STUDY OF THE RELATIONSHIP BETWEEN MATERNAL SIZE AND NUTRITIONAL STATUS OF CHILDREN IN RURAL BANGLADESH

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF DHAKA BANGLADESH
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DEDICATED

TO

MY

Late Father Md. Delwar Hossain
&
Mother Mst. Sakirannessa

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ABSTRACT

This cross sectional analytical study was conducted among 1800 rural mother -child pairs in Bangladesh to estimate the proportion of mothers suffering from chronic energy deficiency and the proportion of their index children suffering from malnutrition and to determine the association between maternal size and nutritional status of children of the mothers. Socio-economic and demographic information of the respondents was obtained through structured questionnaire. Anthropometric data of the mothers and their children were collected through standard procedures. Maternal body mass index (BMI) and child's nutritional status by Z- score of reference median were worked out.

Body mass index indicated that 45.4 percent mothers were found to suffer from chronic energy deficiency (BMI < 18.5). Nutritional status of children by z-score classification indicated that prevalence of underweight, stunting, and wasting were 41.0 percent, 38.8 percent and 25.0 percent respectively. The child's attainment of weight in relation to age was only 71.70 percent of the NCHS reference median. Whereas, height-for- age and weight-for-height were 87.81 percent and 90.54 percent of the reference median respectively.

Weight-for-age z-score (WAZ) and Height-for-age z-score (HAZ) showed highly significant positive correlation between the age groups. Multiple analysis of the variance showed strong relationship between nutritional status of the children and BMI of mothers. Regression analysis revealed that there are statistically significant positive relationship between maternal BMI and all three indicators of child nutrition (WAZ, HAZ, and WHZ). Child growth status, weight status and status of wasting showed positive association with the maternal BMI. Prevalence of stunting, underweight and wasting was significantly higher among the children of the mothers who were chronically malnourished (BMI <18.5). Multiple comparisons by Post Hoc Test of WAZ, HAZ, and WHZ by maternal BMI indicated that all three indicators by BMI<16, 16-16.99 and 17.0-18.49 were significantly lower ($P<0.05$) when compared with these three indicators by BMI 18.5 -24.99 and BMI > 24.99 respectively. Multivariate analysis showed that the mothers who had married earlier (≤ 15 years) and gave birth of their first child within 16 years of age, the mean of WAZ, HAZ, and WHZ of children were lower than that for the mothers who had married after 15 years of age and gave birth of their first child after 16 years. Maternal education, higher family income, and eating more meals with meat or fish per week were found to be positively associated with nutritional status of children. Logistic regression analysis revealed that age at first birth, mother's education, family income, duration of breast-feeding, mother's illness during the last year, and maternal BMI had statistically significant influence on child's height-for-age, and weight-for-age z-score. The findings indicated that maternal size is a determinant of the good nutritional status of their children.

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LIST OF ABBREVIATIONS

ACCSCN	Administrative Committee on coordination (of the United Nations) / Sub-Committee on Nutrition
ADB	Asian Development Bank
ANC	Antenatal care
AusAID	Australian International Development Agency
BBS	Bangladesh Bureau of Statistics
BDHS	Bangladesh Demographic and Health Survey
BINP	Bangladesh Integrated Nutrition Project
BMI	Body Mass Index
CED	Chronic Energy Deficiency
CI	Confidence Interval
CNC	Community Nutrition Centre
FWA	Family Welfare Assistant
HAZ	Height-for-age Z-score
HKI	Helen Keller international
GM	Growth monitoring
IFRI	International Food Policy Research Institute
IMCI	Integrated Management of Child Illness
INFS	Institute of Nutrition and Food Science
IPHN	Institute of Public Health and Nutrition
IUGR	Intrauterine growth retardation
LBW	Low Birth Weight
MCH	Mother and Child Health
MMR	Maternal mortality rate
MAC	Mid arm circumference

MUAC	Mid upper arm circumference
NCHS	National Center for Health Statistics
NNP	National Nutrition Programme
NERP	Nutritional Education and Rehabilitation Programme
PEM	Protein-energy malnutrition
OR	Odds ratio
OR	Relative Risk
SGA	Small for gestational age
UNDP	United Nations Development Programme
UNFPA	United Nations Fund for Population
WAZ	Weight-for-age Z-score
HAZ	Height-for-age Z-score
WHZ	Weight-for-height Z-score
WHO	World Health Organization

Chapter 1

INTRODUCTION

CHAPTER – 1

1. INTRODUCTION

1.1. INTRODUCTION AND BACKGROUND

There is overwhelming epidemiological evidence that malnutrition is a major determinant of health in the developing and developed countries[1,2]. An estimate showed that 800 million people do not have access to sufficient food to lead healthy and productive lives[3]. About 160 million pre school children in the world are currently malnourished[4] which is only a little less than 1990 level of 177 million[5]. The majority of them were from developing countries. More than 60 percent of Bangladeshi children under-five years of age were found to suffer from second and third degrees malnutrition in 1989[6] and recent child nutrition survey (2000) [7] revealed that 37.1% children suffer from severe and moderate degrees of malnutrition and another 50.7% from mild degree malnutriton.

Malnutrition starts in the mother's womb resulting low birth weight babies (LBW)[8]. Asia has a higher prevalence of low birth weight than elsewhere ranging from more than 30 percent in South Central Asia and Bangladesh to less than 10 percent in China, the Philippines, Malaysia, and Thailand[9]. About 60.0 percent of women in South Asia and 40.0 percent in South-East Asia are under weight (<45kg)[10]. LBW is strongly associated with under nutrition of mothers[11] Other studies have shown that health and malnutrition is essentially the end result of a complex set of overlapping and interrelated biological, social, economical, and environmental phenomena [12-16] .

Childhood malnutrition is a major cause of continued high rates of childhood morbidity, mortality and pregnancy wastage [17,18]. Childhood malnutrition reflects a variety of causes, such as inadequate food availability, poor maternal care and inadequate public health measures. The health of a child may also reflect the health status of his/her mother[19,20].

Several studies in sub-Sahara Africa as well as studies from many parts of the world have demonstrated a relationship between women's nutritional status during pregnancy and pre-pregnancy state and the birth weight of the new born. Hence the percentage of LBW infants in a community can be used as a strong indicator of female nutritional status of that community [21-23].

Growth starts from conception with maximum velocity in foetal life and is influenced by genetic, racial, nutritional, social, economic and environmental factors[24-31]. During intrauterine period, growth depends upon the nutritional status of the mother. Maternal weight gain during pregnancy is a predictor of infant birth weight. However, very often miss-beliefs, social taboos and food restrictions prevent mothers meeting their increased demand during pregnancy and as a result the nutritional status of the mother is compromised and a low birth weight may result [32,33]. A Bangladeshi mother takes a total energy of 1943 kcl as opposed to the WHO/FAO recommendation of 2700 kcl per day during pregnancy[34,35]. This has gone to further down to 1868 kcl per days found in National Nutrition Survey 1998 [36]. Research findings from various parts of India reveal that the energy intake of the pregnant women of the low socio-economic status is only between 1200 and 1600 kcal which remains unaltered through out pregnancy[37] . Another study [38] shows that the incidence of LBW is two and half times higher among pregnant women having less than 1500 kcal per day than among those who have adequate energy intake[39].

Birth weight, a strong predictor of weight and height in early childhood, is very much dependent on maternal height and her weight gain during pregnancy [40]. Pre-pregnancy weight gain appears to act as "effect modifier" in the relationship between weight gain and birth weight[41]. Maternal nutrition is a critical determinant of pregnancy outcome in industrialized and developing countries[42]

Abnormal BMI in mother plays an important role on the future fertility [43]. Both extreme low and high BMI can contribute to complications of pregnancy[44]. In the developing countries, higher percentage of low BMI contributes to greater number of low birth weight babies, preterm babies and increase of perinatal mortality [45-50]. Other studies suggest that maternal BMI is positively associated with infant birth weight [51-58]. A study in Honduran population [59] suggested that maternal BMI is positively associated with infant birth weight and milk energy density[60]. In countries, where considerable percentage of mothers are over weight (BMI>29) gain relatively little weight during pregnancy as compared to[61] women with normal BMI [62,63]. Globally, prevalence of over weight in women varies from 7 to 46 percent and prevalence of under weight varies from 0.2 to 35 percent [62,64].

An attainment of adult weight is also thought to be partly determined by factors in uterus, in infancy and in childhood [65-70]. One study[71] also found similar associations between birth weight and adult height as well as birth length and adult height. Other studies[72-79] revealed that infants with lower birth weight were shorter and lighter throughout childhood. Newborns with intrauterine growth retardation have higher rates of subsequent growth retardation during infancy and childhood[80,81].

There is are huge literature demonstrating that children growing in poor circumstances were shorter in stature at all ages than those growing in relatively affluent conditions [82-84]. Genetically short children do differ in various anthropometric and functional traits from those who were short due to environmental causes [85].

Growth faltering is common among infants and children in poor areas throughout the world. The process of growth faltering started during infancy or even in uterus and it is thought to be due to poor dietary intake and morbidity[86]. Infant feeding practices have serious implications for infant survival and growth[87,88]. Increased morbidity and mortality among children living in poor countries like Bangladesh is strongly linked to malnutrition and dietary insufficiency[89,90]. Chronic malnutrition leads to stunted growth and decreases the survival chances of adults later in life[91-93].

A study [94] on Ghananian infant found that weight for age faltering starts as early as 3-4 months but length faltering does not start until after 9 months. Due to the introduction of unhygienic dilute food with lower calorie value in the developing countries, children grow slowly in comparison with their counterparts in the developed countries[95].

In many parts of the world especially in the agrarian society women play the crucial role in ensuring household food security. They try to feed their children with the little food they have at the cost of their own nutrition. In such families, both mothers and children are likely to suffer from malnutrition[96]. Nutrition and health status of children are of high national priority[97]. Provision of adequate maternal nutrition should receive high priority with a view to reduce the incidence of LBW, , early mortality and morbidity [98]. Food supplementation studies in Colombia[99] and in rural Guatemala[100] suggested that supplementation is most efficient during infancy especially during the period of 3-6 months. Reduction in morbidity and improvement in nutritional status of mother and children are major policy issues for health planners in less developed countries[101] . So the nutritional status of mother can be used as an index of food adequacy in a household and inferences can be drawn regarding the nutritional status of the children belonging to these households. In view of those facts stated above the present study is essential to understand the relationship of maternal size and their living children of less than 10 years age.

1.2. OBJECTIVES OF THE STUDY

The study was conducted with the following objectives.

1.2.1 General objective

To determine the association between the maternal size and nutritional status of their children in rural areas of Bangladesh and to compare the nutritional status of Bangladeshi mother-child pairs with that of other countries

1.2.2 Specific objectives

1. To measure the body mass index (BMI) of mother in the household;
2. To assess the nutritional status of children below 10 years (0-9years) old in the Same household;
3. To study the association between the maternal size and nutritional status of children (wasting, stunting, under-weight), in the same household.

1.3. RATIONALE

The need for effective programmes to improve nutrition and health throughout the world is becoming increasingly urgent. Information on the magnitude of the problem of nutrition, the identification of the target group and undertaking remedial measures is of greatest importance.

In developing countries like Bangladesh, maternal and child nutrition is one of the most pressing issues. Maternal nutritional status is one of the most important determinants of foetal growth[96]. Low birth weight (LBW) is a major factor associated with early infant mortality. Twenty five million babies a year are born with LBW (below 2500 gms) globally[102]. Under nutrition is associated with more than 50 percent of childhood deaths[103].

Nutrition during pregnancy have been studied extensively[104]. Nutrition supplementation during pregnancy and childhood has been found to result in improved birth weight and prevent growth faltering of the children[105-108]. Although the association of maternal nutritional status with birth weight had been examined in many studies, fewer studies have examined the relationship between nutritional status of the child and that of the mother. Various researchers from India, Ethiopia, Zimbabwe have conducted limited studies on maternal-child nutritional status and found that nutritional status of children closely associated with the nutritional status of mothers and is also comparable with the nutritional status of other adult women in the same household[109]. As the nutritional status of children is worst in Bangladesh and it is closely related to nutritional status of mothers a study is very much needed in Bangladesh to see the association between maternal size and nutritional status of children for health planners and policy makers in order to improve the nutritional status of mothers and their children.

Chapter 2

LITERATURE REVIEW

CHAPTER - 2

2. LITERATURE REVIEW

2.1 Background Information

In 1974 the world food conference in Rome resolved that by 1984 no child, women or man should go to bed hungry. And no human shall be physically or mentally potentially stunted by malnutrition. Twenty eight years after the resolution was made, even today 700 million people go to bed hungry globally, 800 million do not have access to sufficient food to lead healthy and productive lives in less developed countries and 200 million children below 5 years of age suffer from malnutrition in Asia[110-111]. Around 3.5 million children in different parts of the world die every year due to diseases related to malnutrition[112].

To solve the nutritional problem Food and Agricultural Organization (FAO) had convened a world food summit in 1992 to devise an internationally acceptable strategy for sustainable food security. The government of Bangladesh being a signatory also has put food security high on the national agenda.

Bangladesh is a small country with a land mass of 147,570 square kilometers inhabited by a population of 123.1million (Census 2001) and has one of the highest population density of (834 persons per sq. km.) in the world[113]. The estimated per capita GDP was US$ 370 in 2001[114].

Overall calorie intake has been declining in Bangladesh. In 1937 per capita calorie intake was 2743 kcal and in 1964 it was 2251 kcal. This figure went down to 2094 kcal in 1976 and 1943 kcal in 1982 as revealed from the surveys conducted in 1975 –

76 and 1981-82 respectively by the Institute of Nutrition and Food Sciences[115,116]. This calorie intake has gone down further to 1868 kcal per capita per day as documented in Nation Nutrition Survey 1995-96 [117]. This decreased intake mostly affect the mothers and children- the most vulnerable group in the society who usually consumed less than others of the family's food [118-119] .

In Bangladesh, mothers and children constitute more than two-thirds of its population. Forty five percent mothers are malnourished [120] 48 percent children are underweight, and around 30 percent babies are still born with low birth weight[114]. The severity and various causal factors of malnutrition in Bangladesh has documented by the last three National Nutrition Surveys. There is a traditional saying "Good mother is one who eat last and the least in the family"[116] and as such they get less food and as a consequence suffer more from malnutrition than any other member in the family. It does not only affect herself but also affect the foetus in the womb and subsequent growth and development after birth. If the mother has been given adequate nutrition during pregnancy, have good antenatal care and live in hygienic surroundings, foetus in utero will get healthy environment, the foetus will grow well and will be born with good health and adequate birth weight.

There is no doubt about the woeful condition of maternal nutrition in South-Asia. From various micro-studies, it is evident that South-Asian women receive a raw deal in the allocation of food and health care facilities [121-127]. Thus more women die than men. So the fact remains are fewer women per hundred men in this region[128,129]. The table below shows the per capita income and calorie supply for 12 countries of Asia where the per capita calorie intake of Bangladeshi people is far below than that of China, Indonesia and also to some extent from other countries in this region except Nepal and Mongolia.

Table 1: Per Capita Income and Calorie Supply in Selected Asian Countries

Countries	GNP per capita (US$ 1993	Daily calorie supply per capita 1992	GNP per capita (US$ 2001)
1. Bangladesh	220	2,019	270
2. China	490	2,729	890
3. India	300	2,395	460
4. Indonesia	740	2,755	680
5. Malaysia	3,140	2,884	3640
6. Mongolia	390	1,899	400
7. Nepal	190	1,957	250
8. Pakistan	430	2,316	420
Philippines	850	2,258	1040x
10. Sri Lanka	600	2,275	830
11. Thailand	2,110	2,443	1970
12. Vietnam	170	2,250	410

Source: UNDP, Human Development Report 1996. Oxford University Press[130]. State of the World's Children 2003[131].

2.2 Child Nutrition Situation in the World and in Bangladesh

Malnutrition is the most wide spread condition affecting the health of children in developing countries[132]. Undernutrition is associated with more than 50% of childhood deaths[133,34]. The prevalence of malnutrition among children in Bangladesh is shocking and still among the highest in the world[135]. About 55% of Bangladeshi children 6-71 months were found to suffer from second and third degrees malnutrition, while only 6.6% was considered normal in terms of their nutritional status as reported in the Child Nutrition Survey, 1989-90[136]. Recent Child Nutrition Survey[137] revealed a reduction and that figure is 37.1 percent children suffer from severe and moderate degrees of malnutrition and only 12.2 percent found normal. From the same survey report, it is also revealed that the mean height of Bangladeshi children aged 6-71 months was 87.1 cm and the mean weight was 11.3 kg. The mean weight for height is 90.7 of the reference median whilst the mean height for age and weight for age was 92.4 percent and 78.6 percent respectively of the NCHS median.

South Asia suffers from by far the worst incidence of undernutrition among all the regions in the developing world. Some 17% and as many as 60% of South Asia's under-five children were found to be wasted and stunted respectively during the period 1985-95 as compared to an average of 9% and 41% wasted and stunted respectively in the developing world[138].

Table 2. Regional Variation in Childhood Malnutrition: 1990 & 2003.

Regions / Country	Low weight for height (%) (wasted)		Low height for age (%) (stunted)		Low weight for age (%) (underweight)		Low birthweight babies (%) (LBW)	
	1990	2003	1990	2003	1990	2003	1990	2003
South Asia								
Bangladesh	15.5	10	64.6	45	65.8	48	50	30
Bhutan	4.1	3	56.1	40	37.9	19	-	15
India	19.2	16	62.1	44	63.9	47	33	26
Maldives	6.3	13	-	25	-	30	20	12
Nepal	14.0	10	69.0	51	70.0	48	26	21
Pakistan	9.2	-	50.0	-	40.4	38	25	21x
Sri Lanka	12.9	14	27.5	14	38.1	29	25	17
East and South-East Asia	5.2	4	33.3	21x	23.6	17	11	8
Sub-Sahran Africa	7.0	10	38.8	40	30.2	29	16	12
Middle East/North Africa	8.8	4	32.4	21	25.3	17	10	11
Latin ***American / Caribbean***	2.6	2	22.7	16	12.0	8	11	9
Developing countries	9.1	8	40.7	32	33.9	27	19	14

Source: UNDP (1994)[139], UNICEF (1996)[140], FAO (1996) [141] UNICEF (2003)131

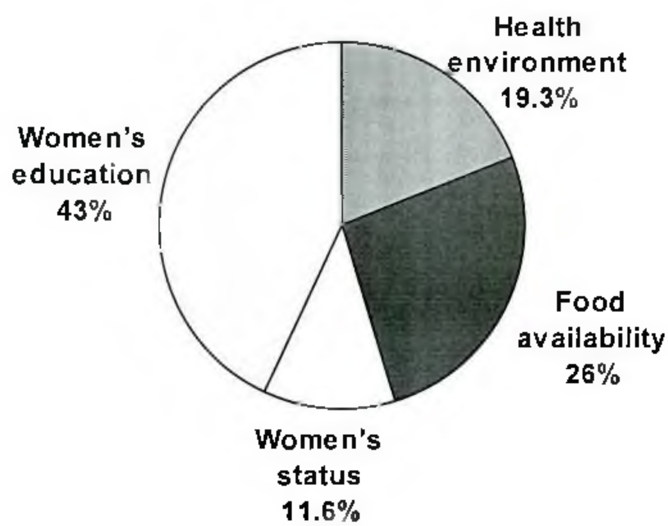
Table 3. Change over Time in the Prevalence of Underweight Children in Developing Asia

Region/ Country	First period	Second period	3rd Period 2003	Direction of change
South Asia				
Bangladesh	84.4 (1975)	65.8 (1990)	48	↓
India	78.0 (1977)	61 (1992)	47	↓
Pakistan	54.7 (1977)	40.4 (1991)	38	↓
Sri Lanka	58.3 (1976)	38.1 (1987)	29	↓
South East Asia				↓
China	21.3 (1987)	17.4 (1992)	10	↓
Laos	36.5 (1984)	40.0 (1994)	40	↑
Malaysia	25.6 (1983)	23.3 (1993)	18	↓
Myanmar	42.0 (1982)	36.7 (1991)	36	→
Philippines	33.2 (1982)	29.6 (1993)	28	↓
Thailand	36.0 (1982)	13.0 (1990)	19	↓
Viet Nam	51.5 (1986)	44.9 (1994)	33	↓
				↓

Source: WHO Global Database on Child growth and Malnutrition. (As reported in FAO 1996)[142] and UNICEF 2003[131].

