Comparison between nutrition education intervention and nutrition education & homestead food production on nutritional status among selected rural secondary school students

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Submitted By:

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Dedication

…… To my husband
Gazi Md. Mohsin

Whose inspiration, encouragement and guidance made it possible to accomplish this task with constant mental support from my daughters **Tahia** and **Tasmiah**.

Declaration

This is to certify that the thesis entitled "Comparison between nutrition education intervention and nutrition education & homestead food production on nutritional status among selected rural secondary school students" by Sonia Zebsyn in partial fulfillment of the requirement for the award of Doctor of Philosophy in Nutrition and Food Science has been completed under my supervision. It is certified that Sonia Zebsyn has fulfilled all conditions laid down in the Academic Ordinance and to the best of my knowledge, the thesis contains her original research.

……

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Declaration

I, hereby, humbly declare that this thesis entitled, "Comparison between nutrition education intervention and nutrition education & homestead food production on nutritional status among selected rural secondary school students" based on works carried by me. No part of it has been presented for higher degree.

The research work was carried out in-

1) Umed Ali Bhuiya High School, Akubpur, Tarail, Kishoreganj,
2) Sahilati High School, Tarail, Kishoreganj,
3) Purura High School, Purura Bazar, Tarail, Kishoreganj,
4) Mahinanda High School, Amirganj, Kishoreganj Sadar, Kishoreganj,
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8) Institute of Nutrition and Food Science (INFS), University of Dhaka

under the guidance of Dr. Md. Aminul Haque Bhuyan, Professor, Institute of Nutrition and Food Science, University of Dhaka.

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Abstract

This study evaluated the effects of nutrition education program alone and in combination with homestead food production (HFP) inputs on nutritional status in selected rural secondary school students of Kishoreganj district. In this interventional study, 1214 students were placed into study group 1 (406), study group 2 (400) and control group (408). The study group 1 participated in nutrition education program whereas the study group 2 got HFP inputs along with nutrition education. Socio-demographic informations were collected at baseline of the study KAP related information, food security related information, anthropometric data, blood samples, school performance related information and dietary data (24 hour dietary recall along with seven days' food frequency) were collected at baseline and after six months of follow up respectively. The data were analyzed by paired *t*-tests. ANOVA test was also done to see the significance level of academic performance between the groups. In all statistical tests, *p* values of less than or equal to 0.05 were considered significant.

Most of the participants' fathers were found to be farmer in three groups. However, among other reported occupations, business and small business were common across the groups. Percentages of illiterate mothers for study group 1, study group 2 and control group were found 11.9%, 12.8% and 8% respectively. Most of the families were found nuclear rather than the joint type in three groups. About half of the participants' monthly per capita income were reported lower than 600 Taka among all the groups.

The knowledge, attitude and practice score were compared among the groups over the study period. The KAP percent score were significantly increased in study group 1 ($p < 0.001$) and study group 2 ($p < 0.001$) after the intervention; no significant change was seen in control group ($p = 0.445$). Although, in the control ($p < 0.510$) and the study group 1 ($p=0.211$) food insecurity followed an increasing pattern; in study group 2 it reduced significantly ($p < 0.001$).

Percentages of the study participants having normal BMI increased a little in the study group 1 and 2 (78 to 82.3 and 85.4 to 87.5 accordingly). In the control group, 89.1% participants' BMI were normal at the baseline which reduced to 87% at the end of the study period of six months. The prevalence of anemia was 43.8%, 48.5% and 48.5% in the study group 1, study group 2 and control group respectively. After 6 months the prevalence of anemia increased in the control group (54.9%). One the other hand, decreased anemia prevalence was reported in study group 1 and study group 2 (35.5% and 44% respectively). The serum ferritin level which is a marker of human storage, also decreased from baseline in control group. Significant changes of the examination marks were found in all the groups after intervention. Among them the changes in study group 1 and 2 were highly significant (p = 0.00 and 0.00 respectively). It was also found that the improvement in academic performance in study group 2 was significantly higher compared to study group 1 (p = 0.007) and control group (p = 0.003).

The participants of study group 2 were found to have better dietary diversity score (p =0.000) and dietary intake (significant increase in food group consumption and also in macro and micronutrients intakes) after intervention compared to others. Still they could not meet the level of RDA and most of the participants of all groups were inadequate in terms of macro and micronutrients intakes.

Nutrition education and HFP program appeared to have positive impact on nutritional status of the participants of study group 2. Healthy eating bahaviour is essential for students to achieve their full academic potential, mental growth and lifelong health & well-being.

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List of Abbreviations

ANOVA	Analysis of Variance
BCC	Behavior Change Communication
BINP	Bangladesh Integrated Nutrition Project
BMI	Body Mass Index
CI	Confidence Interval
cm	Centimeter
dl	Deciliter
EDTA	Ethylenediaminetetraaceticacid
FFQ	Food Frequency Questionnaire
g/dl	Gram per deciliter
Hb	Hemoglobin
HDDS	Household Dietary Diversity Score
HFP	Homestead Food Production
HFIAS	Household Food Insecurity Access Scale
HKI	Helen Killer International
Ht	Height
IDA	Iron Deficiency Anemia
IDDS	Individual Dietary Diversity Score
INE	Intensive Nutrition Education
INFS	Institute of Nutrition and Food Science
IQ	Intelligence Quotient
KAP	Knowledge, Attitude and Practice
kcal	Kilo Calorie
kg	Kilogram
kg/m^2	Kilogram Per Meter Square
LMICs	Low and Middle Income Countries
mg	Milligram

ml	Milliliter
µg	Microgram
NCHS	National Center for Health Statistics
NE	Nutrition Education
NGO	Non-governmental Organization
ng/ml	Nanogram Per Milliliter
No.	Number
RR	Relative Risk
RDA	Recommended Dietary Allowances
SF	Serum Ferritin
SPSS	Statistical Package for Social Scientists
UNICEF	United Nations International Children's Emergency Fund
VADD	Vitamin A Deficiency Disorder
WFP	World Food Program
WHO	World Health Organization
Wt	Weight
%	Percent

Chapter 1

1.1 Introduction

1.2 Rationale

1.3 Objectives

1.1 Introduction

Malnutrition is a devastating problem in the developing countries, particularly for the poor and under privileged groups. In spite of impressive advances in health sectors in recent decades, many in developing countries remain vulnerable to food insecurity, undernutrition and ill health.[1]

Secondary school children lying under the age group of 10 – 19 come under the category of adolescent. Adolescence is a state or process of growing up from puberty to maturity.[2] Adolescent account for 1/5th of the world's population and in Bangladesh they account for almost one-quarter of the total population.[3] Adolescence is a unique intervention point in the life-cycle for a number of reasons.[4] Early adolescence after the first year of life is the second critical period of rapid physical growth and changes in body composition, physiology and endocrine. When more than 20% of the total growth in stature and up to 45% of adult bone mass are achieved and weight gained during this period contributes about 50% to adult weight.[5] Rapid growth and changes heighten their nutritional requirements and risks of undernutrition. There is evidence that the tempo of growth during adolescence is slower in undernourished populations.[6] Adolescence offers the last opportunity to intervene and recover growth faltered in childhood and also support growth spurt and skeletal development to break the vicious cycle of inter-generational undernutrition.[7]

Malnutrition among the rural poor in Bangladesh is probably the highest in the world.[8] According to a WFP (2009) report, 60 million people in Bangladesh still do not have sufficient food to eat and the country has the highest child underweight rate in South Asia and one of the highest in the world.[9] Vitamin A deficiency is a public health problem in nearly 80 developing nations.[10,11] Over half of the prevalence of anemia globally is estimated to be due to iron deficiency.[12] Similarly, current estimates suggest that one-third of the world's population consumes diets inadequate in zinc.[13]

Overall micronutrient deficiencies raise the risk for mortality from diarrhoea, pneumonia, malaria and measles.[14] These micronutrient deficiencies are responsible for a large proportion of infections, poor physical and mental development and excess mortality in the developing world.[15] Micronutrient malnutrition has serious effects on the development of countries due to its long-term impact on health, cognitive function and work productivity. The recent increase in global food prices has substantially boosted overall poverty and has pushed more people into malnutrition.[16] In developing countries, factors associated with undernutrition of adolescents are: poor household economic condition, periodic food-shortage, child-labour (marker of household income - poverty), burden of disease, poor knowledge about long-term consequences of undernutrition of adolescents, quantity and quality of food, and access to health and nutrition services.[17] In Bangladesh, low family income, education and periodic food – shortage were associated with inadequate dietary intake[18], which might have led to undernutrition. Inadequate dietary intake is the main cause of micronutrient deficiencies and thus it seems logical that food and agriculture activities ideally in conjunction with nutrition education, could contribute to improved micronutrient status.[19]

It has been argued that health is an important factor for academic achievement at school.[20,21] Deficiencies in some nutrients have been reported to cause diseases which could lead to impaired cognitive development.[22] Undernourished children have been shown to have decreased attendance, attention and academic performance as well as more health problems compared to well – nourished children.[23,24] Studies of nutrition and academic performance have typically focused on hunger, malnutrition and micronutrient deficiency.[25,26,27]

Health promotion from the early stages in life by fostering healthy eating practices and regular physical activity has the potential for a major impact on health and well-being during childhood and later stages in life.[28] Children progressively acquire and learn eating habits and practices as they grow and develop. Initially, the family plays a vital role in the process. Not only as responsible for feeding the child, but also by setting norms within the family, acting as role models, encouraging certain behaviors and rewarding or limiting others.[29] During school age, children are more independent, start making their own food choices and take personal decisions regarding what they eat. The family is less important for adolescents, while friends, peers and social models are the key influences on their eating practices.[30]

Scientific evidence supports that prevailing food patterns during infancy and childhood influence growth and development; have an impact on health not only during this period of life, but also on the potential development of risk and protective factors related to the onset of chronic diseases later in adulthood.[31] Nutrition during childhood contributes for maintaining lifelong health and optimal learning capacities. Furthermore, food habits that persist during adolescence are more likely to track onto adulthood.[32] So, it is important for children to learn about the benefits of good nutrition. Education can assure that individuals have the information and skills they need to protect and enhance their own health and the health of their families.[33] It has been recommended that effective nutrition interventions for children and adolescents should have a behavioral focus that will minimize the targeted risk factors, utilize theoretical framework, consist of changes to the environment, provide adequate dose and include strategies that are developmentally and culturally appropriate.[34,35] However, to achieve the desired behavioral changes related to health and nutrition it will require the attainment of adequate knowledge, attitudes, skills and self – efficacy.[36,37,38] In other words, for children and adolescents to adopt and

maintain health – enhancing behaviors, they need to have adequate knowledge of the health concern, attain the right attitude to deal with the concern and possess the necessary skills and be self – efficacious to assume the health – enhancing behavior. Any set of learning experiences designed to facilitate voluntary adoption of eating and other nutrition related behavior, conducive to health and well – being is defined as nutrition education.[39] It is recognized as an important component in programs and interventions related to health promotion and disease prevention. Nutrition education has not only been shown to improve knowledge and skills but also eating and physical activity behaviors as well as health status for school-age children.[40,41,42,43] Perez Rodrigo and Arancenta have outlined the characteristics of successful school – based nutrition education programs that focus on dietary practices and physical activity.[44] In summary, a comprehensive and sequential school – based nutrition education is needed to provide school children the knowledge and skills as prerequisites for acquiring healthy nutrition – related behaviors.

Food – based approaches, particularly the ones that involve agricultural interventions, can also contribute to poverty reduction in a variety of ways, which in turn also adds to improving nutritional status.[45,46,47] Increasing availability and consumption of micronutrient – rich foods through a household's own production is considered a sustainable approach because the process empowers women and households to take ultimate responsibility over the quality of their diet through their own production of nutrient – rich foods and educated consumption choices.[48] Until recently, projects that encourage households' own production of food have focused on home gardens that often promote the production of plant source foods only. Plant foods are important sources of micronutrients, particularly vitamin A. But the bioavailability of vitamin A and other micronutrients from plants is lower than originally thought.[49] Therefore, it is crucial to increase the consumption of animal foods, which are known to be rich

sources of bioavailable vitamins and minerals, among micronutrient deficient populations. Helen Keller International (HKI) initiated pilot projects in Bangladesh, Cambodia, Nepal and the Phillippines to integrate animal husbandry and nutrition education into an on – going home gardening program to enhance the intake of bioavailable micronutrients by household members, Which is referred to as homestead food production (HFP). Homestead food production is a world wide practice that has existed for many centuries.[50] The main purpose of this indigenous practice is to grow food for the family and provide additional income.[51,52] The concepts of homestead gardening has increasingly been broadened to also include the production of animal foods, for example through poultry keeping, small animal husbandry and /or fish ponds, and it is therefore called home–stead food production and main aims of homestead food production are still the production of nutritious, micronutrient–rich foods for household consumption and the generation of additional income, but its role in women's empowerment, community mobilization, and poverty reduction are increasingly being recognized.[53]

The present study aims at investigating the influence of nutrition education intervention and nutrition education & homestead food production in selected rural secondary school students on their nutritional status and to compare the results obtained in order to take measures to improve the health and well – being of those children as a whole.

1.2 Rationale of the Study

Bangladesh is the most densely populated country in the world and one of the poorest where millions of children and women suffer from various forms of malnutrition including low birth weight, stunting, under-weight, deficiency of iodine, iron and vitamin. Despite significant progress has been made in recent years to reduce the incidence of poverty and malnutrition, the fact remains that nearly half of the citizens live in deprivation.[54] Childhood undernutrition, highly prevalent in South Asia,[55] continues to persist throughout adolescence but little attention has been given to undernutrition of adolescents perhaps for the belief that adolescents are a low-risk group. Adolescence is such a critical stage of life when growth is accelerated and major physical and sexual development takes place.[56] Adolescent growth and development is closely linked to the diet they receive during childhood and adolescence. Adolescent is a window of opportunity to prepare nutritionally for a healthy adult life. It may also be a time to shape and consolidate a healthy eating and life style behaviors, there by preventing or postponing the onset of nutrition related to the chronic diseases in the adulthood.[57] However, eating patterns are frequently erratic in adolescents, and this may be a common factor for nutritional risk. Eating disorders have become a leading chronic illness especially girls live under sub optimal condition marked by poor nutritional status and thus high level of morbidity and mortality.[58] Dietary knowledge and access to resources are critical to improve health and nutrition in a sustainable way. Adolescence is the proper time to learn and adopt healthy habits to avoid many health and nutritional problems later in life.[17] Adolescents have more easy access to health and nutrition information through schools, recreational activities and mass media than they have later in their lives.[4] Particularly, health and nutrition knowledge and healthy habits of female adolescents will have critical roles to play in maintaining future family health and nutrition. The next generation of our country will be suffered if adolescents who would be the parents would have ill-health and poor nutritional status. Several

strategies in Bangladesh have been taken to combat micronutrient deficiencies including supplementation, fortification and the promotion of dietary diversification. Two decades ago, Helen Keller International (HKI) introduced the homestead food production (HFP) program to address vitamin A deficiency in Bangladesh. The key impacts of homestead food production in Bangladesh on food security include: increased production and consumption of micronutrient – rich foods; diversified diets; improved status of women; increased income from garden and livestock production.[59,60] Homestead food production alone will not improve nutrition; nutrition education is necessary to translate food production into improved dietary intakes, particularly for vulnerable household members. A number of studies experimenting the potential for agriculture programs and food – based strategies to improve nutrition highlighted the importance of explicit nutritional objectives and nutrition education activities – specifically as behavior change communication (BCC) - to affect positive nutrition outcomes.[61,62,63]

Therefore, considering all the views, specially the importance of adolescent period in human life and nutritional problems of adolescents; this study has been designed to compare the changes in nutritional knowledge, attitude and practice, overall the nutritional status (before and after intervention) between three groups of secondary school students – one who has received only nutrition education, other one who has received both nutrition education and inputs of homestead food production and last one who has received nothing.

1.3 Objectives

1.3.1 General objective

To compare the effect of nutrition education intervention and nutrition education & homestead food production on nutritional status among selected rural secondary school students.

1.3.2 Specific objectives

1. To assess the nutritional status of rural secondary school students before and after intervention.
2. To assess the school performance of rural secondary school students before and after intervention.
3. To evaluate the KAP (Knowledge, Attitude & Practice) score of rural secondary school students before and after intervention.
4. To assess the household food security of rural secondary school students before and after intervention.
5. To assess the food intake pattern of rural secondary school students before and after intervention.
6. To observe the socio–demographic condition of rural secondary school students.
7. To execute a nutrition education program containing:
    a) Oral presentation
    b) Showing posters, booklets and leaflets
    c) Practical food demonstration
8. To execute a program for giving various inputs of Homestead Food Production (HFP).
9. To make a comparison of all parameters under study between control and study groups.

