning "the disease that occurs when the next baby is born", kwashiorkor was initially thought to result from a diet high in calories (mainly carbohydrates, such as maize), yet deficient in protein. However, infection, aflatoxin poisoning, and oxidative stress may also play causative roles<sup>62,63</sup>. Edema, a defining characteristic of kwashiorkor, resolves with treatment, despite continuing hypoalbuminemia, suggesting that the edema is due to leaky cell membranes, low capillary filtration rates, high concentrations of free iron, and free radicals that increase capillary permeability<sup>64</sup>.

Kwashiorkor is further distinguished from marasmus by the following findings:

- Massive edema of the hands and feet.
- Profound irritability.
- Anorexia.
- Dermatologic symptoms (desquamative rash, hypopigmentation).
- Alopecia or hair discoloration.
- Fatty liver.
- Loss of muscle tone.
- Anemia and low blood concentrations of albumin, glucose, potassium, and magnesium<sup>65</sup>.

Kwashiorkor may also involve severe, life-threatening hypophosphatemia (<1.0 mg/dL), which has been found to triple the mortality rate when compared with children who have normal phosphorus levels<sup>66</sup>.

Overall, in impoverished regions of Africa, marasmus is more prevalent than kwashiorkor<sup>67</sup>. These conditions are most commonly seen in areas that are both impoverished and affected by human immunodeficiency virus (HIV) infection. Evidence indicates that HIV-infected children in Africa have more than twice the incidence of marasmus, compared with uninfected children (16% vs. 7%).



# **Review of Literature**

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### **Review of Literature:**

A descriptive cross-sectional study was carried out among 144 under-five children from rural (n=72) and urban (n=72) area in Tangail, Bangladesh to assess and compare their socioeconomic information and nutritional status among rural and urban children. Almost one half participants in urban area were nuclear family (<4 member) but major participants in rural area (44.5%) were contained 6-7 family member. In rural area, the occupations of household head were mainly farmer (44.4%) while more than two third were engaged themselves in business in urban areas. It was found for WHZ in rural area that 1.39% children were severely wasted, 1.39% were moderately wasted, 22.23% were mildly wasted and there were no severe overweight but in urban areas 25%, 2.78% and 1.38% were mild overweight, moderate overweight and severe overweight respectively. For WAZ, the results also stated that, the children from rural area were underweight (38.8% mildly underweight and 25% moderately underweight) rather than overweight but inverse results were found for urban children. For HAZ, the prevalence of moderately stunting among rural children (44.45%) was higher than urban children (2.78%). From BAZ, the prevalence of obesity was presented higher among the urban children. As most of the rural children were wasted, underweight and stunted, it should be provided community education concerning about nutritional knowledge, environmental sanitation and personal hygienic practices, breast-feeding and weaning practices, nutritional deficiency diseases, nutritional value of food and dietary practices would perhaps overturn the trends<sup>68</sup>.

A study of infants under 36 months old in a low-income area of Nairobi, Kenya, found that a “lack of information on exclusive breast feeding and low level of education for the mothers is the main cause of the frequent illness and malnutrition among infants,” the East African reports<sup>69</sup>.

The post-tsunami survey described a decline in nutrition and health status amongst women and children in relief camps in post-tsunami Sri Lanka<sup>70</sup>. Though the investigators failed to recognize the relevance and adequately assess the influence of infant and young child feeding practices on the increased morbidity they observed in under two year olds. Their data shows that three quarters of infants aged 6-12 months and 89% of children aged 12-24 months of age (the latter being the group with the highest prevalence of diarrhoea and wasting) had received milk powder in the previous 24 hours. This was despite the fact that most infants and young children were reported as breastfed. The focus group discussions described how hygienic preparation of milk was a problem in the camps. The highest rates of severe malnutrition (1.8%) were among under 1 year olds, who seemed to be living on breast milk, powdered milk and biscuits. The authors did not assess exclusive breastfeeding rates in infants under six months, yet they concluded that "breastfeeding practices were satisfactory in infants under six months". This study highlights how the use of standard indicators to assess infant feeding practice and technical expertise in their interpretation is fundamental to assess impact appropriately. The authors recommendations also reflect the tendency to focus on commodity based responses to infant and young child feeding - adequate food rations, vitamin supplementation, supplementary feeding, with no mention of skills based support for breastfeeding, or the need to ensure a protective aid environment where indiscriminate distribution of milk powder does not feature. UNICEF, together with WFP, supported a nutrition survey, conducted by the Medical Research Institute of the Ministry of Healthcare and Nutrition, in camps housing displaced people. This involved a cross-sectional 30-cluster survey, where 30 children under five years of age were surveyed in each cluster, along with all pregnant and lactating women in selected camps. Mid upper arm circumference (MUAC) was used to assess the nutritional status of pregnant women (MUAC  $\leq$  230 mm for acute malnutrition and  $\leq$  207 mm

for severe acute malnutrition). In lactating women, Body Mass Index (BMI) was calculated (BMI<18.5 considered underweight and >24.9 as overweight). Before the survey, under-nutrition was the primary development challenge for Sri Lankan children. A Demographic and Health Services (DHS) survey in 2000 indicated that 14.0% 13.5% and 29.4% of children under five were wasted, stunted and underweight, respectively. In comparison, the post-tsunami study assessed a total of 878 children and found 16.1%, 20.2% and 34.7% to be wasted, stunted and underweight. The prevalence of each indicator was higher in boys than in girls. During the two weeks before the survey, 69.5% of the children had acute respiratory tract infections and 17.9% had diarrhoea. Although the general food distribution was well in place, the food supply lacked diversity and 70.9% of the children did not get appropriate supplementary food. The prevalence of under-nutrition among pregnant women and lactating women was 37% and 31% respectively. The highest prevalence of wasting was among children between 12 and 23 months of age (31.2%). This age group also experienced the highest prevalence of acute respiratory tract infection and diarrhoea. Although this study found a level of wasting higher than the trigger point of 15% used by the World Health Organization (WHO) to indicate a public health concern, there was a very low level (0.8%) of severely wasted children. The highest prevalence of severe malnutrition was in infants under 1 year (1.8%).

To assess the nutritional status of children under five years of age, pregnant women, and lactating women residing in 40 relief camps after the tsunami<sup>71</sup>. A cross-sectional, 30-cluster study was performed. Thirty children under five from each cluster (camp) and all pregnant and lactating women in selected camps were studied. Data were collected by interviews with the primary caregivers of the children, interviews with key informants in the camps, direct observation, and focus group discussions with mothers. Weight, height, or length was measured on children and pregnant women. Mid-upper-arm circumference of lactating women was measured. A total of 878 children were assessed, of whom 16.1%, 20.2%, and 34.7% were wasted, stunted, and underweight, respectively. The prevalence of each indicator was higher in boys than in girls. During the 2 weeks before the survey, 69.5% of the children had acute respiratory tract infections and 17.9% had diarrhea. Although the general food distribution was well in place, the food supply lacked diversity, and 70.9% of the children did not get appropriate supplementary food. The prevalence of undernutrition among pregnant women (n = 168) was 37%. Thirty-one percent of lactating women (n = 97) were underweight, and 20% were overweight.

A nutritional survey was conducted in 3 affected Counties one year after the Earthquake in April 2009<sup>72</sup>. Peng County, Sichuan Province Kang County, Gansu Province Ningqiang County, Shanxi Province Two towns from each county were selected as study sites. The survey recruited 58 pregnant, 66 lactating and 242 non-pregnant-nonlactating women, and 466 children under 60-months-old including 162 children aged 0-23 months and 304 children aged 24-59 months. The exclusive breast milk feeding rate among infants under 6 months was 58.8%. Among the 0-23 months old children, only 10.7% were breastfed within one hour after delivery. Around 92% of children did not receive any nutritional supplements. The anthropometry and hemoglobin under

24 months old children were evaluated in Sep. 2008, Apr. 2009, May 2010, Oct. 2010, May 2011 and Oct. 2011 which correspond to about three months, one year, two years and two and half years... of Wenchuan Earthquake. The results indicated that after the emergency event such as Earthquake, although the supporting food intakes could meet the energy and protein requirements, but the local dietary were lack of meats, poultries, dairy products, legume products and aquatic products.

One study conducted in Bangalore, India was aimed at correlating biochemical parameters with physical parameters. About 42 clinically undernourished children in the age group of 2-5yrs were enrolled for the study. Their age and body weight were noted and the subjects were accordingly grouped under Grade 1, 2 or 3 malnutrition as per Gomez' classification. Serum Albumin, total lymphocyte count and total cholesterol values of these cases were noted. Depending on the values obtained, the subjects were grouped into 3 categories – mild, moderate and severe malnutrition. Physical parameters were correlated with the biochemical parameters. This study concluded that serum albumin, cholesterol and total lymphocyte count correlate significantly with physical parameters. They are reliable parameters that can be used not only to assess severity of under nutrition but they also provide more information about the nutritional status such as protein and lipid reserves in the body and immune status of the individual<sup>73</sup>.

Another cross sectional, descriptive study was conducted in Nepal to determine biochemical nutritional indicators among children (between ages 6 to 59 months attending outpatient department (OPD) and wards of Kanti Children's Hospital (KCH), Maharajgunj, Kathmandu, Nepal) suffering from PEM and to compare all biochemical parameters with well-nourished children and also to determine the factors affecting PEM among children under five

years. The educational status of parents of children with PEM was found to be significantly less ( $p < 0.05$ ) as compared to their non-PEM counterparts. Occupations of parents whose children were in PEM group include mainly housewives and labourers. Larger proportions of children in our study were born at home and exact birth weights of children were not known. Most of the children are colostrum fed. Most of the children in our study were immunized. Almost equal proportion of children belonged to nuclear family type and joint family type. The mean serum glucose, sodium, potassium, cholesterol, hemoglobin was not significantly different in both groups while mean total protein, albumin, and calcium were significantly ( $p < 0.05$ ) low in PEM group when compared to well-nourished children (control). There was significantly ( $p < 0.05$ ) higher incidence of hypoproteinemia, hypoalbuminaemia, and hypocalcaemia, in PEM group when compared to control group<sup>74</sup>.