The Table 3 shows a decrease trend in the prevalence of child malnutrition over time in the South Asia and South-East-Asia except Laos. The researchers find four critical reasons listed for why child nutrition improved in the developing world between 1970 and 1995[138,142]. The first one is improvement in women's education, which account for almost 45% of the total reduction of child malnutrition during this period, followed by improvement in per capita food availability in both quantity and quality, improved in the health environment, and improved in women's status relative to men (Figure-1).

Figure1: Estimated contribution of major determinants to reductions in child malnutrition, 1970-95.



Source: Smith and Haddad (2000) [143]

Calorie intake also influenced by per capita gross national product (GNP). It might therefore be expected that the calorie intake of a family will rise strongly with rising income and thus the percentage of malnutrition reduces as revealed from the Table 4.

Table 4: Prevalence (%) of stunting and underweight in preschool children and corresponding gross national product (GNP) per capita in the Asia-Pacific region

Country	Year(s) of survey	1998 (GNP per capita (US$)	Stunting %	Underweight %	2003 Stunting %	2003 Underweight %
Afghanistan	1997	<760	47.6	-	52	48
Bangladesh	1996-97	350	54.6	56.3	45	48
Bhutan	1986-88	<760	56.1	37.9	40	19
Cambodia	1996	N/A	56.0	52.0	-	-
People's Republic of China	1992	750	31.4	17.4	17	10
Fiji Island	1993	2110	2.7	7.9	3x	8x
India	1992-93	430	51.8	53.4	46	47
Indonesia	1995	680	42.2	34.0	-	26
Kazakhstan	1995	1310	15.8	8.3	10	4
Kiribati	1985	1180	28.3	12.9	28x	13x
Kyrgyzstan	1997	350	24.8	11.0	-	-
Lao PDR	1994	330	47.3	40.0	41	40
Malaysia	1995	3600	-	20.1	-	18
Maldives	1994	1230	26.9	43.2	25	30
Myanmar	1996	<760	44.6	42.9	37	36
Nepal	1990-91	210	48.4	46.9	51	48
Pakistan	1982-83	480	49.6	38.2	-	38
Papua New Guinea	1993	890	43.2	29.9	25x	-
Philippines	1993	1050	32.7	29.6	30	28
Solomon Islands	1989	750	27.3	21.3	27x	21x
Sri Lanka	1993	810	23.8	37.7	14	29
Thailand	1987	2200	21.5	25.3	16x	19x
Tonga	1986	1690	1.3	-	-	-
Uzbekistan	1996	870	31.3	18.8	31	19
Vanuatu	1983	1270	19.1	19.7	19x	20x
Viet Nam	1994	330	46.9	44.9	36	33

Source: WHO (1999) Global Database on Child Growth and Malnutrition. Forecast of Trends,. Geneva: Nutrition Division, WHO[144].

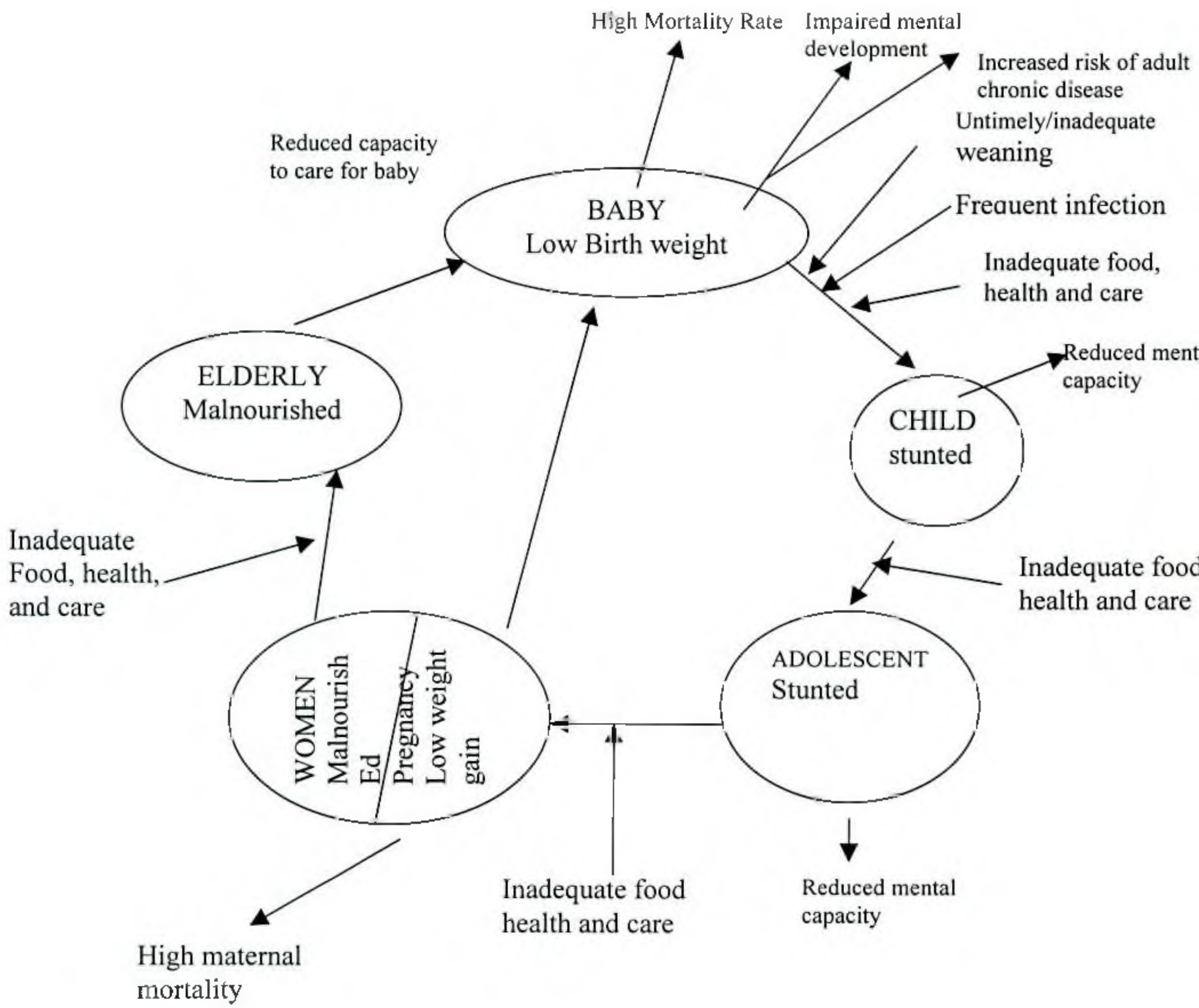
2.3 Undernutrition throughout the life cycle

Malnutrition is a life-cycle phenomenon[145]. Undernutrition often starts in uterus and may extend throughout the life cycle as depicted in Figure-1. *Inadequate* nutrition and ill health in mothers can initiate cycle of ill health in the next generation[146, 147]. A low birth weight infant is thus more likely to be under weight or stunted in early life. Some studies observed growth retardation in developing countries is assumed to start between 4-6 months following birth when low quality and often contaminated foods are introduced in infants diets [148-152]. Another study conducted by Rivera (1997)[153] observed growth faltering starts soon after birth. Others found that undernutrition that occurs during childhood, adolescence, and adulthood spans from generation to generation[154].

Most growth failure started to occur before birth and continues until 2 to 3 years of age. If the socioeconomic situation remains as it was found at the time of birth and the child who is stunted at five likely to remain stunted throughout life[145,155].

If female, she is likely to be undernourished[156-158] before , during and after pregnancy with adverse consequences for the nutritional status of her newborn child who is more likely, in turn, to be of low birth weight- a vicious cycle.

Fig 2 : Undernutrition throughout the life cycle



Source: Adapted from ACC/SCN (2000) Fourth Report on the World Nutrition Situation. Geneva: ACC/SCN in collaboration with the International Food Policy Research Institute. Cited from ACC/SCN Nutrition Policy Paper No. 19, ADB Nutrition and development series No.5, ed. Lyndsay Allen and Stuart Gillespie. What works? A review of efficacy and effectiveness of nutrition intervention.

2.4 Few determinants of low birth weight and benefit of maternal nutrition

The incidence of low birth weight in developing countries especially in Asia ranged between 20% and 50% compared to developed countries where this percentage is less than 7% [159-161]. The result is that 90 percent of low birth weight babies that born each year are from the developing countries. This difference is attributable to short maternal stature, low pregnancy weight gain, and low caloric intake or low weight gain during pregnancy[162-63]. The low birth weight babies 2-3 times more likely to die in infancy than those with normal weight[164,165]. Majority of IBW babies are born by teenagers who are still in the growing stage[166-169]. Parity also affects the birth weight[170-173]. Many studies reveal that birth weight is positively correlated with height of mother[169,1174]. The birth weight of babies is usually directly proportional to mother's weight. Mories et al(1987) [175] found that mean birth weight of babies was less in under weight mothers than of mothers weighing more than 45.5 Kg. In a study conducted by Nahar et al[176] found that the incidence of IBW gradually decreased with the increase of maternal height. They also found incidence of LBW was highest (42.9) among the teenagers (age between 15 and 19 years) and lowest among the mothers whose age was between 30-34 years. This indicates that increasing the age of first birth then incidence of LBW could substantially be reduced.

Benefits to the Woman of Improving Maternal Nutrition

- Improving nutrition during pregnancy will improve nutritional status, physical stamina and well-being, and thus reduce maternal morbidity and mortality.

- Improving nutrition during lactation will allow for replenishment of maternal stores and achievement of an adequate pre-pregnant weight for any subsequent pregnancy.
- Improving iron status will reduce anaemia leading to less fatigue, better productivity and work capacity, improved immune function, reduced risk of reproductive failure like miscarriage, stillbirth, pre-term delivery, low birth weight, perinatal mortality etc and reduced risk of maternal mortality.
- Improving vitamin A stores with low dose (RDA level) supplementation during pregnancy if required and one high dose post-partum will combat maternal deficiency and improve iron status
- Improving iodine status will reduce the risk of miscarriage, stillbirth and maternal mortality due cephalopelvic disproportion
- Improving zinc status will reduce the risk of prolonged labour, intra and postpartum haemorrahge, hypertension, and improve immune function
- Improving riboflavin status, where deficient, will improve iron status with the benefits listed above.

Benefits to the Foetus/Child of Improving Maternal Nutrition

Reductions in chronic (or seasonal) maternal energy deficiency will ensure better foetal growth (birth weight, length, head circumference), adequate (quantity and quality) breast milk production and thus;

- better chances of infant survival

- improved growth and physical development
- improved immune function and reduced risk of serious illness
- better psycho-motor development
- improved bonding with mother
- better attention, learning ability and education achievement in later years.

Improved maternal iron/folate status will result in a better chance of normal, term delivery, a lower risk of congenital abnormalities including neural tube defects, as well as improved immune function

Improved maternal iodine status will result in a lower risk of spontaneous abortion, cerebral palsy, autism, and a lower of risk of impaired vision and hearing

Improved maternal vitamin A status will result in lower infant mortality risk

Improved maternal zinc status will result in better foetal growth and higher birth weight

Improved maternal vitamin B12 status will protect the infant form adverse effects on mental and physical development.

2.5 Maternal Anthropometry and low birth weight

It is estimated that foetal growth and development, birth weight are substantially associated with the maternal anthropometry[177-179]. Anthropometry is a major tool in the identification of pregnant women at nutritional risk. Many recent studies have devoted special attention to the use of several anthropometric indicators for nutritional monitoring during gestation like weight gain during pregnancy, estimation of BMI etc. Of all measurements sufficiently predictive of pregnancy outcome, arm circumference is the most feasible measurement that can be easily used to identify women who are undernourished[180].

Shah (1982) recommends arm circumference (AC) for monitoring purposes. Lechtig (1988) found that AC together with stature and head circumference was at least equivalent to weight gain in predicting birth weight of infants[181-186].

Although WHO (1991) [187] suggested cut off points of MAC in the range of 21to 23.5 cm for assessing biological risk of low birth weight but results of an Indian study[188] reveled that in Indian situation, Mid arm circumference values below 21 cm can be considered as a sign of undernutrition ,and values below 20 cm can be potentially hazardous both to the mother and new born. A study conducted by the government of Tamil Nadu[189] found maternal weight less than 35 kg and mid arm circumference, less than 20 cm had a definite impact on the incidence of low birth weight. As socio-economically we are similar to Indians, the cut off points of 20 cm and below can be assumed as values predictive of poor pregnancy outcome for the Bangladeshi mother.

2.6 Maternal Pre-pregnancy weight, weight gain during pregnancy and birth outcome

Maternal nutrition is a fundamental determinant of foetal growth, birth weight and infant morbidity[190,191]. It has been established that low pre-pregnancy weight gain during pregnancy is associated with increased incidence of LBW babies and IUGR[192-196]and birth weight is the most important determinant of mortality and morbidity in the neonatal period[197]. The influence of maternal malnutrition on birthweight has gained special interest in view of the possibility of nutritional intervention[198,199]. It is suggested that assessments of the velocity or increment of weight gain especially in the second and third trimester of pregnancy is very much important for monitoring intrauterine growth [200,201].

Maternal pre-pregnancy weight gain has been shown to be a sensitive initial indicator of the risk of delivering a LBW baby [202-204] and is independent of pregnancy weight gain [205]. The mother with normal pre pregnancy weight, give birth a healthier baby than the mother who has less weight than the average. Since 1941, Scott & Benjamin[206]. valued Maternal weight gain during pregnancy. They routinely estimated the weight gain in antenatal clinics. From that period several studies found a positive association between maternal weight gain and infant birth weight [207,208].

In developing countries where a large number of mother suffer from malnutrition and infectious diseases during pre pregnancy period and failed to gain desirable weight during pregnancy due to inadequate intake of food especially micronutrients[209]. Many studies revealed that pre pregnancy weight, weight loss, insufficient weight gain[45],[209-213]and extreme weight gain[209,214-217] are potentially hazardous[218].

International Conference on "Maternal anthropometry for prediction of pregnancy outcome pointed out that a gain of less than one kilogram per month is a danger sign calling for immediate action[208].

Dawes et al[45], found in their study low maternal booking weight as the most effective maternal weight measurement for antenatal detection of small for gestational age (SGA). Their findings also confirmed that the major determinants of birth weight, after taking into consideration gestational age, were maternal size at booking, maternal weight gain and maternal age [209]. Weight gain during pregnancy varies in women with different pre pregnancy weight. Weight gain in pregnancy in over weight women is less than the normal weight women as revealed from some studies[43,219]. Another study[220] among Iranian women found an increase in mean weight gain in under weight groups was 14.3 kg. While in the over weight group was 9.5 kg. Studies in Kenya and Mexico also revealed that women with a lower BMI gain more weight and in pregnancy and loss more weight and fat during lactation[225]. Another study shows Egyptian mothers with >27.4 BMI gained only 6.0±2.3 kg. in the last two trimester, compared to 8.2± 3.4 kg for women with low BMI between 22.6 and 27.4. Overweight women (BMI >29) produces the highest birth weight infants but gain relatively little weight in pregnancy[221]

In a three countries study Egypt, Kenya and Mexico showed maternal BMI was positively correlated to infant length at 3-6 months [61].

The difference in risk of LBW between women of low and high pre-pregnancy weights was found to only disappear if women gained at least 11.8 kg during pregnancy[222]. WHO study suggested that if a woman gained 10.5 kg during pregnancy and her pre-pregnancy weights fell within a range of 44-54 kg, it is expected that she could deliver an infant of 3 kg or more (WHO 1995) [223]. But in developing countries average weight gain range from 5-9 kg, and in much of South Asia is around 5 -7 kg[11] rather than 10-15 kg obtained by British women[224-226]. In Some study suggested that average weight gain during pregnancy in Bangladesh is 4.8 kg which indicates they are actually loosing1-2 kg of their own weight during pregnancy[227,228]. Recent trial from Gambia[229]. indicated that effect on foetal growth may be greater in extremely malnourished mothers. Bangladesh Integrated Nutrition Programme (BINP) has started a food supplementation programme for pregnant and lactating women since 1996. They are supplementing pregnant women with BMI less than 18.5 Their target is achieving at least 7.0 kg weight gain in at least 50.0% of the pregnant population targeted[230].

Birth weight is influenced by many factors e.g., maternal age, parity socio-economic status, smoking, prenatal care etc[231-232]. Other studies[167-169,177,233] reported that higher incidence of low birth weight, prematurity and neonatal mortality in children are observed in young mothers than those of older ones. Studies on parity reveal that birth weight on first born baby has lower birth weight than subsequent birth [171,234] weight is highest for second and third births[170,173,174]. Other studies show that the average birth weight of newborn in Bangladesh ranged between 2.48 and 25.3 kg [166,235]and percentage of low birth weight is 30%to 50% as that of many Asiatic countries [236,237].

2.7 Nutrition requirements during pregnancy and lactation

Pregnant and lactating women have to meet their own nutritional requirements and also supply nutrients to growing foetus and the infants. In the 1950s and 1960s, several studies were carried out for accurate estimation of nutrition requirements of pregnant and lactating mothers[238,239]. Research studies during the 1960s and 1970s documented the magnitude of adverse effects associated with iron, folate, iodine and vitamin A deficiency during pregnancy and lactation[240]. During lactation mothers require more intake of energy which is about 500 kcal per day (American recommended dietary allowances) and it is also assumed that the lactating women utilized 2-3 kg of fat reserves gained in pregnancy[241]. The effect of maternal diet on breast milk content has been examined, and it has been found that the maternal ingestion of protein[242] vitamin A[243] and water soluble vitamins [244] may alter the concentration of these nutrients in human milk. Studies in countries where women tend to be undernourished indicate a potential for limited milk production and lowered breast milk fat content with lowered maternal nutritional status[245]

Another study suggests that lactation may be maintained on lower levels of energy intake than currently recommended[246]. However it is observed that body size should be considered, the women with lower body fat content may have greater dietary requirements [247].

It is also recommended that women who are breastfeeding need increase, intake of most other nutrients like Zinc, vitamin B12 vitamin A etc. to maintain the proper composition of human milk[248]. For example, if zinc concentration is less in milk resulting from less intake of zinc during lactation or mother's reserve of zinc is not sufficient this put both mother and infant at risk of deficiency which may result in growth retardation in the infant[249].

Adequate energy intake is necessary to achieve optimal weight gain. Energy requirement varies from women to women on the basis of prepregnancy weight body composition and necessary weight gain during pregnancy[250]. The dietary allowances recommended (US RDAs) in 1989 is 300 kcal during pregnancy[251-253] and additional 500kcal during lactation for the reference women[247,254] to meet the additional requirement of energy for the production of breast milk and prevent excessive weight loss. More evidence suggest approximately 150kcal per day may be sufficient for some women. But women who begin pregnancy under weight or need to perform more physical activities during pregnancy energy requirement may be more. However, the best assurance of adequate intake is a satisfactory weight gain[251-253].

For the growth of a baby along the 50th NCHS weight percentile current data indicate that he needs 850 ml/day which supply 600 kcal = 2510 kg to satisfy his/her energy requirement until 4 months. As the baby in the developing countries grows along 25th percentile rather than 50th, this period is theoretically extended to 6 month with some controversy[255]. The average female baby tends to consume less milk for her age than a male counterpart[256-259].

2.8 Child Development, Malnutrition and its Subsequent Effects

Human growth and development is dependent on genetic endowment plus social and environmental factors[260-262]. Growth potential in early years of life is not much affected by the ethnic difference[27] . Studies on affluent school children in Bangladesh, in India , in Saudi Arabia and in Kuwait have shown that with the provision of proper nutrition and congenial environment children from these parts of the world grow similar to the American children.[83,84,263,264]. Infant feeding practices have serious implications for infant survival and growth[265,266]. Increased morbidity and growth retardation among children living in poverty is strongly linked to malnutrition and in an inadequate diet[89]. Chronic protein energy deficiency leads to stunted growth and increased morbidity and mortality among children in the developing countries, and childhood malnutrition also decreases the survival chances of adult later in life[91]. In Bangladesh, undernutrition is a major risk factor for childhood mortality[267-269].