Chapter 2

Literature Review

2.1 Literature Review

Under nutrition remains as an unfinished agenda for the majority of low and middle-income countries (LMICs). The UNICEF defined undernutrition as the outcome of insufficient food intake and repeated infectious diseases. It includes being underweight for one's age, too short for one's age (stunted), dangerously thin for one's height (wasted) and deficient in vitamins and minerals (micronutrient malnutrition).[64]

Risk factors of under nutrition are complex; include national scale determinants to individual specific and factors which effect at various age and period of life (Scaling up of Nutrition, 2011). The UNICEF conceptual framework on the causes of malnutrition suggests that aetiology of undernutrition is multifactorial, complex and intricate. The framework classified the causes of undernutrition to three categories as immediate causes (i.e. inadequate dietary intake and infectious diseases), underlying causes (i.e. insufficient access to food, inadequate maternal and child care, poor sanitation hygiene and inadequate health services) and basic causes (i.e. the roles of formal and non-formal institutions, political and ideological superstructure, economic structure and potential resources).[65]

Under-over-nutrition can have adverse effects throughout the life cycle and has been considered as a leading cause of death, disability and ill-health.[66] For example, maternal overweight and obesity are associated with maternal morbidity, preterm birth, and increased infant mortality. Fetal growth restriction is associated with maternal short stature and underweight and causes 12% of neonatal deaths.[67] Being underweight makes it susceptible to infection and longer duration to recover from illness and with repeated bouts of infectious diseases estimated 3.1 million preventable maternal and child deaths occur annually. Stunting (defined by the WHO as low height-for-age) impair cognitive development, increase susceptibility to infection and affect school attainment and future productivity with intergenerational

effects.[68] Further, deficiencies in iron, iodine, zinc and vitamins can cause problems such as brain damage, blindness, anaemia and stunted growth. Undernutrition affects learning abilities, and cause delayed achievement of developmental milestones in children. In turn, such adults fail to reach their full growth potentials influencing their socio-economic productivity resulting in poor economic growth.[69]

Many adverse effects of undernutrition including morbidities and mortalities in vulnerable populations could be prevented through timely nutrition interventions. These nutrition interventions have both preventive and curative purposes, especially in LMICs and scaling up of these valuable interventions have shown to be hugely beneficial to the millions of populations. The Lancet (2013) series on maternal and child health examined these multitudes of interventions that were implemented in 34 countries and ascertained that scaling up of these interventions reduce deaths in children younger than five years by 15%.[68]

The nutrition interventions were categorized to nutrition-specific and nutrition-sensitive interventions.

- Nutrition-specific interventions refer to those programmes and approaches that have direct impact on nutritional outcomes and address the immediate causes of undernutrition (i.e. inadequate food intake, poor feeding and care practices and high burden of infectious diseases). The ten nutrition-specific interventions with evidence for effectiveness of nutrition interventions and delivery strategies identified included supplementation of folic acid, calcium, balanced protein-energy and micronutrients to pregnant women; promoting breast feeding and delivering appropriate complementary feeding to infants, providing vitamin A and zinc supplements to children up to the age of five; and using proven treatment strategies to manage moderate to severe malnutrition in children.

- Nutrition-sensitive interventions and programmes include programmes that address some of the underlying determinants of nutrition (e.g. poverty, food insecurity, poor health, gender inequity, etc.). Nutrition-sensitive interventions include agriculture, home gardens and homestead production systems, biofortification, social safety nets, conditional and unconditional cash transfers, school feeding programmes, household food distributions, early child development and schooling.

The above interventions could be delivered through a wide variety of platforms providing enough opportunities to scale up these strategies to reach large number of these socioeconomically disadvantaged and vulnerable populations in LMICs. The different platforms include fortification of staple foods to reach large segments of populations; cash transfer programmes to reduce poverty, reduce financial barriers and to improve population health; community based platforms for nutrition education and promotion aimed to promote behaviour change; community mobilization strategies to promote health care; integrated management of childhood illnesses strategies to improve healthcare practices at health facilities and home; school based delivery platforms to reach children >5 years of age to improve nutritional status through feeding programmes while promoting school enrolment; and child health days to deliver nutrition interventions such as vitamin A supplements, immunizations, insecticide-treated nets and deworming drugs.[68]

Nutrition-specific interventions are short-term strategies and are aimed to combat issues of undernutrition through targeted approach of supplementation of nutrients to the specific groups of populations. The sustainability of such interventions/ programmes are often a great challenge and needs huge investments. A more prudent approach would be to have a combination of both nutrition-specific and nutrition-sensitive approach in

order to improve the dietary intakes of nutrients and thus, nutritional status indirectly.

Nutrition-sensitive programmes aid to accelerate improvements in nutritional status by augmenting household and community environments, protecting the poor from the adverse implications of food security threats and climate change.[70] Targeted agricultural programmes can influence nutrition through key mediators including women's social status, empowerment, control over resources, time allocation, and health and nutritional status.[71, 72] The effects of homestead food production systems on intermediary outcomes along the impact pathway, showed positive effects on household production and consumption, maternal and child intake of target foods and micronutrients and overall dietary diversity.[73] Biofortification strategies are found to be successful in improving the dietary intakes of different micronutrients such as vitamin A, iron and zinc, contributing to achieve adequate intakes of these deficient nutrients. The majority of these nutrition-sensitive programmes improve the food availability and food consumption, thus, favouring adequate food intakes, increase dietary diversity to ensure appropriate nutrient intakes in the vulnerable populations.

Nutrition interventions are primarily aimed to improve the nutritional status of populations augmenting their dietary intakes to achieve optimal/desirable intakes of various nutrients. Nutrition-specific interventions such as direct supplementation of various nutrients (i.e. balanced protein-energy, calcium, iron, folic acid, vitamin A, zinc, iodine etc.) aims to improve the intakes of these nutrients to prevent nutrient deficiencies in different populations including women and children. The majority of populations living in LMICs have limited access to nutrient dense foods, such interventions are beneficial as they subsist on predominantly cereal-pulse based diets that are insufficient to adequately provide many of these nutrients.

Supplementation of folic acid to women of reproductive age has shown 72% reduction in risk of development of neural tube defects;[74] daily iron supplementation during pregnancy reported 70% reduction in anaemia at term, 67% reduction in iron deficiency anaemia (IDA) and 19% reduction in the incidence of low birthweight;[75] multiple micronutrient supplementation reported 11-13% reduction in low birthweight and SGA births;[76] calcium supplementation during pregnancy reduced the incidence of gestational hypertension by 35%, preeclampsia by 55% and preterm births by 24%;[77] iodised oil supplementation in pregnancy in severe iodine deficient populations showed a 73% reduction in cretinism and a 10-20% increase in developmental scores in children[78] and balanced energy-protein supplementation during pregnancy increased birthweight by 73g (95% Cl 30-117) and reduced risk of SGA by 34%, with more pronounced effects in malnourished women.[79]

In neonates, breast feeding initiation within 24 h of birth was associated with a 44-45% reduction in all-cause and infection-related neonatal mortality[80]; in children between 6 to 23 months of age consumption of a minimum acceptable diet with dietary diversity reduced the risk of both stunting and underweight;[81] vitamin A supplementation reduced all-cause mortality by 24% and diarrhoea-related mortality by 28% in children aged 6-59 months;[82] intermittent iron supplementation to children younger than 2 years reduced the risk of anaemia by 49% and iron deficiency by 76%[83] and preventive zinc supplementation reduced the incidence of diarrhoea by 13% and pneumonia by 19%, with a nonsignificant 9% reduction in all-cause mortality.[84]

A study displayed interventions that address poor diet quality and related deficiencies of vitamin A, zinc, iron, among others, are important for achieving full food security in vulnerable populations. The homestead food production (HFP) program, introduced in Bangladesh by Helen Keller

International nearly two decades ago, promotes an integrated package of home gardening, small livestock production and nutrition education with the aim of increasing household production, availability and consumption of micronutrient-rich foods and improving the health and nutritional status of women and children. Implemented by NGO partners and the Government of Bangladesh, HFP has expanded its reach into over one half of the country's sub districts and is now operating in several countries of Asia and Sub-Saharan Africa. Evidence shows that HFP in Bangladesh has improved food security for nearly 5 million vulnerable people in diverse agro ecological zones. This has been achieved through: increased production and consumption of micronutrient-rich foods; increased income from gardens and expenditures on micronutrient-rich foods; women's empowerment; enhanced partner capacity and community development.[85]

A cluster-randomized intervention trial design was employed. After the intervention, more students in NE school knew the main function of dairy products and vegetables, which micronutrient is rich in dairy products and beans and in meat and the symptom of food poisoning, than those in Control school. The rate of students who thought nutrition is very important to health and foods with an expired date should be thrown away in NE school was higher than that in Control school (93.8 vs. 80.3 and 92.3 vs. 78.7 %, respectively). The rate of students who ate vegetables and breakfast every day in NE school was higher than that in Control school (96.9 vs. 80.3 and 89.2 vs. 75.4 %, respectively). ($p<0.05$).[86]

A number of interventions which focused only on providing nutrient supplementation have failed to change child undernutrition status during the last 2 decades. The present study aimed to assess the impact of nutrition education on the nutritional status of children living in resource-limited environments. Subjects were 586 children from Tando Jam and Quetta, Pakistan, aged from 6 months to 8 years. Children were characterized as

mild, moderate or severely wasted on Z-scores. Anthropometry and 24-hour dietary recall were used for nutritional assessment. Intervention strategy was nutrition counseling targeting mothers. Primary outcome was decrease in the severity of wasting and changes in the feeding practices. Nearly 36% children in Tando Jam and 32% children in Quetta progressed to a normal nutritional status. There was a significant increase in the number of meals taken per day (Tando Jam $p \leq 0.000$/Quetta ≤ 0.025). In Tando Jam, significant increase was reported in the intake of high starch food items, vegetables and fruits ($p \leq 0.000$). In Quetta, significant increase was noted in the intake of plant protein ($p \leq 0.005$), dairy foods ($p \leq 0.041$) and vegetables ($p \leq 0.026$). Nutrition education was successful in reducing undernutrition in food insecure households.[87]

A study showed intervention and control households were similar at baseline in sociodemographic characteristics, but more intervention households owned animals, earned income from homestead food production and produced and consumed micronutrient-rich foods. At end line, some of these differences had widened; more intervention households produced and consumed more vegetables, had higher dietary diversity, and had a lower prevalence of fever among children under 5 years of age. In the intervention group, more children consumed more eggs and more mothers consumed micronutrient-rich food more frequently than in the control group. There were no other differences between the groups in maternal and child health and nutrition. Greater household production of fruits and vegetables was associated with greater household dietary diversity, which was associated with dietary diversity among mothers and children. Dietary diversity was not associated with other maternal and child health and nutrition outcomes.[88]

A study represented that micronutrient malnutrition is a serious public health problem among women and children in Bangladesh, Cambodia,

Nepal and the Philippines. Helen Keller International has been implementing homestead food production (HFP) programs (coupled with nutrition education) in these countries to increase and ensure year-round availability and intake of micronutrient-rich foods in poor households, particularly among women and children. Between 2003 and 2007, the HFP program was implemented among ~ 30,000 households in these four countries. Data collected from representative samples taken for evaluations of HFP programs in these countries it will be illustrated the benefit of the program for households. Data were collected through interviews with households in villages that had the HFP program and from control households in non-HFP program villages. Blood samples collected from ~ 1000 children aged 6-59 months and ~ 1200 non-pregnant women before and after program implementation were analyzed for hemoglobin. The review showed that the HFP program significantly improved dietary diversification. The combined data from all four countries showed improved animal food consumption among program households, with liver consumption increasing from 24% at baseline to 46% at end line and the median number of eggs consumed by families per week increasing from 2 to 5. The sale of HFP products also improved household income. Anemia prevalence among children in program households decreased in all the countries; however, the decrease was only significant in Bangladesh and the Philippines. Although anemia prevalence also decreased among control households in three countries, the magnitude of change was higher in program households compared with control households.[16]

A study reviewed and summarized the effects of agricultural interventions to increase household food production on the nutrition and health outcomes of women and young children and provide recommendations for future research and programming. Although studies were too heterogeneous to conduct meta-analysis, agricultural strategies consistently reported significantly improved diet patterns and vitamin A intakes for both women

and children. Although some individual studies reported significant reductions in child malnutrition, summary estimates for effects on stunting [relative risk (RR) 0.93 [95% confidence interval (CI) 0.84, 1.04]], underweight (RR 0.80 [95% CI 0.60, 1.07]) and wasting (RR 0.91 [95% CI 0.60, 1.38]) were not significant. Findings for an effect on vitamin A status, anemia and morbidity were inconsistent. Overall the evidence base for the potential of agricultural strategies to improve the nutrition and health of women and young children is largely grounded in a limited number of highly heterogeneous, quasi-experimental studies, most of which have significant methodological limitations. While household food production strategies hold promise for improving the nutrition of women and children.[89]

A baseline cross-sectional survey shows that malnutrition was a problem of public health concern in the study sites. Stunting affected 24.4% of the 204 children assessed, 9.9% were underweight, 39.8% were anemic, while 37.9% were vitamin A deficient. Food selection patterns suggest that bananas were the major staple while beans were the major relish and protein source. Diets of children were limited in variety and possibly inadequate to support normal growth. The intervention was designed to change the caregivers' food selection patterns to ensure that young children get adequate calories and nutrients. Two groups of caregivers and their children participated in the intervention. One group of caregivers attended nutrition education classes whereas the controls concurrently participated in sewing classes that lasted 5 weeks. Children were weighed and measured each month for one year. Compared to controls, caregivers in the intervention group reported selecting an increased variety of grains, fats and sweets, legumes, meats, fruits and vegetables one month after the intervention (Time 2) and nine months later (Time 3). The intervention group also provided young children with more snacks than the controls at Time 2 (Mean: 1.26 versus 0.35, p = 0.000) and at Time 3 (Mean: 1.22 versus 0.58,

p = 0 .001), but no changes were observed in number of meals. Children in the intervention group also had improved vitamin A status (Mean change retinol binding protein concentration = 0.24 µmol/L versus 0.04 µmol/L) and growth (Mean weight-for-age: 0.61 ± 0.15 versus -0.99 ± 0.16, p = .038).[90]

An experimental study conducted on fifty randomly selected rural girls in Dharwad taluk where they distributed a textbook on foods and nutrition for distance education. The information on five food groups, nutritional requirements of different age groups, better cooking methods and low cost nutritional recipes were disseminated through the booklet. After a post-test after two months and two contact classes within the specified period, they revealed that there was a significant impact of distance education on the rural female school dropouts. The correlation coefficient showed that the mass media participation and education were significantly related to gain in knowledge of health and nutrition.[91]

A cross sectional study showed that an improvement in the nutrition knowledge of the subjects about juvenile diabetes after nutrition counseling. The improved knowledge lead to better practices which in turn lead to improvement in the blood glucose level, thereby making nutrition counseling as an effective measure for bringing favorable and significant changes.[92]

A study elucidated the effectiveness of teaching nutrition education in various settings that can positively reinforce and support health messages. According to them, by integrating nutritional concepts in physical education classes, students can make better understanding of concepts related to caloric intake and expenditure and further demonstrated improved dietary behaviors and more correct health and food beliefs.[93]

An experimental study was assessed the impact of nutrition education intervention in rural adolescent girls and concluded that nutrition education can be one of the relevant, effective and sustainable strategies to combat anaemia. The student t-test showed a significant difference in the mean knowledge within the experimental group.[94]

A study was conducted nutrition educational intervention using classroom counseling with the objective to improve the knowledge as well as practice of adolescents with regard to consumption of fruits and vegetables. After seven intervention sessions a highly significant difference was obtained in the knowledge regarding the benefits of fruits and vegetables consumption.[95]

A study concluded that the nutrition education intervention in Bangalore improved nutrition knowledge of children and their parents which in turn improved their food behavior and dietary diversity. A significant improvement was evident in diversity of food selection and reduction in the number of families watching television during meals and snacks.[96]

A review included 23 studies, mostly evaluating home garden interventions. The studies reviewed did not report participation rates or the characteristics of participants in programmes. The interventions had a positive effect on the production of the agricultural goods promoted, but not on households' total income. The interventions were successful in promoting the consumption of food rich in protein and micronutrients, but the effect on the overall diet of poor people remains unclear. No evidence was found of an effect on the absorption of iron, but some evidence exists of a positive effect on absorption of vitamin A. Very little evidence was found of a positive effect on the prevalence of stunting, wasting, and underweight among children aged under 5.[97]