A hospital based study was conducted in Dhaka Shishu (children) Hospital<sup>75</sup>, the largest tertiary care paediatric hospital of the country during the period of 1<sup>st</sup> July 2003 to 30<sup>th</sup> June 2004. A total of 114 mothers of hospitalized moderate to severe malnourished under 5 children or without evidences of anaemia were selected for interview to collect data about their children. Amongst the 114 mothers 57 were given to nutrition education were cases and the rest 57 were not exposed to nutrition education were control. Nutritional status of the Children was assessed and estimation of hemoglobin was done in case and control group initially before nutrition education session and again after six months. Anthropometric and biochemical data were compared among the two groups. Among the 114 malnourished under five children weight for age, weight for height and height for age of case group having  $< -2SD$  showed reduction after six months from 54% to 44% ( $p = 0.008$ , significant), 21% to 8.8% ( $p = 0.00$ , significant) and 35% to 10% respectively. But results of control group did not show any significant improvement. Before nutritional education

60% children were severely malnourished which was reduced to 33% after 6 months of nutritional education but in control group it reduced only from 77% to 65%. In terms of wasting and stunting also there was a significant impact on nutritional status, it reduced from 35% to 10% and 21% to 9% respectively. Children of case group having anaemia also showed reduction from 88% to 27% ( $p=0.000$ , significant) but in control group from 74% to 62% only.

A population-based cross-sectional study on children under 5 years of age was conducted in the municipality of Assis Brasil, AC, Brazil, in 2003 and 2010. The prevalence of low HAZ (undernutrition) was 7.0% in 2003 and 12.2% in 2010. The prevalence of high WHZ (overweight) was 1.0% and 6.6% for 2003 and 2010, respectively. It was not possible to adjust the multiple model for the year 2003. The factors associated with low HAZ in 2010 were: wealth index, the situation of living with biological parents, maternal height and presence of open sewage, whereas the factors associated with a high WHZ in the same year were: child's age, mother's time of residence in the location, mother's body mass index<sup>76</sup>.

One study was undertaken to analyze the growth performance and iron status of school-age children in rural Benin, not only in relation to season but also to school attendance. The study was carried out in three villages in the Atacora province in northern Benin<sup>77</sup>. Eighty children aged 6 to 8 years were randomly selected. Anthropometric parameters, hemoglobin level, serum ferritin and C-reactive protein were measured in the same children in the post-harvest season and the next pre-harvest season. Complete anthropometric data sets were available for 74 children while for blood analysis 69 children completed the study. In the post-harvest season, mean Z-scores for height-for-age and for weight-for-height were  $-1.72 \pm 0.89$  and  $-0.89 \pm 0.62$ , respectively. The Z-score for height-for-age of children attending school ( $-1.55 \pm 0.87$ ) was



significantly different from that of children not attending school ( $-2.14 \pm 0.80$ ) ( $P < 0.05$ ). In the post-harvest season, haemoglobin level was  $119 \pm 13$  g/l and median serum ferritin level was  $36 \mu\text{g/l}$ .

To assess nutritional iron status and anemia prevalence in children less than 5 years old at public daycare centers in the city of Recife, PE, Brazil, a cross-sectional study, with a systematic random sampling of 162 children aged 6 to 59 months was conducted. Nutritional iron status was assessed in terms of body iron reserves (serum ferritin), transferrinemia (serum iron, total iron binding capacity, and transferrin saturation %), erythropoiesis (free erythrocyte protoporphyrin) and hemoglobin production (hemoglobin). The prevalence of anemia (hemoglobin  $< 11.0$  g/dL) was 55.6% (95%CI 47.3-63.5), evidence was found of depleted iron stocks (serum ferritin  $< 12.0$  ng/mL) in 30.8% (95%CI 22.9-39.3), low transferrinemia levels (transferrin saturation %  $< 16$ ) in 60.1% (95%CI 51.7-68.0) and deficient erythropoiesis (free erythrocyte protoporphyrin  $> 40$   $\mu\text{mol/mol}$  heme) in 69.6% (95%CI 61.0-77.1) of the children. Iron parameters were not correlated with sex ( $p > 0.05$ ). However, children  $< 24$  months exhibited lower hemoglobin concentrations ( $p < 0.00$ ) and higher levels of free erythrocyte protoporphyrin ( $p < 0.000$ ) and total iron binding capacity ( $p < 0.001$ ) when compared with children  $> 24$  months. The significant correlation observed between reserves, transferrinemia and erythropoiesis is a finding that is compatible with the expected lifecycle of iron in the body<sup>78</sup>.

A cross-section study was conducted in Iran on 252 reproductive, 15-49 year old women of the city of Tabriz, randomly selected from among the general population. From each subject 5 mL vein blood was obtained and serum levels of calcium, phosphor, alkaline phosphatase, and vitamin D were measured. Levels of  $< 5$  ng /mL were considered as severe deficiency, 5- 9.90

ng/ mL as moderate, and 10- 20 ng /mL as mild. A demographic questionnaire was completed; weight and height were measured using seca scale and cotton ruler. Body mass index was calculated based on weight and height. Vitamin D was measured by radioimmunoassay. The results indicated that vitamin D deficiency in women was as follows: severe vitamin D deficiency 15.1%, moderate deficiency 15.5%, and mild deficiency 33.7%. Of these women 3.7% were underweight and 59.8% had different stage of obesity. Only 37.5% had BMI within normal range. There was a significant correlation between serum levels of vitamin D and weight and age ( $r = 0.16$ ,  $p = 0.01$  and  $r = 0.19$ ,  $p = 0.003$ ). There was no significant association between BMI and serum vitamin D level<sup>79</sup>.

Korean researchers investigated the vitamin D status and the effect of vitamin D supplementation in Korean breast-fed infants. The healthy term newborns were divided into 3 groups; A, formula-fed; B, breast-fed only; S, breast-fed with vitamin D supplementation. We measured serum concentrations of vitamin D (25OHD3), calcium (Ca), phosphorus (P), alkaline phosphatase (AP), intact parathyroid hormone (iPTH) and bone mineral density (BMD) at 6 and 12 months of age. Using questionnaires, average duration of sun-light exposure and dietary intake of vitamin D, Ca and P were obtained. At 6 and 12 months of age, 25OHD3 was significantly higher in group S than in group B ( $P < 0.001$ ). iPTH was significantly lower in group S than in group B at 6 months ( $P = 0.001$ ), but did not differ at 12 months. Regardless of vitamin D supplementation, BMD was lower in group B and S than in group A ( $P < 0.05$ ). Total intake of vitamin D differed among 3 groups ( $P < 0.001$ ,  $A > S > B$ ), but total intake of Ca and P were higher in group A than in group B and S ( $P < 0.001$ ). In conclusion, breast-fed infants show lower vitamin D status and bone mineralization than formula-fed infants. Vitamin D supplementation (200

IU/day) in breast-fed infants increases serum 25-OH vitamin D<sub>3</sub>, but not bone mineral density<sup>80</sup>.

One review described the vitamin D status in different regions of the world with the objective of understanding the scope of hypovitaminosis D and the factors related to its prevalence that may contribute to the pathogenesis of osteoporosis and fragility fractures across different regions of the world; Asia, Europe, Middle East and Africa, Latin America, North America, and Oceania. Serum 25(OH)D levels was found below 75 nmol/L in every region studied whilst levels below 25 nmol/L are most common in regions such as South Asia and the Middle East. Older age, female sex, higher latitude, winter season, darker skin pigmentation, less sunlight exposure, dietary habits, and absence of vitamin D fortification are the main factors that are significantly associated with lower 25(OH)D levels<sup>81</sup>.

One study was conducted to assess the nutritional status of school children aged 5-12 years in Kawo District, Kaduna State, Nigeria in relation to gender and school background In between October 2009 and December 2009. One hundred and forty one (141) school children were randomly selected from two public and two private schools. Sex distribution of children studied was 51.8% male and 48.2% female, while severe underweight and stunting occurred in 35% and 26.4% of the children respectively. Significant difference ( $p < 0.05$ ) was not observed between severely underweight or stunted boys and girls, while normal WAZ and HAZ occurred in 20% and 17.1% of the children, respectively. About 5% and 12.9% of the severely underweight and stunted children were respectively from private schools, while 30.7% and 13.6% were from public schools. Severe stunting was found to progress with age as 8.5% of severe stunting was observed in children 5-8 years, while 17.9% was observed in the 9-12 years age bracket. Severe under-weight was however found to be

higher in children 5-8 years (20.7%) compared to children 9-12 years (15.0%)<sup>82</sup>.

Biochemical assessment of zinc status of under-five children in orphanages of Federal Capital Territory, Abuja, Nigeria was conducted. The objective of the study was to assess the zinc status of the under-five children in the orphanages of Federal Capital Territory using biochemical method and determine the relationship between the dietary intakes zinc with the biochemical status of the under-five children. A cross sectional descriptive study was carried out on 200 under-five orphans, between 0-5 years living in ten orphanages in Abuja, Nigeria. Blood samples were analysed to determine the Zinc status of the under-five children also questionnaires were used to collect information on feeding practices of the children. The values obtained from nutrient intakes were compared with FAO/WHO recommended nutrients intake. Biochemical results from this study, revealed high prevalence of zinc deficiency (60.0%) among the under-five children, while less than half (40%) of the children had normal zinc status. It was found that zinc deficiency affected some age groups more than others. Children aged between 25-60 months had the highest prevalence (25.0%) of zinc deficiency while children between the ages of 0-6 months had the least deficiency (15.0%). Result from the chi-square analysis however, showed that there were no significant ( $P < 0.05$ ) difference between zinc deficiency and the ages of the children ( $\chi^2 = 0.876$ ,  $df = 2$ ,  $p = 0.675$ ). The study also revealed that more females were zinc deficient than males. This study revealed a strong association between zinc and stunting. Correlation between the anthropometric results and the micronutrient deficiency of the children in the orphanages showed that there was a significant ( $P < 0.05$ ) relationship between the children that were moderately stunted and zinc deficiency<sup>83</sup>.

In a study in Ethiopia to evaluate the relationship between multiple micronutrient levels and nutritional status among school children a study was conducted. The prevalence of stunting, underweight, wasting and intestinal parasitoses among school children was 23%, 21%, 11% and 18%, respectively. The mean serum levels of magnesium, calcium, iron, copper, zinc, selenium and molybdenum were  $2.42 \pm 0.32$  (mg/dl),  $15.31 \pm 2.14$  (mg/dl),  $328.19 \pm 148.91$  ( $\mu\text{g/dl}$ ),  $191.30 \pm 50.17$  ( $\mu\text{g/dl}$ ),  $86.40 \pm 42.40$  ( $\mu\text{g/dl}$ ),  $6.32 \pm 2.59$  ( $\mu\text{g/dl}$ ), and  $0.23 \pm 0.15$  ( $\mu\text{g/dl}$ ), respectively. Selenium deficiency, zinc deficiency and magnesium deficiency occurred in 62%, 47%, and 2% of the school children, respectively. Height-for-age showed significant positive correlation with the levels of copper and molybdenum ( $p = 0.01$ ) and with the levels of magnesium ( $p = 0.05$ )<sup>84</sup>.