Maturation is also delayed in children who are malnourished on entering adolescent[270]. Early childhood growth failure manifested by stunting may be irreversible if s/he continues to reside in the same environment, which gave rise to stunting[271]. In an Indian study early childhood, stunting among young girls was found a generation later, to relate significantly with the birth weight and infant mortality risk of their children[272]. Some longitudinal observational studies between 9 and 17 years

Source[301]: Ending Malnutrition by 2020: An agenda for change in the millennium, final report to the ACC/SCN by the Commission on the Nutrition Challenges of the 21st century, February 2000, Figure 3, p. 19; Adapter from A.C.J. Ravelli et al., 'Glucose tolerance in adults after prenatal exposure to famine', The Lancet,, 351 (9097) copyrighted by the Lancet, January 1998. (Inserted from The State of the World's Children 2001, UNICEF, UNICEF House, 3 UN Plaza, New York 10017, USA).

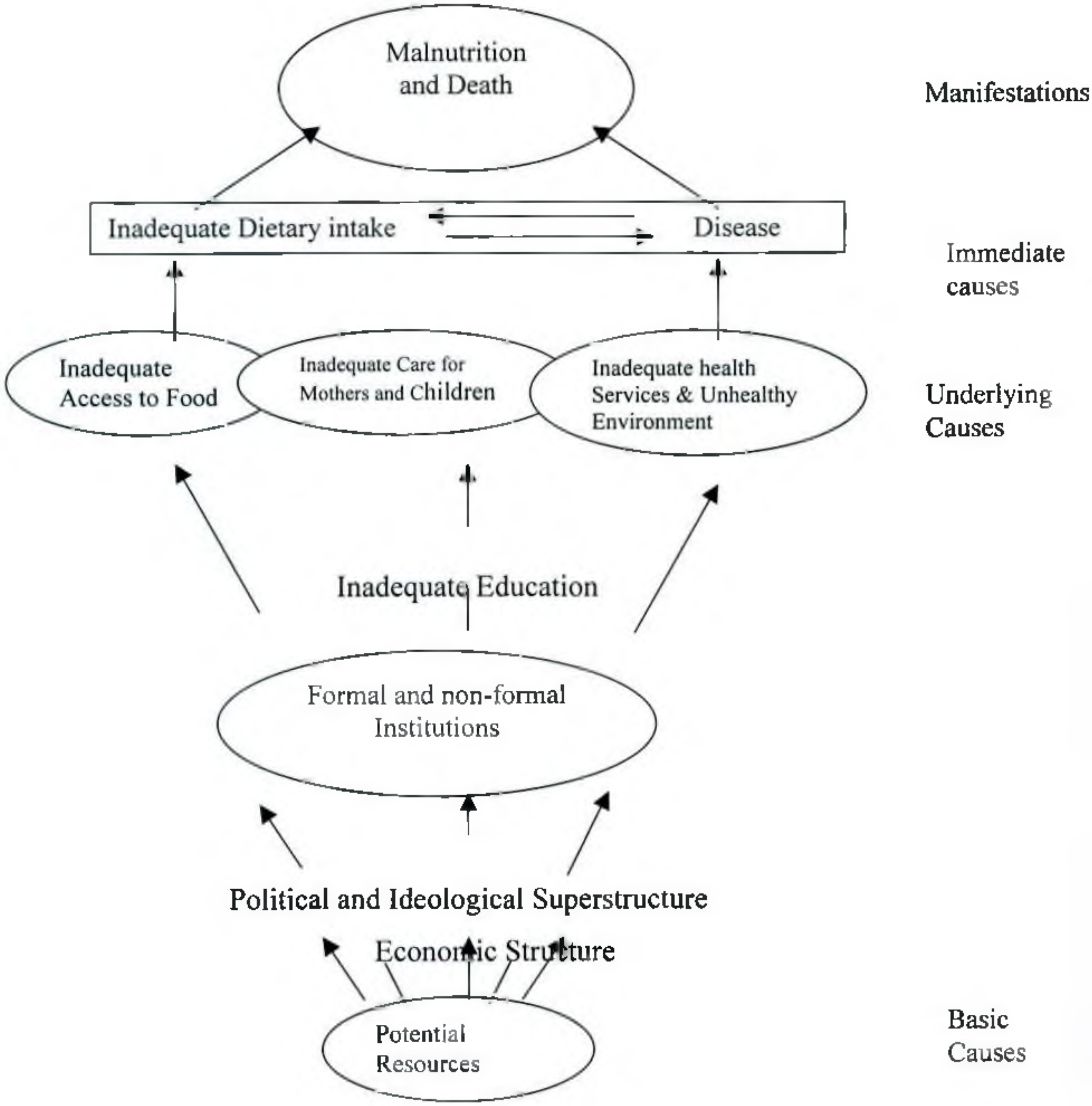
2.9 Causes of malnutrition

The causes of malnutrition are complex and multifactorial. For better understanding what causes nutrition problems, it is necessary to consider systematically the causes of undernutrition at different levels in society. In 1990 UNICEF proposed the food-care-health conceptual framework which illustrates the cause of undernutrition and their interactions at three different levels - immediate, underlying, and basic. The synergistic interaction between the two immediate causes-inadequate dietary intake and disease-accounts for much of the child malnutrition and mortality in developing countries. Three groups of underlying factors contribute to inadequate dietary intake and infectious disease are (1) household food insecurity, (2) inadequate maternal and child care, (3) and poor health services in an unhealthy environment. These underlying causes are, in turn, underpinned by basic causes that relate to the amount, control, and use of various resources[302]. Although this version of the framework pertains to child undernutrition, it can easily be adapted to other age groups and to other nutritional outcomes[10].

UNICEF Conceptual Framework

The framework suggested that not only food security and health care services are necessary for child survival, growth and development but also care for women and children is equally important. It is argued that food, health and care are all necessary but none alone is sufficient for healthy growth and development of children. For the proper nourishment of children all these three elements should be adequate. However, in the case of food insecurity and limited health care caused by poverty, enhanced caregiving can optimize the use of existing resources to promote good health and nutrition in women and children. This frame is used as an organizing principle for discussion of aetiology and approaches to remedial action

Figure 4.UNICEF Conceptual Framework of the causes of malnutrition



Source: [303]UNICEF (1990) Strategy for Improved Nutrition of children and Women in Developing Countries. New York : UNICEF

2.10 Maternal and Child Anthropometry

2.10.1 Maternal Anthropometry: Body mass index

The BMI is a simple but objective anthropometric indicator of nutritional status of the adult population and seems to be closely related to their food consumption level. It is also called Quetelet's index[304]. The BMI is highly correlated with weight and consistently independent of height as evident from several studies in different population groups [305-313]. As there is no other satisfactory reference standards BMI have long been used to distinguish between normal and undernourished or energy deficient adults.

After examining a wide range of possible monitoring tools, FAO selected the body mass index (BMI) as potentially valuable monitoring approach to diagnose CED and the index of choice for epidemiological purpose. BMI measurements of adults' height and weights can be quickly carried out and results are immediately available. Thus at the community, regional or country level at risk groups can be identified. The BMI is sensitive to socio-economic status and to seasonal fluctuations in food consumption relative to the level of physical activity. Detailed activity study suggested that BMI values alone can be used to assess CED[314]. Abnormal BMI in mother plays very important role on the future fertility[61]. Prevalence of over weight in women varies from 7 to 46% (001er 3)[315] .In USA 20-30 percent of women have 20 percent overweight [316], figures are available about the prevalence of under weight in women from different countries varies from 0.2 to 35percent. British Royal College of

Physician have chosen BMI of 18.6 and 20.0 for women and men respectively as their lower cut-off poins[17].

FAO believes that use of the BMI will serve as an extremely valuable nutrition-monitoring tool, particularly for vulnerable groups such as the rural and urban poor in developing countries, and in monitoring the effects of nutritional improvement programmes. BMI ranging from 18.5 to 25.0 is a useful reference standard for normality and hence optimum for health thorough out the world. BMI below 20 and over 25 may be associated with health problems for some individuals [318].

2.10.2 Measurements of Child Anthropometry: Z-score

Over the last 25 years anthropometry has been commonly used as a tool to estimate the nutritional status of population and to monitor the growth and health of the individuals throughout the world. Measurement such as weight and stature are accurate and valid . Furthermore, they are quick and inexpensive to carryout and therefore, applied to large sample sizes in a variety of environments[319].

During the 1950s and 1960s weight-for-age using the Gomez[320] *et al.* 1956) classification was the main method used to assess nutritional status both of individuals and of populations. In the 1970s, other workers recognized the importance of using both weight and height. In 1971 Seoane & Latham[321] suggested that three different types of malnutrition could be distinguished using knowledge of a child's height and weight. These three types of malnutrition were:

Acute, current, short-duration malnutrition where weight-for-age and weight-for-height are low, but height-for-age is normal.

Past, chronic malnutrition, where weight-for-age and height-for-age are low, but weight-for-height is normal.

Acute on chronic long-duration malnutrition, where weight-for-age, height-for-age and weight-for-height are all low.

Presently these three types are commonly referred to as wasting (acute), stunting (chronic), and wasting-stunting (acute on chronic) after (Water-low)[322] .

2.11 Maternal anthropometry and breastfeeding performances

Breast milk is a unique health resource for the newborn providing optimal growth and nutrition up to 4-6 months of age[328]. Traditionally Bangladesh is a breastfeeding country. From various study it is observed that mean breastfeeding in this country was 30 months [329,330]. It is also recorded that breastfeeding significantly reduces morbidity and mortality of infants irrespective of place of residence, socioeconomic status and maternal education than formula fed one[331].

Though there is some controversy [332-337] volume of milk produced by mother in developing countries is low compared to developed countries[338-344]. In first six months, milk yields in developing countries vary from 400-700ml/day as compared to 600-800ml/day in the developed countries [345]. The optimal health of mother does not only affect the quantity of milk but also the quality of milk. If the diet during lactation is inadequate, then milk output will be reduced and composition of milk also altered [242-245].

Lactational performance of mother depends on weight gain during pregnancy. The effect of BMI on lactation output shows that as BMI increases milk output is also increases[61]. Although the potential influence of maternal anthropometric status on milk volume is still debatable, there is now considerable evidence that the mother's postpartum body composition is associated with the concentration of fat in breast milk, and thus its energy density [149,341,347]. However, excess weight at one month postpartum, as determined by a body mass index above the normal range, was found to be an independent risk factor for early cessation of breast feeding [348].

In other studies found that a body mass index above the normal range in lactating women associated with earlier cessation of breastfeeding and an increased prevalence of " insufficient breast milk syndrome"[349]. So the prepregnancy weight and weight gain during pregnancy evident from maternal BMI is a good indicator for lactational performance.

Chapter 3

METHODOLOGY

CHAPTER – 3

3. MEHTODOLOGY

3.1 Study Design

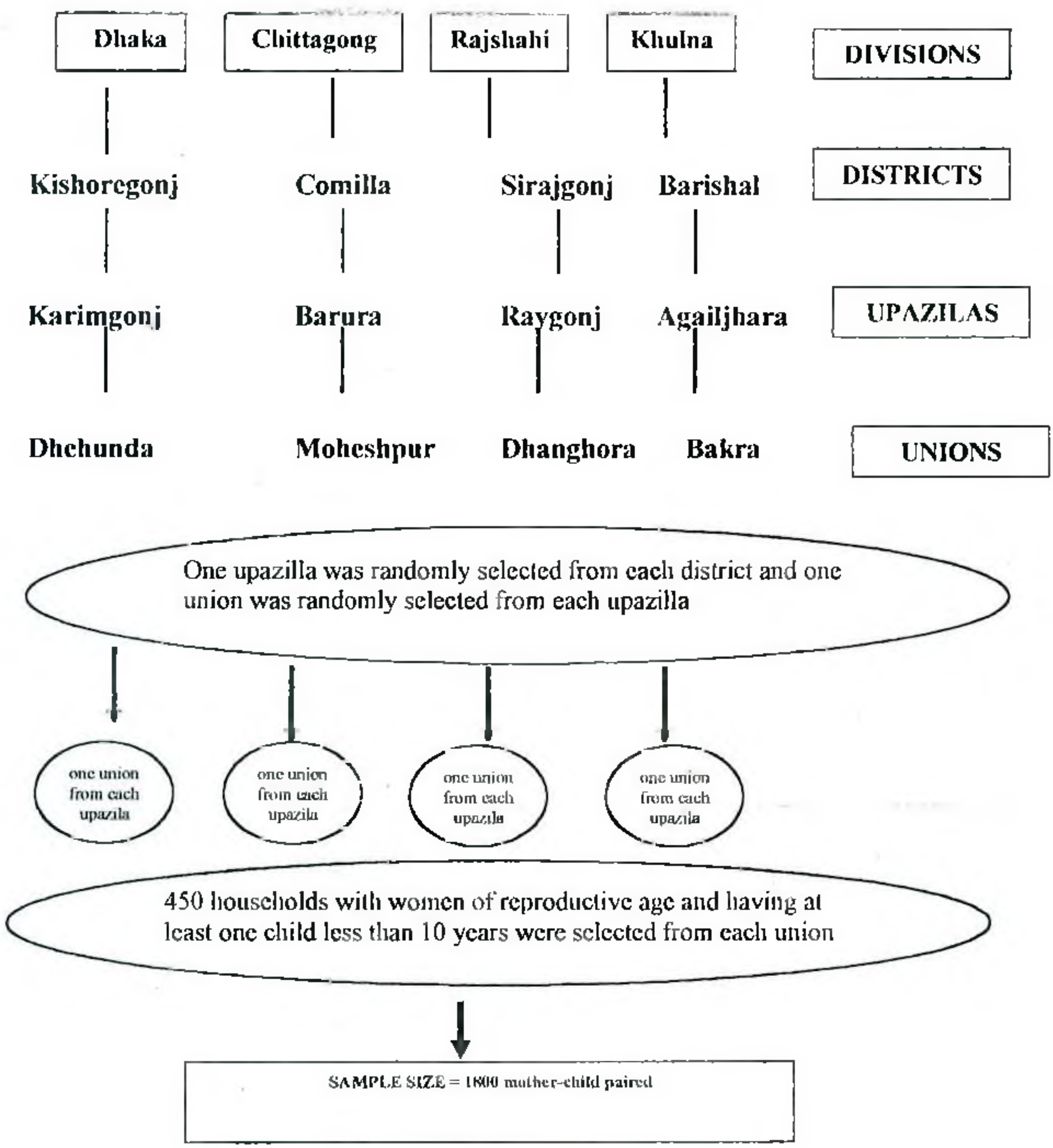
A cross-sectional study was undertaken to assess the nutritional status of 1800 mother-child pairs randomly drawn from selected rural areas of Bangladesh.

3.2 Study place and study population

The study was conducted in four unions, randomly selected from four original administrative divisions of Bangladesh. The mother having at least one child below the age of 10 years (0-9yrs) were included in the study. The child under 10 years of age who had been included in the study was termed as index child. The unions were selected following multistage sampling technique. At the first stage, out of 64 districts in Bangladesh, four districts were randomly selected. At the second stage, four upazilas from four selected districts, and finally four unions from the four upazilas were selected randomly. Thus all the mothers having at least one child below the age of 10 years (0-9 years) with their children of the four selected unions constituted the study population.

Algorithm depicting the steps for sites selection and data collection

Sampling Procedure



3.3 Sample Size and Sample selection

3.3.1 Determination of Sample Size

There is no definite value available for proportion of malnourished children among the malnourished and well-nourished mothers in Bangladesh. The respective anticipated proportion of malnourished children prevalent in the population at large was presumed to be 50 percent in each group, which yield the largest sample size for a particular confidence level and precision. The sample size in this situation is calculated using the formula,

$n = z^2 pq/d^2$,

n = sample size, z = Standard normal deviate =1.96 (at 95% Confidence Interval)

p = prevalence of malnourished children, = 50% =0.5

q= prevalence well nourished children 1-p =50%=0.5

d = 0.05 (the allowable error)

Putting the value of "p", "q", "d" and "z"

The sample size, $n = (1.96)^2 (0.5 \times 0.5)/(0.05)^2 = 384$

This means that 384 mother-child pairs was required in each group i.e., malnourished and well nourished mothers. So for two groups, double the sample size, 384x2=768. In multi-stage, sampling a large sample size is needed to account for the 'design' effect. Assuming a design effect of two, the required sample size is 1536 mother-child pairs. To be on the safe side, more 100 mother-child pairs were chosen for each group, which makes a sample of 1736, to round up the figure we have taken 1800.

Reference: Sample size determination in health studies: a practical manual. World Health Organization, Geneva 1991(Epidemiology and Statistical Methodology Unit)

3.3.2 Selection Criteria

All the mothers in each selected union who had fulfilled the selection criteria were included in the study sample. The mothers or children who were found ill from any chronic diseases other than nutritional deficiency for example tuberculosis, diabetes, rheumatoid arthritis and any malignancy not included in the study. The mothers who were currently pregnant were also excluded from the study.

3.4 Methods of Data Collection

Three-member four teams each consisting of one male and two females research assistants were constituted for data collection. Each team started data collection from the centre of the union towards North , South , East and West directions respectively and continued until the interview of 125 mother-child pairs were reached. Before starting to data collection initial contact was made with the mothers having at least one child less than ten years and requested them for cooperation. Informed consent forms were signed by the respective household heads before data collection. Ethical clearance was also obtained from Bangladesh Medical Research Council (BMRC) before going to the field. During data collection at the beginning from the central place of the union one household having mother with at least one child less than 10 years of age identified. This household was treated as first, then every alternate household i.e., third household having mother with index child towards the respective definite direction was selected as the second, third, forth sample households and so on. In case of third household failing mother with index child, the next household having mother with index child was taken as the sample household. In this way, the households were selected until 125 sample households (mother-child pairs) were obtained. In case of mothers having more than one child less than 10 years of age, one was picked-up by lottery as index child. Necessary information about the mother and her index child of each household were collected through a pre-tested, structured questionnaire.

Socio-demographic characteristics including age, education, occupation, family income, living status, number of living and dead children, parity and gravidity of each respondent mother were collected. Anthropometric measurements- such as body weight, height/length, mid arm circumference of all the sampled mothers and their 0 to 9 years old index children were done according to internationally accepted and standardized procedures. The supine length of children under 2 years was measured using an Anthropometric board in laying position, while for other children measurements of standing height were taken with shoes off and body straight against a specially made anthropometric rod (Height measuring scale). Reading was taken to the nearest 0.1 cm. Weight of the children was measured with a portable Saltier scale with a precision of 10 gms. Maternal weight was measured using a beam balance (Bathroom scale) with a precision of 100gms, and height was measured with the same anthropometre rod as mentioned above (.01 cm. precision). During measuring weight, the subjects were asked to wear minimum clothing. A flexible non-stretch tape was used to measured mid arm circumference (MAC).

3.5 Data Analysis:

Data analysis was done when compilation of all the data completed for all the respondents. It is to be mentioned here that although data were collected from 2000 mother-child pairs from all the locations, but for inconsistency and incompleteness some questionnaires were dropped from analysis. However, finally it was decided to analyze 1800 questionnaires. A tabulation plan was prepared and necessary programs were developed using statistical software package SPSS/PC+ software and EPI Info by a system analyst under the guidance of researcher. Data analysis was done as per objectives and variables of the study. Frequency distribution for all the variables were worked out and average values of the continuous variables with standard deviation were produced in tabular form. In the second stage of the analysis, a number of cross tables consistent to the research objectives were produced. Some important findings were presented in graphical form.

Appropriate statistical analysis was done wherever necessary. Chi-square test was done to find out the association between dependent and independent variables. Odds ratio (OR) were calculated to measure the strength of association between the risk factors and development of malnutrition. Correlation coefficient was done to find out the degree of relationship among the variables. Logistic regression analysis was done to find out the effects of various independent variables on nutritional status of mothers and children. Multiple comparisons of means were done by Post Hoc test. F-test was done to compare variances across groups.