A study assessed the additional benefits of a homestead gardening program designed to control vitamin A deficiency in Bangladesh. In February and March 2002, data were collected on the food security and social status of women from 2,160 households of active and former participants in the gardening program and from control groups in order to assess the impact and sustainability of the program. The proportions of active and former-participant households that gardened year-round were fivefold and threefold, respectively, higher than that of the control group (78% and 50% vs. 15%). In a three-month period, the households of active participants produced a median of 135 kg and consumed a median of 85 kg of vegetables, while the control households produced a median of 46 kg and consumed a median of 38 kg ($p < .001$). About 64% of the active-participant households generated a median garden income of 347 taka (US$1 =51 taka), which was spent mainly on food and 25% of the control households generated 200 taka in the same period ($p < .001$). The garden production and income levels of formerly participating households three years after withdrawal of program support were much higher than those of the control households, illustrating the sustainability of the program and its ability to increase household food security. Significantly more women were active and former-participant households than in control households perceived that they had increased their economic contribution to their households since the time the program was launched in their sub districts (> 85% vs. 52%). Similar results were found for the level of influence gained by women on household decision-making. These results highlight the multiple benefits that homestead gardening programs can bring and demonstrate that these benefits should be considered when selecting nutritional and development approaches targeting poor households.[98]

A food-based strategies such as homestead food production have the potential to increase micronutrient intake and improve the health and nutritional status of nutritionally at-risk women and children through

various pathways, including increased household production for own consumption, increased income from the sale of products and improved social status of women through greater control over resources.[99]

A study carried in Bangladesh, Helen Keller International (HKI) is known for its homestead food production (HFP) programme, which promotes small-scale agriculture among women, specifically to improve women's and children's nutrition outcomes, including dietary diversity and knowledge of maternal self-care and infant-young child feeding practices. To achieve these aims, the programme focuses on women's empowerment. This article presents some of the challenges and opportunities involved in a programme in which gender equity is intrinsically recognized as a social justice goal, as well as a foundation for nutrition and food security gains.[100]

A prospective randomized trial was carried out to test the efficacy of a specific intervention for reducing the extent of their malnutrition and to change behaviour of mothers relating to child-feeding practices, care-giving and health-seeking practices under the Bangladesh Integrated Nutrition Project (BINP). The study was conducted in rural Bangladesh among 282 moderately-malnourished (weight-for-age between 61% and 75% of median of the National Center for Health Statistics standard) children aged 6-24 months. Mothers of the first intervention group received intensive nutrition education (INE group) twice a week for three months. The second intervention group received the same nutrition education, and their children received additional supplementary feeding (INE+SF group). The comparison group received nutrition education from the community nutrition promoters twice a month according to the standard routine service of BINP. The children were observed for a further six months. After three months of interventions, a significantly higher proportion of children in the INE and INE+SF groups improved (37% and 47% respectively) from moderate to mild or normal nutrition compared to the comparison group

(18%) ($p<0.001$). At the end of six months of observation, the nutritional status of children in the intervention groups improved further from moderate to mild or normal nutrition compared to the comparison group (59% and 86% vs 30%, $p<0.0001$). As the intensive nutrition education and supplementation given were highly effective, more children improved from moderate malnutrition to mild or normal nutritional status despite a higher incidence of morbidity. The frequency of child feeding and home-based complementary feeding improved significantly ($p<0.001$) in both the intervention groups after three months of interventions and six months of observation. Body-weight gain was positively associated with age, length-for-age, weight-for-length, frequency of feeding of khichuri, egg, and potato ($p<0.05$). Ability of mothers to identify malnutrition improved from 15% to 99% in the INE group and from 15% to 100% in the INE+SF group, but reduced from 24% to 21% in the comparison group. Use of separate feed pots, frequency of feeding, and cooking of additional complementary feeds improved significantly in the INE and INE+SF groups compared to the comparison group after three months of interventions and six months of observation. It can be concluded from the findings of the study that intensive nutrition education significantly improves the status of moderately-malnourished children with or without supplementary feeding.[101]

A study determined the impact of a community-based nutrition education programme, using trained community nutrition advisors, on the anthropometric nutritional status of mixed-race children aged between 2 and 5 years. The programme was implemented over two years in four study areas in the Free State and Northern Cape Provinces. Two control areas were included to differentiate between the effect of the education programme and a food aid programme that were implemented simultaneously. Initially 536 children were measured and, after two years of intervention, 815. The education programme in combination with food aid

succeeded in improving the weight status of children, but was unable to facilitate catch-up growth in stunted children after two years of intervention.[102]

A study displayed that about 100 children with goiter from a region with low iodine in diets were given iodized oil or plain mineral oil. Both groups were studied for intelligence (Stanford Binet and Bender tests). After 22 months, urinary iodine had increased in the treated group. Those who showed goiter reduction (regardless of treatment or control group) showed improvements in overall IQ. The effect was strongest in girls. Correcting iodine deficiency may improve mental performance.[103]

Another study revealed that 86 school children (age 11 – 13) were randomly given either vitamin and mineral supplements or placebo for 7 months. A nonverbal performance test of reasoning was studied. A small, nonsignificant difference between the control and supplementation groups was found in a nonverbal test. Vitamin and mineral supplementation does not improve the performance of school children in tests of reasoning.[104]

A study showed that 208 children (12-16 years of age) were matched with 205 controls for age, sex, and IQ. Treated group received iron and ascorbic acid for 16 weeks. An initial correlation between hemoglobin levels and IQ was found to be small but significant. There was no significant difference between treatment and control groups, excepting for those with low ferritin (measure of iron). In this group, the treated group gained 3 IQ points, whereas the placebo group lost 2 IQ points.[105]

In the experimental village, 126 home gardens were established, representing approximately one-third of the households. Serum retinol concentrations in the experimental village increased significantly (p = 0.0078), whereas those in the control village decreased significantly (p =

0.0148). At follow-up, children from the experimental village consumed yellow and dark-green leafy vegetables more often and had significantly higher (p = 0.005) serum retinol concentrations (0.81 ± 0.22 mol/L; n = 110) than did children from the control village (0.73 ± 0.19 mol/L; n = 111). Maternal knowledge regarding vitamin A improved significantly in the experimental village (p = 0.001).[106]

Relationships between nutrition and brain function have been the focus of much research. Studies have shown the impact of dietary foundations on normal brain functions. Chemical messengers within the brain called neurotransmitters have been studied in conjunction with nutrition. Growden and Wurtman suggested that the brain can no longer be viewed as an autonomous organ, free from other metabolic processes in the body; instead, the brain needs to be seen as being affected by nutrition, the concentration of amino acids and choline (in the blood) which let the brain create and use many of its neurotransmitters such as serotonin, acetylcholine, dopamine, and norepinephrine. Food consumption is vital to the brain being able to make the right amount of amino acids and choline. These are two precursor molecules obtained from the blood that are needed for the brain to function normally.[107] It is no surprise that what we eat directly influences the brain.[108]

Wood cited Kretsch et al. showed further possibilities that our nutrition has a role with affecting our cognitive functioning. Studies have been done with school-aged children and point to a direct correlation between poor nutrition and lowered school performance. Iron has also been shown to play an important role in brain function as well. Kretsch et al. cited details from a study done with men aged 27 to 47 that looked at iron and its effect on concentration. Low scores on a concentration test corresponded with lowered levels of iron in the bodies of the subjects. A connection was made between low iron levels in children with attention span; children with iron

deficiency anemia have been shown to have short attention spans. Kretsch et al. also found that zinc was another nutrient that had a role with cognition, specifically with memory. In a test of mental function called verbal memory, scientists found that volunteers' abilities to remember everyday words slowed significantly only after three weeks of a low-zinc diet.[109]

Erickson pointed out five key components, based on research, required to keep the brain functioning correctly. The substances, all found in food, are important to brain development and function. Proteins are found in foods such as meat, fish, milk, and cheese. They are used to make most of the body's tissues, including neurotransmitters, earlier identified as chemical messengers that carry information from brain cells to other brain cells. A kck of protein, also known as Protein Energy Malnutrition, led to poor school performance by children and caused young children to be lethargic, withdrawn, and passive, all of which help affect social and emotional development.

Carbohydrates are commonly found in grains, fruits, and vegetables. Carbohydrates are broken down into glucose (sugar) which is where the brain gets its energy. Fluctuating levels of carbohydrates may cause dizziness and mental confusion, both of which can affect cognitive performance. Eating a carbohydrate-heavy meal can cause one to feel more calm and relaxed because of a brain chemical called serotonin and its effect on mood. Serotonin is created within the brain through the absorption and conversion of tryptophan. Tryptophan is absorbed within the blood and this absorption is enhanced with carbohydrates.

Erickson also noted that fat makes up more than 60% of the brain and acts as a messenger in partial control of aspects such as mood. Omega-3 fatty acids are very important to the optimum performance of the brain and a lack

of these fats can lead to depression, poor memory, low IQ, learning disabilities, dyslexia, and ADD. Important foods to consume to ensure an Omega-3 fatty acid diet are certain fish and nuts.

Erickson discussed vitamins and minerals as an important substance for the functioning of the brain. Most important are the vitamins A, C, E, and B complex vitamins. Manganese and magnesium are two minerals essential for brain functioning; sodium, potassium and calcium play a role in message transmission and the thinking process. Aforementioned in the research, neurotransmitters are crucial to brain function in the transferring of messages. Erickson stated research that shows nutrition is important to the production of key neurotransmitters such as acetylcholine, dopamine, and serotonin.[110]

Furthering the research supporting nutrition and its effects on cognition, Wolpert and Wheeler cite research done by Gomez-Pinilla, a UCLA professor of neurosurgery and physiological science. According to the article, diet, exercise and sleep have the potential to alter brain health and mental function. Gomez-Pinilla stated that it stands to reason that changes in diet could be used to enhance cognitive abilities. His research has shown that Omega-3 fatty acids such as those found in salmon, kiwi fruit, and walnuts, provide many benefits in improving memory and learning, much of which occurs at the synapses. Omega-3 fatty acids support synaptic plasticity and seem to positively affect the expression of several molecules related to learning and memory that are found on the synapses. Omega-3 fatty acids are essential for normal brain function. The article states that a deficiency in Omega-3 fatty acids can lead to increased risk of attention-deficit disorder and dyslexia. According to Gomez-Pinilla, children who had an increase of Omega-3 fatty acids performed better in reading, spelling, and had fewer behavioral problems.

Wolpert and Wheeler also highlighted a study in England that found school performance improved among a group of students receiving Omega-3 fatty acids. The article also tells of an Australian study of 396 children between the ages of 6 and 12 who were given drinks with Omega-3 fatty acids along with other nutrients like iron, zinc, folic acid and vitamins A, B6, B12, and C. These students showed higher scores on tests measuring verbal intelligence, learning skills and memory after six months and one year as compared to a control group of students who did not receive the drink.

In the Wolpert and Wheeler article, Gomez-Pinilla suggested that diets high in trans fats and saturated fats negatively affect cognition. These trans fats are found in common fast food and most junk foods. Through these trans fats, junk food affects the brain synapses as well as many molecules that aid in learning and memory. A diet low in trans fats and high in Omega-3 fatty acids can strengthen synapses and provide cognitive benefits.[111]

Wolfe and Burkman cited research that confirmed proper nutritional support is important to allow the brain to function at its highest ability and to enhance learning. Wolfe and Burkman suggested that it didn't take much complication or obscurity through expensive foods and supplements to help students reach their potentials; healthful nutritional habits learned early in life help endure normal physiological and neurological growth and development, which translated into students' achieving optimal learning, defined as the abilities to recall information, to problem solve and to think critically. Wolfe and Burkman pointed out the importance of utilizing the Food Guide Pyramid for Young Children, which is an adaptation of the Food Guide Pyramid from the U.S. Department of Food and Agriculture. This food guide focuses on food preferences and nutritional requirements of young children and needs to be the foundation of their diets.

Wolf and Burkman stated several dietary components support brain function and neurotransmitter activity and that scientists recommend a wide range of foods as nutrient sources; the most important known today are protein, fat, B vitamins, iron, chlorine and antioxidants. Offering students the right food choices and helping them develop positive, healthy eating habits will support optimal functioning of the brain. Eating breakfast helps students to eliminate or reduce stomach pain, headache, muscle tension and fatigue, all which lead to an interference with learning. School personnel have the perfect access to students' breakfast eating habits and need to utilize the opportunity to teach students good breakfast eating habits, whether at school or home. The negative impact of skipping a meal is also highlighted by Wolfe and Burkman. Without an adequate daily intake of nutrients from food, the body puts learning on a lower shelf below its need to sustain life-support functions. Therefore, in many cases, skipping a meal negatively affected the body and its learning functions. Wolfe and Burkman concluded that as many as half of low-income elementary students skipped breakfast and that children who eat a good breakfast at school perform better on standardized tests. Also, they found that children who eat breakfast have improved attention in late-morning performance tasks, retrieve information more quickly and accurately, make fewer errors in problem-solving activities and concentrate better and perform more complex tasks. Also, what the child eats for breakfast is important. A breakfast comprised of protein, fat, and sugar will prevent drops in blood sugar for several hours, whereas, as breakfast of just starch and sugar will sustain a child for only about two hours. A meal that included food from several food groups was the best for a child who was expects to perform at his or her best in school, educationally and physically. Wolfe and Burkman called attention to school food programs and contend that such programs need support, not disdain. Every lunch must contain at least one-third of the Recommended Daily Allowance (RDA) for specific key nutrients and every breakfast must contain one-fourth of the RDA for specific nutrients. School

meals must conform to the U.S. Dietary Guidelines and on a weekly average, no more than thirty percent of the calories can be from fat. To sum up Wolfe and Burkman's findings, the performance possibilities of children are very dependent upon their health and well-being; minds that have been given the proper nutrition will perform better on tests and general classroom tasks.[112]

Lahey and Rosen furthered the research that nutrition affects learning and behavior and suggested that diet can influence cognition and behavior in many ways, which include the condition of not enough nutrition or the condition of the lack of certain nutrients. About one-third of children who completed a food-habit questionnaire had inadequate fruit and vegetable intake. These students also showed poor school performance as compared to those students who had an adequate intake of fruits and vegetables.[113]

Zhang, Hebert and Muldoon looked specifically at fats in the American diet, as the customary diet of American children and adults is high in total fat, saturated fat and cholesterol. Zhang et al. sought to identify associations with fat intake and psychosocial and cognitive functioning in U.S. school-aged children, since it had been unclear whether and how specific fats may affect social and cognitive development. Data was used from the Third National Health and Nutrition Examination Survey (NHANES III). Medical and cognitive examinations and interviews were conducted with children and proxy respondents. A total of 5,367 children aged 6-16 participated in the Household Youth Interview. After attrition, a total of 3,666 children remained for the analyses.[114]

Kar, Rao and Chandramouli examined the effect of stunted growth on the nature of cognitive impairments and on the rate of cognitive development. The study investigated if malnutrition would result in a concentrated impairment and a general slowing in the rate of development of all

cognitive processes or these effects could be present for some specific cognitive processes. Effects of malnutrition on cognitive processes were also looked at in relation to impairment without affecting the rate of development and its effect on the rate of development of the cognitive process itself. The participants were identified as being malnourished or adequately nourished in the age groups of five to seven-year olds and eight to ten-year olds.

Students in the malnourished group were identified by their height (stunting) and weight (wasting) of children in the same age categories with reference to the national center of health statistics (NCHS). Height for age/weight for height score less than two standard deviations from the mean were considered an indicator for moderate to severe malnutrition. Adequately nourished students were identified as children who were in or above the 50th percentile of height and weight as stated by the NCHS standards. Adequately nourished students were paired with malnourished students with respect to age and grade level. Each group had 20 participants.