One study tried to correlate measurements of serum ferritin with other hematologic laboratory indexes in 250 hospitalized subjects with anemia or disorders in iron metabolism at Division of Hematology (RM-10), Department of Medicine, University of Washington School of Medicine, Seattle, Washington<sup>85</sup>. A geometric mean value of 4 ng per milliliter was found in 32 patients with uncomplicated iron-deficiency anemia, and one of 2930 ng per milliliter in 23 with iron overload. Among subjects with anemia from causes other than iron deficiency, the mean serum ferritin level was increased to 180 ng per milliliter (geometric mean in normal controls, 59 ng per milliliter, with a 95 per cent confidence range of 12 to 300 ng per milliliter), presumably reflecting the transport of red-cell iron to stores. The wide range of values found was shown to be related primarily to the magnitude of body iron stores in each case as evaluated by bone-marrow hemosiderin. In addition, however, inflammation, liver disease and increased red-cell turnover were shown to elevate the serum ferritin concentration to a degree disproportionate to that of iron stores.

Another cross-sectional study of 299 preschool children from 9 months to 5 years old tried to establish relationship between dietary iron intake and blood lead levels<sup>86</sup>. Mothers of children attending the University of Maryland Pediatric Ambulatory Clinic volunteered for the children and themselves to join the study. The data collected included nutritional status, socioeconomic status, medical history, and potential sources of lead exposure. Blood samples from all participants were evaluated for levels of blood lead, serum iron (ferritin), free erythrocyte protoporphyrin, calcium, and hematocrit. The average blood lead level (standard deviation) in the studied population was 11.4 (73)  $\mu\text{g/dL}$ . With multiple linear and logistic regression analyses to adjust for covariates, a negative association ( $P = 0.03$ ) between blood lead and dietary iron intake was found. This finding is consistent with similar results from experimental studies. It is concluded that there is evidence that higher dietary iron intake is associated with lower blood lead among urban preschool children in the studied population.

To determine the association of blood lead level  $> 10 \mu\text{g/dl}$ , with the increased risk to anemia, also, to investigate the relationship between anemia and changes in blood iron, zinc and copper levels, and measure lead level in drinking water, a cross-sectional study was performed on 60 children from the pediatric clinic in Al-Zhraa University hospital and a special pediatric clinic in a rural area of Lebanon<sup>87</sup>. Venous blood samples were taken from the studied population for estimating hematological parameters as well as iron and ferritin levels. The concentrations of zinc, copper, and lead were measured. The studied population was divided into anemic and non-anemic (control) groups. The anemic group was further classified into mild, moderate and severe anemia. The study subjects were also categorized into low and high blood lead level groups. Approximately 63.33% of children had blood lead levels  $\geq 10 \mu\text{g/dl}$ . At the blood lead level range of 10-20  $\mu\text{g/dl}$ , a significant association

was found for mild and severe anemia. The blood level of iron and ferritin was found to be significantly lower in high blood lead level and anemic groups than those of the low blood lead level and control groups. Lead level in drinking water was higher than the permissible limit.

To determine the serum iron status of under-five, sickle cell anaemia patients in in Lagos, Nigeria<sup>88</sup>. The study spanned from December 2009 to February 2010 at the Consultant Outpatient Clinics involving 97 HbSS subjects and 97 age- and sex-matched HbAA controls. Biochemical iron status was assayed in subjects and controls. Age range of the children was seven months to five years, with a mean of 30.6 ( $\pm 15.97$ ) months. Irrespective of gender, mean serum iron values were higher in HbAA controls than their HbSS counterparts but the observed difference was not significant ( $p=0.299$  and  $0.111$ , resp.). The mean total iron binding capacity values of males and females were also not significantly different for sickle cell anaemia subjects and controls ( $p>0.05$ ). Males and females with HbAA had significantly lower serum ferritin when compared with their HbSS counterparts. Irrespective of gender, mean transferrin saturation was lower in HbSS subjects but the difference was not statistically significant ( $p>0.05$ ).

A cross-sectional study of 100 apparently healthy children with no history of abnormal bleeding, blood transfusion, any extensive surgery or infection visiting Paediatric OPD Lady Reading Hospital, Peshawar<sup>89</sup> for routine check up was performed. Iron deficiency anaemia was considered to be present when, haemoglobin was less than 10 g/dl, transferrin saturation less than 16 percent, TIBC was greater than 400  $\mu\text{g/dl}$  and serum ferritin was less than 10 ng/ml. For the sake of convenience, children were divided in to two groups, 0.5 years to 3 years as group A and above 3 to 12 years as group B. They were examined for red cell morphology, haemoglobin, serum iron, TIBC

and ferritin levels. On the basis of transferrin saturation and serum ferritin level, iron deficiency anaemia was more frequent in group A as compared to group B children. Out of a total of 80 anaemic children, 66 (83%) were iron deficient. Compared with non-anaemic children, all anaemic children showed various degrees of red cell morphology. Group A children were highly abnormal than group B. However, no normoblast was seen in any smear of group B children.

To determine the correlation between serum albumin and creatinine levels in children with nephrotic syndrome, a cross-sectional study was carried out on children with idiopathic nephrotic syndrome, aged between 1 to 14 years old, and admitted to Pediatric Department in Hasan Sadikin Hospital<sup>90</sup> from January 2001 to September 2007. Researchers used data from patients' medical records to obtain serum albumin and creatinine levels during nephrotic stage. Statistical analysis using Pearson correlation test was performed to establish the correlation between serum albumin and creatinine levels. The type of correlation was determined by regression analysis. Subjects were 113 children, consisted of 81 boys (72%) with mean of age 6.8 (SD 3.3) years. Mean of serum albumin and creatinine levels were 1.4 (SD 0.4) g/dL and 0.7 (SD 0.4) mg/dL, respectively. Analysis using Pearson correlation test showed a moderate ( $r=-0.478$ ) significant correlation ( $P<0.001$ ) between serum albumin and creatinine levels in children with nephrotic syndrome. Regression analysis suggested a negative linear relationship between serum albumin level as the independent variable (X) and serum creatinine level as the dependent variable (Y) by using equation  $Y=1.329-0.460X$ . The researchers concluded that in patients with nephrotic syndrome there is a moderate negative correlation between serum albumin and creatinine levels.



# **Methods and Materials**

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### 3. Methods and Materials

**3.1 Study design:** Community based cross sectional study.

#### 3.2 Place of study:

This study was conducted in three villages; Mangalpur, Madabpur and Tilakpur Village of Kamalganj under Moulovibazar district.

#### 3.3 Study population

- All the Manipuri under five children and their mothers

**3.4 Period of Study :** 1<sup>st</sup> July 2010 to 30<sup>th</sup> June 2011

#### 3.5 Sample Size:

The sample size was detected using the formula:  $n = z^2pq / d^2$

Where,

n = required sample size

z = 95% of confident limits i.e 1.96

p = Proportion of under nutrition child in Bangladesh aged under 5 years (41% according to BDHS 2007)

d = Precision or error allowed in the study = 5% = 0.05

$$\begin{aligned} \text{Therefore, } n &= \{(1.96)^2 \times (0.41) \times (0.59)\} / (0.05)^2 \\ &= \underline{232.63} \end{aligned}$$

But in the current study all the children of under five were taken as sample population total 357



### **3.6 Selection Criteria**

#### **Inclusion Criteria:**

- The children aged 7-59 months

#### **Exclusion criteria**

- Severely ill children
- Children having congenital anomalies

### **3.7 Variables studied:**

#### ***Independent variables***

##### **Socio-demographic Variables**

- Ethnicity
- Age
- Occupation
- Education
- Monthly income of family
- Age of Children
- Sex of Children

##### **Anthropometric indices of mother**

- Weight, Height, BMI

##### **Anthropometric indices of subject**

- Weight, Height, MUAC

##### **Nutritional status of subject**

- Weight for age, Height for age, Weight for height

##### **Biochemical parameters of subject**

- Hemoglobin, Iron, Ferritin, Vitamin D, Zinc, Total Protein, Serum Albumin

#### **Dependent variables**

- Nutritional status

### **3.8 Research Instrument:**

Questionnaire, Checklist & blood collection tools (disposable syringe with needle and hand gloves), Biochemical reagents.

#### Anthropometrical

- Measuring tape (Non Stretchable MUAC tape).
- Steadiometer

### **3.9 Study procedure:**

A questionnaire based on the study objectives was prepared for this purpose. After taking verbal consent from mother/guardians all required data were collected. Data components were about general information, maternal factor, socio-economic factor and anthropometric measurement.

Standardized anthropometric measurements of body weight (W) and height (H) were made by trained nurses. The measurements were expressed as Z scores for H/A and W/H (height/age and weight/height), which are the differences between the child's weight and height. All the estimates of wasting, underweight, and stunting amongst children have been done using standard computer software, where global acute malnutrition is defined as  $<-2$  z scores weight-for-height and/or oedema, severe acute malnutrition is defined as  $<-3z$  scores weight-for-height and/or oedema. Anthropometric data were analyzed by NCHS standard for the classification of malnutrition. For reporting of height for age, weight for age and weight for height relative to the NCHS reference percentile and Z-score was used<sup>91</sup>.

## **Length**

A wooden measuring board was used for measuring the length of children under two years old to the nearest millimetre. Measuring the child lying down always gives readings greater than the child's actual height by 1-2 cm.

## **Procedure**

- Both assistant and measurer were on their knees.
- The assistant hold the child's head with both hands and makes sure that the head touches the base of the board .
- The assistant's arms were comfortably straight.
- The line of sight of the child was perpendicular to the base of the board (looking straight upwards).
- The child was lie flat on the board.
- The measurer placed their hands on the child's knees or shins.
- The child's foot were flat against the footpiece .
- The length from the tape attached to the board was read.

## **Height**

This was measured with the child in a standing position (usually children who are two years old or more). The head was in the **Frankfurt position** (a position where the line passing from the external ear hole to the lower eye lid is parallel to the floor) during measurement, and the shoulders, buttocks and the heels touch the vertical stand. It was measured by a stadiometer and measurements are recorded to the nearest millimetre.

## Procedure

- Both the assistant and measurer were on their knees.
- The right hand of the assistant was on the shins of the child against the base of the board.
- The left hand of the assistant was on the knees of the child to keep them close to the board.
- The heel, the calf, buttocks, shoulder and **occipital prominence** (prominent area on the back of the head) were flat against the board .
- The child was looking straight ahead.
- The hands of the child were by their side.
- The measurer's left hand was on the child's chin.
- The child's shoulders were levelled.
- The head piece was placed firmly on the child's head (arrow 15).
- The measurement were recorded on the questionnaire.

## Weight

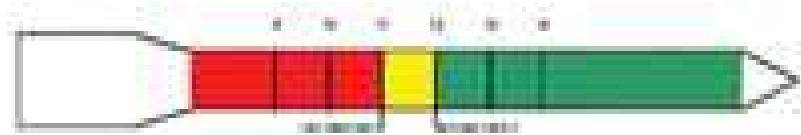
A weighing sling (spring balance), also called the 'Salter Scale' was used for measuring the weight of children under two years old, to the nearest 0.1 kg. In children over two years a digital electronic scale was used and the measurement was also to the nearest 0.1 kg.