3.5.1 Socio-economic Data Analysis:

Few simple table were constructed with socio- demographic and economic variables to display the means and standard deviation.

3.5.2. Anthropometric Data Analysis:

3.5.2.1 Child anthropometry

The Anthropometric data of the index children: weight-for-age z-score (WAZ), height-for-age z-score (HAZ) and weight-for-height z-score (WHZ), were calculated by using Anthro software which uses the reference population of the United States National Centre for Health Statistics (NCHS) and recommended by WHO. Standard deviation scores (Z-scores) were calculated using the following equation:

$$\text{SD-score (Z-score)} = \frac{\text{(Observed value)} - \text{(Median reference value)}}{\text{Standard deviation of reference population}}$$

The calculation of weight-for-age Z-score (WAZ), height-for-age Z-score (HAZ) and weight-for-height Z-score (WHZ) are shown as below:

$$\text{WAZ} = \frac{\text{(Observed weight)} - \text{(Median weight of reference for given age and sex)}}{\text{Standard deviation of reference}}$$

$$\text{HAZ} = \frac{\text{(Observed height)} - \text{(Median height of reference for given age and sex)}}{\text{Standard deviation of reference}}$$

$$\text{WHZ} = \frac{\text{(Observed weight)} - \text{(Median weight of reference for given sex and height)}}{\text{Standard deviation of reference}}$$

The following cut-off points were used to categorize severe and moderate forms of under-weight, stunting, wasting and over-weight or obesity:

Weight-for-age Z score (WAZ)

WAZ = less than or equal to - 3 SD	: Severely underweight
WAZ = - 2 SD to - 2.99 SD	:Moderately underweight
WAZ = Greater than - 2SD	: Not underweight

Height-for-age Z score (HAZ)

HAZ = less than or equal to - 3 SD	: Severely stunted
HAZ = - 2 SD to -2.99 SD	: Moderately stunted
HAZ = Greater than - 2SD	: Not stunted

Weight-for-height Z- score (WAZ)

WHZ = less than or equal to - 3 SD	: Severely wasted
WHZ = - 2 SD to -2.99 SD	: Moderately wasted
WHZ = Greater than - 2SD to ≤+2 SD	: Normal
WHZ = Greater than + 2SD & less than+3 SD	: Overweight
WHZ = Greater than or equal to + 3 SD	: Obese

3.5.2.2 Maternal anthropomerty

Maternal weight, height and mid arm circumference were measured. Body Mass Index **(BMI)** was calculated by dividing weight(in kg) by the square of the height (in meters). (BMI=wt (kg) /ht (m) ^{2}.

Classification of Body Mass Index (BMI)

To identify chronic energy deficiency (CED) in adult BMI is usually classified into five categories.

BMI < 16.0	Grade III CED
BMI 16.0- 16.99	Grade II CED
BMI 17.0 18.49	Grade I CED
BMI 18.5-24.99	Normal
BMI equal or greater than 25	Overweight

Mid arm circumference (MAC)

Mid arm circumference (MAC) of mothers was classified into two categories to identify their nutritional status-

Category I: MAC $\leq$22 cm. = malnourished

Category II: MAC > 22 cm. = not malnourished

Cut off point of mid arm circumference (MAC) of children was taken as 13.4 cm. to identify the malnourished group.

CHAPTER - 4

RESULTS

4.1 Socio-economic and demographic Characteristics of the subjects

Table 1: Socio-economic and demographic Characteristics of the subjects

Maternal	
Age (year) (mean± SD)	28.8±7.2
Age at first marriage (mean± SD)	15.72±1.99
Ag at first birth (mean± SD)	16.82±2.27
Number of pregnancy (mean± SD)	3.77±2.31
Number of child (mean± SD)	3.07±1.14
Maternal education	
Illiterate	56.2%
Literate	43.8%
Occupation	
Housewife	85.6%
Others	14.4%
Children	
Average age index children (month) (mean± SD)	47.69±26.54
Sex	
Male	51.8%
Female	48.2%
Household condition	
Average family size	5.84±2.24
Average monthly income (Taka)	4093±2258
Land ownership	
Yes	40.6%
No	59.4%
Sanitation	
Hygienic	60.5%
Not hygienic	39.5%
Eating habits	
Number of meal consumed per day:	
Two times	4.3%
Three times	95.7%
Meals with meat/fish per week	
≤ 10 meals	34.4%
> 10 meals	65.6%
Meals with vegetables per week	
<5 meals	56%
≥5 meals	44%
Meals with fruits per week	
None	37.7%
One	36.9%
Two or more	25.3%

Table 1 shows the socio-economic and demographic characteristic of the study subjects. Average maternal age, age at first marriage and age at first birth were 28.8±7.2, 15.72±1.99 and 16.82±2.27 years respectively. Average number of maternal pregnancy was 3.77±2.3 and average number of child was 3.07±1.14. Majority of the mothers were illiterate (56.2%) and housewives (85.6%). Average age of the study children was 47.69±26.54 months. Out of them 51.8 percent were male and the rest 48.2 percent were female. Average family size and monthly household income of the subjects were 5.84±2.24 and Taka 4093±2258 respectively. Only 40.6 percent of the households owned cultivating land and 39.5 percent had no hygienic sanitation. Majority (95.7%) of the subjects consumed meal three times per day. It is remarkable to note that 37.7 percent of the subjects did not eat any varieties of fruits during last week.

4.2 Anthropometric Measurements

4. 2.1 Anthropometric Measurements of Respondent Mothers

Table 2. : Mean and standard deviation of anthropometric Indicators of the mothers

Indices	Mean	St. deviation
Weight (kg)	42.84	6.58
Height (cm)	149.78	5.24
BMI (cm)	19.07	2.61

Table 2 shows the average weight, height and BMI of respondent mothers were 42.8 ± 6.6 kg., 149.78 ±5.24 cm. and 19.07± 2.61kg/m^2 respectively.

Table 3: Mother's Body Mass Index (BMI)

Mother's BMI	N	Percent	Nutritional status
<16.0	139	7.7	Grade-III Under nutrition
16-16.99	237	13.2	Grade-II Under nutrition
17-18.49	441	24.5	Grade-I Under nutrition
18.5-24.99	931	51.7	Normal
BMI ≥25	52	2.9	Overweight

Table 3 reveals the number and percentage distributions of maternal body mass index (BMI) computed using the height-weight data. From this table it was revealed that more than half of the respondent mothers (51.7%) had normal BMI (18.5-14.99 kg/m^2); only 2.9 percent were overweight. On the other hand 7.7 percent had BMI <16.0 kg/m^2 (Grade-III CED- severe thinness); 13.2 percent had BMI 16-16.99 kg/m^2 (Grade-II CED-moderate thinness) and 24.5 had BMI 17-18.49 kg/m^2 (Grade-I CED-mild thinness) . The average BMI was= 19.07 ± 2.61 kg/m^2

Table 4 : Comparison of age and anthropometric characteristics of women Studied with some selected countries

Study centre	No.	Age (y)	Height (m)	Weight (kg)	BMI (kg/m²)
INDIA					
Bangalore	296	38.1±13.8	1.52±0.06	41.6±5.8	18.9±2.2
ETHIOPIA					
Sidama	172	35.4±10.5	1.55±0.06	44.8±6.1	18.6±2.1
South Shoa	647	36.9±13.6	1.56±0.06	47.8±5.9	19.6±2.0
North Region	3046	32.7±9.3	1.57±0.07	48.6±6.2	19.7±2.1
ZIMBABWE	801	38.4±15.5	1.59±0.07	55.4±9.3	22.0±3.3
BANGLADESH	1800	28.8±7.2	149.78±5.24	42.84±6.6	19.1±2.6

Source Inserted from James et al[19]

In the present study the average age of the respondent mothers in Bangladesh was found a quite below the average age of mothers from India, Ethiopia and Zimbabwe (Table 4). BMI was found almost similar to India and Ethiopia and lower than that of Zimbabwe. The average height and average weight were far below than that of Ethiopia and Zimbabwe but mean weight was little higher than women of India.

4.2.2 Anthropometric Measurements of index child

Table 5: Mean, standard deviation and skewness of anthropometric indicators of the children

Indicators	Mean	St. deviation
Weight (kg)	12.5	3.96
Height (cm)	92.0	16.02
MAC (cm)	13.07	0.25
Weight-for-age Z-score	-0.89	2.29
Height-for-age Z-score	0.06	3.76
Weight-for- height Z-score	-1.10	1.34
Weight-for-age (% median)	71.70	12.67
Height-for-age (% median)	87.81	8.21
Weight-for-height (% median)	90.54	9.77

Table 5 shows the mean values with standard deviation and skewness of different anthropometric indicators of the children surveyed. The mean weight, height and MAC of index children were 12.5±3.96 kg, 92.0 ±16.02 cm, and 13.07±0.25 cm respectively, and the percentage of median of the Weight-for-age, Height-for-age, and Weight-for-height were 71.7 percent, 87.81 percent, and 90.54 percent of the NCHS reference respectively. The mean Z-score values of both the weight-for-age and height-for-age indicators were above−1SD. The weight-for-height Z-score was slightly below −1SD.

4.2.3 Nutritional status of the study children (Z-score classification)

Table 6: Percent distribution of nutritional status of children aged 0-9 years by SD scores of NCHS reference height-for-age, weight-for-height and weight-for-age

Nutritional Indicators	Z-score classification									
	≤ -3 SD		-2.99 to -2 SD		>-2 & <+2 SD		>+2 & <+3 SD		≥ 3 SD	
	No.	%	No.	%	No.	%	No.	%	No.	%
HAZ	362	20.1	336	18.7	476	26.4	140	7.8	486	27.0
WHZ	52	2.9	398	22.1	1304	72.4	4	0.2	42	2.3
WAZ	314	17.4	425	23.6	863	47.9	90	5.0	108	6.0

Table 6: reveals that 20.1 percent of all children were severely stunted (≤ -3 SD) and 18.7 percent were moderately stunted (-2.99 to -2 SD). The total prevalence of stunting was 38.8 percent. By weight-for-height indicator the prevalence of severe wasting was 2.9 percent and that of moderate wasting was 22.1 percent. Weight-for-age Z-score classification shows that severe and moderate underweight were 17.4 percent and 23.6 percent respectively.

4.2.4 Cross-examination of nutritional status of study children

Table 7: Cross-classification of stunting and wasting of study children

Height-for-age z-score	Count % within row % of total	Weight-for-height z-score			Total
		≤ −3 SD (Severely wasted)	−2.99 to −2 SD (Moderately wasted)	> − 2 SD (Not wasted)	
≤ −3 SD (Severely stunted)	Count	4	45	313	362
	% within row	1.1	12.4	86.5	100.0
	% of total	0.2	2.5	17.4	20.1
−2.99 to −2 SD (Moderately stunted)	Count	8	112	216	336
	% within row	2.4	33.3	64.3	100.0
	% of total	0.4	6.2	12.0	18.7
> − 2 SD (Not stunted)	Count	40	241	821	1102
	% within raw	3.6	21.9	74.5	100.0
	% of total	2.2	13.4	45.6	61.2
Total	Count	52	398	1350	1800
	% within raw	2.9	22.1	75.0	100.0
	% of total	2.9	22.1	75.0	100.0

Table 7 presents cross-classification of stunting and wasting. The prevalence of severe stunting was 20.1 percent of whom 1.1 percent children were also severely wasted and another 12.4 percent moderately wasted. In other words 86.5 percent of the severely stunted children had body weights that were proportional to their existing heights. Of all of the severely stunted children, 0.2 percent were both severely stunted and severely wasted and 2.5 percent severely stunted and moderately wasted. Among the 18.7 percent moderately stunted children 2.4, percent were severely wasted and 33.3 percent moderately wasted. The remaining 64.3 percent of the moderately stunted children were proportional to their existing stature. From this table it is evident that among the moderately stunted group highest percentage was found moderately wasted as compared to severely stunted and non-stunted groups. From this table it is also revealed that 63.8 percent children were either stunted or wasted or both.

Table 8: Cross-classification of stunting and underweight of study children

Height-for-age z-score (stunting)	Count % within row % of total	Weight-for-age z-score (underweight)			Total
		≤ −3 SD (Severely underweight)	−2.99 to −2 SD (Moderately underweight)	> − 2 SD (Not underweight)	
≤ −3 SD (Severely stunted)	Count	259	86	17	362
	% within row	71.5	23.8	4.7	100.0
	% of total	14.4	4.8	0.9	20.1
−2.99 to −2 SD (Moderately stunted)	Count	43	253	40	336
	% within row	12.8	75.3	11.9	100.0
	% of total	2.4	14.1	2.2	18.7
> − 2 SD (Not stunted)	Count	12	86	1004	1102
	% within row	1.1	7.8	91.1	100.0
	% of total	0.7	4.8	55.8	61.2
Total	Count	314	425	1061	1800
	% within row	17.4	23.6	58.9	100.0
	% of total	17.4	23.6	58.9	100.0

Cross-classification of stunting and underweight has shown in Table 8. Among 20.1 percent severely stunted children 14.4 percent were also severely underweight and 4.8 percent were moderately underweight. Only 0.9 percent of the severely stunted children were classified as normal. On the other hand, out of 18.7 percent moderately stunted children, 2.4 percent were severely underweight, 14.1 percent were moderately under weight, and only 2.2 percent of the moderately stunted children were classified as normal. Similarly among the 61.2 percent children who were not stunted, 0.7 percent were severely underweight and 4.8 percent were moderately under weight and 55.8 percent were classified as normal - the weight is proportional to their existing height.

4.2.5 Sex differentials in malnutrition

Table 9: Height-for-age z-score by sex of the children

Height-for-age z-score	Count	Sex		Total
	Row %	Male	Female	
HAZ ≤ −2 SD	Count	352	346	698
(Stunted)	Row %	50.4	49.6	100.0
HAZ > −2 SD	Count	580	522	1102
(Not stunted)	Row %	52.6	47.4	100.0
Total	Count	932	868	1800
	Row %	51.8	48.2	100.0

Chi-square = 0.74   p = 0.38   Odds ratio = 0.92

Table 9 shows the association between nutritional status by height-for-age z-score (HAZ) of the children and sex. Based on the chi-square ($\lambda^2 = 0.74$ P>0.05) test it was found that nutritional status by HAZ of the children was not significantly associated with sex. This implies that prevalence of stunted was equally common in all groups. Odds ratio (OR=0.92) showed that exposure (HAZ ≤ −2 SD) was unrelated with sex.

Table 10: Weight-for-age z-score by sex of the children

Weight-for-age z-score	Count	Sex		Total
	Row %	Male	Female	
WAZ ≤ −2 SD	Count	377	362	739
(Underweight)	Row %	51.0	49.0	100.0
WAZ > −2 SD	Count	555	506	1061
(Not underweight)	Row %	52.3	47.7	100.0
Total	Count	932	868	1800
	Row %	51.8	48.2	100.0

Chi-square = 0.24 p = 0.62 Odds ratio = 0.95

Table 10 shows the association between nutritional status by weight-for-age z-score (WAZ) of the children and sex. Based on the chi-square ($\lambda^2 = 0.62$ P>0.05) test it was found that nutritional status by WAZ of the children was not significantly associated with sex. This implies that prevalence of underweight was equally common in all groups. Odds ratio (OR=0.95) showed that exposure (WAZ ≤ −2 SD) was unrelated with sex.

Table 11: Weight-for-height z- score by sex of the children

Weight-for-height z-score	Count Row %	Sex		Total
		Male	Female	
WHZ ≤ −2 SD (Wasted)	Count	215	235	450
	Row %	47.8	52.2	100.0
WHZ > −2 SD (Not wasted)	Count	717	633	1350
	Row %	53.1	46.9	100.0
Total	Count	932	868	1800
	Row %	51.8	48.2	100.0

Chi-square = 3.63 p = 0.05 Odds ratio = 0.81

Table 11 shows the association between nutritional status by weight-for-height z-score (WHZ) of the children and sex. Based on the chi-square ($\lambda^2 = 3.63$ $P<0.05$) test it was found that nutritional status by WHZ of the children was significantly associated with sex. This implies that prevalence of wasted was not equally common in all groups. Odds ratio (OR=0.81).

4.2.6 Age differentials of malnutrition

Table 12: Association between Weight-for-age Z-score and age groups

Age group in year	Count % of Row % of Total	Nutritional status by WAZ		Total
		WAZ ≤ −2 SD (underweight)	WAZ > −2 SD (Not underweight)	
≤ 5 years	Count	658	672	1330
	% of Row	49.5	50.5	100.0
	% of Total	36.6	37.3	73.9
> 5 years	Count	81	389	470
	% of Row	17.2	82.8	100.0
	% of Total	4.5	21.6	26.1
Total	Count	739	1061	1800
	% of Row	41.1	58.9	100.0
	% of Total	41.1	58.9	100.0

Chi-square = 147.83 $p = 0.000$ Odds ratio = 4.70

Table 12 shows the association between nutritional status by weight-for-age z-score (WAZ) of the children and age groups. Based on the chi-square (λ^2 = 147.83 $P<0.000$) test it was found that age group was significantly associated with the nutritional status by WAZ. This implies that prevalence of underweight was not equally common in all groups. Odds ratio (OR=4.70) showed that exposure (≤ 5 years children) was positively associated with underweight.

Table 13: Association between Height-for-age Z-score and age groups

Age group in year	Count % of Row % of Total	Nutritional status by HAZ		Total
		HAZ ≤ −2 SD (stunted)	HAZ > −2 SD (not stunted)	
≤ 5 years	Count	619	711	1330
	% of Row	46.5	53.5	100.0%
	% of Total	34.4	39.5	73.9%
> 5 years	Count	79	391	470
	% of Row	16.8	83.2	100.0%
	% of Total	4.4	21.7	26.1%
Total	Count	698	1102	1800
	% of Row	38.8	61.2	100.0%
	% of Total	38.8	61.2	100.0

Chi-square = 128.07 $p = 0.000$ Odds ratio = 4.31

Table 13 shows the association between nutritional status by height-for-age z-score (HAZ) of the children and age groups. Based on the chi-square ($\lambda^2 = 128.07$ P<0.000) test it was found that age group was significantly associated with the nutritional status by HAZ. This implies that prevalence of stunting was not equally common in all groups. Odds ratio (OR=4.31) showed that exposure (≤ 5 years children) was positively associated with stunted among the younger and older age group i.e., younger age group (≤ 5 years children) was 4.3 folds of higher risk of being stunted than the older age group (>5 years children).

Table 14: Association between Weight-for-Height Z-score and age groups

Age group in year	Count % of Row % of Total	Nutritional status by WHZ		Total
		WHZ ≤ −2 SD (wasted)	WHZ > −2 SD (not wasted)	
≤ 5 years	Count	347	983	1330
	% of Row	26.1	73.9	100.0
	% of Total	19.3	54.6	73.9
> 5 years	Count	103	367	470
	% of Row	21.9	78.1	100.0
	% of Total	5.7	20.4	26.1
Total	Count	450	1350	1800
	% of Row	25.0	75.0	100.0
	% of Total	25.0	75.0	100.0

Chi-square = 3.01 $p = 0.08$ Odds ratio = 1.26

Table 14 shows the association between nutritional status by weight-for-height z-score (WHZ) of the children and age groups. Based on the chi-square ($\lambda^2 = 3.03$ $P>0.05$) test and Odds ratio (OR=1.26) it was found that there was not significant association of nutritional status by WHZ between younger and older age groups.