Kar et al. compared the performance of adequately nourished children to malnourished children and also compared age related differences in cognitive function and found that the malnourished children differed from the adequately nourished children on tests of phonemic fluency, design fluency, selective attention, visuospatial working memory, visuospatial functions, verbal comprehension and verbal learning and memory. Results for the verbal fluency test show adequately-nourished children achieved higher mean scores in both age categories, five to seven- year olds and eight to ten- year olds (4.3 and 5.7 respectively), when compared to their malnourished counterparts (1.36 and 4.4 respectively). Some of the other results had similar findings such as visual construction adequately nourished in both age categories (10.0 and 15.8) score higher than

malnourished students (3.0 and 4.8) in the same age categories and also for verbal learning (32.4 and 42.3 vs. 26.9 and 30.7). These results show age related differences within each group as well as between the two age groups. Kar et al. also found a lack of age-related improvement in malnourished children when looking at cognitive functions of attention, cognitive flexibility, visuospatial construction, ability and verbal learning. Malnourished students showed lower results than the adequately nourished students but they showed age related improvement for these same functions. Differences were tested for statistical significance. Test scores for adequately nourished children between 5 to 7- years olds and 8 to 10- year olds were found significant but most of the test scores for undernourished children showed a delay in development of certain cognitive functions.[115]

Li, Dai, Jackson and Zhang examined the associations between academic performance, cognitive functioning and increased BMI. They studied a nationally representative sample of 2,519 children ages eight to sixteen years old. Each participant had completed a brief neuropsychological battery and measures of height and weight. Trained examiners administered tests in a standardized environment using uniform procedures. Body weight was measured to the nearest 0.05 kg and height was measured to the nearest 0.1 cm. BMI was calculated in kilograms per meter square and then converted to a sex and age specific BMI percentile. Each participant was then categorized to an overweight BMI, an at-risk BMI or a normal BMI. Parent-reported measures of children's TV watching habits were also surveyed. Children were asked to report how many times per week they played or exercised enough to sweat or breathe hard. This question did not exclude school involvement, but another question about sports and exercise did. Children were then categorized as a participation group or nonparticipation group. Blood pressure, cholesterol, serum triglycerides levels and iron deficiency were also observed. Iron deficiency has been known to be associated with poor cognitive function and a high occurrence

of iron deficiency was observed among overweight and obese children and adolescents.

The average age of participants was 12 and they were about equally divided in gender. The subjects included differed on most of the characteristics from the subjects excluded. Those excluded were likely to be non-white and come from families with a low socioeconomic status. Among the subjects 20.33% were classified as overweight and 15.92% were obese. Li et al. found the association between BMI, cognitive functioning, and academic performance to be noteworthy. Test scores decreased as BMI on increased. The block design test had the greatest discrepancy among participants with 5.04% of normal weight children scoring poorly, 9.19% of at-risk children scoring poorly, and 12.18% of obese children scoring poorly. Test scores were defined as poor when they were less than 2 standard deviations from the mean. The odds of poor performance in visuospatial organization and general mental ability were doubled among at-risk children and tripled among overweight children when compared to normal weight children.

Academic performance was measured by a test designed to assess basic school performance. Li et al. observed that being overweight was not the root cause of poor academic performance but found that obese adolescents consider themselves worse students. Another result from the study was that decreased cognitive function was associated with increased weight status. Cognitive deficits on tests of motor speed, weakened performance on motor speed and manual dexterity and executive function were found. Poor performance on memory tasks was also common among obese people. Those with poorer cognitive ability may do worse in school and opt for a lifestyle that promotes weight gain. This study verified that this association may exist among overweight children or children at-risk of being overweight without clinically diagnosed diabetes mellitus, vascular disease or cardiac disease that often characterize adult patients. Li et al also found a

relationship with decreased block design and weight. Block design is a measure of visuospatial organization and general mental ability which has been shown to be sensitive to brain damage. Results showed that the unfavorable effects of increased body weight on cognitive function start showing as early as childhood. Cognitive function decline may occur in younger persons and findings show an increase body weight worsens other risks factors for cardiovascular disease as time passes.[116]

One of the most concerning outcomes of iron deficiency in children is the change of behavior and cognitive performance. Halterman, Kaczorowski, Aligne and Szilagyi looked at the relationship between iron deficiency and cognitive test scores among school-aged children and adolescents. The objective of this study was to evaluate the relationship between iron deficiency and standardized test scores among six to 16-year-old US children. This relationship was considered for both children who had iron deficiency with anemia and for children who had iron deficiency without anemia.

The National Health and Nutrition Examination Survey III (NHANES III) provided cross-sectional data for 5,398 children aged six to 16 and contained measures of iron status including transferrin saturation, free erythroirin status, protoporphyrin and serum ferritin. Children were considered iron-deficient if any two of these variables were abnormal for their age or gender. Status hemoglobin values were used to detect anemia.

Among the 5,398 children in the study, 3% were iron deficient. This translated into 1.2 million school-aged children and adolescents in the United States who have an iron deficiency. Iron deficiency with or without anemia was determined for children with different age, gender and demographic characteristics. Iron deficiency without anemia was more widespread than was iron deficiency with anemia. Iron deficiency was less

than three percent among six to 11-year-old children. Among 12 to 16-year-olds, iron deficiency was common among 8.7% of females, but only 0.9% of males.

Halterman et al. examined results from the Standardized Test and found a trend of lower scores with diminishing iron status. This trend was most evident in math. Math scores were lower for the iron-deficient children without anemia compared to normal iron status children. Children with anemia also had lower math scores when compared to children with normal iron status. Seventy-one percent of children with an iron deficiency scored below average in math as well as 72% of children with anemia. Only 49% of children with normal iron status scored below average. There were no real discrepancies found among these students with reading, block design and digit span but children with normal iron status performed better. Results from this comparison were adjusted for age, gender, race, poverty status, caretaker education and lead status.[117]

Chapter 3

Materials and Methods

3.1 Materials and Methods

3.1.1 Study design

An intervention (quasi – experimental) study was conducted among 1214 secondary school students (class six to ten) of six selected high schools of Kishoreganj district during August 2014 to May 2015 to investigate their school performance, KAP score, food intake pattern, food security, nutritional status and to execute a nutrition education and homestead food production program to evaluate the changes in these variables. Socio-demographic status of them was also observed. The locations were selected purposively.

Two groups of school students were selected using a selection criteria for the intervention with nutrition education as well as nutrition education and inputs of homestead food production. The group who received only nutrition education were named as study group 1 (n = 406); whereas the group who received nutrition education along with homestead food production inputs, were named as study group 2 (n = 400). They were followed up to 6 months along with a control group (n = 408). Each group consisted of total participants of two schools out of six schools.

3.1.2 Sample size and Sampling

Sample size determination

In this intervention study, KAP (knowledge, attitude and practice) score was defined as primary variable. During literature review, no intervention study was found where nutritional knowledge and homestead food production inputs were provided to the subjects of the study. To calculate final sample size we conducted a pilot study which aimed to estimate the KAP score among the students of the six selected schools. The six schools were selected upon prior communication and the authorities of the schools agreed to conduct the intervention study. A total of 96 students (2 boys and 2 girls form each class e.g. six, seven, eight, nine; 16 in 1 school and 96 in 6

schools) were surveyed for the demographic and KAP part of the questionnaire. The result of the pilot study was-

Name of the schools in Kishoreganj district	KAP score % (obtained score out of 35)	Group Name
Umed Ali Bhuiya High School	56 (19.5)	Study group 2
Sahilati High School	63 (22)	Control group
Purura High School	57 (20)	Study group 1
Mahinanda High School	56 (19.5)	Study group 2
Guuzadia Abdul Hekim Secondary School	61 (21.5)	Study group 1
Talzanga RC Roy High School	63 (22)	Control group

Considering the social implication and to maximize the benefits for the subjects, the groups were set according to their KAP score. The schools with lowest KAP score were kept in study group 2 and got nutrition education and homestead food production inputs. Then the better performing schools in term of KAP score were kept in study group 1, who got only nutrition education and the highest KAP scoring schools were kept in control group; got no intervention.

The KAP score according to the type of group was as follows-

Type of Group	KAP score %
Control group	63
Study group 1	59
Study group 2	56

According to YH Chan the study determined the success of the study as dichotomous e.g. success or failure. The study determined 10% improvement in the group with lowest KAP score of 56% will be the success of the intervention of the study. YH Chan suggested this equation of sample size calculation in the article published in 2003.[118]

$$\text{Sample size per group} = c \times \frac{\pi 1(1-\pi 1) + \pi 2(1-\pi 2)}{(\pi 1 - \pi 2)^2}$$

Where, c = 7.9 for 80% power and 10.5 for 90% power, $\pi 1$ and $\pi 2$ are the proportion estimates.

In the study, power was set at 80% and $\pi 1 = 0.56$, $\pi 2 = 0.66$

$$\text{Sample size per group} = 7.9 \times \frac{0.56(1-0.56) + 0.66(1-0.66)}{(0.56-0.66)^2}$$

$$= 371.3$$

Considering 5% non-response rate,

$$\text{Sample size per group} = 371.3 \times 1.05$$

$$= 389.86$$

$$= 390$$

But, to be on safe side the study considered a sample size of 400 per group and a total of 1200. However, the subjects for pilot study were not considered for the final study.

Alternatively, we also used R package[119] to calculate the sample size. It was found from R that, a sample size of 371 per group in the study would give 80% power. In the R package, the following command was used- power. prop. test (p1 = 0.56, p 2 =0.66, power = 0.8) $n.

Where, p1 = the lowest proportion of KAP score, p2 = the desired proportion of KAP score, power = power of the study set at 80% and n= sample size per group.

However, as the sample size was like the previous method, we finally designed our study with 400 samples per group.

3.1.3 Sample selection criteria

Inclusion criteria

i. Rural school children of classes six to ten (Age between 10 to 17 years).

ii. Subjects who never received any type of nutrition education and whose families never involved in any kind of homestead food production.

Exclusion Criteria

i. Subjects who received any type of nutrition education and whose families involved in any kind of homestead food production.

3.1.4 Time Frame

The baseline and the follow up data were collected including conduct of nutrition education sessions and inputs of HFP (Homestead Food Production) between August 2014 to May 2015.

3.1.5 Development of Questionnaire

A questionnaire was developed to obtain relevant information on the socio-demographic conditions, food intake pattern, nutritional knowledge, food security and school performance. A face to face interview of the subjects was conducted with the structured questionnaire.

3.1.6 Procurements of consents

The purpose and nature of the study was explained to each participant and after getting their verbal consent, they were recruited in the study.

3.1.7 Collection of Data

Socio-economic and demographic information

Parents education, parents occupation, monthly family income, family size, living arrangement, housing pattern etc. were procured through direct interview and parents were also asked to complete this form.

KAP related information

For adjudging the existing level containing list of questions pertaining to food belief, fads and fallacies as well as constituent of balanced diet, functions of food, food hygiene and sanitation etc. were procured through direct interview. For evaluating the level of nutritional knowledge 1 score was awarded for right, o for wrong and 0.5 for partially correct answer for each question.

Suggested levels indicating the need for a nutrition education intervention

Nutrition education strategy	Percentage of "correct answers" in survey population
is urgent	≤ 70
should be considered	71-89
is not needed or difficult to justify	≥ 90

Source: Peter Glasauer, personal communication.[120]

Food security related information

Household Food Insecurity Access Scale (HFIAS) questions were asked with a recall period of four weeks (30 days). The respondent was first asked an occurrence question- that is, whether the condition in the question happened at all in the past four weeks (yes or no). If the respondent answered "yes" to an occurrence question, a frequency-of-occurrence question was asked to determine whether the condition happened rarely (once or twice), sometimes (three to ten times) or often (more than ten

times) in the past four weeks. Where the answer to the corresponding occurrence question was "no" then code was "o". When the answer was "rarely" "sometimes" or "often" the code was "1", "2" and "3" respectively. By summing the codes for each frequency-of-occurrence question, a HFIAS score variable was calculated. The higher the score, the more food insecurity the household experienced. The lower the score; the less food insecurity a household experienced.[121]

Anthropometric measurement

Anthropometric parameter (height, weight and BMI) was determined by standard anthropometric method.[122]

Height – Height of the subjects was measured with a locally constructed portable height scale made of steel sheet to the nearest 0.1 cm in standing up straight without assistance and wearing minimum clothing, with bare heels close together, legs straight, arms at the sides and shoulders relaxed, looking straight ahead.

Body weight – A digital "Bathroom Scale" (TANITA, Japan) was used to record body weight. Body weight was recorded to the nearest 0.1 Kg on bare foot with minimum clothing. The weighing scale was checked for performance everyday before use.

Body mass index (BMI) – Body mass index (BMI) was calculated from the body weight and height of the subjects using the following formula:

$$\text{BMI} = \frac{\text{Weight of the subject in Kg}}{(\text{Height of the subject in meter})^2}$$

Z – Scores were calculated for BMI–for–age according to 2007 WHO Reference for 5–19 years old children to identify the nutritional status of respondents.[123]

$$Z - score = \left(\frac{Observed\ value - median\ reference value}{Standard deviation\ of\ reference population} \right)$$

Classification of Nutritional Status according to Z-score

Range	Category
≤-3SD	Severely malnourished
-2 SD to – 2.99 SD	Moderate malnourished
- 1 SD to – 1.99 SD	Mild malnourished
>1 SD to + 2SD	Normal
+ 2 SD to + 3 SD	Over Nutrition
> +3 SD	Obese

Sample collection and biochemical measurements

Blood sample was collected from each of the participants for analysis of biochemical indices. Trained personnel were engaged for the purpose of drawing blood samples. Five ml of venous blood was drawn by one time use disposable syringe and collected into EDTA tube. After thorough mixing the tubes were kept into racks. Serum samples were then transported into cooler box.

Laboratory analysis

Analyses of hemoglobin and serum ferritin were done on the same day of blood collection in the Institute of Kidney Diseases and Urology laboratory.

Estimation of hemoglobin

Hemoglobin concentration was determined by cyanmethemoglobin method[124] using a commercial kit (Boehringer Mannheim, Germany).

Procedure: An aliquot of 20 μl blood was added to 5 ml Drabkin's solution. It was then mixed well by vortex mixture and incubated at room temperature for at least 3 min. The absorbance was measured at 540 nm against a reagent blank.

Estimation of serum ferritin

Serum ferritin level was estimated by enzyme – linked immuno sorbant assay (ELISA) method[125,126] using a commercial kit (Bio check, Inc).

Procedure: An aliquot of 20 μl serum samples were dispensed into appropriate wells and 100 μl of Enzyme Coagulate Reagent were also dispensed into each well. After 45 min. incubation at room temperature, the wells were washed with deionized water to remove unbound – labeled antibodies. A solution of TMB Reagent was added and incubated at room temperature for 20 min., resulting in the development of a blue color. The color development was stopped with the addition of Stop Solution and the color was changed to yellow and measured spectrophotometrically at 450 nm.

Normal range of hemoglobin by WHO (World Health Organization)

Age or gender group	Hemoglobin (g/dl)*
Children 10-11 years	11.5 and higher
Children 12-14 years	12 and higher
Girls 15-18 years	12 and higher
Boys 15-18 years	13 and higher

*** Hemoglobin level below this value dictates anemic condition**

Normal range of serum ferritin by WHO (World Health Organization)

Age or gender group	Serum ferritin (ng/ml)*
More than 10 years of age (Both boys and girls)	15 and higher

*** Serum ferritin level below this value dictates depleted iron store in body.**

School performance related information

Total obtained marks of examination, No. of hours studying at home, completion of homework in time and attendance were collected to see the school performance of the participants. Marks and attendance were collected from the records of schools administrations.

Collection of data on dietary intake and dietary assessment

Dietary data was collected by a 24 hour dietary recall along with a seven days food consumption frequency.

Dietary assessment

Dietary intake of the participants was assessed using 24 hour recall method and details of all foods and drinks consumed by the participants were recorded. The participants were informed the day before data collection for the memorization of their dietary intake of that day. The participants were shown various standards of utensils, such as measuring cups, spoons, glasses, plates and models of different foods to get nearest possible serving sizes of the food consumed. From this information the serving weight of different food items were calculated. Equivalent raw food weight was calculated by using a conversion table for Bangladeshi foods formulated in the Institute of Nutrition and Food Science.[127] Food Composition Table for Bangladesh was used to calculate the intake of nutrients from foods on the basis of raw weight.[128] The adequacy of the intake of nutrients was assessed by comparing with recommended dietary allowances.[129,130,131,132]

A food frequency questionnaire (FFQ) was used to collect information on the weekly consumption of 8 food groups (cereals, pulse, fruits & vegetables, green leafy vegetables, fats and oils, meat and fish, egg and milk & milk products)[133] that consist of the most commonly consumed foods in Bangladesh. Each participant was required to report their usual consumption frequency as the number of time per week. It was used to obtain information about the dietary diversity score of each participant.

3.1.8 Contents and procedure of nutrition education

A lesson plan of nutrition education was structured to determine the educational content of each session. The purpose of this lesson plan was to provide a targeted and systematic nutrition education to improve the education quality. Students in the intervention groups received twelve 45 minutes sessions during a six-month period. Around 50 students (25 boys and 25 girls) were in each group.