## Procedures

- The pointer of the scale was set to zero level.
- Take off the child's heavy clothes and shoes.
- Child's legs were hold through the leg holes.
- The child's feet were hold.
- The child was hold on the Salter Scale.

### Measuring the MUAC

A special tape was used for measuring the MUAC. The tape has three colours, with the red indicating severe acute malnutrition, the yellow indicating moderate acute malnutrition and the green indicating normal nutritional status. Figure 5.8 shows you how to use the tape to measure a child's MUAC.



### Procedures for measuring MUAC

- The mother was asked to remove any clothing the child's left arm.
- The midpoint of the left upper arm was estimated.
- The child's arm was straighten and the tape was wrapped around the arm at the midpoint.
- The tension of the tape was inspected on the child's arm.
- When the tape was in the correct position on the arm with correct tension, the measurement to the nearest 0.1 cm was read and recorded



## **BIOCHEMICAL TESTS PROCEDURES**

### **BLOOD SAMPLE COLLECTION**

Blood samples (10 ml) were drawn from children; 2ml were put into plain tubes, and 2ml into EDTA tubes. The samples were transported on ice to the laboratory within 4 h. After the haematological indices were assayed in EDTA-containing blood samples.

For estimation of haemoglobin, test was carried out by the Cyanmethemoglobin method. For the measurement of serum albumin, ferritin, iron, Vit D the blood were taken in the red-top tube for serum separator. Then the tubes were kept in cold box for maintaining the temperature +2 to +80C and send it to the Dhaka Shishu (Children) Hospital laboratory and measures within the 48 hours.

Serum zinc estimation, blood was collected in a royal-top tube and avoid hemolysis. Allow the specimen to clot for 30 minutes; then centrifuge the specimen to separate serum from the cellular fraction within 4 hours of specimen collection. The serum was place on the polypropylene vial tightly, attach a specimen label and send specimen to the laboratory at refrigerated temperature (+2 to +80C) by cold box.

### **Hb estimation**<sup>92,93</sup>

Cyanmethemoglobin method is the internationally recommended method for determining hemoglobin.

#### **Principle:**

Blood is diluted in a solution containing potassium cyanide and potassium ferricyanide. The latter converts Hb to methemoglobin which is converted to cyanmethemoglobin (HiCN) by potassium cyanide. The absorbance of the solution is then measured in a spectrophotometer at a wavelength of 540nm or in a colorimeter using a yellow green filter.

#### **Equipment required**

- Hb pipette
- Spectrophotometer
- Reagents required
- Drabkin's solution pH7.0-7.4 which contains
- Potassium cyanide 50 mg
- Potassium ferricyanide 200 mg
- Potassium dihydrogen phosphate 140 mg
- Nonionic detergent 1 ml
- Distilled water 1 L

The solution should be clear and pale yellow in color. When measured against water as a blank in a spectrometer at a wavelength of 540 nm, the absorbance must be zero. The solution is unstable if exposed to light and can be stored at room temperature in brown borosilicate bottles for several months. However, if the room temperature is higher than 30°C, the solution should be stored in a refrigerator but brought to room temperature before use. The solution must never be frozen.

The pH of the solution must be checked every month. Discard the solution if found to be turbid/if pH is outside range/ its absorbance is not zero at 540 nm.

**Sample:** Venous blood collected in EDTA

**Procedure**

- 5ml of Drabkin's solution was taken in a test tube.
- The blood sample was mixed by gentle inversion and draw 0.02ml of blood into the Hb pipette. The outer surface of the pipette was wiped to remove excess blood.
- The pipette was placed into the tube containing Drabkin's solution and slowly expel the blood into the solution and kept undisturbed for 5min.
- The absorbance of this solution was measured at 540nm in a spectrophotometer after adjusting the OD at 0 by using Drabkin's solution as blank.
- The hemoglobin concentration was calculated using a standard curve.

**ESTIMATION OF SERUM PROTEIN AND ALBUMIN<sup>94,95</sup>**

## Experimental procedures

## Materials Provided:

- Serum samples for Total Serum Protein and Serum Albumin Estimation.
- 0.9% saline.
- Standard Serum Protein 7 g %
- Biuret Reagent
- Distilled Water
- BCG Reagent
- Standard Serum Albumin 4.5 g %

**Estimation of serum protein****Principle:**

Peptide bonds of proteins react with copper (II) ions in alkaline solutions to form purple coloured product whose absorbance is measured spectrophotometrically at 540 nm.

**Procedure:**

Label three test tubes as B for Blank, T for Test and S for Standard. Proceed as follows:

	<b>Blank</b>	<b>Test</b>	<b>Standard</b>
0.9 % saline (mL)	1.4	1.35	1.35
Standard Protein – 7g % (mL)	-	-	0.05
Serum (mL)	-	0.05	-
<b>Biuret Reagent (mL)</b>	<b>1.6</b>	<b>1.6</b>	<b>1.6</b>

Mix the contents of the tubes thoroughly. Wait for 15 minutes and take the readings using a spectrophotometer at 540nm. Calculate the concentration in g/dL of total protein in the given serum.

### Calculation:

$$\text{Concentration of protein in serum (g/dL)} = \frac{\text{Reading of Test} \times \text{Concentration of Standard}}{\text{Reading of Standard}}$$

### Estimation of serum albumin

#### Principle:

Albumin binds quantitatively with bromocresol green (BCG) at pH 4.15 resulting in the formation of a green colour which shows maximum absorbance at 630 nm.

#### Procedure:

Pipette out 0.2mL of serum into a test tube. Add 1.8mL distilled water to it to achieve a dilution of 1 in 10. Dilute the standard protein in a similar way. Add the solutions to individual test tubes marked Blank, Standard and Test as indicated the in the table below.

	Blank	Standard	Test
Distilled Water (mL)	0.1	-	-
Diluted Standard Protein- 4.5g % (mL)	-	0.1	-
Diluted Serum (mL)	-	-	0.1
<b>BCG Reagent (mL)</b>	<b>3.0</b>	<b>3.0</b>	<b>3.0</b>

Mix all tubes by tapping them, one by one, against the palm. Let stand for 10 minutes at room temperature, take the reading in a spectrophotometer at 630nm. Calculate the concentration of serum albumin and determine the A/G ratio in your sample.

**Calculation:**

$$\text{Concentration of albumin in serum (g/dL)} = \frac{\text{Reading of Test}}{\text{Reading of Standard}} \times 4.5$$

**Normal Level:**

Total protein: 6-8 g/dL

Albumin: 3.5-5 g/dL

Globulins: 2.5-3.5 g/dL

**ESTIMATION OF SERUM IRON<sup>96,97</sup>**

The method used to measure the iron concentration is a timed-endpoint method. In the reaction, iron is released from transferrin by acetic acid and is reduced to the ferrous state by hydroxylamine and thioglycolate. The ferrous ion is immediately complexed with the FerroZine Iron Reagent. The system monitors the change in absorbance at 560 nm at a fixed time interval. This change in absorbance is directly proportional to the concentration of iron in the sample.

Serum iron measurements in conjunction with total iron binding capacity are useful in the diagnosis and treatment of disorders relating to iron intake, absorption, storage, and release mechanisms. Such changes are indicative of a wide range of dysfunctions including anemias, nephrosis, cirrhosis, and hepatitis.

**SPECIMEN COLLECTION, STORAGE, AND HANDLING PROCEDURES**

Serum/plasma was being separated from the red cells within two hours after collection and separated serum or plasma was stored at +2 to +8°C. If assays are not completed within 48 hours, or the separated sample was stored beyond 48 hours, samples were frozen at -15 to -20°C.

Sample volume for individual test is 25 µl added to 210 µl of reagent. Sample was run singly as part of Multi-analyte Biochemistry Panel. Only borosilicate glass containers was used to store samples.

## INSTRUMENTATION

Beckman Synchron LX20

Materials

Beckman Synchron CX Micro Sample Tube

Plastic Transfer Pipette

Brand Accutube Flange Caps

## **ESTIMATION OF SERUM FERRETIN<sup>98,99</sup>**

Ferritin, like hemoglobin, is a major iron storage protein. Isoferritin moieties have been identified for liver and spleen (L isoferritin) and for heart and kidney (H isoferritin). Circulating plasma ferritin is most like the L isoferritin. A serum ferritin assay provides a much more sensitive indicator of iron body stores than a traditional serum iron assay. Serum ferritin levels increase as a result of iron overload, aging, infection, inflammation, liver disease, juvenile rheumatoid arthritis, leukemia, and Hodgkin's disease; and they decrease as a result of iron deficiency. Ferritin was measured by using the single-incubation two-site immunoradiometric assay. Which measures the most basic isoferritin, the highly purified <sup>125</sup>I-labeled antibody to ferritin is the tracer, and the ferritin antibodies are immobilized on polyacrylamide beads as the solid phase. Serum or ferritin standards (made from human liver) are mixed with the combined tracer/solid-phase antibody reagent, and the mixture is incubated. During incubation, both the immobilized and the <sup>125</sup>I-labeled antibodies bind to the ferritin antigen in the serum or standards, thus creating a "sandwich." After incubation, the beads are diluted with saline, centrifuged, and decanted. The level of <sup>125</sup>I-labeled ferritin found in the pellets is measured by using a gamma counter.

Diurnal variation is not a major consideration. Specimens for ferritin analysis should be fresh or frozen serum. Serum specimens may be collected by using regular red-top or serum separator Vacutainers.

A minimum sample volume of 100  $\mu\text{L}$  is required for the assay; 250  $\mu\text{L}$  will permit repeat analysis as well. Specimens may be stored in glass or plastic vials as long as the vials are tightly sealed to prevent desiccation of the sample. Because ferritin is very stable, serum may be frozen at  $-20^{\circ}\text{C}$  to  $-70^{\circ}\text{C}$  for years before analysis. Specimens were arrived frozen from the site of collection.

### **ESTIMATION OF SERUM VITAMIN D<sup>100, 101</sup>**

Although a fasting specimen is recommended, it is not required. No special instructions such as special diets are required. Diurnal variation is not a major consideration. Specimens for vitamin D analysis should be fresh or frozen serum. Serum specimens was collected by using regular red-top or serum-separator Vacutainers. Serum specimens should be stored at #  $-20^{\circ}\text{C}$ . A sample volume of 50  $\mu\text{L}$  is required for the assay; 150  $\mu\text{L}$  will permit repeat analysis and adequate pipetting volume as well.