4.2.7 Area differentials of malnutrition

Figure 1 : Prevalence of malnutrition (- 2 SD) by Z-score of the children in different geographic location

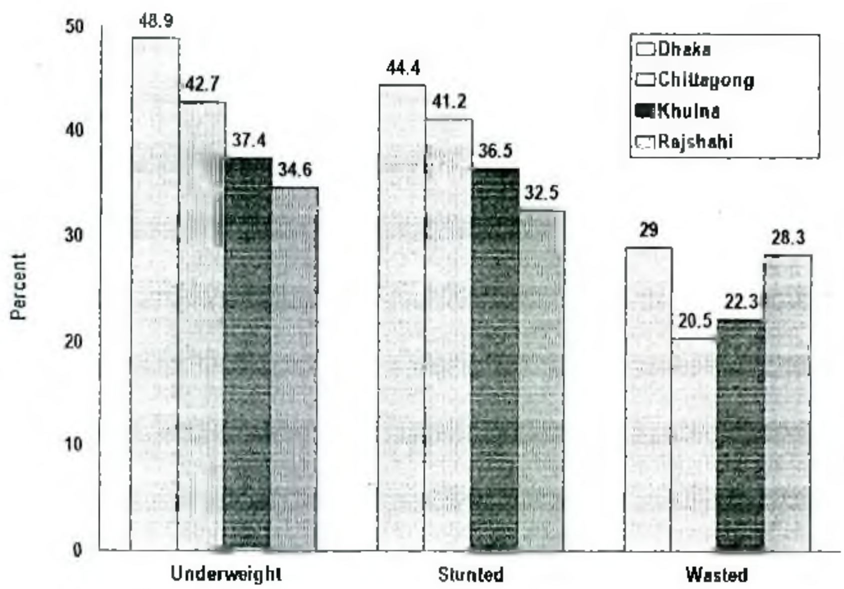


Figure 1 shows multiple comparisons of the prevalence of malnutrition by z-score in different geographic area of Bangladesh. It was found that 48.9 percent children were underweight in Dhaka Division, 42.7 percent in Chittagong Division, 37.4 percent in Khulna Division and 34.6 percent were in Rajshahi Division. This indicated that percentage of underweight was highest in Dhaka Division and was lowest in Rajshahi Division. Highest prevalence of stunted (44.4%) was in Dhaka Division, 41.2 percent in Chittagong Division, 36.5 percent in Khulna Division and 32.5 percent was in Rajshahi Division. Prevalence of wasted was 29.0 percent in Dhaka Division, 20.5

percent in Chittagong Division, 22.3 percent in Khulna Division and 28.3 percent was in Rajshahi Division.

Figure 2:Nutritional status by average WAZ of the children by administrative division

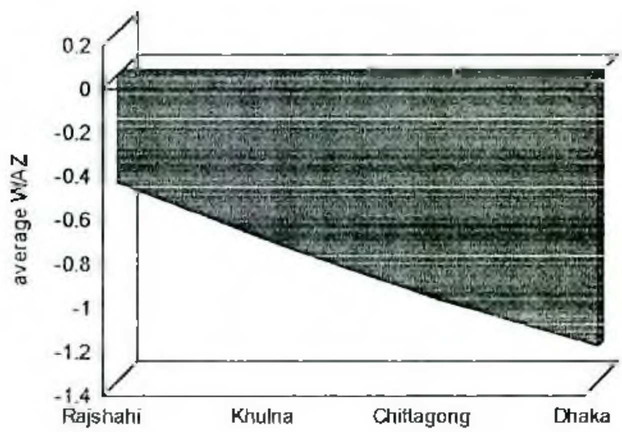


Figure 2 shows the comparisons of nutritional status by average WAZ by administrative division. It was found that nutritional status by average WAZ of Rajshahi division was better than others divisions. Khulna, Chittagong and Dhaka division were in the next positions respectively.

Figure 3:Nutritional status by average HAZ of the children by administrative division

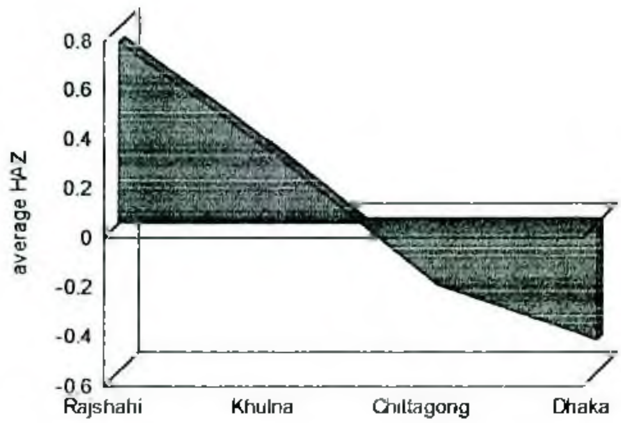


Figure 3 shows the comparisons of nutritional status by average WHZ by administrative division. It was found that nutritional status by average WHZ of Rajshahi division was better than others divisions. Khulna, Chittagong and Dhaka division were in the next position respectively.

Figure 4:Nutritional status by average WHZ of the children by administrative division

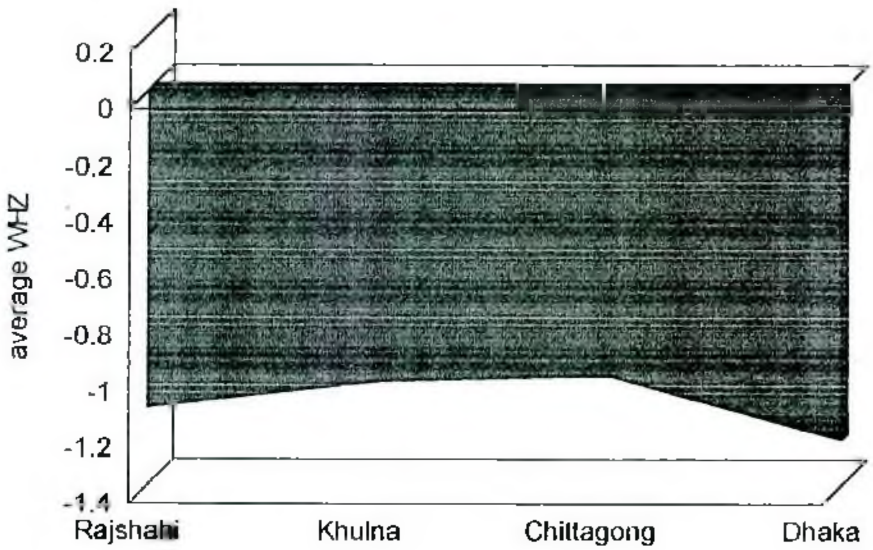


Figure 4 shows the comparisons of nutritional status by average WHZ by administrative division. It was found that nutritional status by average WHZ of Chittagong division was better than others divisions. Khulna, Rajshahi and Dhaka division were in the next position respectively.

4.2.8 Nutritional status of children in relation to the WHO reference pattern (WHO, 1995) in some selected countries

Table 15.Comparison of nutritional status of children studied expressed as the mean ± SD of the Z-score derived with the WHO reference pattern (WHO, 1995) in some selected countries

		Boys				Girls			
Location	Age (years)	No. studied	WAZ	HAZ	WHZ	No. studied	WAZ	HAZ	WHZ
INDIA	0-5.99	45	-3.1±1.2	-2.9±1.8	-1.7±1.3	41	-2.8±1.1	-2.4±1.4	-1.7±1.3
Bangalore	6-9.99	58	-2.6±0.9	-2.5±1.5	-1.6±1.1	37	-2.3±0.7	-2.3±1.4	-1.4±1.2
ETHIOPIA	0-5.99	143	-2.0±1.3	-2.1±1.6	-1.1±1.1	122	-1.9±1.5	-2.0±1.9	-0.9±1.1
Sidama	6-9.99	06	-2.7±1.0	-2.9±1.7	-1.5±0.8	87	-2.2±1.0	-2.5±1.5	-1.1±0.9
South Shoa	0-5.99	347	-2.1±1.5	-2.4±2.2	-0.9±1.0	314	-1.9±1.5	-2.1±2.3	-0.8±1.0
	6-9.99	187	-2.1±1.2	-2.3±2.0	-0.9±0.8	199	-1.7±1.1	-2.0±1.8	-0.6±0.8
North Region	0-5.99	2629	-1.9±1.1	-1.7±1.7	-1.1±1.1	2574	-1.8±1.2	-1.6±1.8	-1.1±1.1
	6-9.99	1116	-1.8±1.0	-1.8±1.6	-0.9±1.0	1173	-1.5±1.0	-1.6±1.5	-0.7±1.0
ZIMBABWE	3-5.99	242	-0.9±1.0	-1.1±1.5	-0.3±1.0	247	-0.9±1.1	-0.9±1.8	-0.4±1.0
	6-9.99	290	-1.1±1.0	-1.0±1.4	-0.6±0.9	269	-0.5±0.8	-0.9±1.2	-0.5±1.0
BANGLADESH	0-5.99	680	-1.6±1.9	-1.1±3.3	-1.1±1.2	650	-1.6±1.8	-1.1±3.2	-1.1±1.4
	6-9.99	252	1.1±2.2	3.2±3.2	-1.1±1.4	218	1.0±1.1	3.4±3.1	-1.2±1.3

Source: Inserted from James et al[19]

Table 15 shows that weight of both 0-5.99 years and 6-9.99 years age group of all children of Indian and Ethiopia was deficit in respect of their ages in comparison to Bangladeshi children of both sexes with an exception of Zimbabwe boys and girls of 0-5.99 years age group. On the other hand, height-for-age showed the similar trend with the exception of Bangladeshi 6-9.99 years boys and girls. There is a marked distinction between the mean weight-for-height z-score of boys and girls of different countries. It is found that Bangladeshi children were better off than the Indian children, while worse off compared to Zimbabwe and Ethiopian children.

4.2.9 Bivariate and multivariate analysis

Table 16: Comparison of WAZ, HAZ and WHZ of the children by age groups

Dependent variables	Fixed factors (age groups)	N	Mean	Std. Deviation	Test of Equality of Variances across groups F	Sig.
WAZ	1-2 yrs	431	-3.1765	1.252	41.88	0.000
	3-4 yrs	684	-1.161	1.544		
	5-6 yrs	377	0.353	1.605		
	7-8 yrs	243	1.188	2.203		
	9-10 yrs	65	2.084	2.819		
	Total	1800	-0.892	2.294		
HAZ	1-2 yrs	431	-4.116	2.177	18.32	0.000
	3-4 yrs	684	-0.191	2.424		
	5-6 yrs	377	2.504	2.627		
	7-8 yrs	243	3.462	3.290		
	9-10 yrs	65	3.458	3.613		
	Total	1800	0.058	3.763		
WHZ	1-2 yrs	431	-0.918	1.213	0.89	0.466
	3-4 yrs	684	-1.203	1.315		
	5-6 yrs	377	-1.096	1.491		
	7-8 yrs	243	-1.204	1.308		
	9-<10 yrs	65	-0.872	1.482		
	Total	1800	-1.100	1.340		

Average WAZ (−3.17) and HAZ (−4.11) indicated that 1-2 years children were underweight (WAZ < −2 SD) and stunted (HAZ < −2 SD). It was also found that average WAZ and HAZ gradually increased as ages of the groups increase. Variance was found to be significantly different (F=41.88 P<0.000 & F=18.32 P<0.000) across age groups respectively. Average WHZ showed that there were no wasted children (WHZ < −2 SD) across age groups. No trend of average WHZ by age groups was found. Variance was not significantly different (F=0.89, P<0.46) at 5% level when compare among the age groups **(Table 16).**

Table 17: Comparison of WAZ, HAZ and WHZ of the children by age groups ≤ 5 years and > 5 years

Dependent variables	Fixed factors (age groups)	N	Mean	Std. Deviation	z-test for Equality of Means		Test of Equality of Variances across groups	
					Z	Sig.	F	Sig.
WAZ	≤ 5 yrs	1330	-1.602	1.862	23.83	0.000		
	> 5 yrs	470	1.116	2.211			9.77	0.002
	Total	1800	-0.892	2.294				
HAZ	≤ 5 yrs	1330	-1.092	3.255	25.87	0.000		
	> 5 yrs	470	3.317	3.147			5.66	0.017
	Total	1800	0.058	3.763				
WHZ	≤ 5 yrs	1330	-1.091	1.329	0.50	0.618	1.96	0.162
	> 5 yrs	470	-1.127	1.374				
	Total	1800	-1.100	1.340				

Table 17 shows that average WAZ (1.11) of >5 years children was significantly higher ($Z=23.83$ $P<0.000$) than –1.60 that of ≤ 5 years children. Variance was significantly different ($F=9.77$ $P<0.002$) across groups. Average HAZ (3.31) of >5 years children was found to be significantly ($Z=25.87$ $P<0.000$) elevated when compared to –1.09 that of ≤ 5 years children. Variance was also significantly different ($F=5.66$ $P<0.017$) across groups. Average WHZ (–1.12) of >5 years children was higher than –1.09 that of ≤ 5 years children but no significant difference ($Z=0.50$ $P<0.61$) in the mean WHZ between two groups was noted. Variance was also not significantly different ($F=1.96$ $P<0.16$) at 5 percent level across groups.

Table 18: Comparison of WAZ, HAZ and WHZ of the children by sex and age groups

Dependent variables	Fixed factors: Age group	Sex	N	Mean	Std. Deviation	Test of Equality of Variances across groups: F	Sig.
WAZ		Male	680	-1.575	1.877		
	≤ 5 yrs	Female	650	-1.629	1.846		
		Total	1330	-1.602	1.862		
	> 5 yrs	Male	252	1.186	2.279	4.13	0.006
		Female	218	1.035	2.132		
		Total	470	1.116	2.211		
		Male	932	-0.829	2.340		
	Total	Female	868	-0.960	2.242		
		Total	1800	-0.892	2.294		
HAZ		Male	680	-1.070	3.305	2.75	0.041
	≤ 5 yrs	Female	650	-1.117	3.204		
		Total	1330	-1.092	3.255		
	> 5 yrs	Male	252	3.241	3.208		
		Female	218	3.404	3.080		
		Total	470	3.317	3.147		
	Total	Male	932	0.095	3.796		
		Female	868	0.018	3.729		
		Total	1800	0.058	3.763		
WHZ		Male	680	-1.066	1.228	1.33	0.262
	≤ 5 yrs	Female	650	-1.116	1.427		
		Total	1330	-1.091	1.329		
	> 5 yrs	Male	252	-1.072	1.415		
		Female	218	-1.192	1.325		
		Total	470	-1.127	1.374		
	Total	Male	932	-1.068	1.281		
		Female	868	-1.135	1.401		
		Total	1800	-1.100	1.340		

Nutritional status by average WAZ and HAZ of male across age groups were better than female as revealed from the table 18. Variance was significantly different ((F=4.13 P<0.006 & F=2.75 P<0.04 respectively) among male and female children across the age groups. Overall average WHZ (−1.06) of male was better than −1.13 that of female but variance was not found significantly different (F=1.33 P<0.26) at 5% level when compared between sex.

Figure 5: Linear relationship between weight-for-age z-score by age of the children

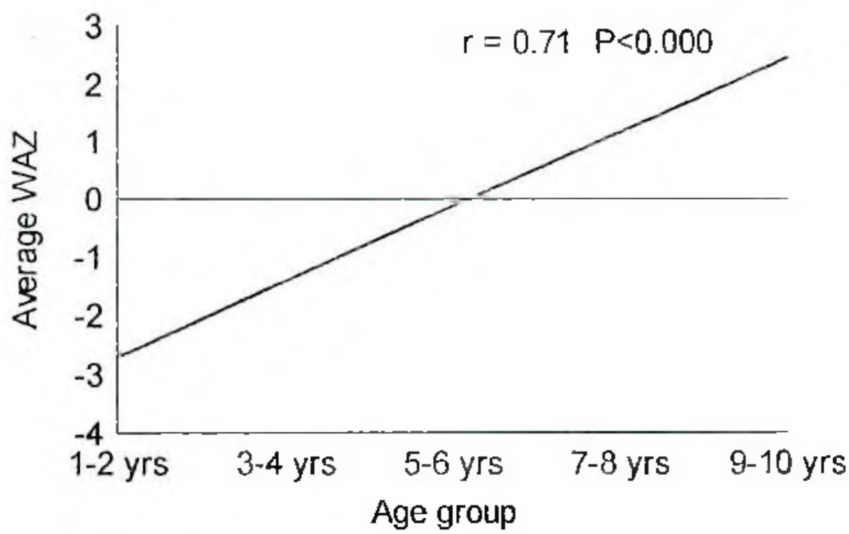


Figure 5 shows the linear relationship between weight-for-age z-score and age of the children. It was found that there was a highly significant correlation ($r = 0.71$ $P<0.000$) between WAZ and age groups. Positive relationship implies that WAZ tends to increase as age increase.

Figure 6: Linear relationship between height-for-age z-score by age of the children

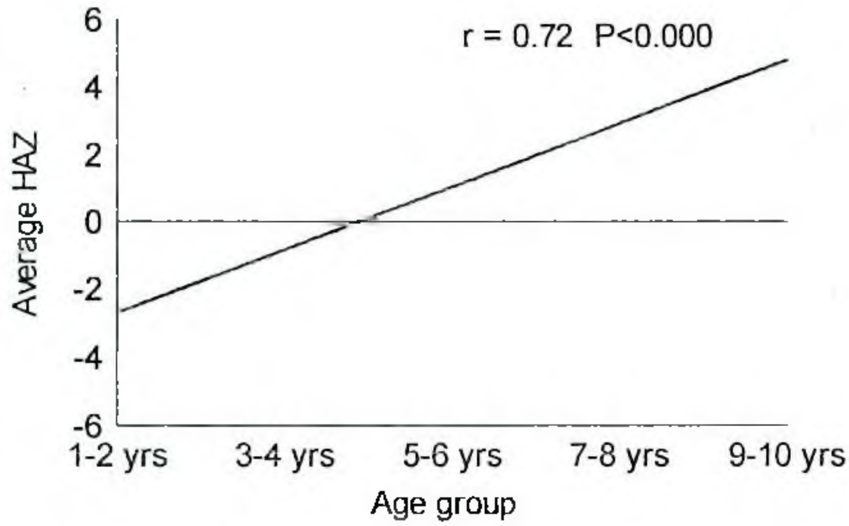


Figure 6 shows the linear relationship between height-for-age z-score and age of the children. It was found that there was a highly significant correlation (r = 0.72 P<0.000) between HAZ and age groups. Positive relationship implies that HAZ tends to increase as age increase.

Figure 7: Curveylinear relationship between weight-for-height z-score by age of the children

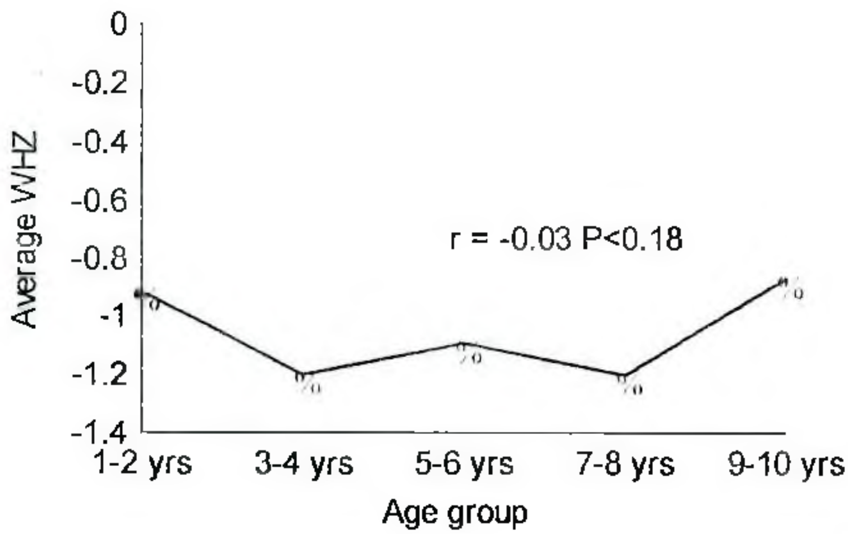


Figure 7 shows the curvilinear relationship between weight-for-height z-score and age of the children. It was found that WHZ was not significantly correlated ($r = 0.03$ $P>0.05$) with age groups.