Lesson plan of nutrition education

Session Title	Nutrition Education Materials
1. Definition of food and its general function in the body	Booklets
2. Easily available common nutritious foods	Posters & booklets
3. Basic food groups	Practical food demonstration
4. Balanced diet	Practical food demonstration
5. Malnutrition related diseases and their preventive foods	Posters and practical food demonstration
6. Extra need for adolescents	Posters & leaflets
7. Iodized salt (importance & testing)	Posters
8. Personal hygiene & sanitation	Booklets & leaflets
9. Homestead food production	Posters
10. Safe food	Booklets & leaflets
11. Rememberable informations on nutrition	Posters
12. Review (the materials presented in the past sessions were recounted and summarized)	A question-answer session

3.1.9 Inputs giving of Homestead food Production (HFP)

To implement HFP program, families of study group 2 received some selected inputs (seeds, seedlings, fertilizer, chicks and fry) along with nutrition messages.

Inputs	Sample given
Seeds	Lalshak, Puishak, Mistikumra, Dheros, Begun, Lau (1+1+1+1+1+1=6 Packets)
Seedlings	Peyara, Papaya (1+1=2)
Fertilizer	Organic fertilizer (2 packets)
Chicks	One to one and half months old chicks (2)
Fry	Grass carp, Gonia, Carfu (50+50+50=150)

3.1.10 Follow up history

After the collection of baseline data and HFP input giving, the participants of study group 2 were followed up by visiting households of them fortnightly for 6 months. These participants were from Shahbag, Vatgaon, Jalalpur and Chawdhuryhati villages of Kishoreganj district. During the follow up period the parents of the participants were asked about the effectiveness of homestead food production inputs, whether their children ate those or not and whether they earned something from those and also their homestead gardens were monitored.

3.1.11 Statistical Analysis

All of the statistical analysis and all other data processing were done by using IBM SPSS 20 version windows program. For tabular, charts and graphical representation, Microsoft Word and Microsoft Excel were used. Comparative analysis between data from baseline and after six months was done by paired *t*-test. ANOVA test was done to see the significance level of academic performance between the groups. In all statistical tests, *p* values of less than or equal to 0.05 were considered significant.

Chapter 4

Results

4.1 Results

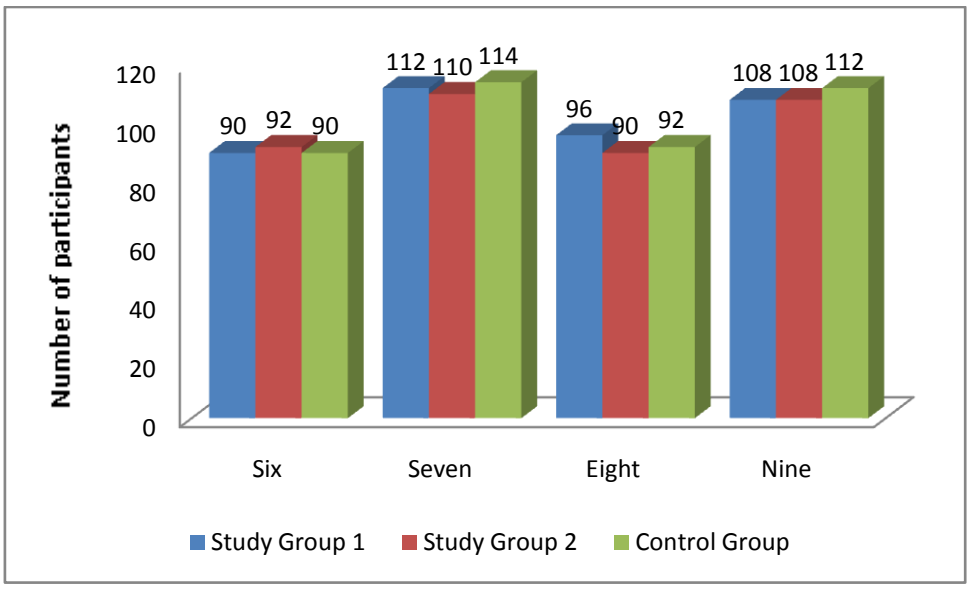
The gender characteristics of the participants are described in table 1. Almost equal number of boys and girls were recruited in each group.

Table 1: Distribution of the respondents' gender by different groups

Gender	Study Group 1		Study Group 2		Control Group	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Boys	205	50.5	199	49.5	204	50.0
Girls	201	49.5	201	50.5	204	50.0
Total	406	100.0	400	100.0	408	100.0

The participants in the study were recruited from four classes who maintain the adolescent age status. Almost equal number of participants were recruited from each of the classes in three groups (figure 1).

Figure 1: Classes of students by different groups



While looking at the occupation of the participants' fathers, we found most of them were farmer (52.7%, 71.3% and 61.3%) or doing business (26.8%, 17% and 19.6%) in study group 1, study group 2 and control group respectively (table 2).

Table 2: Distribution of the respondents fathers' occupation by different groups

Father's occupation	Study Group 1		Study Group 2		Control Group	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Farmer	212	52.7	278	71.3	244	61.3
Fisherman	2	0.5	2	0.5	6	1.5
Small business	44	10.9	42	10.8	18	4.5
Day labourer	26	6.5	14	3.6	10	2.5
Rickshaw puller or Van driver	12	3.0	0	0	14	3.5
Motor car driver	8	2.0	6	1.5	8	2.0
Service	30	7.5	20	5.1	32	8.0
Business	64	15.9	24	6.2	60	15.1
Others	4	1.0	4	1.0	6	1.5

Almost all the participants' mother were housewives (95%, 96.9% and 93.5% in study group 1, study group 2 and control group respectively) (table 3).

Table 3: Occupation of the participants mothers' by different groups

Occupation	Study Group 1		Study Group 2		Control Group	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Housewife	382	95	376	96.9	372	93.5
Industry worker	4	1	2	0.5	2	0.5
Day labourer	2	0.5	0	0	0	0
Service	8	2	6	1.5	16	4
Small business	2	0.5	4	1	4	1
Others	4	1	0	0	4	1

Table 4 shows the percentage of participants fathers' education level among the groups. 16.3%, 33.7% and 14.1% respondents' fathers were illiterate in study group 1, study group 2 and control group respectively. Whereas, 14.9%, 10.6% and 10.6% respondents' fathers were found with a minimum level of schooling in study group 1, study group 2 and control group respectively.

Table 4: Education level of the participants fathers' by different groups

Education Level	Study Group 1		Study Group 2		Control Group	
	Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Illiterate	66	16.3	134	33.7	56	14.1
Can sign only name	150	37.1	100	25.1	122	30.8
Can read and write	40	9.9	38	9.5	58	14.6
Class I – V	60	14.9	42	10.6	42	10.6
Class VI – VIII	26	6.4	28	7.0	38	9.6
Class IX – SSC	38	9.4	26	6.5	52	13.1
HSC	18	4.5	20	5.0	26	6.6
Graduate	6	1.5	10	2.5	2	0.5

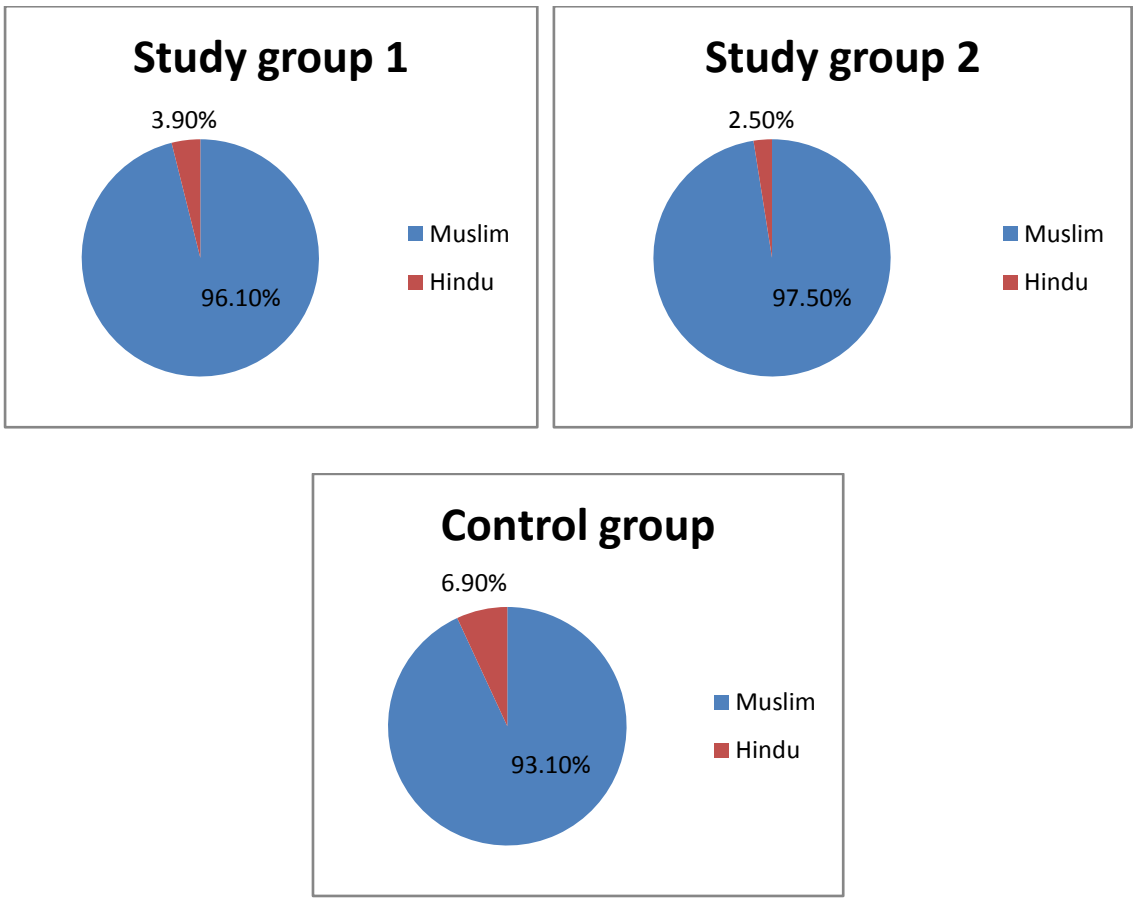
Education level of the participants mothers' among the groups is illustrated in table 5. Percentage with minimum level of schooling were 19.3%, 20.2% and 20.4% in study group 1, study group 2 and control group respectively. Percentages of illiterate mothers for the same groups were found 11.9%, 12.8% and 8% respectively.

Table 5 : Education level of the participants mothers' by different groups

Education Level	Study Group 1 n (%)	Study Group 2 n (%)	Control Group n (%)
Illiterate	48 (11.9%)	51 (12.8%)	32 (8.0%)
Can sign only name	162 (40.1%)	130 (32.7%)	128 (31.8%)
Can read and write	34 (8.4%)	50 (12.6%)	58 (14.4%)
Class I-V	78 (19.3%)	80 (20.2%)	82 (20.4%)
Class VI- VIII	46 (11.4%)	48 (12.1%)	50 (12.4%)
Class IX – SSC	30 (7.4%)	28 (7.1%)	40 (10.0%)
HSC	6 (1.5%)	10 (2.5%)	12 (3.0%)

The religious status of the participants are described in figure 2. Most of the participants in three groups were Muslim (above 90%). Religion reported other than Islam was only Hinduism.

Figure 2: Religion of the participants' by different groups



Types of the respondents' family are depicted by figure 3. Most of the families were found nuclear (75.5%, 77.1%, 73.6%) rather than the joint type (24.5%, 22.9%, 26.4%) in study group 1, study group 2 and control group respectively.

Figure 3: Type of family of the participants by different groups

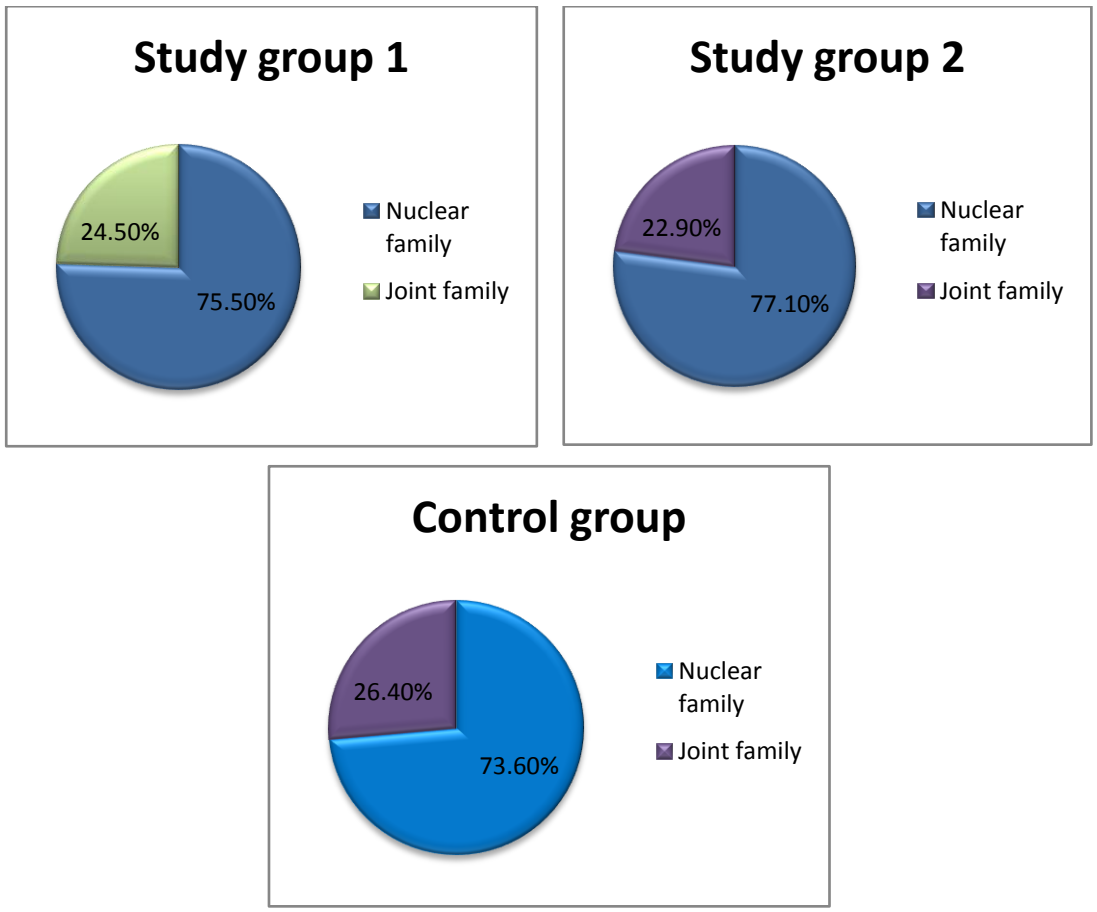
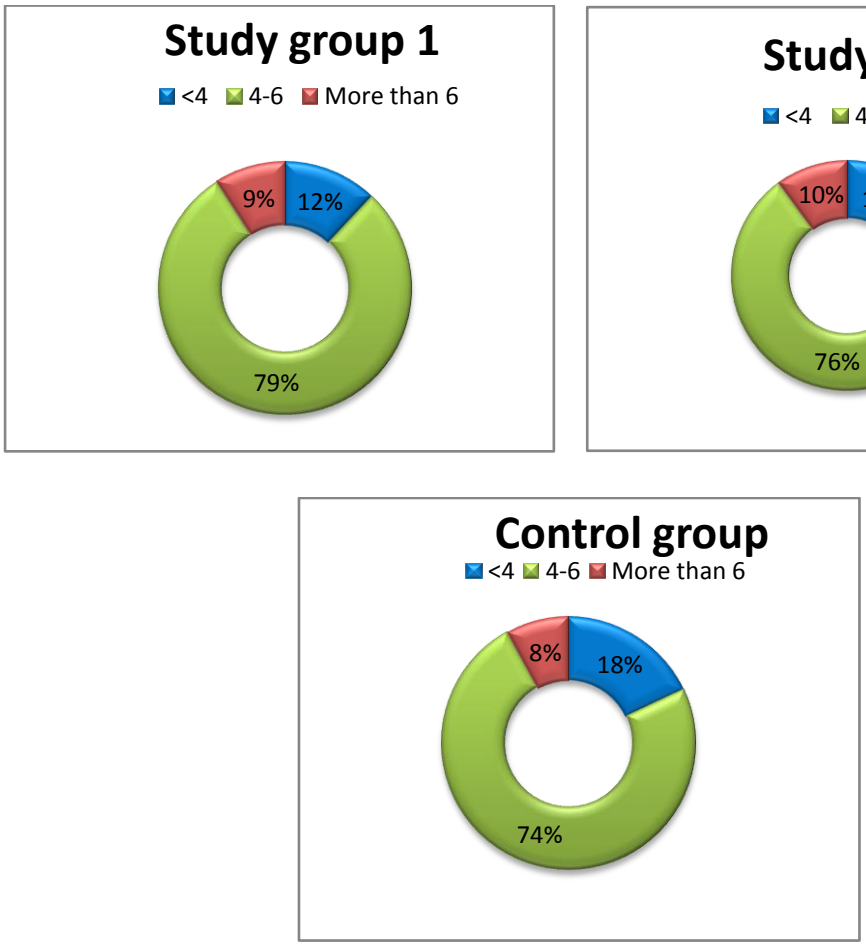


Figure 4 shows the distribution of family size for the three groups. Most of the families were found having 4 to 6 members (79%, 76%, 74%) rather than families consisting of more than 6 members (9%, 10%, 8%) and less than 4 members (12%, 14%, 18%) in study group 1, study group 2 and control group respectively.