Specimens may be stored in glass or plastic vials, as long as the vials are tightly sealed to prevent desiccation of the sample. Because vitamin D is very stable, serum samples may be frozen at  $-20^{\circ}\text{C}$  to  $-70^{\circ}\text{C}$  for years before analysis. Several freeze-thaw cycles do not seem to adversely affect the assay, although repeated freeze-thaw cycles should be avoided. Specimens should generally arrive frozen. Refrigerated samples may be used provided they are brought promptly from the site of collection. Moderately hemolyzed specimens may be used because red blood cells do not contain vitamin D.



### **ESTIMATION OF SERUM ZINC** <sup>102-106</sup>

Butterfly vacutainer was used to collect specimen from subject and then collected in a royal blue top tube. To avoid hemolysis, the specimen was then allowed to clot for 30 minutes; then centrifuged to separate serum from the cellular fraction within 4 hours of specimen collection.

The stopper was then removed and carefully pour 0.4 mL serum into a 7.0 mL, metal free, screw-capped, polypropylene vial, and avoiding transfer of the cellular components of blood. The cap on the polypropylene vial was placed tightly, and specimen label was attached then to the laboratory at refrigerated or frozen temperature. Serum Zinc level was determined by Atomic absorption spectrophotometry.

#### **3.10 Ethical Implication:**

- This current study proposal received ethical approval from Dhaka Shishu Hospital
- Objectives of the research was explained in simple language to parents of all subjects before data collection
- Informed written consent was taken from mothers/ guardians of <5 yrs children prior to data collection.
- Confidentiality were maintained
- Right to withdraw from the study by any mothers/ guardians at any time was ensured

#### **3.11 Limitations of the Study**

Lack of skilled technician in the community for sample collection, transport of serum sample to reference laboratory, timing and funding

### 3.12 Operational Definitions

#### **Mid-upper arm circumference (MUAC):**

It is the arm circumference midway between acromion process and olecranon process.

#### **Body mass index (BMI):**

- It was measured by weight (kg)/ Height (meter)<sup>2</sup>
- Any value less than 18.5 is considered below normal

#### **Exclusive breast feeding (EBF):<sup>33</sup>**

Exclusive breast feeding means giving baby breast milk only not even a drop of water or other food till 6 months. ORS or medicine can be given when indicated.

#### **Complementary feeding:<sup>34</sup>**

The family food that is given progressively to the infant from 6 months of age in addition to the breast milk is call complementary feeding.

#### **Abortion:<sup>35</sup>**

Abortion is defined as unintentional termination of pregnancy before 20 wks of gestation or when the birth weight is < 500 gm.

#### **Still birth:<sup>35</sup>**

Still birth is a fetal death occurring after 20 wks of gestation or when fetal weight is > 500 gm.

#### **Infant death:<sup>36</sup>**

The death of a live born child between the age 1 month and 1 year of age.

**Kacha house:**

Houses made of mud, straw and bamboo.

**Semi pucca house:**

Tin shed houses made of bamboo, wood or mud.

**Building:** A structure with a roof and walls such as house, school, store or factory.

**Illiterate:**

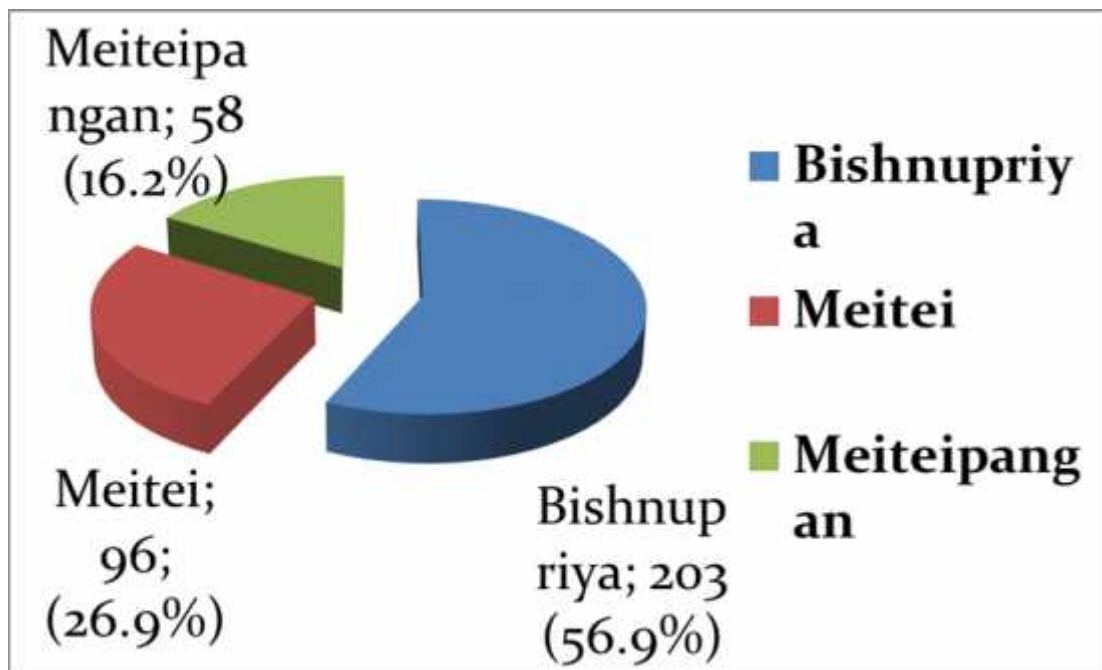
A person unable to read and write.

# RESULTS

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### 3. RESULTS

**Figure 1: Distribution of respondents by ethnic group**



This study was conducted upon 357 children. Among them, 61.1% (n=218) were of from Bishnupriya, 30.5% (n=109) from Meitei and rest 8.4% (n=30) from Meiteipangan ethnic group of Manipuri people (Figure-1).

**Table 1: Distribution of mothers by age (n= 357)**

<b>Age (in year)</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Up to 27 years	219	61.3
Above 27 years	138	38.7
<b>Total</b>	<b>357</b>	<b>100.0</b>

**Mean 26.51± 2.38 years**

Among the respondents, 61.3 (n=219) were of 20 to 27 years old and rest 38.7% (n=138) were of 27 to 33 years old.

**Table 2: Distribution of respondents by occupation (n= 357)**

<b>Occupation</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Housewife	315	88.2
Service	42	11.8
<b>Total</b>	<b>357</b>	<b>100.0</b>

The table shows the Distribution of respondents by occupation. Among all, 88.2% (n=315) were housewife while only 11.8% (n=42) were found engaged with services.

**Figure 2: Distribution of mothers by their level of education (n= 357)**

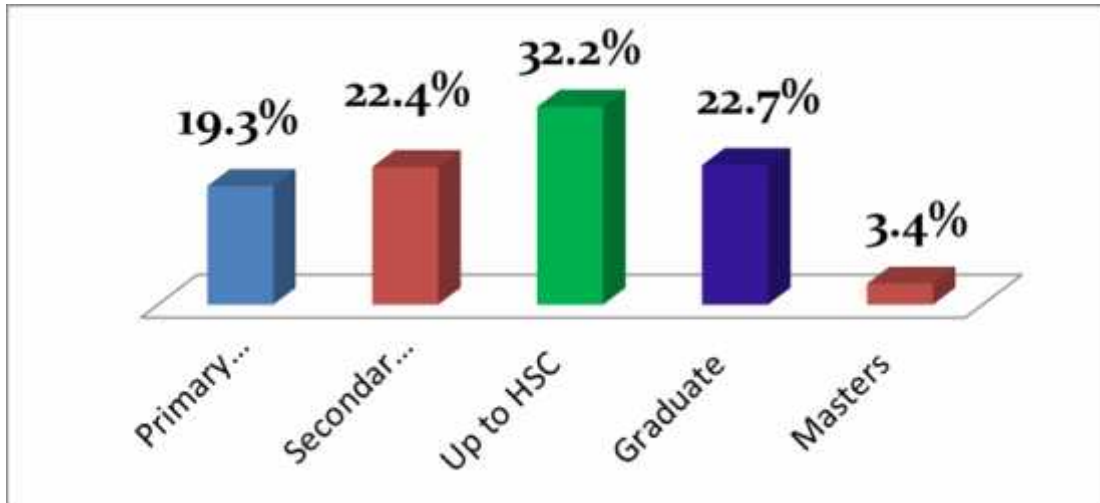


Figure 2 reveals that among the respondents, 19.3% (n=69) had primary level of education, 22.4% (n=80) had secondary level (up to SSC), 32.2% (n=115) had up to HSC, 22.7% (n=81) were graduate and only 3.4% (n=12) had Masters level of education.

**Table 3: Distribution of respondents by monthly family income (n= 357)**

<b>Income</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Up to BDT 10000	111	31.1
BDT 10001 - 15000	117	32.8
BDT 15001 - 20000	36	10.1
BDT 20001 and above	93	26.1
<b>Total</b>	<b>357</b>	<b>100.0</b>

According to their monthly income the Manipuri population were subdivided into 4 groups & their income ranging from 5000 taka to >30,000 taka. Among them most of people about 32.8% was in income range of 10001-15,000 taka, 31.1% was within the range of up to 10000 taka, 26.1% was within the range of 20001 and above and 10.1% was within the income range of 15001 – 20000 taka.



**Table 4: Distribution of respondents by nutritional status (n= 357)**

<b>Nutritional status</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Normal	269	75.35
Under weight	63	17.65
Over weight	25	7.0
<b>Total</b>	<b>357</b>	<b>100.0</b>

The above table shows that among the mothers of the study subjects, 75% (n=269) of mothers were normal, 17.65% (n=79) were underweight and only 7.0% (n= 25) were overweight.

**Table 5: Distribution of subjects by sex (n= 357)**

<b>Sex</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Male	220	61.6
Female	137	38.4
<b>Total</b>	<b>357</b>	<b>100.0</b>

Among the subjects 61.6% (n=220) were male and rest 38.4% were female.

**Table 6: Distribution of Subjects by Age Group & Sex (n= 357)**

<b>Age group (Months)</b>	<b>Male Sex</b>	<b>Female Sex</b>	<b>Total</b>
7-12	62(28.2%)	32(23.4%)	94(26.3%)
13-24	76(34.5%)	53(38.7%)	129(36.1%)
25-36	56(25.5%)	36(26.3%)	92(25.8%)
37-48	19(8.6%)	7(5.1%)	26(7.3%)
49-59	7(3.2%)	9(6.6%)	16(4.5%)
<b>Total</b>	<b>220(100.0%)</b>	<b>137(100.0%)</b>	<b>357(100.0%)</b>

The above table shows that among the subjects 28.2% male and 23.4% females were in the age group of 7- 12 months, 34.5% of male and 38.7% female were in the age group of 13 – 24 months, 25.5% of male and 26.3% females were in the age group of 25 – 36 months, 8.6% of male and 5.1% of female were in the age group of 37 – 48 month and 3.2 % of male and 6.6% female were in the age group of 49 -59 months.