Table 19: Multivariate analysis among WAZ, HAZ and WHZ of the children by maternal BMI

Dependent variables	Fixed factors (Maternal BMI)	N	Mean	Std. Deviation	Test of Equality of Variances across groups	
					F	Sig.
WAZ	BMI<16	139	-1.807	1.773	9.78	0.000
	16-16.99	237	-1.523	1.932		
	17-18.49	441	-1.164	2.104		
	18.5-24.99	931	-0.560	2.394		
	BMI>24.99	52	0.805	2.707		
	Total	1800	-0.892	2.294		
HAZ	BMI<16	139	-1.226	3.155	4.76	0.001
	16-16.99	237	-0.649	3.355		
	17-18.49	441	-0.238	3.729		
	18.5-24.99	931	0.458	3.867		
	BMI>24.99	52	2.086	3.629		
	Total	1800	0.058	3.763		
WHZ	BMI<16	139	-1.885	0.927	42.33	0.000
	16-16.99	237	-1.478	1.003		
	17-18.49	441	-1.252	0.977		
	18.5-24.99	931	-1.063	1.026		
	BMI>24.99	52	3.334	2.518		
	Total	1800	-1.100	1.340		

Table 19 shows that average WAZ, HAZ and WHZ gradually increased as maternal BMI increase. Variance was found to be significantly different ($F=9.78$ $P<0.000$, $F=4.76$ $P<0.001$ & $F=42.33$ $P<0.000$) across groups respectively.

Table 20: Multiple Comparisons by Post Hoc Tests of WAZ by maternal BMI

Dependent Variable	(I) Maternal BMI	(J) Maternal BMI	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
WAZ	BMI<16	16-16.99	-0.283	0.238	0.842	-1.020	0.452
		17-18.49	-0.643	0.217	0.068	-1.313	0.027
		18.5-24.99	-1.246(*)	0.203	0.000	-1.873	-0.620
		BMI>24.99	-2.612(*)	0.363	0.000	-3.733	-1.492
	16-16.99	BMI<16	0.283	0.238	0.842	-0.452	1.020
		17-18.49	-0.359	0.180	0.409	-0.914	0.196
		18.5-24.99	-0.963(*)	0.162	0.000	-1.464	-0.461
		BMI>24.99	-2.328(*)	0.342	0.000	-3.384	-1.273
	17-18.49	BMI<16	0.643	0.217	0.068	-0.027	1.313
		16-16.99	0.359	0.180	0.409	-0.196	0.914
		18.5-24.99	-.603(*)	0.129	0.000	-1.002	-0.205
		BMI>24.99	-1.969(*)	0.327	0.000	-2.980	-0.958
	18.5-24.99	BMI<16	1.246(*)	0.203	0.000	0.620	1.873
		16-16.99	0.963(*)	0.162	0.000	0.461	1.464
		17-18.49	0.603(*)	0.129	0.000	0.205	1.002
		BMI>24.99	-1.365(*)	0.318	0.001	-2.348	-0.383
	BMI>24.99	BMI<16	2.612(*)	0.363	0.000	1.492	3.733
		16-16.99	2.328(*)	0.342	0.000	1.273	3.384
		17-18.49	1.969(*)	0.327	0.000	0.958	2.980
		18.5-24.99	1.365(*)	0.318	0.001	0.383	2.348

- The mean difference is significant at the 0.05 level.

Multiple comparisons by Post Hoc Test of WAZ by maternal BMI showed that average WAZ by BMI < 16, 16-16.99 and 17-18.49 were significantly lower ($P<0.05$) when compared with the average WAZ by BMI 18.5-24.99 and BMI > 24.99 respectively. It was also found that average WAZ by BMI 18.5-24.99 was significantly lower ($P<0.05$) when compared with the average WAZ by BMI > 24.99. (Table 20).

Table 21: Multiple Comparisons by Post Hoc Tests of HAZ by maternal BMI

Dependent Variable	(I) Maternal BMI	(J) Maternal BMI	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
HAZ	BMI<16	16-16.99	-0.577	0.396	0.714	-1.800	0.645
		17-18.49	-0.988	0.361	0.112	-2.101	0.124
		18.5-24.99	-1.685(*)	0.337	0.000	-2.725	-0.644
		BMI>24.99	-3.313(*)	0.603	0.000	-5.173	-1.452
	16-16.99	BMI<16	0.577	0.396	0.714	-0.645	1.800
		17-18.49	-0.411	0.299	0.755	-1.333	0.510
		18.5-24.99	-1.107(*)	0.270	0.002	-1.940	-0.275
		BMI>24.99	-2.736(*)	0.568	0.000	-4.488	-0.983
	17-18.49	BMI<16	0.988	0.361	0.112	-0.124	2.101
		16-16.99	0.411	0.299	0.755	-0.510	1.333
		18.5-24.99	-.696(*)	0.214	0.033	-1.358	-0.034
		BMI>24.99	-2.324(*)	0.544	0.001	-4.003	-0.646
	18.5-24.99	BMI<16	1.685(*)	0.337	0.000	0.644	2.725
		16-16.99	1.107(*)	0.270	0.002	0.275	1.940
		17-18.49	0.696(*)	0.214	0.033	0.034	1.358
		BMI>24.99	-1.628	0.528	0.051	-3.259	0.002
	BMI>24.99	BMI<16	3.313(*)	0.603	0.000	1.452	5.173
		16-16.99	2.736(*)	0.568	0.000	0.983	4.488
		17-18.49	2.324(*)	0.544	0.001	0.646	4.003
		18.5-24.99	1.628	0.528	0.051	-0.002	3.259

* The mean difference is significant at the 0.05 level.

Table 21 shows the multiple comparisons by Post Hoc Test of HAZ by maternal BMI. It was found that average HAZ by BMI <16, 16-16.99 and 17-18.49 were significantly lower ($P<0.05$) when compared with the average HAZ by BMI 18.5-24.99 and BMI > 24.99 respectively. It was also found that average HAZ by BMI 18.5-24.99 was significantly lower ($P<0.05$) when compared with the average HAZ by BMI > 24.99. Confidence limits (95%) indicated that there is only a 5% chance that the ranges of mentioned factors excluded the percentage of the population.

Table 22: Multiple Comparisons by Post Hoc Tests of WHZ by maternal BMI

Dependent Variable	(I) Maternal BMI	(J) Maternal BMI	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
WHZ	BMI<16	16-16.99	-0.406(*)	0.115	0.014	-0.761	-0.005
		17-18.49	-0.632(*)	0.104	0.000	-0.955	-0.309
		18.5-24.99	-0.821(*)	0.097	0.000	-1.123	-0.519
		BMI>24.99	-5.219(*)	0.175	0.000	-5.759	-4.680
	16-16.99	BMI<16	0.406(*)	0.115	0.014	0.051	0.761
		17-18.49	-0.226	0.086	0.147	-0.493	0.041
		18.5-24.99	-0.415(*)	0.078	0.000	-0.656	-0.173
		BMI>24.99	-4.813(*)	0.164	0.000	-5.321	-4.304
	17-18.49	BMI<16	0.632(*)	0.104	0.000	0.309	0.955
		16-16.99	0.226	0.086	0.147	-0.041	0.493
		18.5-24.99	-0.189	0.062	0.056	-0.381	0.002
		BMI>24.99	-4.587(*)	0.157	0.000	-5.073	-4.100
	18.5-24.99	BMI<16	0.821(*)	0.097	0.000	0.519	1.123
		16-16.99	0.415(*)	0.078	0.000	0.173	0.656
		17-18.49	0.189	0.062	0.056	-0.002	0.381
		BMI>24.99	-4.398(*)	0.153	0.000	-4.87	-3.925
	BMI>24.99	BMI<16	5.219(*)	0.175	0.000	4.680	5.759
		16-16.99	4.813(*)	0.164	0.000	4.304	5.321
		17-18.49	4.587(*)	0.157	0.000	4.100	5.073
		18.5-24.99	4.398(*)	0.153	0.000	3.925	4.871

* The mean difference is significant at the 0.05 level.

Multiple comparisons by Post Hoc Test of WHZ by maternal BMI showed that average WHZ by BMI < 16, 16-16.99 and 17-18.49 were significantly lower ($P<0.05$) when compared with the average WHZ by BMI 18.5-24.99 and BMI > 24.99 respectively. It was also found that average WHZ by BMI 18.5-24.99 was significantly lower ($P<0.05$) when compared with the average WHZ by BMI > 24.99. Confidence limits (95%) showed that there is only a 5% chance that the ranges of mentioned factors excluded the percentage of the population **(Table 22).**

Table 23: Multivariate analysis among WAZ, HAZ and WHZ of the children by maternal chronic energy deficiency (CED)

Dependent variables	Fixed factors (Maternal CED)	N	Mean	Std. Deviation	z-test for Equality of Means		Test of Equality of Variances across groups	
					Z	Sig.	F	Sig.
WAZ	BMI < 18.5	817	-1.378	2.015	8.49	0.000	24.99	0.000
	BMI ≥ 18.5	983	-0.488	2.430				
	Total	1800	-0.892	2.294				
HAZ	BMI < 18.5	817	-0.525	3.545	6.11	0.000	5.53	0.019
	BMI ≥ 18.5	983	0.544	3.870				
	Total	1800	0.058	3.763				
WHZ	BMI < 18.5	817	-1.425	1.002	9.96		23.41	0.000
	BMI ≥ 18.5	983	-0.830	1.515		0.000		
	Total	1800	-1.100	1.340				

Table 23 shows that average WAZ (−0.488), HAZ (0.544) and WHZ (−0.830) by maternal BMI ≥ 18.5 were significantly higher (P<0.000) when compared with the average WAZ (−1.378), HAZ (−0.525) and WHZ (−1.425) by maternal BMI < 18.5 respectively. Variance was also significantly different (F=24.99 P<0.000, F=5.53 P<0.019 & F=23.41 P<0.000) across groups respectively.

Table 24: Multivariate analysis among WAZ, HAZ and WHZ of the children by maternal CED and sex of the children

Dependent variables	Fixed factors		N	Mean	Std. Deviation	Test of Equality of Variances across groups	
	CED	Sex				F	Sig.
WAZ	BMI< 18.5	Male	417	-1.258	2.059		
		Female	400	-1.503	1.963		
		Total	817	-1.378	2.015		
	BMI ≥ 18.5	Male	515	-0.481	2.494	9.25	0.000
		Female	468	-0.496	2.360		
		Total	983	-0.488	2.430		
	Total	Male	932	-0.829	2.340		
		Female	868	-0.960	2.242		
		Total	1800	-0.892	2.294		
HAZ	BMI< 18.5	Male	417	-0.438	3.563	2.00	0.112
		Female	400	-0.616	3.528		
		Total	817	-0.525	3.545		
	BMI ≥ 18.5	Male	515	0.528	3.925		
		Female	468	0.561	3.814		
		Total	983	0.544	3.870		
	Total	Male	932	0.095	3.796		
		Female	868	0.018	3.729		
		Total	1800	0.052	3.763		
WHZ	BMI< 18.5	Male	417	-1.327	1.035	9.78	0.000
		Female	400	-1.528	0.957		
		Total	817	-1.425	1.002		
	BMI ≥ 18.5	Male	515	-0.858	1.417		
		Female	468	-0.800	1.618		
		Total	983	-0.830	1.515		
	Total	Male	932	-1.068	1.281		
		Female	868	-1.135	1.401		
		Total	1800	-1.100	1.340		

Multivariate analysis showed that overall nutritional status by average WAZ (−0.829) and WHZ (−1.068) of male were better when compared with the average WAZ (−0.960) and WHZ (−1.135) of female respectively. F-test showed that variance was significantly different (F=9.25 P<0.000 & F=9.78 P<0.000) across groups respectively. Overall average HAZ (0.095) of male was higher than the average HAZ (0.018) of female but variance was not significantly different (F=2.00 P<0.11) at 5% level across groups (Table 24).

Figure 8: Linear relationship between maternal BMI and weight-for-age z-score of the children

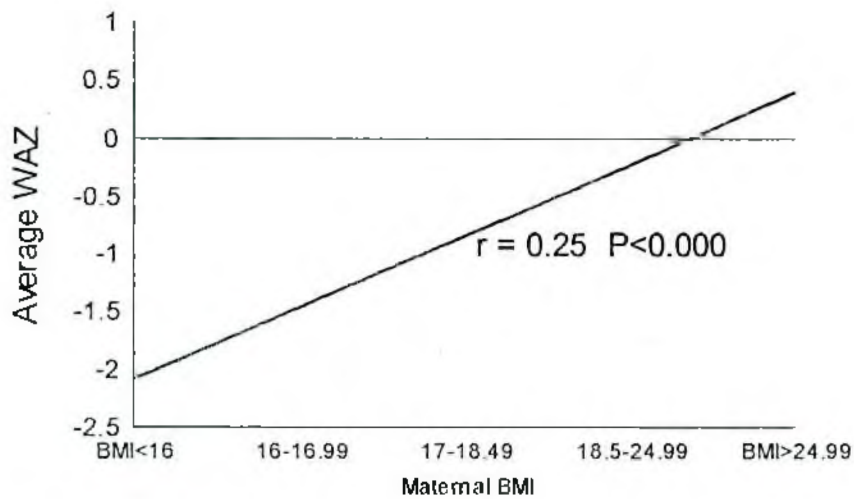


Figure 8 shows the linear relationship between maternal BMI and weight-for-age z-score of the children. It was found that maternal BMI and WAZ was significantly correlated (r = 0.25 P<0.000). Positive relationship implies that WAZ tends to increase as maternal BMI increase.

Figure 9: Linear relationship between maternal BMI and height-for-age z-score of the children

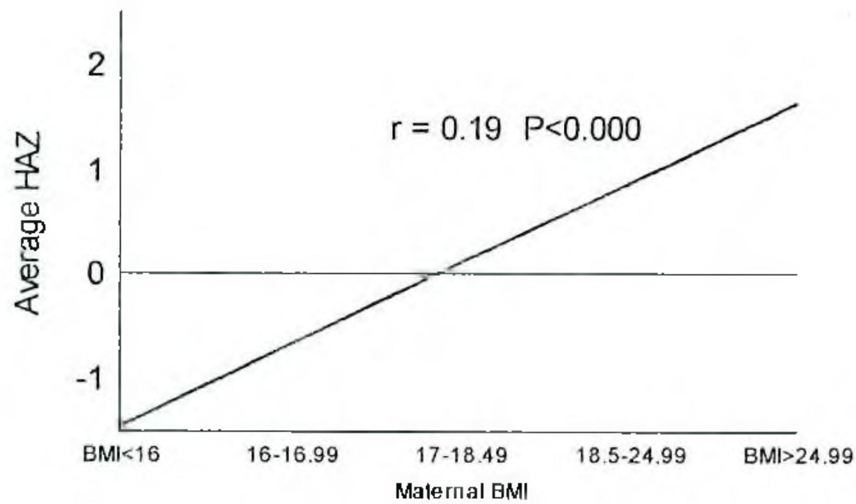


Figure 9 shows the linear relationship between maternal BMI and Height-for-age z-score of the children. It was found that maternal BMI and HAZ was significantly correlated ($r = 0.19$ $P<0.000$). Positive relationship implies that HAZ tends to increase as maternal BMI increase.

Figure 10: Linear relationship between maternal BMI and weight-for-height z-score of the children

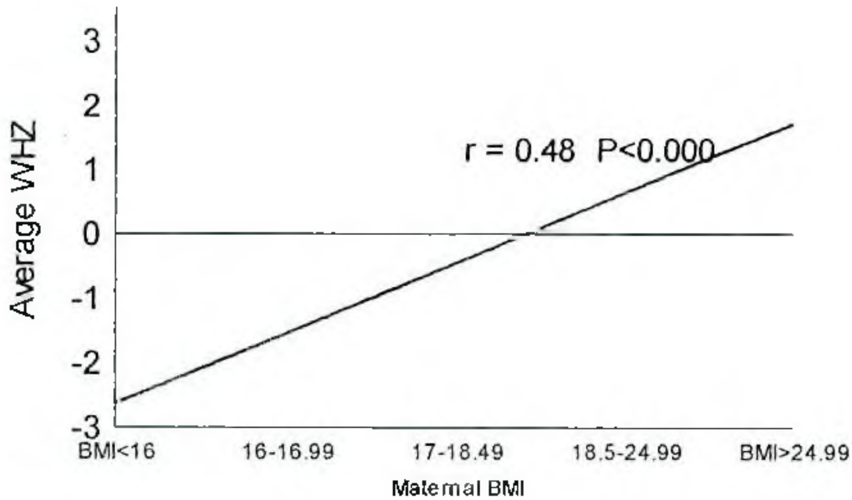


Figure 10 shows the linear relationship between maternal BMI and weight-for-height z-score of the children. It was found that maternal BMI and WHZ was significantly correlated ($r = 0.48$ $P<0.000$). Positive relationship implies that WHZ tends to increase as maternal BMI increase.

Table 25: Association between child growth status and maternal CED

Child growth status	Count / Row %	Maternal BMI: BMI < 18.5 (CED)	Maternal BMI: BMI ≥ 18.5 (Not CED)	Total
Stunted	Count	400	417	817
(HAZ ≤ −2 SD)	Row %	49.0	51.0	100.0
Not stunted	Count	298	685	983
(HAZ > −2 SD)	Row %	30.3	69.7	100.0
Total	Count	698	1102	1800
	Row %	38.8	61.2	100.0

Chi-square = 64.55 p = 0.000 Odds ratio = 2.20

Table 25 shows the association between child growth status and maternal CED. Based on the chi-square (λ^2 = 64.55 P<0.000) test it was found that child growth status was significantly associated with maternal BMI. Odds ratio (OR=2.20) showed that exposure (stunted, HAZ ≤ −2 SD) was positively associated with maternal CED (BMI< 18.5).

Table 26: Association between child weight status and maternal CED

Child weight status	Count / Row %	Maternal BMI: BMI < 18.5 (CED)	Maternal BMI: BMI ≥ 18.5 (Not CED)	Total
Underweight	Count	433	306	739
(WAZ ≤ −2 SD)	Row %	58.6	41.4	100.0
Not underweight	Count	384	677	1061
(WAZ > −2 SD)	Row %	36.2	63.8	100.0
Total	Count	817	983	1800
	Row %	45.4	54.6	100.0

Chi-square = 87.28 p = 0.000 Odds ratio = 2.49

Table 26 shows the association between child weight status and maternal CED. Based on the chi-square ($\lambda^2 = 87.28$ P<0.000) test it was found that child weight status was significantly associated with maternal BMI. Odds ratio (OR=2.49) showed that exposure (underweight, WAZ ≤ −2 SD) was positively associated with maternal CED (BMI< 18.5).

Table 27: Association between nutritional status of child by WHZ and maternal CED

Nutritional status	Count	Maternal BMI		Total
	Row %	BMI < 18.5 (CED)	BMI ≥ 18.5 (Not CED)	
Wasted	Count	270	180	450
(WHZ ≤ −2 SD)	Row %	60.0	40.0	100.0
Not wasted	Count	547	803	1350
(WHZ > −2 SD)	Row %	40.5	59.5	100.0
Total	Count	817	983	1800
	Row %	45.4	54.6	100.0

Chi-square = 50.89 p = 0.000 Odds ratio = 2.20

Table 27 shows the association between nutritional status by WHZ of the children and maternal CED. Based on the chi-square (λ^2 = 50.89 P<0.000) test it was found that nutritional by WHZ of the children was significantly associated with maternal BMI. Odds ratio (OR=2.20) showed that exposure (wasted, WHZ ≤ −2 SD) was positively associated with maternal CED (BMI< 18.5).