Figure 4: Distribution of family size of the respondents in different groups



The monthly family income distribution of the respondents' in three groups is described in table 6. Most of the respondents belonged to the income group of less than Tk. 3000 (53.2% in study group 1, 48.7% in study group 2 and 47.8% in control group). However, some of the participants also belonged to the income group of Tk. 3000 – Tk. 6000 in study group 1 (22.4%) and in study group 2 (20.4%). Even a notable number of the participants had a monthly family income above Tk. 9000 in study group 2 (24.1%) and in control group (23.6%).

Table 6: Monthly family income of the participants by different groups

Income (Tk.)	Study Group 1 n (%)	Study Group 2 n (%)	Control Group n (%)
< 3000	214 (53.2%)	186 (48.7%)	194 (47.8%)
3001- 6000	90 (22.4%)	78 (20.4%)	68 (16.7%)
6001- 9000	46 (11.4%)	26 (6.8%)	48 (11.8%)
> 9000	52 (12.9%)	92 (24.1%)	96 (23.6%)

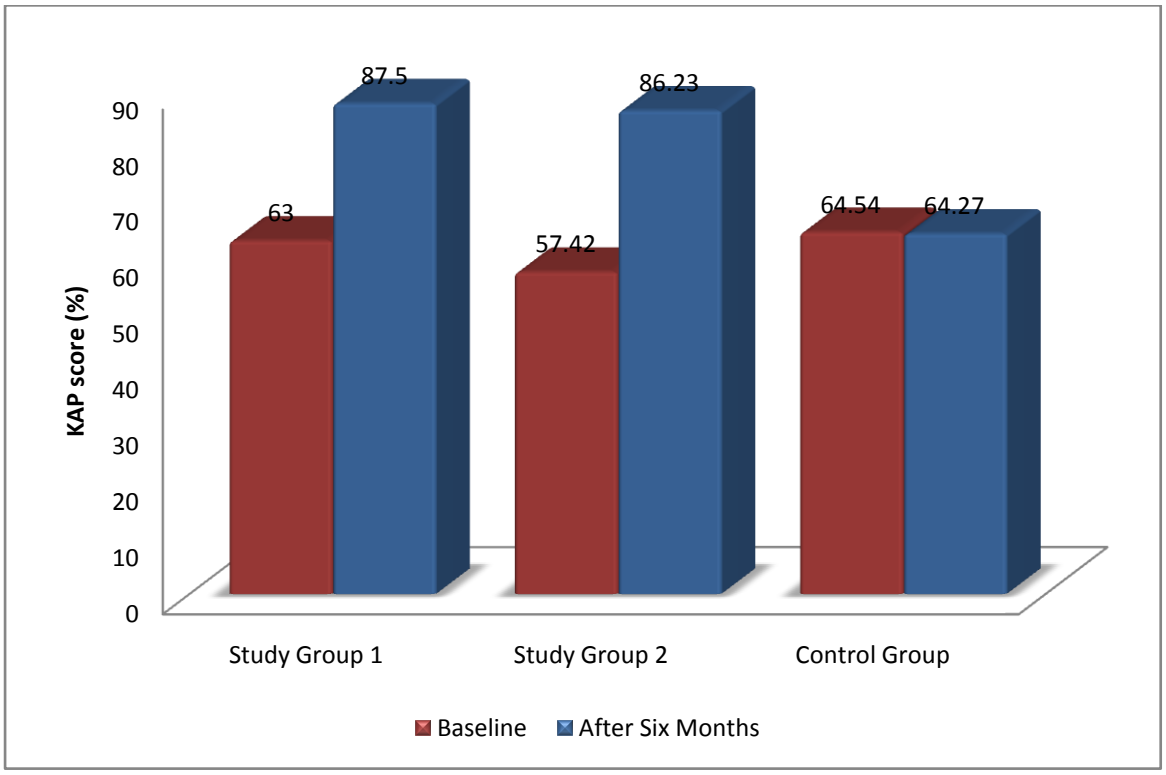
Table 7 Shows the monthly per capita income of the participants of different groups. About half of the participants' monthly per capita income were reported lower than 600 Taka among all the groups (52.5%, 49.0% and 50.2% in study group 1, study group 2 and control group respectively).

Table 7: Monthly Per Capita income of the participants by different groups

Income (Tk.)	Study Group 1		Study Group 2		Control Group	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
<600	213	52.5	196	49.0	205	50.2
600 – 900	39	9.6	34	8.5	31	7.6
901 – 1200	33	8.1	47	11.8	38	9.3
1201 – 1500	18	4.4	27	6.7	22	5.4
1501 – 1800	32	7.9	18	4.5	26	6.4
> 1800	71	17.5	78	19.5	86	21.1

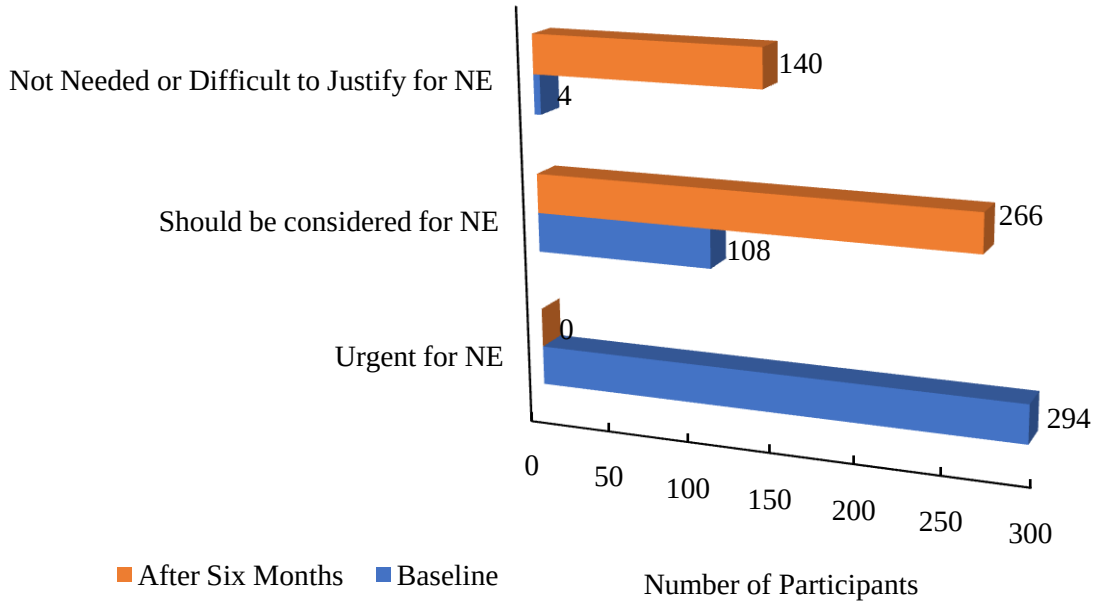
The knowledge, attitude and practice score were compared among the groups over the study period. The KAP percent score were significantly increased in the study group 1 (p <0.001) and study group 2 (p < 0.001) after the intervention, although no significant change was seen in the control group (p = 0.445) (figure 5).

Figure 5: Knowledge attitude practice (KAP) percent score changes across the groups



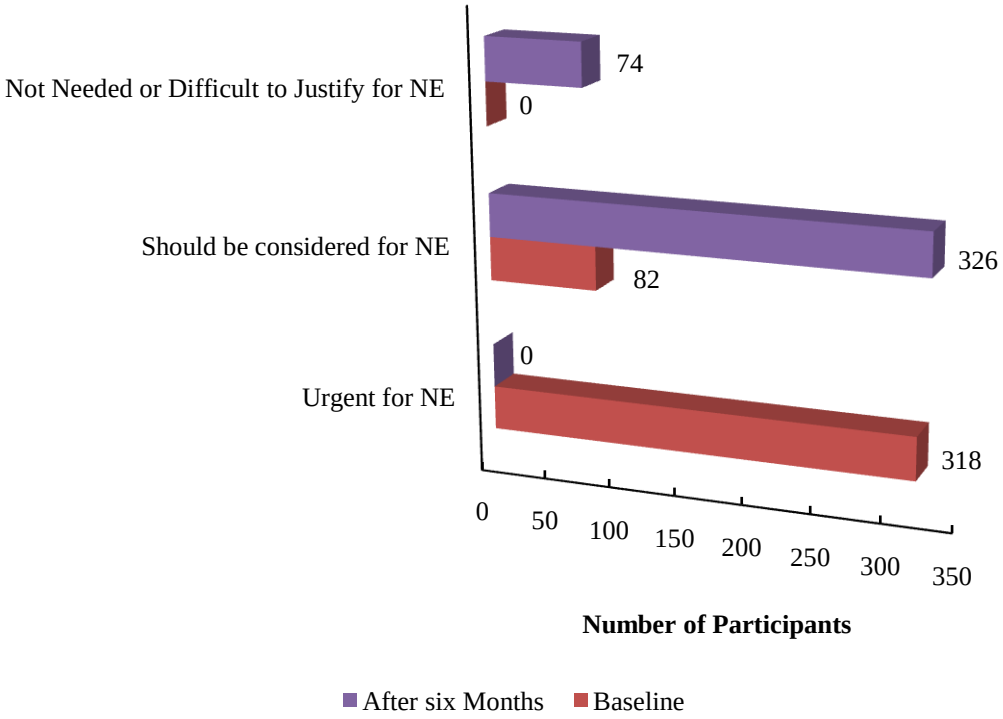
Although, in the baseline there were 294 participants categorized as urgent for nutrition education this number reduced to o after the intervention, whereas the number for other categories “should be considered” and “not needed” for nutrition education increased dramatically in study group 1 (figure 6).

Figure 6: Knowledge attitude practice (KAP) category changes across the study group 1



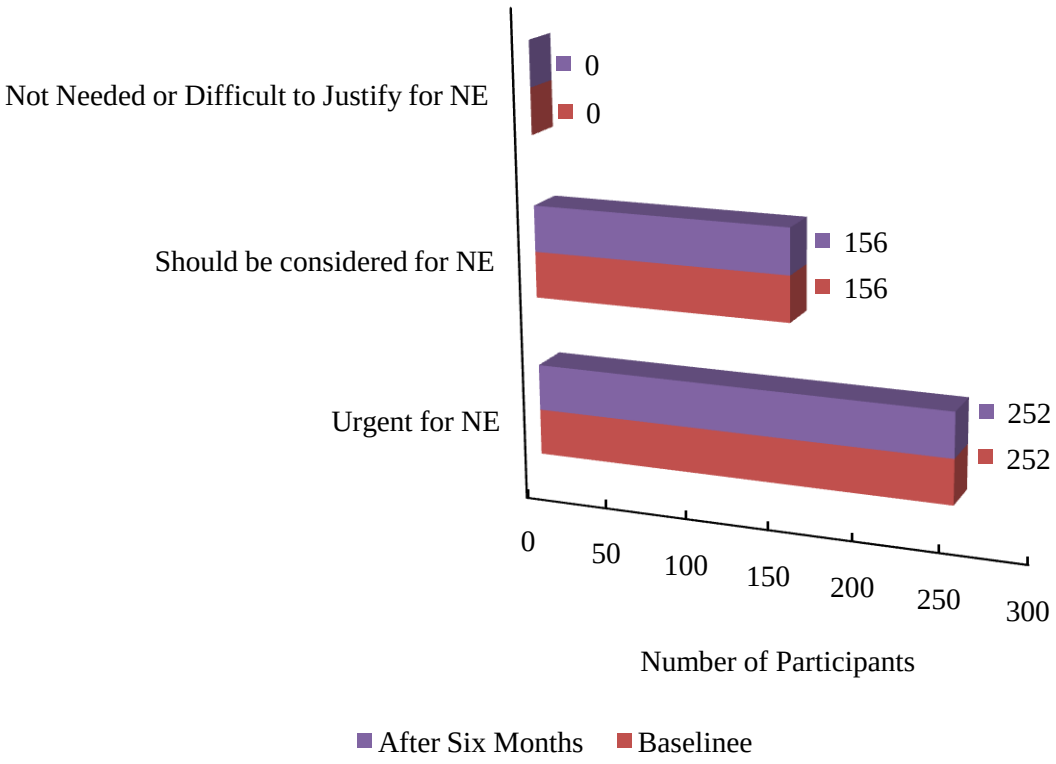
In study group 2, 318 participants were categorized in urgent for nutrition education group at baseline which reduced to o after the intervention, whereas the number for other categories "should be considered" and "not needed" for nutrition education increased dramatically (figure 7).

Figure 7: Knowledge attitude practice (KAP) category changes across the study group 2



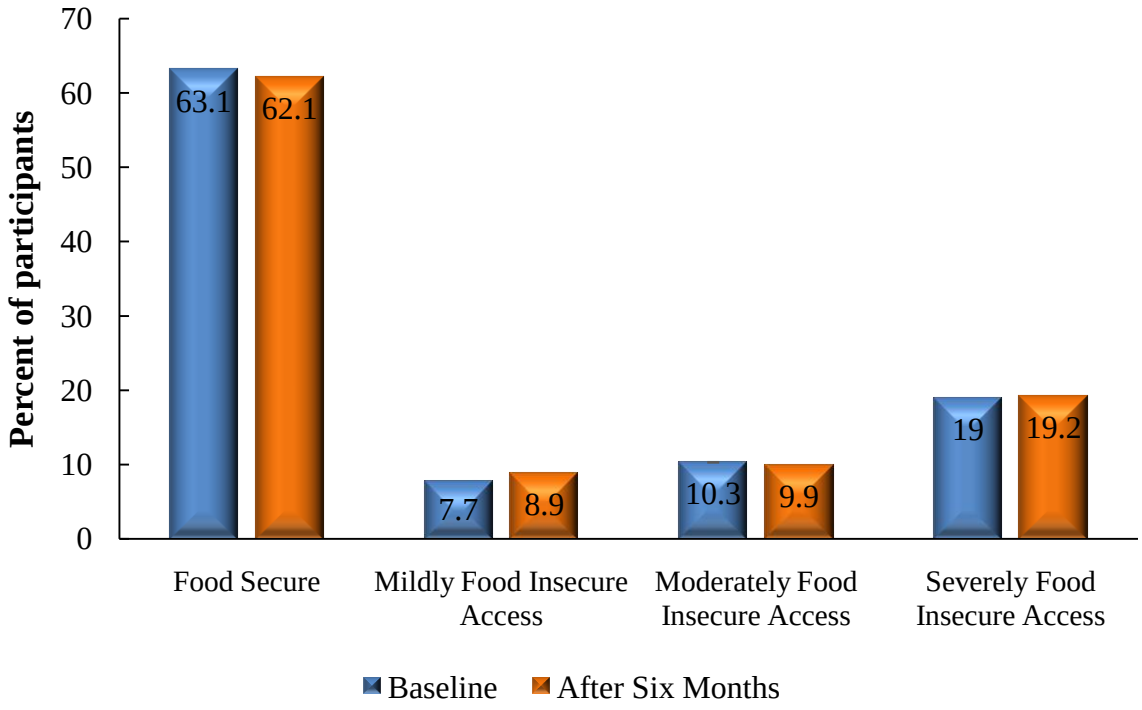
There were no changes in the number of participants in different category of KAP at the end of the study in control group after six months (figure 8).