**Table 7: Distribution of children by their breast feeding practice (n= 357)**

<b>Breast feeding practice (n-357)</b>		
Exclusively Breast fed	174	48.8
Not exclusively Breast fed	183	51.2
<b>Pre lacteal feeding (n=143)</b>		
Honey	70	48.95
Sugar water	45	31.46
Cow's/ Formula milk	28	19.58

Table showing that among the subjects 48.8% were Exclusively Breast fed while 51.2% were not Exclusively Breast fed. As prelacteal feed Manipuri mother practice giving of sugar water about 31% before initiation of breast feeding just after birth and 49% used to give honey and 20% gave cow's/formula milk .

**Table 8: Status of complementary feeding of the studied children (n= 357)**

Type of food	Number of children	Percent
Khichury	240	67.3
Rice Powder with egg/fish	90	25.2
Cow Milk and others	27	7.5

Table showing that the Manipuri mother starts their child's weaning with rice powder with egg/fish, they are about 25.2%. About 67.3% start complementary feeding with khichury.

**Table 9: Immunization status of studied children (n=357)**

Immunization	Frequency (n)	Percentage (%)
Complete	332	93.0
Incomplete	20	6.5
No immunization	5	1.5

Immunization status of Manipuri children is as good as national level. Ninety three percent children were fully immunized as per EPI schedule & about 6.5% incompletely immunized & about 1.5% are non-immunized.

**Table 10: Morbidity pattern of studied children (n= 357)**

<b>Disease pattern</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Diarrhea	85	23.8
Pneumonia	107	30.0
Other diseases (skin, CSOM, Tonsilitis)	56	15.7
No diseases	109	30.5

Table shows Diarrhoea & Pneumonia are the most commonly occurring disease among the study children of under 5 years of age. 23.8% child suffered from diarrhoea and 30% suffered from Pneumonia.

**Table 11: Source of drinking water of studied children (n= 357)**

<b>Source</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Tube well	345	96.6
Tap water	12	3.36

About ninety seven percent of Manipuri population used to drink tube well water and only 3.4% uses Tap water.

**Table 12: Sanitation status of studied children (n= 357)**

Type	Frequency (n)	Percentage (%)
Sanitary latrine	331	92.8
Others	26	7.2

Table showing their sanitation status, 92.8% percent people use sanitary latrine & 7.2% use other than sanitary latrine.

**Table 13: Housing status of studied children (n= 357)**

Type	Frequency (n)	Percentage (%)
Kacha	32	8.9
Semipucca	263	73.7
Building	62	17.4

Table showing only 8.9% people lives in kacha house, 73.7% lives in semipacca house and 17.41% people lives in building.

**Table 14: Distribution of studied children by mid upper arm circumference (MUAC)**

<b>MUAC</b>	<b>No. of children</b>	<b>Percent</b>
Severe (<12.5)	21	5.88
Moderate (12.5-13.5)	110	30.81
Normal (>13.5)	226	63.31

Majority 63.3% of Manipuri children's mid upper arm circumference is >13.5 which reflects their good nutritional status. 30.8% lies between 12.5 to 13.5.

**Table 15: Distribution of subjects by weight for age (Underweight)**

<b>WAZ</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Mild	288	80.7
Moderate	69	19.3
<b>Total</b>	<b>357</b>	<b>100.0</b>

Table showing nutritional status of Manipuri children by weight for age Z score. No one was found with severe malnutrition. Only 19.3% were found with moderate malnutrition and majority were in mild underweight.

**Table 16: Distribution of subjects by height for age (Stunting)**

<b>HAZ</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Mild	259	72.5
Moderate	61	17.1
Severe	37	10.4
<b>Total</b>	<b>357</b>	<b>100.0</b>

Table showing nutritional status of Manipuri children by Height for age Z score. Among the study subjects 10.4% were found with severe stunting, 17.1% with moderate and 72.5% with mild stunting

**Table 17: Distribution of subjects by weight for height (wasting)**

<b>WHZ</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Mild	325	91.04
Moderate	29	8.12
Severe	3	.84
<b>Total</b>	<b>357</b>	<b>100.0</b>

Table showing nutritional status of Manipuri children by weight for height Z score. Among the study subjects 0.84% were found with severe wasting, 8.12% with moderate and 91.04% with mild wasting



**Table 18: Distribution of subjects by Ethnicity and underweight**

Underweight	Ethnicity			Total
	Bishnupriya	Meitei	Meiteipangan	
Normal to mild	175(80.3%)	87(79.8%)	26(86.7%)	288(80.7%)
Moderate	43(19.7%)	22(20.2%)	4(13.3%)	69(19.3%)
<b>Total</b>	<b>218(100.0%)</b>	<b>109(100.0%)</b>	<b>30(100.0%)</b>	<b>357(100.0%)</b>

The above table shows that among the study subjects of Bishnupriya, 19.7% were in moderate and rest 80.3% were in mild underweight. Among the Meitei subjects 20.2% were in moderate and 79.8% in mild underweight. And among the Meiteipangan subjects, 13.3% were in moderate and 86.7% in mild underweight.

**Table 19: Distribution of subjects by Ethnicity and stunting**

Stunting	Ethnicity			Total
	Bishnupriya	Meitei	Meiteipangan	
Normal to mild	156(71.6%)	79(71.1%)	24(85.8%)	259(72.5%)
Moderate	39(17.9%)	21(18.9%)	1(3.6%)	61(17.1%)
Severe	23(10.5%)	12(10.8%)	2(7.1%)	37(10.4%)
<b>Total</b>	<b>218(100.0%)</b>	<b>111(100.0%)</b>	<b>28(100.0%)</b>	<b>357(100.0%)</b>

The above table shows that among the study subjects of Bishnupriya, 10.5% were in severe, 17.9% in moderate and rest 71.6% were in mild wasting. Among the Meitei subjects 10.8% were in severe, 18.9% in moderate and rest 71.1% were in mild wasting. And among the Meiteipangan subjects, 7.1% were in severe, 3.6% in moderate and rest 85.8% were in mild wasting.

**Table 20: Distribution of subjects by Ethnicity and wasting**

Wasting	Ethnicity			Total
	Bishnupriya	Meitei	Meiteipangan	
Normal to mild	193(88.5%)	103(94.5%)	29(96.7%)	325(91.04%)
Moderate	23(10.6%)	5(4.6%)	1(3.3%)	29(8.12%)
Severe	2(0.9%)	1(0.9%)	0(0.0%)	3(0.84%)
<b>Total</b>	<b>218(100.0%)</b>	<b>109(100.0%)</b>	<b>30(100.0%)</b>	<b>357(100.0%)</b>

The above table shows that among the study subjects of Bishnupriya, 0.9% were in severe, 10.6% in moderate and rest 88.5% were in mild stunting. Among the Meitei subjects 0.9% were in severe, 4.6% in moderate and rest 94.5% were in mild stunting. And among the Meiteipangan subjects, 3.3% were in moderate and 96.7% in mild stunting.

**Table 21: Distribution of subjects by blood Hemoglobin level (n=248)**

Hemoglobin	Frequency (n)	Percentage (%)
>11	24	9.7
10 - 10.9	66	26.6
7 - 9.9	158	63.7
<b>Total</b>	<b>248</b>	<b>100.0</b>

**Mean 54.19±3.60**

The Hemoglobin level could be estimated only 248 subjects out of 357 subjects. Among them 63.7% had Hemoglobin level within 7-9.9, 26.6% had within 10- 10.9, and 9.7% had within >11 level (mean 54.19±3.60)

**Table 22: Distribution of subjects by serum ferretin level (n=261)**

Ferretin	Frequency (n)	Percentage (%)
Below 15 ng/ml	104	39.8
15 - 200 ng/ml	157	60.2
<b>Total</b>	<b>261</b>	<b>100.0</b>

**Mean 25.78±17.47 ng/ml**

The serum ferretin level was calculated among 261 subjects out of 357 subjects. Among them 60.2% had serum ferretin level within 15 - 200 ng/ml and rest 39.8% below 15 ng/ml. The association between hemoglobin and Serum Ferritin was found statistically significant (  $t=24.519$   $p=0.000$ )

**Table 23: Association Between Hb and serum Ferritin (n=231)****Paired Samples Statistics**

Parameter	Mean	Std. Deviation
HB	54.19	3.608
Ferritin	25.738	17.4793

Paired Differences				t	df	Sig. (2-tailed)	
Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
			Lower	Upper			
28.4567	17.6396	1.1606	26.1699	30.7435	24.519	230	.000

A Paired Samples t Test was conducted to compare the mean of Hemoglobin level and serum ferritin level among the subjects. These were  $54.19 \pm 3.608$  and  $25.738 \pm 17.4793$ . Statistically it was found highly significant ( $t = 24.519$ ,  $p < 0.05$ ).

**Table 24: Distribution of subjects by serum iron level (n=260)**

<b>Iron</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Below 50 µg/dl	136	52.3
50 - 175 µg/dl	124	47.7
<b>Total</b>	<b>260</b>	<b>100.0</b>

Serum iron level was estimated among 260 subjects. Of them 52.3% had below 50 µg/dl and rest 47.7% had within 50 - 175 µg/dl.

**Table 25: Distribution of subjects by serum protein level (n=264)**

<b>Protein</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Below 6.2 gm/dl	79	29.92
6.2 - 8.4 gm/dl	185	70.08
<b>Total</b>	<b>264</b>	<b>100.0</b>

Serum protein level could be estimated of 264 subjects. Among them 70.08% had within 6.2 - 8.4 gm/dl and rest 29.92 had below 6.2 gm/dl.

**Table 26: Distribution of subjects by serum albumin level**

<b>Albumin</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
<3.5 gm/dl	46	17.6
3.5 -6.0 gm/dl	215	82.4
<b>Total</b>	<b>261</b>	<b>100.0</b>

Serum albumin level was estimated among 261 subjects of whom 82.4% had 3.5 – 6.0 gm/dl and rest 17.6% had less than 3.5 gm/dl.

**Table 27: Association between serum albumin and serum protein**

<b>Albumin</b>	<b>Protein</b>	
	<b>Below 6.2 gm/dl</b>	<b>6.2 - 8.4 gm/dl</b>
Below 3.5 gm/dl	43(50.6%)	3(1.7%)
3.5 -6.0 gm/dl	42(49.4%)	173(98.3%)
<b>Total</b>	<b>85(100.0%)</b>	<b>176(100.0%)</b>

It was observed that those who had protein 6.2- 8.4 gm/dl of them 98.3% had albumin 3.5 – 6.0 gm/dl and those who had protein below 6.2 gm/dl of them half had albumin below 3.5 gm/dl and rest half had within 3.5 – 6.0 gm/dl.