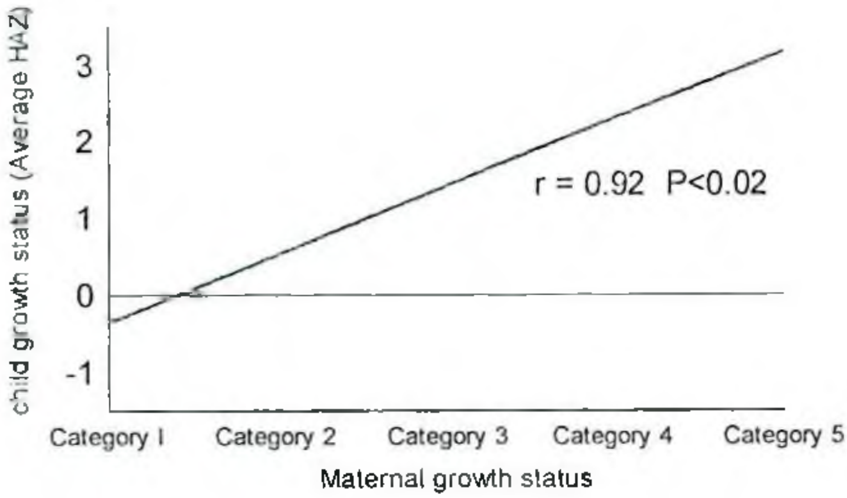
Table 28: Association between nutritional status of by child MAC and maternal MAC

Nutritional status of the children aged 1-5 yrs by MAC	Count / Row %	Maternal MAC: MAC ≤ 22	Maternal MAC: MAC >22	Total
MAC ≤ 13.4	Count	325	141	466
	Row %	69.7	30.3	100.0
MAC >13.4	Count	220	644	864
	Row %	25.5	74.5	100.0
Total	Count	545	785	1330
	Row %	41.0	59.0	100.0

Chi-square = 243.5 p = 0.000 Odds ratio = 6.75

Table 28 shows the association between nutritional status by MAC of the children and maternal MAC. Based on the chi-square (λ^2 = 243.5 P<0.000) test it was found that nutritional by MAC of the children was significantly associated with maternal MAC. Odds ratio (OR=6.75) showed that exposure (malnourished, MAC ≤13.4 cm) was positively associated with maternal MAC (MAC< 22 cm).

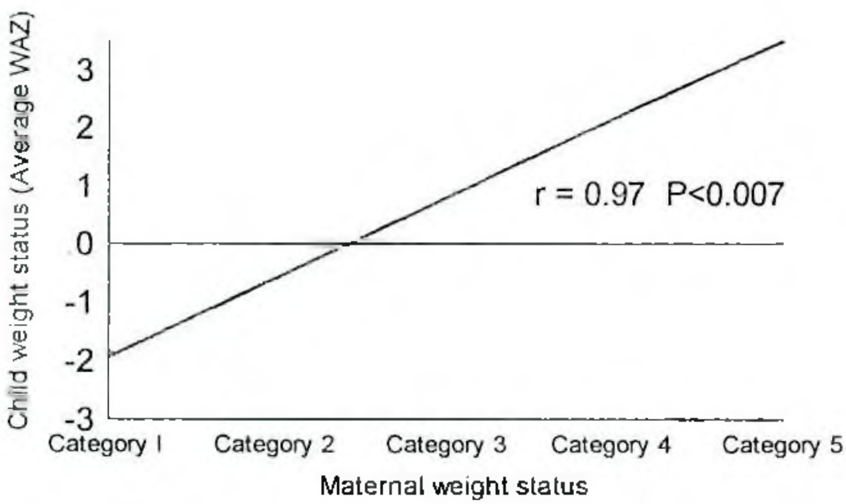
Figure 11: Linear relationship between maternal growth status and child growth status



Category 1=Z<-1.65 Category 2=-1.65<Z<-1.04 Category 3=-1.04<Z<+1.03
Category 4=+1.04<Z<1.64 Category 5=Z>+1.65

Figure 11 shows the linear relationship between mater growth status and child growth status. It was found that there was a highly significant correlation (r = 0.92 P<0.000) between mater growth status and child growth status. Positive relationship implies that child growth status tends to increase as maternal growth status increase.

Figure 12: Linear relationship between maternal weight status and child weight status



Category 1=Z<-1.65 Category 2=-1.65<Z<-1.04 Category 3=-1.04<Z<+1.03 Category 4=+1.04<Z<1.64 Category 5=Z>+1.65

Figure 12 shows the linear relationship between mater weight status and child weight status. It was found that there was a highly significant correlation (r = 0.97 P<0.000) between mater weight status and child weight status. Positive relationship implies that child weight status tends to increase as maternal weight status increase.

Table 29: Comparison of WAZ, HAZ and WHZ of the children by maternal age at first marriage

Dependent variables	Fixed factors (maternal age at 1st marriage)	N	Mean	Std. Deviation	z-test for Equality of Means		Test of Equality of Variances across groups	
					Z	Sig.	F	Sig.
WAZ	≤ 15 years	1021	-1.090	2.367	3.19	0.001	6.479	0.011
	> 15 years	779	-0.740	2.225				
	Total	1800	-0.892	2.294				
HAZ	≤ 15 years	1021	-0.342	3.916	3.92	0.000	8.604	0.003
	> 15 years	779	0.364	3.614				
	Total	1800	0.058	3.763				
WHZ	≤ 15 years	1021	-1.177	1.264	2.75	0.00	6.060	0.014
	> 15 years	779	-1.000	1.429				
	Total	1800	-1.100	1.340				

Table 29 shows that average WAZ (−0.740), HAZ ((0.364) and WHZ (−1.000) of the children by maternal age > 15 years at first marriage were significantly higher (Z=3.19 P<0.001, Z=3.92 P<0.000 & Z=2.75 P<0.002) when compared with the average WAZ (−1.090), HAZ (−0.342) and WHZ (−1.177) by maternal age ≤ 15 years at first marriage respectively. Equality of variance test showed that variation was significantly different (F=6.47 P<0.011, F=8.60 P<0.003 & F=6.06 P<0.014) across groups respectively.

Table 30: Comparison of WAZ, HAZ and WHZ indicators of the children by maternal age at first birth

Dependent variables	Fixed factors (maternal age at 1st birth)	N	Mean	Std. Deviation	z-test for Equality of Means		Test of Equality of Variances across groups	
					Z	Sig.	F	Sig.
WAZ	≤ 16 years	1020	-1.184	2.336	4.75	0.000	1.79	0.180
	> 16 years	780	-0.668	2.236				
	Total	1800	-0.892	2.294				
HAZ	≤ 16 years	1020	-0.478	3.646	5.41	0.000	2.17	0.140
	> 16 years	780	0.490	3.845				
	Total	1800	0.058	3.763				
WHZ	≤ 16 years	1020	-1.126	1.318	0.92	0.35	1.41	0.234
	> 16 years	780	-1.067	1.369				
	Total	1800	-1.100	1.340				

Multivariate analysis showed that average WAZ (–0.668) and HAZ (0.490) of the children by maternal age > 16 years at first birth were significantly higher (Z=4.75 P<0.000 & Z=5.41 P<0.000) when compared with the average WAZ (–1.187) and HAZ (–0.478) by maternal age ≤ 16 years at first birth respectively. Variance was not significantly different (F=1.79 P<0.180 & F=2.17 P<0.140) across groups respectively. Average WHZ (–1.067) by maternal age > 16 years at first birth was higher than the average WHZ (–1.126) by maternal age ≤ 16 years at first birth. No significant difference (Z=0.92 P<0.35) at 5% level in the mean WHZ between two groups was noted. Variance was also not significantly different (F=1.41 P<0.234) across groups (Table 30).

Table 31. Prevalence of stunting, wasting and underweight of the children by maternal age at first marriage

Maternal age at first marriage	% of stunted	% of wasted	% of underweight
≤ 15	47.8	28.8	49.3
16	47.7	26.1	49.0
17	47.5	23.7	44.2
18	37.6	23.2	41.1
> 18	35.6	22.5	38
Correlation coefficient (r)	- 0.89*	- 0.95*	- 0.98*

- Highly significant.

The Table shows that prevalence of stunting, wasting and underweight of the children gradually decreased as maternal age at first marriage increase. It was also found that prevalence of stunting, wasting and underweight was inversely related with maternal age at first marriage. These relationships imply that when maternal age at first marriage increased, prevalence of stunting, wasting and underweight tend to decrease.

Table 32.Risk of stunting, wasting and underweight of the children by maternal age at first marriage

Nutritional indicators	Maternal age at first marriage	Chi-square	Sig.	OR	RR	Sensitivity	Specificity
Stunted	≤ 15	9.95	0.000	2.48	1.45	48	73
	16	5.96	0.01	1.44	1.21	48	61
	17	0.02	0.89	0.95	0.97	48	51
	18	3.03	0.10	0.57	0.67	37	49
Wasted	≤ 15	17.66	0.000	1.62	1.21	29	80
	16	98.13	0.000	0.22	0.43	26	38
	17	55.02	0.000	0.19	0.33	24	38
	18	16.83	0.000	0.18	0.32	24	45
Under-weight	≤ 15	66.49	0.000	2.26	1.40	49	70
	16	3.74	0.05	1.34	1.17	49	58
	17	1.33	0.24	0.77	0.85	44	49
	18	1.32	0.25	0.68	0.74	41	50

Table shows that risk of stunting, wasting and underweight of the children gradually decreased as maternal age at first marriage increase. Risk of stunting of the children of mothers aged ≤ 15 - 16 years at first marriage had 1.45 - 1.21 times higher than the children of mother aged >16 years at first marriage. Similarly, risk of wasting of children of mothers ≤ 15 at first marriage had 1.21 times higher than the mothers who had marriage after 15 years. Risk of underweight of the children of mothers aged ≤ 15 - 16 years at first marriage had 1.40 - 1.17 times higher than the children of mother whose age was >16 years at first marriage.

Table 33: Multivariate analysis among WAZ, HAZ and WHZ of the children by number of pregnancy of mothers

Dependent variables	Fixed factors (number of pregnancy)	N	Mean	Std. Deviation	z-test for Equality of Means		Test of Equality of Variances across groups	
					Z	Sig.	F	Sig.
WAZ	≤ 3	944	-0.740	2.178	2.68	0.007	6.07	0.014
	> 3	856	-1.029	2.386				
	Total	1800	-0.892	2.294				
HAZ	≤ 3	944	0.412	3.560	3.82	0.000	10.85	0.001
	> 3	856	-0.262	3.913				
	Total	1800	0.058	3.763				
WHZ	≤ 3	944	-1.015	1.400	2.86	0.004	5.65	0.018
	> 3	856	-1.195	1.266				
	Total	1800	-1.100	1.340				

Table 33 shows that average WAZ (−0.746), HAZ (0.412) and WHZ (−1.015) of the children by maternal pregnancy ≤ 3 were significantly higher (Z=2.68 P<0.007, Z=3.82 P<0.000 & Z=2.86 P<0.004) when compared with the average WAZ (−1.029), HAZ (−0.262) and WHZ (−1.195) by maternal pregnancy >3 respectively. Variance was significantly different (F=6.07 P<0.014, F=10.85 P<0.001 & F=5.65 P<0.018) across groups respectively.

Table 34: Comparison of WAZ, HAZ and WHZ of the children by number of child

Dependent variables	Fixed factors (number of child)	N	Mean	Std. Deviation	z-test for Equality of Means		Test of Equality of Variances across groups	
					Z	Sig.	F	Sig.
WAZ	≤ 2	788	-0.645	2.181	5.14	0.000	7.614	0.006
	> 2	1012	-1.208	2.395				
	Total	1800	-0.892	2.294				
HAZ	≤ 2	788	0.548	3.544	6.24	0.000	13.816	0.000
	> 2	1012	-0.570	3.941				
	Total	1800	0.058	3.763				
WHZ	≤ 2	788	-1.024	1.432	2.09	0.04	9.275	0.002
	> 2	1012	-1.160	1.262				
	Total	1800	-1.100	1.340				

Table 34 shows that average WAZ (–0.645), HAZ (0.548) and WHZ (–1.024) of the children by the number of child ≤ 2 were significantly higher (Z=5.14 P<0.000, Z=6.24 P<0.000 & Z=2.09 P<0.040) when compared with the average WAZ (–1.028), HAZ (–0.570) and WHZ (–1.160) by the number of child >2 respectively. Equality of variance test showed that variation was significantly different (F=7.614 P<0.006, F=13.81 P<0.000 & F=9.27 P<0.002) across groups respectively.

Table 35: Relationship among WAZ, HAZ and WHZ of the children and maternal education level

Dependent variables	Fixed factors (education level)	N	Mean	Std. Deviation	Test of Equality of Variances across groups F	Sig.
WAZ	Illiterate	1011	-0.898	2.165	16.87	0.000
	Literate	789	-0.883	2.449		
	Total	1800	-0.892	2.294		
HAZ	Illiterate	1011	-0.087	3.999	19.43	0.000
	Literate	789	0.172	3.566		
	Total	1800	0.058	3.763		
WHZ	Illiterate	1011	-1.248	1.173	17.21	0.000
	Literate	789	-0.911	1.508		
	Total	1800	-1.100	1.340		

Multivariate analysis showed that nutritional status by average WAZ (–0.883), HAZ (0.172) and WHZ (–0.911) of the children of literate mothers were better when compared with the average WAZ (–0.898), HAZ (–0.087) and WHZ (–1.248) of the children of illiterate mothers respectively. F-test showed that variance was significantly different (F=16.87 P<0.000, F=19.43 P<0.000 & F=17.21 P<0.000) across groups respectively **(Table 35).**

Table 36: Relationship among WAZ, HAZ and WHZ of the children and household monthly income

Dependent variables	Fixed factors (monthly income)	N	Mean	Std. Deviation	z-test for Equality of Means		Test of Equality of Variances across groups	
					Z	Sig.	F	Sig.
WAZ	Taka ≤ 3500	966	-0.990	2.259	1.96	0.05	0.42	0.514
	> 3500	834	-0.779	2.329				
	Total	1800	-0.892	2.294				
HAZ	Taka ≤ 3500	966	0.001	3.785	0.69	0.49	0.09	0.755
	> 3500	834	0.124	3.739				
	Total	1800	0.058	3.763				
WHZ	Taka ≤ 3500	966	-1.216	1.181	3.94	0.000	8.80	0.003
	> 3500	834	-0.967	1.494				
	Total	1800	-1.100	1.340				

Table 36 shows that average WAZ (−0.779) of the children by monthly household income >3500 was significantly higher (Z=1.96 P<0.05) than the average WAZ (−0.990) of the children by monthly household income ≤3500. There was no significant variation (F=0.42 P<0.514) at 5% level across groups elevated. No significant difference (Z=0.69 P<0.49) at 5% level in the average HAZ between two income groups was noted. Variance was also not significantly different (F=1.54 P<0.213) at 5% level across groups. Average WHZ (−0.967) of the children by monthly household income >3500 was significantly higher (Z=3.94 P<0.000) when compared with the average WHZ (−1.216) of the children by monthly household income ≤3500. Variance was also significantly different (F=8.80 P<0.003) across groups.

Table 37: Relationship among WAZ, HAZ and WHZ of the children and number of eating fish and meat per week

Dependent variables	Fixed factors (eating fish and meat in a week)	N	Mean	Std. Deviation	Test of Equality of Variances across groups	
					F	Sig.
WAZ	≤ 10	619	-0.939	2.258	0.89	0.409
	11-15	768	-0.885	2.333		
	≥ 16	413	-0.834	2.275		
	Total	1800	-0.892	2.294		
HAZ	≤ 10	619	0.030	3.652	1.54	0.213
	11-15	768	0.024	3.858		
	≥ 16	413	0.165	3.756		
	Total	1800	0.058	3.763		
WHZ	≤ 10	619	-1.140	1.202	3.73	0.024
	11-15	768	-1.121	1.499		
	≥ 16	413	-1.058	1.356		
	Total	1800	-1.100	1.340		

Table 37 shows that average WAZ and HAZ of the children by eating fish and meat in a week ≥ 16 times were higher than the average WAZ and HAZ by eating fish and meat in a week < 16 times in a week. No variation was found (F=0.89 P<0.409 & F=1.54 P<0.213) at 5% level across groups respectively. It was found that average WHZ of the children gradually increased as eating fish and meat in a week increase. It was also found that variance was significantly different (F=3.73 P<0.024) across groups.

Table 38: Relationship among WAZ, HAZ and WHZ of the children and number of meals with fruits per week

Dependent variables	Fixed factors (meals with fruits per week)	N	Mean	Std. Deviation	Test of Equality of Variances across groups	
					F	Sig.
WAZ	None	678	-1.036	2.228	1.52	0.218
	1-2	952	-0.832	2.302		
	> 2	170	-0.655	2.477		
	Total	1800	-0.892	2.294		
HAZ	None	678	-0.053	3.763	1.72	0.179
	1-2	952	0.120	3.729		
	> 2	170	0.160	3.961		
	Total	1800	0.058	3.763		
WHZ	None	678	-1.272	1.089	14.19	0.000
	1-2	952	-1.052	1.394		
	> 2	170	-0.688	1.773		
	Total	1800	-1.100	1.340		

Table 38 shows that average WAZ and HAZ of the children by meals with fruits per week ≥ 2 were higher than the average WAZ and HAZ by meals with fruits per week < 2. No variation was found (F=1.52 P<0.218 & F=1.72 P<0.179) at 5% level across groups respectively. It was found that average WHZ of the children gradually increased as meals with fruits per week increase. It was also found that variance was significantly different (F=14.19 P<0.000) across groups.

Table 39: Multivariate analysis among WAZ, HAZ and WHZ of the children by suffering of children from any disease during last two weeks

Dependent variables	Fixed factors (disease during last two weeks)	N	Mean	Std. Deviation	z-test for Equality of Means		Test of Equality of Variances across groups	
					Z	Sig.	F	Sig.
WAZ	Yes	1065	-1.198	2.217	6.83	0.000	1.93	0.165
	No	735	-0.448	2.331				
	Total	1800	-0.892	2.294				
HAZ	Yes	1065	-0.405	3.736	6.38	0.000	0.00	0.985
	No	735	0.731	3.702				
	Total	1800	0.058	3.763				
WHZ	Yes	1065	-1.130	1.291	1.12	0.26	3.98	0.046
	No	735	-1.057	1.408				
	Total	1800	-1.100	1.340				

Multivariate analysis showed that average WAZ (−0.448) and HAZ (0.731) of the disease free children were significantly higher (Z=6.83 P<0.000, Z=6.38 P<0.000) when compared with the average WAZ (−1.198) and HAZ (−0.405) of the disease developed children. No variation was found (F=1.93 P<0.165 & F=0.00 P<0.98) at 5% level across groups respectively. Nutritional status by average WHZ (−1.057) of the disease free children was better when compared with the average WHZ (−1.130) of disease developed children. No significant difference (Z=1.12 P<0.26) at 5% level in the average WHZ between two groups was noted. But variance was significantly different (F=3.98 P<0.046) across groups **(Table 39).**

Table 40: Logistic regression analysis showing the effect of independent variables on height-for-age z-score (1. Stunted 2. Not stunted) of the children

Independent variables	B	SE B	Significant
Age at first marriage	-0.035	0.043	0.416
Age at first birth	-0.068	0.036	0.058*
Number of pregnancy	-0.077	0.052	0.135
Number of child	0.017	0.068	0.799
Level of maternal education	-0.050	0.020	0.002*
Income	0.000	0.000	0.521
Duration of breast feed	0.106	0.007	0.000*
Illness of the child during last two weeks	0.004	0.214	0.250
Major illness of mother during last one year	-0.303	0.128	0.018*
Maternal BMI	0.227	0.026	0.000*
Constant	-4.399	0.768	0.000

Logistic regression analysis was done to see the effect of 10 factors on height-for-age z-score of the children **(Table 40).** The factors which might influence the height-for-age z-score were taken as independent variables and the height-for-age z-score as dependent variable in the logistic regression analysis. The variables maternal age at first birth, mother's education, income, duration of breast feed, mother's illness during last one year and maternal BMI had significant influence on height-for-age z-score.