Figure 8: Knowledge attitude practice (KAP) category changes across the control group



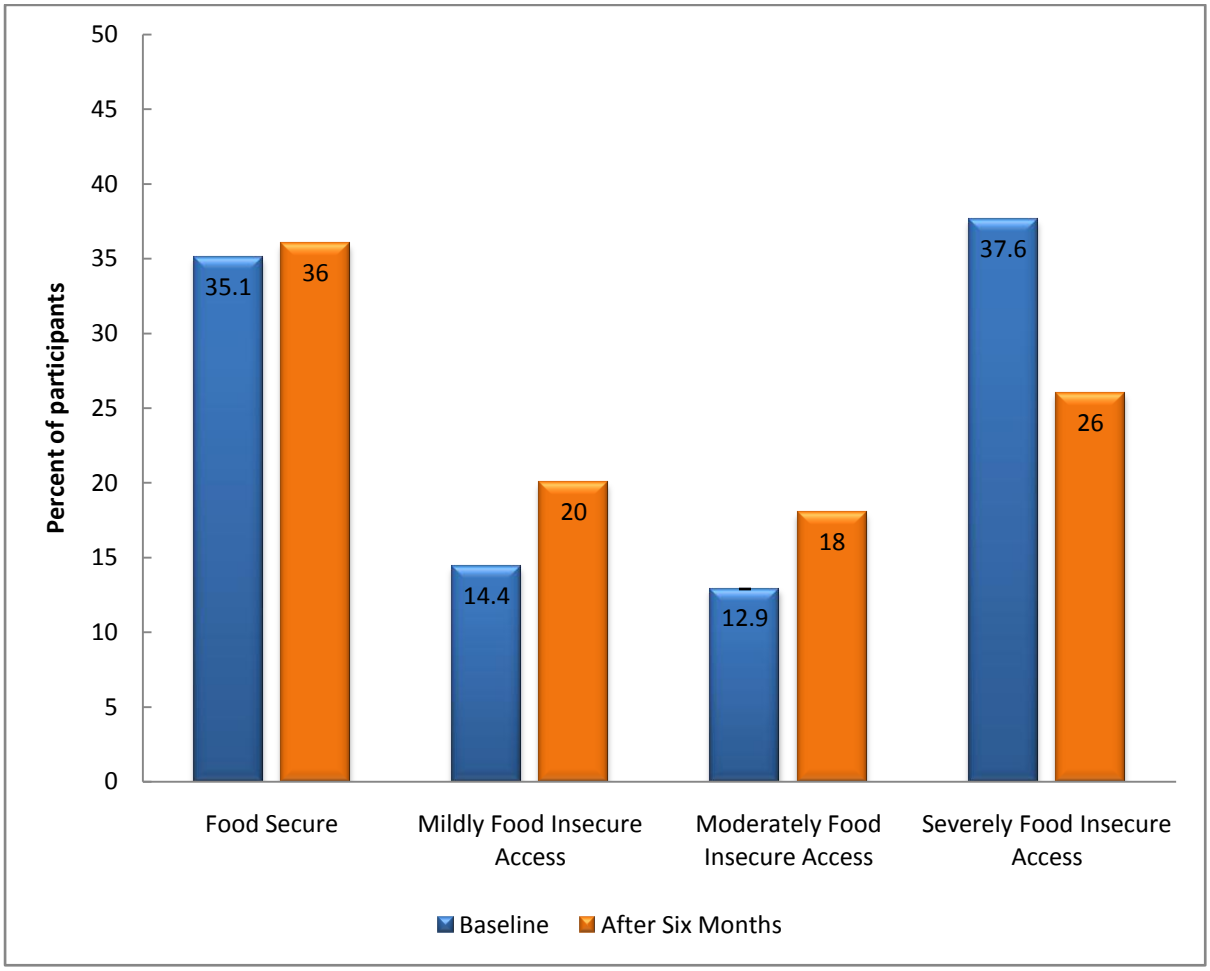
Food security status was measured according to Household Food Insecurity Access Scale (HFIAS). The percent of the participants from food secured and food insecure household did not remarkably change from baseline to the end of the study in study group 1 (figure 9).

Figure 9: HFIAS category changes in the study group 1 across the study



After 6 months of intervention the percent of participants from severely food insecure access household reduced to 37.6 to 26 in study group 2 (figure 10).

Figure 10: HFIAS category changes in the study group 2 across the study



In the baseline, 56% of the participants among the control group were from food secured household which did not change much after six months. Whereas, 18% of the participants were reported to come from the severely food insecure household; which was also almost same at the end of the study (figure 11).

Figure 11: HFIAS category changes in the control group across the study

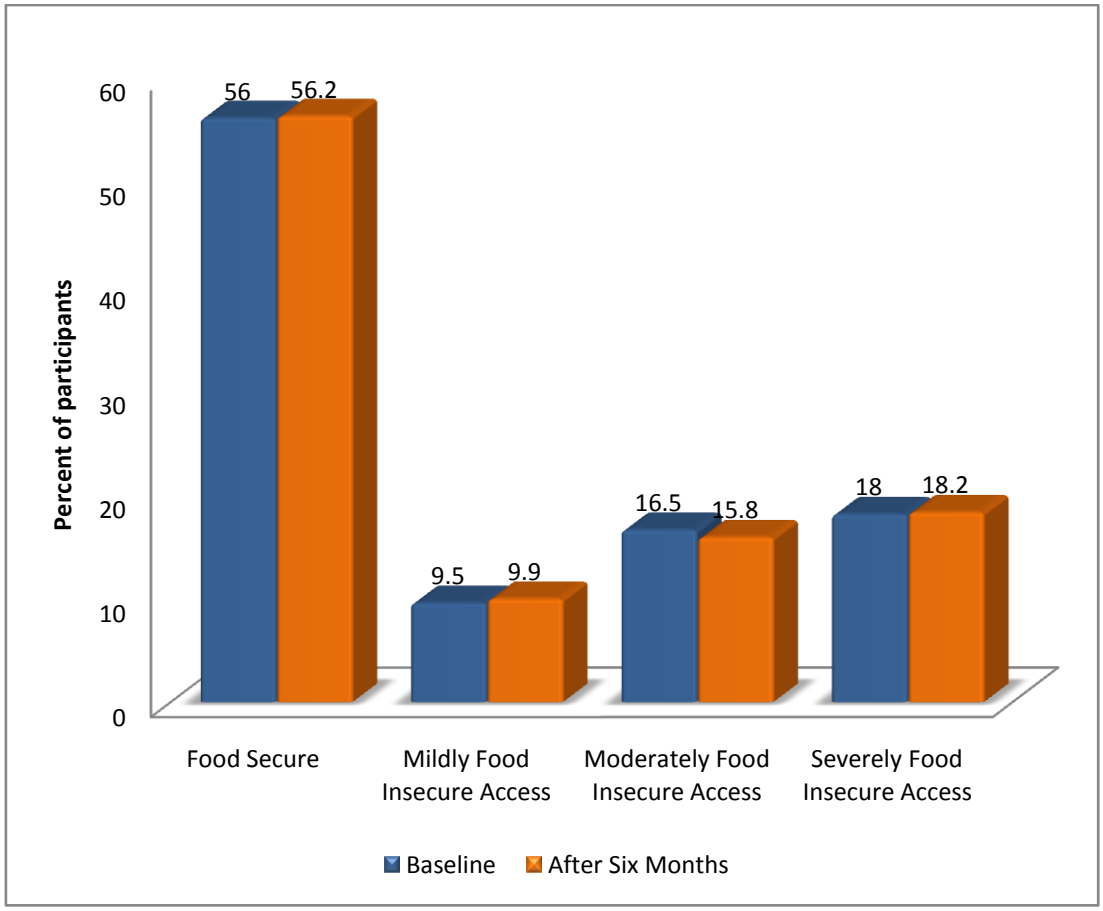
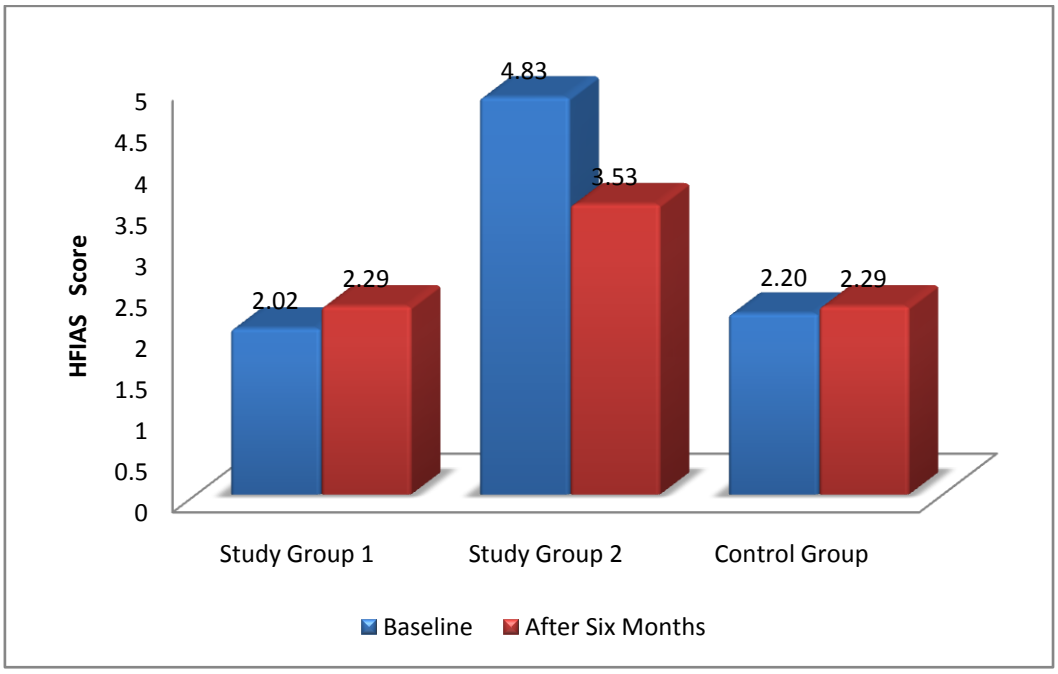


Figure 12 shows the mean HFIAS score for different groups in the baseline and after intervention. Less score indicates less food insecurity in a household. Although, in the control (p<0.510) and the study group 1 (p = 0.211) food insecurity followed an increasing pattern; in study group 2 it reduced significantly (p <0.001).

Figure 12: HFIAS score changes in different groups across the study



Comparing with the World Health Organization's body mass index reference for children and adolescents, the study participants were classified accordingly in severe, moderate malnourished and normal group. Figure 13, 14, 15 shows the BMI category changes in different groups across the study. Percentage of the study participants having normal BMI increased a little in study group 1 and 2 after intervention. But in the control group, 89.1% participants' BMI were normal at the baseline which reduced to 87% at the end of the study.

Figure 13: BMI category changes in the study group 1 across the study

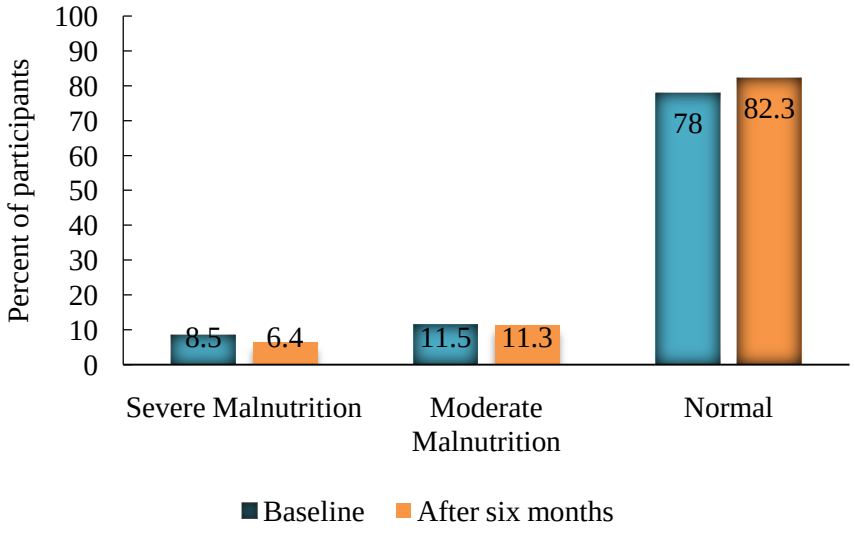


Figure 14: BMI category changes in the study group 2 across the study

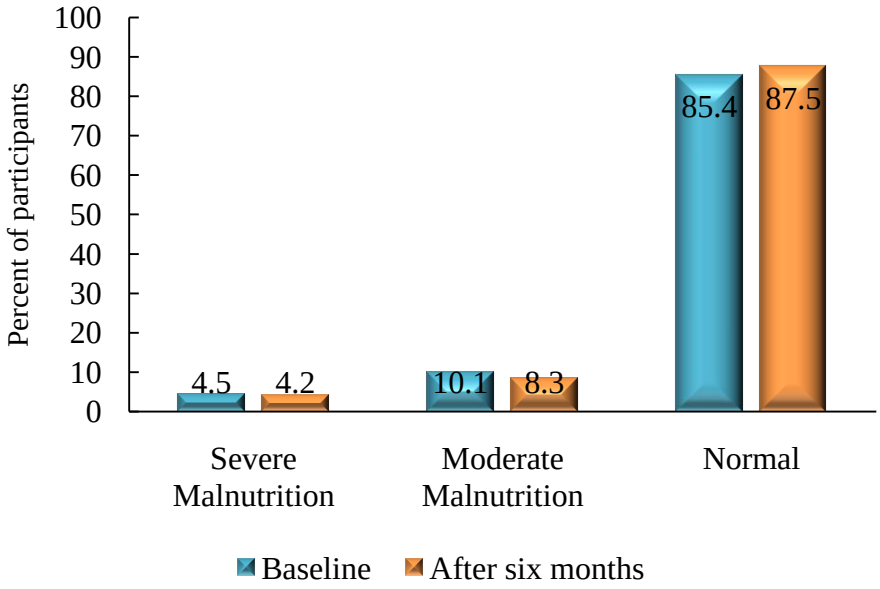
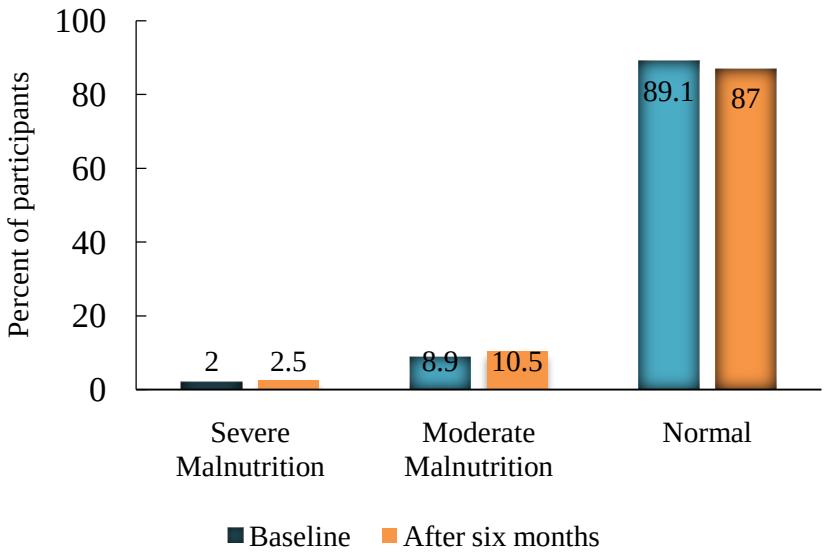


Figure 15: BMI category changes in the control group across the study



The prevalence of anemia were 43.8%, 48.5% and 48.5% in baseline in the study group 1, study group 2 and control group respectively. After 6 months the prevalence of anemia increased in the control group. On the other hand, decreased anemia prevalence was reported in study group 1 and 2 (table 8).

Table 8 : Anemia prevalence (measured by hemoglobin) in different groups

Group	Baseline		After 6 months	
	Normal n (%)	Anemic n (%)	Normal n (%)	Anemic n (%)
Study Group 1	228 (56.2%)	178 (43.8%)	262 (64.5%)	144 (35.5%)
Study Group 2	206 (51.5%)	194 (48.5%)	224 (56%)	176 (44%)
Control Group	210 (51.5%)	198 (48.5%)	184 (45.1%)	224 (54.9%)

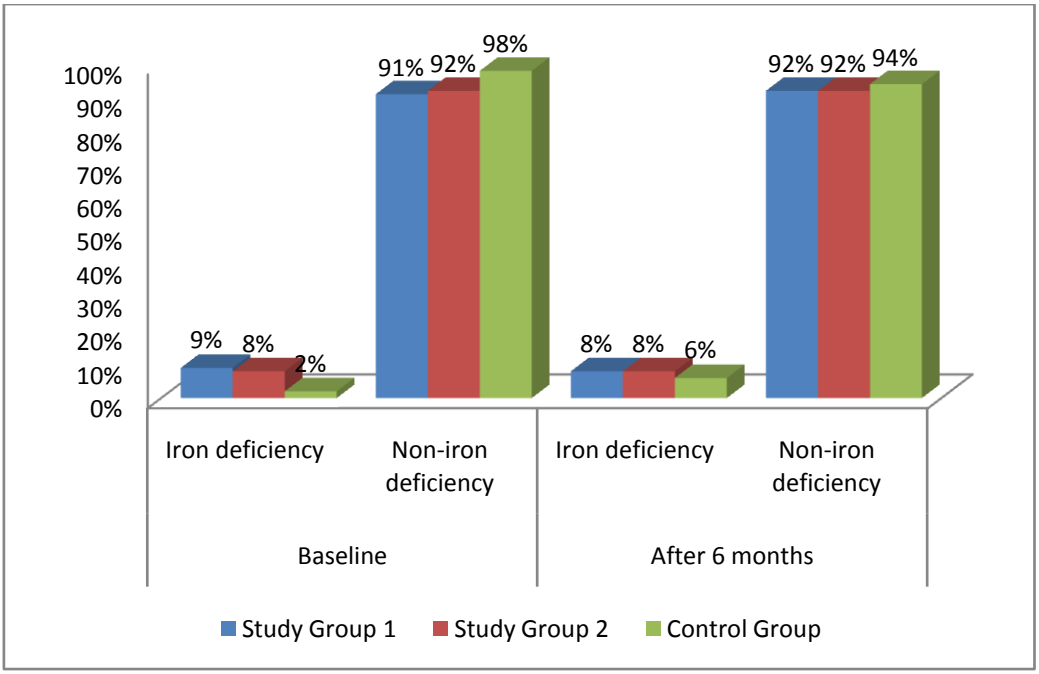
Table 9 shows the serum ferritin level of the participants. The number of iron store depleted participants increased from baseline to after 6 months (from 1% to 3.4%) in control group.