**Table 28: Distribution of subjects by serum Vitamin D level (n=53)**

<b>Vitamin D</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Below 20 ng/ml	6	11.3
20 - 29 ng/ml	14	26.4
30 - 100 ng/ml	33	62.3
<b>Total</b>	<b>53</b>	<b>100.0</b>

Serum Vitamin D could estimate among 53 subjects of them 62.3% had within 30 – 100 ng/ml, 26.4% had within 21 – 29 ng/ml and rest 11.3% had below 20ng/ml.

**Table 29: Distribution of subjects by serum zinc level (n=56)**

<b>Zinc</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Below 700 µg/l	15	26.79
700-1200 µg/l	35	62.50
Over 1200 µg/l	6	10.71
<b>Total</b>	<b>56</b>	<b>100.0</b>

The serum zinc level could estimate only 56 subjects. Of them 62.5% had within 700- 1200 µg/l, 10.71% had over 1200 µg/l and rest 26.79% had below 700 µg/l.



**Table 30: Association between Serum Parameters and Underweight**

Parameters	Chi Square test	Significance
Hb	$\chi^2= 2.321$	p= 0.313
Protein	$\chi^2= 0.105$	p= 0.748*
Albumin	$\chi^2= 0.991$	p= 0.321*
Ferritin	$\chi^2= 1.958$	p= 0.165*
Iron	$\chi^2= 0.288$	p= 0.647*
Vitamin D	$\chi^2= 0.642$	p= 0.726
Zinc	$\chi^2= 0.427$	p= 0.808

**\*Fisher's Exact test**

Statistically it was found that no serum nutrient parameter was significantly associated with underweight ( $p>0.05$ ).

**Table 31: Association between Serum Parameters and Stunting**

Parameters	Chi Square test	Significance
HB	$\chi^2 = 1.622$	p= 0.444
Protein	$\chi^2 = 0.040$	p= 0.882
Albumin	$\chi^2 = 0.032$	p= 0.854*
Ferritin	$\chi^2 = 0.559$	p= 0.391*
Iron	$\chi^2 = 0.170$	p= 0.670*
Vitamin D	$\chi^2 = 0.813$	p= 0.666
Zinc	$\chi^2 = 1.229$	p= 0.541

**\*Fisher's Exact test**

Similarly no serum nutrient parameter was significantly associated with stunting ( $p > 0.05$ ).

**Table 32: Association between Serum Parameters and Wasting**

Parameters	Chi Square test	Significance
Hb	$\chi^2= 3.386$	p= 0.184
Protein	$\chi^2=5.089$	p = 0.044*
Albumin	$\chi^2= 13.978$	p = 0.001*
Ferritin	$\chi^2= 3.663$	p= 0.054*
Iron	$\chi^2= 1.997$	p= 0.114*
Vitamin D	$\chi^2=3.482$	p= 0.175
Zinc	$\chi^2= 0.844$	p= 0.624

**\*Fisher's Exact test**

The above table shows that only protein, albumin and ferretin were found statistically associated with development of wasting. (p<0.05).

# DISCUSSION

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## 5. DISCUSSION

The study was conducted on one ethnic group of people of Bangladesh – the children of Manipuri population. These children had mongolite ethnic origin and good socio-economic background.

Among them, about sixty percent were of from Bishnupriya, thirty percent from Meitei and rest from Meiteipangan ethnic group of Manipuri people. This study tried to assess status of the mothers of the study subjects. Majority of mothers 61.25% were in the age group of 20-29 years with the mean age of  $26.51 \pm 2.38$  years, by occupation most majority were housewife and rest were found engaged with services.

If we consider the education status of the mothers of Manipuri population, it is far better than national level. Among them no one was found illiterate, one-third were SSC passed, one-fifth had primary level, another fifth had secondary level, twenty three percent were graduate. While one in four ever-married women age 15-49 has never attended school, while 14 percent of women have completed secondary or higher education (BDHS 2014). By family income almost all the study Manipuri family were found more or less solvent on Bangladeshi perspective with mean income  $18175.070 \pm 11734.58$  BDT. According to BDHS 2015, close to 20 percent in each wealth quintile from lowest to highest. A study by Hong R and Banta JE indicates that household wealth inequality is strongly associated with childhood adverse growth rate (stunting). Children in the poorest 20% of households are more than three times as likely to suffer from adverse growth rate stunting as children from the wealthiest 20% of households<sup>103</sup>. So reducing poverty is essential for overall child health and nutritional status in Bangladesh.

Body mass index of the attending mothers also showed Manipuri mothers were more or less nutritionally well, 70% of mothers were normal, 22.1% were underweight, and only 7.0% were overweight. BMI reflex mother's health condition as child nutrition from womb to thereafter depends on mother's nutrition.

This current study included a total 357 children of whom more than sixty percent were male and rest were female, M:F= 3:2. among the subjects 26% were in the age group of 7- 12 months age, 36% were in the age group of 13 – 24 moths, 25.5% were in the age group of 25 – 36 months, 7.3% were in the age group of 37 – 48 month and 4.5 % were in the age group of 49 -59 months of age.

As breast feeding is almost universal in Bangladesh, proper breast feeding is on the decline due to several factors. Breast milk is the best and safest way of feeding infants for the first 4-6 month of life. Manipuri population have exclusively breast feeding rate about 48% at least for 1<sup>st</sup> 6 month. In this respect Manipuri children are far below than the Bengali population which was about 64% according to Bangladesh Breast-feeding Foundation. The rate is 46.8% in India, 37% in Pakistan, 50.5% Maldives, 53% in Nepal<sup>74</sup>, 59.5% in Bhutan and 75.8% in Srilanka<sup>104</sup>. Possibly poor health and nutrition services in this remote area made this inequality.

Complementary foods given to infants in Bangladesh are often nutritionally inadequate and leading to malnutrition. Situation is relatively better for children of Manipuri. About 25% of them were offered with rice powder with egg/ fish and 64% started with khichuri.

Diarrhoea & Pneumonia are the most commonly occurring disease among the study children of under 5 years of age. 23.8% child suffered from diarrhoea and 30% suffered from Pneumonia. Lack of proper sanitation facilities is a fundamental health problem for Manipuri community. Living with a low economic capacity means that most of the population cannot construct a well-built hygienic sanitation facility. Although, almost all of the villagers use tube well water for drinking purposes, other activities such as bathing, cooking and washing use unprotected pond water which may cause of many water contaminated diseases among them. Furthermore most of the villagers do not have their own source of drinking water, and they have to depend on a neighbor's source. There is no government hospital or health centers close to their community.

According to BDHS 2014, Bangladesh 2006 shows that the proportion of 12-23 months old who are fully immunized is 84% and this study showed 93% of children in Manipuri population are fully immunized as per EPI schedule.

Mid upper arm circumference of the studied children showed more than sixty percent (63%) of the children were well nourished. Improving nutrition is necessary for meeting the Millennium development goals. Nourished children perform better in school, grow into healthier adult & are able to give their own children a better life. The significance of nutrition for MDGs doesn't end with poverty reduction, good nutrition is essential for reducing child mortality & improving maternal health.

Nutritional status was further confirmed by Z scoring of weight for height (wasting), height for age (stunting) and weight for age (underweight). Among the subjects only 19.3% were in moderate underweight by weight for

age Z score, sixteen percent were in moderate and twenty eight percent in severe stunting by height for age Z score and four percent were in moderate and five percent in severe wasting by weight for height Z score.

According to BDHS 2014, 36 percent of children under 5 are considered to be short for their age or stunted (12% severely). Rural children are more likely to be stunted than urban children (38 percent compared with 31 percent).

Fourteen percent of children are considered wasted or too thin for their height and 3 percent are severely wasted, thirty-three percent of children under age 5 are underweight (low weight-for-age), and 8 percent are severely underweight.

However, anthropometry as the method of assessment of the nutritional status of individuals has some limitations. These include the absence of local standards for comparison and the difficulty in obtaining the actual age of the studied subjects. If these limitations are taken care of however, anthropometric measurements can be used to assess the stage of general undernourishment, since height/ length and weight are not usually affected in pure protein malnutrition<sup>105</sup>. In this study, losses in weight, height, mid arm circumference due to ill health and genetic factors were not accounted for.

In this current study underweight was found more among Meitei (20.2%) and Bishnupriya population (19.7%) while it was 13% among Meiteipangan subjects respectively. Similarly stunting in moderate to severe was found more among Bishnupriya population (28%) which was 29% among Meitei and 11% among Meiteipangan population. Wasting was also found more among Bishnupriya (12%) which was found about nil among Meitei and Meiteipangan subjects.



The current study also tried to ascertain the different nutrients and other related parameters in serum among the study subjects, such as hemoglobin, protein, albumin, ferritin, zinc and vitamin D. It was observed that sixty four percent of the subjects had Hemoglobin level within 7-9.9, 27% had within 10-10.9, 10% had within >11 Hemoglobin level (mean  $54.19 \pm 3.60$ ). Serum ferritin was found among 40% below 15 ng/ml (mean  $25.78 \pm 17.47$ ). The association between hemoglobin and Serum Ferritin was found statistically significant ( $t=24.59$   $p=0.000$ ). That means if hemoglobin level increases ferritin level also increases. In the study conducted in Benin<sup>64</sup> showed that among the children haemoglobin level was  $119 \pm 13$  g/l and median serum ferritin level was  $36 \mu\text{g/l}$ .

Among the study subjects more than half had serum iron level below  $50 \mu\text{g/dl}$ . Study in Kerala India<sup>106</sup> the mean serum iron and ferritin were  $64.60 \pm 20.30 \mu\text{g/dl}$  and  $46.60 \pm 22.40 \text{ ng/dl}$  respectively which was significantly low ( $p < 0.001$ ) in children with PEM than in the control group (iron :  $135.0 \pm 31.80 \mu\text{g/dl}$  and ferritin:  $151.20 \pm 69.90 \text{ ng/dl}$ ).

Iron deficiency itself seemed to be more prominent problem. It most often occurs as result of inadequate iron intake. Among infant and young child (up to 4 years), low iron content of milk and other preferred food, and also rapid growth rate can cause iron deficiency. Another cause of iron deficiency may be over cooking of food among the study population as observed by the researcher. The other possible mechanism of decrease in serum iron, and ferritin levels are due to elevated needs and chronic loss from parasitic infections. Diarrhea and other infections can cause malnutrition through decreased nutrient absorption, decreased intake of food, increased metabolic requirements, and direct nutrient loss. Parasite infections can also lead to malnutrition<sup>107</sup>. Another mechanism for decreased iron and ferritin is majority

of dietary non-haem iron enters the gastrointestinal tract in the ferric form. However, Fe<sup>3+</sup> is thought to be essentially non-bioavailable and therefore, it must first be converted to ferrous iron prior to absorption. The most potent enhancer is ascorbic acid (vitamin C), which acts by reducing ferric iron to the more soluble and absorbable ferrous form. There are numerous dietary components capable of reducing Fe<sup>3+</sup> to Fe<sup>2+</sup>, including ascorbic acid, and amino acids such as cysteine and histidine<sup>108</sup>.