Table 41: Logistic regression analysis showing the effect of independent variables on weight-for-age z-score (1. underweight 2. Not underweight) of the children

Independent variables	B	SE B	Significant
Age at first marriage	-0.039	0.042	0.344
Age at first birth	-0.081	0.035	0.020*
Number of pregnancy	-0.100	0.054	0.052*
Number of child	0.075	0.069	0.281
Level of maternal education	-0.040	0.020	0.030*
Income	0.005	0.0002	0.050*
Duration of breast feed	0.001	0.000	0.018*
Illness of the child during last two weeks	0.098	0.007	0.000*
Major illness of mother during last one year	-0.169	0.125	0.176
Maternal BMI	0.255	0.025	0.000*
Constant	-4.484	0.734	0.000

Logistic regression analysis showing the effect of 10 independent variables on weight-for-age z-score. The variables maternal age at first birth, number of pregnancy, mother's education, income, duration of breast feed, illness of child during last two weeks, mother's illness during last one year and maternal BMI had significant influence on weight-for-age z -score **(Table 41).**

Table 42: Regression analysis showing the effect of independent Variables on maternal BMI

Independent variables	B	SE B	T	Significant
Age of mother	0.077	0.015	4.916	0.000*
Age at first marriage	0.070	0.046	1.538	0.124
Age at first birth	-0.037	0.041	-.915	0.360
Number of pregnancies	-0.256	0.066	-3.872	0.000*
Number of abortion	-0.020	0.156	-.131	0.896
Number of child	0.134	0.082	1.620	0.105
Family size	-0.059	0.034	-1.738	0.082
Level of education of mother	0.103	0.021	5.023	0.000*
Family income	0.0001	0.000	4.244	0.000*
Number of meals with meat/fish/week	0.0007	0.012	.057	0.955
Any major diseases suffered by mothers during the last year	0207	0.139	1.487	.137
Constant	16.246	0.666	24.385	.000

Multiple regression analysis showing the effect of 11 independent variables on maternal BMI. The variable mother's age, number of pregnancy, mother's education and income had significant influence on maternal BMI (Table 42).

Chapter 5

DISCUSSION & CONCLUSION

CHAPTER - 5

DISCUSSION, CONCLUSION AND LIMITATIONS

5.1 Discussion

One of the simple ways of diagnosing chronic energy deficiency (CED) among adult has recently been proposed which utilizes body mass index (BMI)[350-352]. The study findings showed strong association between nutritional status of mothers and their children. Chronic energy deficient mothers had higher proportion of undernourished children than healthy mothers (Table 19-24). From the multivariate analysis, it was found that nutritional status of the children by average weight-for-age z-score, height-for-age z-score and weight-for-height z-score gradually increased with increase of maternal BMI. Multiple comparisons by Post Hoc Test indicated that nutritional status by weight-for-age z-score, height-for-age z-score and weight-for-height z-score of the children of mothers who had BMI $\geq$18.5 were significantly better than the nutritional status of the children of mothers who had BMI < 18.5 respectively.

A strong positive linear relationship ($P<0.000$) between weight-for-age, height-for-age and weight-for height were found. These imply that nutritional status of the children by z-score indicators tends to increase as maternal BMI increases (Figure 8-10).

BMI is a useful indicator of adult nutritional status. In developed countries, morbidity and mortality risks associated primarily with the upper range of BMI have been relatively well investigated[351]. Evidence on the link between low BMI and mortality in developing countries is extremely scarce. The most notable recent data from Indian study showed that, a progressive increase in mortality below a BMI of 18.5 with a three fold increase in death rates after 10 years in those with a BMI <16[354]. Like other developing countries in Bangladesh, low BMI is the main issue, where about half of the mothers have a BMI < 18.5. Adult BMI is a good reflection of household income, household food consumption, physical work capacity and productivity , pregnancy outcome, lactational performance and morbidity and mortality as well[355-359]. There are bodies of evidence that birth weight and subsequent growth of the child are directly associated with maternal BMI. Data from the National Natality Survey in the USA have been used to illustrate the existence of an interaction between pregnancy weight gain, birth weight and maternal BMI[360]. Women with a low BMI (<19.8) early in pregnancy tends to produce the lowest birth weight infants, but this effect can be partially overcome by higher weight gain during pregnancy. Overall the US data illustrate that the thinnest women with the lowest pregnancy weight gain are greatest risk of having a low birth weight infant[361]. In this study it was also found that women in the lowest quartile (< 45kg) in either trimester 1or 2, had an odds ratio of 9.1 for LWB. Similarly, being below the 25^{th} percentile for mid arm circumference (MAC < 23.7cm) in first trimester increased the odds ratio for LWB to 3.5, while in second trimester MAC < 25 raised the odds ratio to 12.6. A logistic regression analysis to predict the risk of LBW showed that maternal BMI, parity, maternal haemoglobin , and socioeconomic status correctly classified 86.0 percent of the cases. Calloway et al[362] conducted a study in Mexican, Kenya and Egypt and found that in all three countries Maternal BMI was positively related to infant length at 3-6 months (correlations 0.26-0.37).

All these indicate that BMI has a major impact on birth weight. Mothers with low BMI as highly prevalent in the developing countries like Bangladesh should be given more emphasis to gain more weight during pregnancy to reduce the LBW infants and thus reducing infant mortality and morbidly.

From the cross-classification it was found that prevalence of stunted, underweight and wasted children were positively associated (P<0.000) with the maternal chronic energy deficiency (CED). Malnutrition by MAC (MAC ≤ 13.4cm.) of the children was also positively associated (P<0.000) with maternal malnutrition by MAC (MAC ≤ 22cm.). Risk of being undernourished (child MAC ≤ 13.4cm.) was found to be higher among the mothers who had MAC ≤ 22cm. than the mothers who had MAC ≥ 22cm (Table 25-28). It is important to note that maternal growth status by height-for-age z-score and weight status by weight-for-age z-score were positively correlated (P<0.000) with the child growth status and child weight status respectively (Figure 11-12). It is interesting to note that early marriage (age ≤ 15 years), early birth (age ≤ 16 years), more number of pregnancy (pregnancy > 3) and more number of child (children > 2) of the mothers had nutritionally poor children when compared with the rest respectively (Table 29-32). Khoi et al (1993) in their study found that Vietnamees mothers with high parity were more likely to have CED than the others[363]

It was also found that nutritional status of children by average z-score values of illiterate mothers were lower than the nutritional status of the children of literate mothers (Table 33).

Low level of income (Taka ≤ 3500) group of the household had lower level of nutrition status of the children compare to that of higher income (Taka > 3500) group (Table 34). Hasan N and Jahan K[364] observed higher weight and higher height of pregnant mothers as well as higher birth weight babies in higher income group. BMI data from Brazil has also shown the median BMI values were lower for both male and female in the lowest income class[365].

Ene-Obong HN et al[366] in their study found that income had significant ($P<0.05$) positive correlation with all nutritional variables except Vitmin C, age at marriage and nutritional knowledge. They also found age at first marriage had a positive correlation with body mass index (BMI). The mothers who experienced higher number of pregnancy (>3) and living in a large family were seen significantly worse anthropometrically. In the present study multivariate analysis also showed that the mothers who had married earlier (≤ 15 years), and gave birth of their first child within 16 years of age, the mean of WAZ, HAZ, and WHZ of children were lower than those mothers who had married after 15 years of age and gave birth of their first child after 16 years. It is observed that the girls who had married before 18 years and gave birth of their first child during adolescence experienced higher morbidly and mortality and gave birth higher percentage of low birth weight babies [367]

There is now considerable evidence that the mother's postpartum body composition is associated with the concentration of fat in breast milk, and thus its energy density [149,341,347].

Lactation is considered a physiological process that is robust and hence preserved well in spite of poor nutritional status of mother. However, there is some evidence to show that poor maternal status exemplified by a low BMI is associated with poor lactational performance and poorer growth in infants[368]. Another study showed that low maternal BMIs are associated with poorer post-partum outcomes such as lower breast milk output and underweight children[369]. Other studies revealed that repeated pregnancies further stresses the mother's nutritional status and reduces her body energy stores[370] This reductions in body energy stores will in turn, affect subsequent pregnancy and lactational performance. These indicate that age at first marriage , age at first birth, family income have direct impact on the nutritional status of mothers and their children.

Majority (95.7%) of the study subjects consumed meal three times per day and 34.4 percent of the subjects ate meat/fish ten times or less per week. About 56 percent of the subjects ate vegetables less than five times per week. More than 37 percent of the subjects did not eat any fruits during the week prior to interview. Fish/meat a good source of first class protein, is very essential for child growth. It was found that nutritional status by z-score indicators of the children gradually increased as intake of fish/meat increased. Fruits are the source of vitamins, which plays a vital role to protect our body from diseases. It was also found that nutritional status by z-score indicators of the children gradually increased as intake of fruit increased. Nutritional status of disease free children was seen better than the nutritional status of diseased children (Table 35-37). Eating habit of the subjects indicated that their meals were not balance diet which may be due to lack of nutritional knowledge and/or less purchasing capacity (Table 1). Several studies revealed that influence of nutritional knowledge of the mother on child's growth and development is an established fact[371-375]. More illiteracy (56%) among mothers, average family size (5.84±2.24), low monthly income (taka 4093±2258), land ownership, poor hygienic condition, all have shown negative impact on child nutritional status.

Anthropometric measurements showed that average weight of mothers was 42.84±6.58 kg, 71.2 percent of them had weight <45.0 Kg. Average height was 149.7 ±5.24 cm, and 17.9 percent had height less than 145.0 cm. (Table 2), who are considered to be gynaecologically unfit- more chance of having obstructed labour. Maternal Body Mass Index (BMI) indicated that 45.4 percent mothers were found to suffer from chronic energy deficiency (BMI<18.5). Only 51.7 percent were normal and 2.9 percent were overweight. Overall 48.3 percent of the mothers were not nutritionally sound (Table 3). The findings from Helen keller International (HKI) on 57000 women in 2000 revealed that 45.0 percent of rural mothers in Bangladesh and 34.0 percent mothers in urban slums had BMI less than 18.5[120].

Baqui et al [376] in their study found high prevalence of maternal malnutrition with mean weight 40 kg, height 147cm and BMI 18.5. In their study, all three measurements were found to have lower values than the present study. This difference may be due to differences in sample size, study place and time interval between two studies. On comparison of the respondent mothers in Bangladesh with the mothers of India, Ethiopia and Zimbabwe (Table 4), BMI was found almost similar to India and Ethiopia and lower than that of Zimbabwe. The average height and average weight were far below than that of Ethiopia and Zimbabwe but mean weight was little higher than women of India[260].

It was found that average weight and height of the children were 12.4 and 92.0 cm, which were 81.43 percent and 93.59 percent of the NCHS standard respectively. The average z-score values of weight-for-age, height-for-age and weight-for-height were above –2 standard deviations. Based on the average z-score values it was also found that the children were not underweight, stunted and wasted (Table 5). However, nutritional status of the children by z-score classification indicated that prevalence of stunting, wasting and underweight were 38.8 percent, 25.0 percent and 41.0 percent respectively (Table 6). Nutrition surveys in Bangladesh since 1981 have consistently reported a high rate of PEM among children[116, 377,378]. The nationwide child Nutrition survey of Bangladesh (1995-96) found by WAZ score classification that 57.4 percent were underweight. This indicates that the overall percentage of underweight was found much lower than the national figure. Child Nutrition Status Survey (1989-90), Child Nutrition Survey of Bangladesh (1995-96) and Child Nutrition Survey of Bangladesh (2000) revealed that prevalence of stunted children were 65.5 percent, 51.4 percent and 48.8 percent respectively. In the present study, prevalence of stunting was found much lower i.e., 38.8 percent. This gradual lowering trend of stunting and underweight might be due to the adoption of various effective measures as well as the positive impact of proper national food and nutrition policy activities going on in the country since 1980s[379]. Off course nutrition activities in the visible form started in Bangladesh since 1960s[380-382].

Cross-classification of stunting and wasting showed that 63.8 percent children were either stunted or wasted or both. On the contrary, cross-classification of stunting and underweight revealed that 79.8 percent children were either stunted or underweight or both. That means only 21.2 percent children were nutritionally sound in respect of both height and weight (Table 7 & 8). A cross sectional study was conducted in Alexadria, Egypt among the children aged 6-7 months and found that 15.0 percent were stunted, 7.3 percent underweight, and 3.6 percent wasted. This indicates that the percentages of malnutrition among the Egyptian children using all three indicators were much lower than that of Bangladeshi children[383].

Prevalence of stunting and underweight were not significantly associated ($P>0.05$) with sex. On the other hand prevalence of wasting was negatively associated ($P<0.05$) with the male children (Table 9-11). Prevalence of stunting and underweight were higher among the boys than the girls, but wasting was significantly more common among girls (Table9-11). Giashuddin et al, found that male children were more likely to be stunted than female children (OR = 1.12 , 95% CI = 1.02 – 1.43)[384].

Though it is saying that due to the gender discrimination female children are given less food than the males. Waldron (1983)[385] and United Nations [386] Population

Division described gender difference in nutritional status is probably the result of biological rather than cultural factors

For better comparison study children were divided into two groups: ≤ 5 years and >5 years. Multivariate analysis showed that all the three indicators of nutritional status were better observed among the older age group children and the differences between two groups for all three indicators were found statistically highly significant (Table 12-14). This indicates that after crossing the pre school age, nutritional status of the children improved. This might be due to the fact that after preschool age, the children usually get release of frequent infections and being adjusted with the family food habits which might have contributed to improved nutritional status. Poor hygienic condition resulted in infection and higher incidence of malnutrition in Bangladesh. Intestinal parasites, a common feature in Bangladesh, alone can lead to food loss of 25 percent of ingested calories. De Onis et al [387] in their findings showed that in South East Asia nearly one-half of preschool children were underweight.

Multiple comparisons of the prevalence of malnutrition by z-score indicators in different geographical areas indicated that prevalence of underweight and stunting were highest in Dhaka Division and lowest in Rajshahi Division whereas, prevalence of wasting was also highest in Dhaka Division and lowest in Chittagong Division (Figure 1-4).

By using multivariate analysis it was found that nutritional status of the children by average weight-for-age z-score (WAZ), height-for-age z-score (HAZ) and weight-for-height z-score (WHZ) gradually improved with increase in age. Variation of improvement of the nutritional status by WAZ and HAZ were found to be significantly different (P<0.000) across age groups respectively. Nutritional status by average z-score among 1-2 years children was worst than the others. (Table 16-18).

From the linear relationship it was found that weight-for-age and height-for-age of the children were positively correlated (P<0.000) with the age of children. No linear trend (P>0.05) between weight-for-height and age was found (Figure 5-7).

Logistic regression analysis indicated that age at first birth, maternal education, duration of breastfeeding, major illness of mother during last one year and maternal BMI had significant influence on height-for-age of the children. It was also found that age at first birth, number of pregnancy, maternal education, income, duration of breast feeding, illness of the child during last two weeks and maternal BMI had significantly influence on weight-for-age of the children. Multiple regression analysis indicated that age of mother, number of pregnancy, level of maternal education and family income had significantly influence on maternal BMI (Table 38-40). Grameen Bank and other studies show that families with a higher income or with more land consume more calories, more protein and more of the most other nutrients[388]. From the bodies of evidence it is indicated that nutritional status of mother has great potentials to the nutritional status of children . And it is clear that the choice of BMI for defining the lowest limit of normality of maternal size is of vital importance.

5.2 Conclusion

In the present study, maternal height and weight status were found positively correlated with child's height and weight status. The nutritional status of the children was positively associated with maternal Body Mass Index (BMI). Higher percentage of children was found undernourished among the mothers who were found to suffer from chronic energy deficiency (BMI < 18.5). Study findings revealed that 45.4 percent of mothers and one-third of children in the study population had been suffering from undernutrition. In this study, it was observed that there were strong association between maternal and child nutritional status at a given time when compared by maternal and child anthropometric indicators. Maternal size is found to be related to the good nutritional status of their children. The study results revealed that some factors like maternal education, family income, age at first marriage, and age at first birth have influence on the nutritional status of the mothers as well as the nutritional status of their children in the same family. So any intervention programme towards the improvement of maternal nutrition might improve the nutritional status of their children.

5.3 Limitations

1. As the study was a cross-sectional one, follow–up of the mothers and children were not possible. So the change overtime was not observed.
2. Sample size was only 1800 drawn from four randomly selected rural areas, which may not truly represent the entire rural population of the country.
3. While comparing the nutritional status of the children, data were available only from the index children- age ranging from 0 to 9 years.
4. Household food intake, specially for the mothers and children was not included in the study.
5. The disease situation beyond the study period was not observed.

Chapter 6

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Questionaire on:

STUDY OF THE RELATIONSHIP BETWEEN MATERNAL SIZE AND NUTRITIONAL STATUS OF CHILDREN IN RURAL BANGLADESH

A. General Information:

Identification number of respondents (ID#) ☐☐☐☐

Name of village ………………………………… Household # (If available) ……………………

Name of Union ………………………………… Name of Thana ……………………………………

Name of District ………………………………

B. Socio-demographic Information

1. What is your name ? ……………………………………

2. What is your religion? ☐

   1. Islam 2.Hindu 3. Buddisht

   4. Christian 5. Others (specify)-----------------

3. What is your age (in completed years)? ☐☐

4. What was your age at first marriage ☐☐

5. What was your age at the time of birth of your first child? ☐☐

6. How many times did you get pregnant? ☐☐

7. How many live births have you had? Son ☐ Doughter ☐ Total ☐☐

8. How many of your children had died? Son ☐ Doughter ☐ Total ☐☐

9. How many abortion (s) have you had? ☐

10. How many of your child (ren) below 5 years of age? ☐

11. How many of your child (ren) below 10 years of age? ☐ ☐

☐☐☐☐

12. How many members do you have in your family?

13. What is your family type?

1. Single 2. Joint 3. Others

14. What is your educational status?

Illiterate = 1 Upto grade V = 2 Upto grade VIII = 3

SSC passed = 4 HSC passed = 5 Degree & above = 6

15. What is the educational status of your husband?

Illiterate = 1 Upto grade V = 2 Upto grade VIII = 3

SSC passed = 4 HSC passed = 5 Degree & above = 6

16. Do you do any work other than household work?

No =0 Poultry =1 Handicrafts/Needle work =2

Business =3 Aya/maid = 4 Garment worker= 5

Govt. service=6 Private service =7 Day labor = 8.

Others =9

17. What is your husband's occupation?

Farmer=1 Day laborer =2 Grocer/business=3

Rickshaw puller =4 Garments worker =5 Service=6

Hawker =7 Nothing =8 Others (Specify) =9--------------

18. What is your monthly family income (in Taka)?

19. How much of your income spends for food?

20. How do you maintain your family with this income?

1. Very well =1 Moderate =2

Hardship =3 By Loan =4

21. Do you have your own land

1. Yes 2. No

22. If yes, how much? (Write in decimal)

C. Information on food habit?

23. How many times do you eat in a day?

24. How many times do you eat meet/fish in a week?

25. How many times do you eat vegatable in a week?

26. From where do you get vegetables?

    Always from own field =1   Sometimes have to buy =2

    Always have to buy =3

27. How many times do you eat fruits in a week?

28. What type of house do you live in?

    Kacha = 1   Semi pacca = 2   Pacca = 3

29. What is your source of drinking water?

    Tube well = 1   River water = 2   Rain water=3   Pond water=4

    Dug well = 5   Other source (specify) = 6 ....

30. Where do you defaecate?

    Kacha /pit latrine=1   Sanitary latrine=2

    Open field=3   Other (specify) =4

D. Breast feeding patterns of the index child

31. Did you give colostrums to this baby?

    Yes = 1   No = 2

32. How long did you feed this baby only on breast (in month)

33. How long did you feed this baby on breast with other food (in month)

34. Did this baby suffer from any disease(s) during the last weeks?

    Yes = 1   No = 2

35. If yes, what was the disease(s) (may be multiple answers)

Measles =1 Diarrhoea =2 Dysentary =3

Cough/common cold =4 Fever =5 Other =6

36. Did you consult any doctor for this baby?

Yes = 1 No = 2

37. If yes, what was the doctor?

MBBS =1 Paramedics = 2 Village doctor =3

Homeopath =4 Kobiraj/Fokir =5 Other (specify) =6 ----------------------

38. How many times did you consult MBBS doctors for this baby in his life?

39. Did you suffer from any major disease(s) during the last one year?

Yes = 1 No = 2

40. If yes, specify …………………..

E. Anthropometry

41. Maternal Anthropometry

Weight (in kg)	Height (in cm)	MAC (in cm)	BMI

42. Index child anthropometry

Age (in month)	Sex Male=1 Female=2	Birth order	Weight (in kg)	Height (in cm)	MAC (in cm)