Among the study subjects about thirty percent had serum protein level below 6.2 gm/dl, 18% had serum albumin level less than 3.5 gm/dl. Though the urine analysis is not done under this study. A decrease in total protein is also observed when hepatic function is normal but the proteins are lost in the urine. Loss of proteins in the urine results in a decrease in total serum protein<sup>109</sup>. In Nepalese study the mean while mean total protein, albumin, were significantly (p<0.05) low in PEM group when compared to well-nourished children (control).

Vitamin D deficiency is a global public-health concern, even in tropical regions where the risk of deficiency was previously assumed to be low due to cutaneous vitamin D synthesis stimulated by exposure to sun. The current study observed that 11% of the study subjects had Vitamin D below 20ng/ml. While one study conducted in Sylhet of Bangladesh very nearer to this study area showed that we estimated that about one-third of infants aged 1-6 months may be vitamin D-deficient<sup>110</sup>. Vitamin D could be obtained from food, but very few foods naturally contain vitamin D (such as liver, beef, veal, eggs etc<sup>26</sup> Beside foods, the most important source of vitamin D is from its synthesis in the skin upon exposure to ultraviolet B radiation (UVB)<sup>111</sup> In tropical countries which close to equator line, such as Indonesia, UVB rays are the most intense allowing vitamin D synthesis in the skin throughout the year. Since

conservative maternal clothing practices (i.e. veiling) and low frequency of intake of foods from animal source (other than fish) were common among the mothers of the participants, which deserve more detailed consideration in future studies. In Bangladesh, rickets may be more common than previously thought, based on surveys of lower limb deformities in ambulating children. Recent data from a nationwide survey suggest that about 0.6% of Bangladeshi children, aged 1-15 years, may have radiologic evidence of rickets, with the highest prevalence in Chittagong and Sylhet divisions<sup>112</sup>. However, it has to be kept in mind that the serum vitamin D status was determined from relatively small (n=53) samples and, therefore, the results should be interpreted with caution.

Plasma or serum zinc levels are the most commonly used indices for evaluating zinc deficiency, but these levels do not necessarily reflect cellular zinc status due to tight homeostatic control mechanisms. Clinical effects of zinc deficiency can be present in the absence of abnormal laboratory indices. Clinicians consider risk factors (such as inadequate caloric intake, alcoholism, and digestive diseases) and symptoms of zinc deficiency (such as impaired growth in infants and children) when determining the need for zinc supplementation. Low intake of dietary zinc *per se* (as it was observed that Manipury people take less animal food) rather than poor bioavailability was probably the primary dietary factor responsible for the low biochemical zinc status of these study subjects. Similar comments was found by the study conducted among school children in North East Thailand<sup>113</sup>. In addition, this study showed that the prevalence of diarrhea was 23.8% which was one possible explanation for the medium prevalence of zinc deficiency. It was also observed that those who were moderate to severely stunted had serum zinc level below 700 µg/l. Zinc deficiency is not the only risk factor of stunted, deficiency of other nutrient, and other factors such as maternal malnutrition,

and infectious diseases, could also result in stunted growth. Indonesian study also showed the similar findings<sup>114</sup>. Several studies globally have documented the relationships between lowered zinc concentrations during childhood and morbidity from infectious diseases and the effect on cognitive development<sup>115</sup>. Statistically it was found that no serum nutrient parameter was significantly associated with underweight ( $p>0.05$ ). Similarly no serum nutrient parameter was significantly associated with stunting ( $p>0.05$ ). Only protein, albumin and ferritin were found statistically associated with development of wasting. ( $p<0.05$ ). But studies conducted in Ethiopia demonstrated that severely stunted school children had low serum concentrations of iron when compared to normal children<sup>116</sup>.

Now a day's one debate is ongoing, whether malnutrition is a deficiency in caloric intake, protein intake, or a deficiency in both? Could a deficiency in micronutrients such as vitamins and minerals be defined as malnutrition? Is malnutrition defined by a specific clinical condition, or is it the presence of multiple conditions? Decreasing intake does not consistently correlate with a decrease in Albumin, transferrin, nor does increasing intake necessarily increase these levels. Serum proteins are neither specific, nor sensitive indicators of nutrition status<sup>117</sup>.

# **Conclusion & Recommendation**

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## **5.1 Conclusion**

- The study shows that the nutritional indicators of under 5 children of Manipuri population is reasonably good.
- The frequency of malnutrition in Manipuri children is lower than those obtained from national data.
- This study also finds higher frequency of anemia and some micronutrient deficiency in Manipuri community of Bangladesh.

## **5.2 Recommendation of the study**

- Adequate attention should be given to micronutrients while treating Manipuri under 5 children.
- Regular intake of protein as well as iron, zinc and vitamin D rich food for under 5 Manipuri children should be promoted through appropriate ethnic friendly approaches.
- Further multi-centric study may be carried out.

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# ANNEXURE

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**ANNEXURE-I**  
**INFORMED CONSENT**

**Written consent form for blood sampling for research study of child**  
**under 5 years**

*Study Title: Nutritional Status of Under Five Children among Manipuri Population of Bangladesh*

You are being asked to provide permission to collect some blood from your index child for a research study. Your permission is voluntary. Your decision whether or not to provide some blood or a decision to withdraw your blood from research use will not involve any penalty or loss of benefits to which you are entitled.

The Manipuri, is one of the many ethnic communities in Bangladesh. Reports on nutritional status among the under two children in Bangladesh is many but among the Manipuri children is inadequate.

The purpose of this study is to determine the nutritional status of under 5 children among Manipuri population of Bangladesh. This study have received ethical clearance from the Ethical Review Committee for the Protection of Human Subjects at Dhaka Shishu Hospital.

For this purpose we need to collect 10 mls of blood *from your child under all aseptic precaution.*

The blood sample after collection will be kept and used for testing until study activities are completed. At that time any unused blood will be discarded.

In addition, the research involves the use of the following health information of your child.

- anthropometric indices
- anthropometric status of mother of the child

There are no benefits to you should you decide to participate in this study. But you will receive the results from tests done on your child's blood. Generally there is no harm in collecting blood sample from your child. A risk of providing blood is mild to moderate pain at the site of the needle puncture into your child's vein. Other risks are redness, minor bleeding, swelling and a bruise at the site of the needle puncture or, rarely, an infection. Some people feel dizzy or faint when blood is taken; however, most people do not experience any problems. But if any unwanted health problem arises, the researcher is bound to take all the necessary management steps.

**Other important information you should know.**

- Any health information you may provide about your child will be kept confidential, unless its disclosure is permitted by law. Information created or collected in this research may be shared with other researchers, but none of it can be traced back to you. Your name will not be used in any publication or presentation that may result from this research.
- You will not be paid to participate in this study.
- You may withdraw your child's blood from use in this research at any time. If you wish to remove your blood from use in the study, please contact the researcher in writing. If your blood has not already been used up by the researchers, any blood that remains will be destroyed.

By signing this form, you are allowing the research team to use your health information and disclose it to others involved in the research. The research team includes the researcher directing this study plus the people working on this study at DHMC and elsewhere. You are also permitting any health care

provider holding your health information needed for this study to give copies of it to the research team.

Your permission to use your child's health information for this study will not end until the all study activities by the researcher is completed. You may request study data once the study activities have been completed.

If you do not allow use of your health information for this study, you child may not include in this study.

If you choose to stop inclusion in this study, you may cancel permission for the use of your child's health information. You should let the researcher know in writing that you are cancelling your permission. Information collected for the study before your permission is cancelled will continue to be used in the research.

Name of the researcher: **DR. SYED SHAFI AHMED**

Telephone number : 01711144371

**Consent:** I have read the above information and have been given an opportunity to ask questions. I agree to provide to collect blood from my child for this study, *Nutritional Status of Under Five Children among Manipuri Population of Bangladesh*, and I have been given a copy of this signed consent form for my own records.

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Subject's Father/Mother's name

Signature

Date

## ANNEXURE- II

### QUESTIONNAIRE

#### **Study Title: Nutritional Status of Under Five Children among Manipuri Population of Bangladesh**

##### **General Information**

1. Serial No.
2. Ethnic group (Bishnupriya-1: Meiteis-2: Meiteis Pangan-3):
3. Name:
4. Age:
5. Sex (M=1:F=2):
6. Father's name:
7. Father's occupation:
8. Father's educational qualification:
9. Mother's name:
10. Mother's occupation:
11. Mother's educational qualification:
12. Address:
13. Date of interview:

##### **Socio-economic factors**

1. Housing ) Kacha- 1: Semipacca -2: Building-3):
2. Number of people living in households:
3. Total area of cultivable land (decimal):
4. How many months of a year are maintained with the yielded crops ?:
5. Monthly income:
6. Monthly expenditure:
7. Monthly expenditure on food consumption:



**Maternal factors**

1. Age of mother:
2. Level of education (Illiterate- 1:<SSC-2: HSC-3):
3. Age of first pregnancy:
4. Maternal height:
5. Maternal weight:
6. BMI:

**Feeding history of the target child**

1. Feeding breast milk immediately (knowledge and practice):
2. Colostrums feeding history (knowledge and practice):
3. Exclusive breast feeding history (knowledge and practice):
4. Sustained breast feeding history (knowledge and practice):
5. Complementary feeding history (knowledge and practice):
6. Type of complementary food given:
  - Pre-lacteal (Honey-1: Water-2: Others-3):
  - Post-lacteal (Breast milk-1: Formula milk-2: Cow's milk-3):
  - Weaning ( Khichuri-1: Others-2):

**Morbidity information**

1. Immunization (Not-given-1:Incomplete-2: Complete-3):
2. History of past illness during last three months ( Diarrhea-1: Pneumonia-2: Others-3):
3. Duration of illness:
4. Places where treatment was sought:

**Hygiene and sanitation**

1. Drinking water (Tubewell-1: Tap water-2: Others-3) (knowledge and practice):
2. How taken (Boiled-1: Un-boiled-2):
3. Latrine (Sanitary-1: Others-2) (knowledge and practice):
4. Materials used after using latrine (knowledge and practice):
5. Hand washing before taking food (knowledge and practice):

**Anthropometric measurements**

1. Height (cm):
2. Weight (kg):
3. MBI (of months):
4. Mid-arm circumference for age \*cm):      Wrist (cm):      Hip (cm):

**Biochemical measurements**

1. Blood Hb (gm/dl):
2. Serum ferritin ( $\mu\text{g/dl}$ ):
3. Serum albumin (gm/dl):
4. Serum total protein (gm/dl):
5. Determination (Zinc-----, Vitamin D----- , Iron-----):

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