Table 9 : Serum ferritin level in different groups

Group	Baseline		After 6 months	
	Normal n (%)	Iron store Depleted n (%)	Normal n (%)	Iron store Depleted n (%)
Study Group 1	390 (96.1%)	16 (3.9%)	394 (97%)	12 (3%)
Study Group 2	384 (96%)	16 (4%)	386 (96.5%)	14 (3.5%)
Control Group	404 (99%)	4 (1%)	394 (96.6%)	14 (3.4%)

Type of anemia in different groups across the study are shown in figure 16. Among the anemic participants 9%, 8% and 2% were iron deficient in study group 1, study group 2 and control group respectively at the baseline. An increasing pattern of iron deficiency (6%) were noted in control group after 6 months.

Figure 16: Type of anemia in different groups



Mean percentage of the examination marks were found improved in all the groups after intervention (table 10). Among them the performance of study group 2 was comparatively better. The changes were highly significant in study group 1 and 2 (p = 0.00 and 0.00 respectively).

Table 10 : Changes in the total percentage of marks obtained across the study

Group	Baseline Mean ± SD	After 6 months Mean ± SD	p value
Study Group 1	53.42 ± 8.09	56.30 ± 11.38	0.00
Study Group 2	52.91 ± 11.79	65.20 ± 11.87	0.00
Control Group	52.21 ± 11.18	54.43 ± 11.80	0.01

To see whether the improvement in total percent of marks was significant or not among the groups, we calculated delta changes for each individual in each group (Mean delta change of a group = Mean marks of endline – Mean marks of baseline). Mean delta changes for total marks were +2.88 in study group 1, +12.29 in study group 2 and +2.22 in control group. The delta changes among the groups were then subjected to one way analysis of variance (ANOVA) test, including Bonferroni correction to adjust the multiple comparison. The study found, the improvement in study group 2 was significantly higher compared to study group 1 (p = 0.007) and control group (p = 0.003) (table 11).

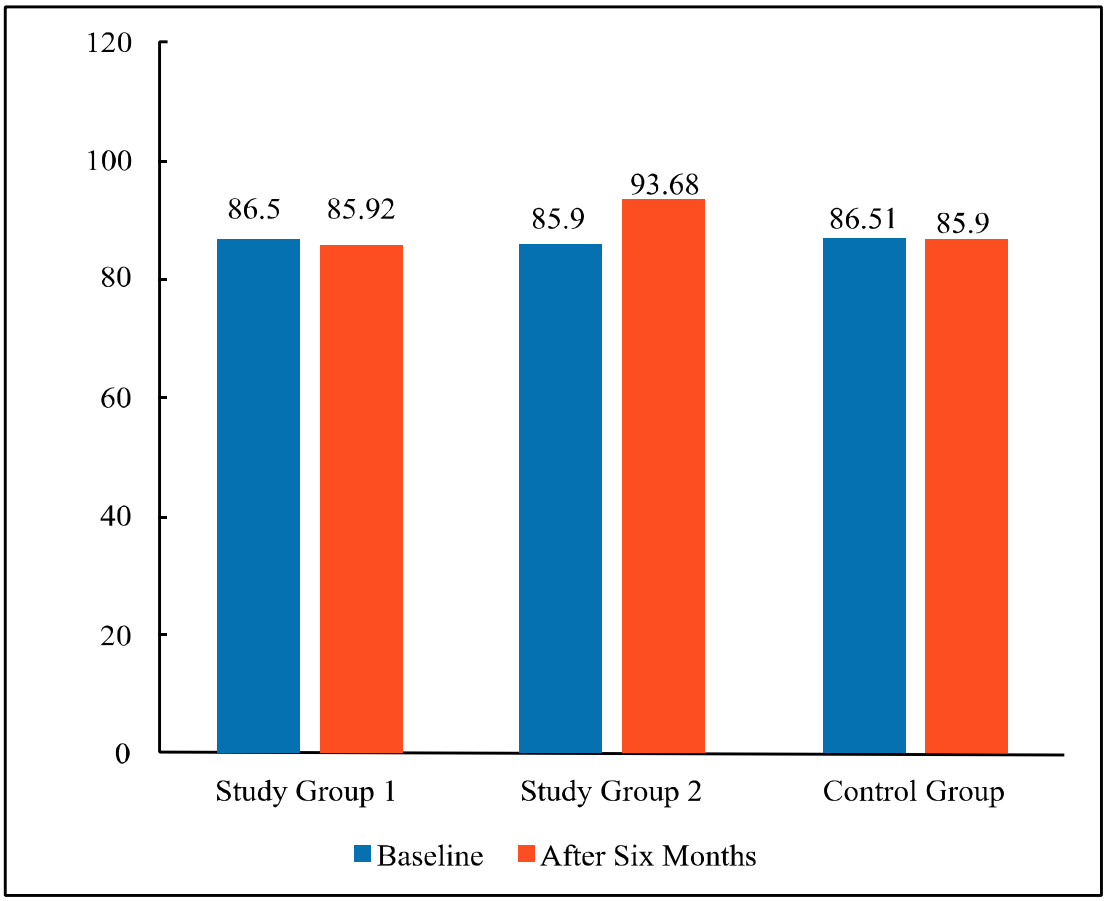
Table 11 : Comparison of the changes in academic performance after intervention between different groups (based on obtained marks)

Multiple Comparisons (Bonferroni)						
Dependent variable: Delta of % of total marks						
Type of respondent (I)	Type of respondent (J)	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Study Group 1	Control Group	0.660	3.050	1.000	-6.673	7.973
	Study Group 2	-9.410*	3.066	0.007	-16.770	-2.046
Study Group 2	Control Group	10.070*	3.081	0.003	2.659	17.456
	Study Group 1	9.410*	3.066	0.007	2.046	16.770
Control Group	Study Group 1	-0.660	3.050	1.000	-7.973	6.673
	Study Group 2	-10.070*	3.081	0.003	-17.456	-2.659

* The mean difference is significant at the 0.05 level.

Attendance of the participants of study group 2 increased after intervention (figure 17) and the change was highly significant (p = 0.000).

Figure 17 : Attendance in classes across the study (study group 1 = NS, study group 2, p = 0.000, control group = NS)



Number of hours spent in studying at home by different groups is shown in table-12. It was found that after 6 months more number of hours was spent in studying at home by all the groups but the percentage was higher in study group 2.

Table 12 : Comparison of no. of hours studying by different groups

Parameters		Study group 1		Study group 2		Control group	
		Baseline n(%)	After 6 months n(%)	Baseline n(%)	After 6 months n(%)	Baseline n(%)	After 6 months n(%)
No. of hours studying at home	>3	46 (11.3%)	49 (12.1%)	39 (9.8%)	52 (13%)	37 (9.1%)	45 (11%)
	3-2	231 (56.9%)	249 (61.3%)	252 (63%)	287 (71.8%)	212 (52%)	238 (58.3%)
	2-1	129 (31.8%)	108 (26.6%)	109 (27.2%)	61 (15.2%)	159 (38.9%)	125 (30.7%)

Table 13 shows the comparison of homework completion by different groups. The percentage of completion homework in time is comparatively better after 6 months in study group 2.

Table 13: Comparison of homework completion by different groups

Parameters		Study group 1		Study group 2		Control group	
		Baseline n(%)	After 6 months n(%)	Baseline n(%)	After 6 months n(%)	Baseline n(%)	After 6 months n(%)
Complete homework in time	Always	25 (6.2%)	28 (6.9%)	19 (4.8%)	30 (7.5%)	23 (5.6%)	29 (7.1%)
	Mostly	174 (42.8%)	191 (47.0%)	167 (41.7%)	200 (50.0%)	159 (39.0%)	155 (38.0%)
	Sometime	198 (48.8%)	179 (44.1%)	212 (53.0%)	163 (40.7%)	213 (52.2%)	217 (53.2%)
	Rarely	9 (2.2%)	8 (2%)	2 (0.5%)	7 (1.8%)	13 (3.2%)	7 (1.7%)

Individual dietary diversity score has been used very popularly in nutritional sciences to report the variety of food items consumed by individuals which ultimately provide a perception about the macro and micronutrient adequacy of an individual's diet. Table 14 represents the IDDS among the participants of different groups through the study period. It was observed that IDDS of the participants of study group 2 increased significantly. On the other hand, IDDS of the participants of study group 1 and control group decreased significantly.

Table 14: Individual dietary diversity score (IDDS) in different groups

Type of respondent	Baseline (Mean±SD)	After 6 months (Mean±SD)	*p* value
Study Group 1	5.29±0.87	5.16±0.93	0.000
Study Group 2	4.97±0.97	5.65±0.94	0.000
Control Group	5.38±0.95	5.33±0.98	0.006

Figure 18, 19, 20 show the mean food group consumption in different groups in baseline and after intervention. In study group 2, significant increase in the dietary consumption of pulse (p = 0.037), fruits & vegetables (p=0.000), green leafy vegetables (p=0.000), fats and oils (p=0.039), meat and fish (p=0.057), egg (p=0.000) and milk & milk products (p=0.000) were reported. Though significant increase was not found in both study group 1 and control group, significant decrease was found in case of meat and fish (p=0.000) and fruits & vegetables (p=0.010) respectively in these groups.

Figure 18 : Changes in the consumption of different food groups in study group 1 (n=406)

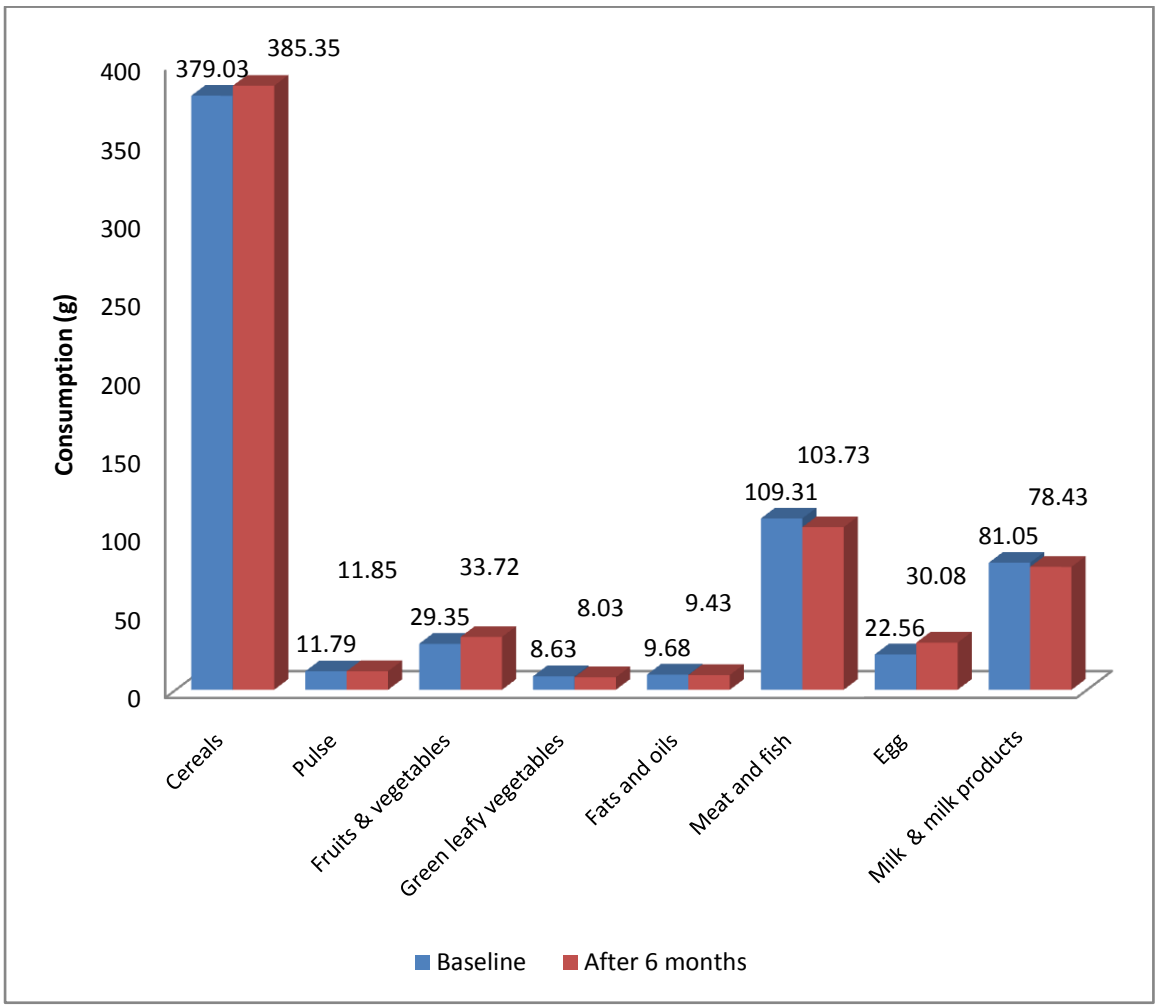


Figure 19 : Changes in the consumption of different food groups in study group 2 (n=400)

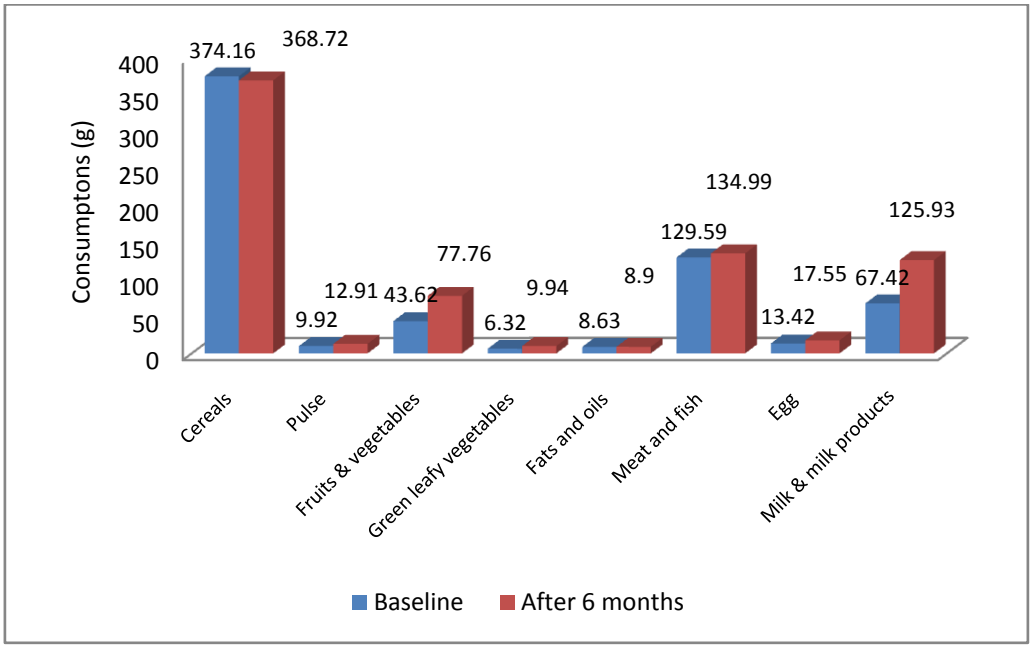


Figure 20: Changes in the consumption of different food groups in control group (n=408)

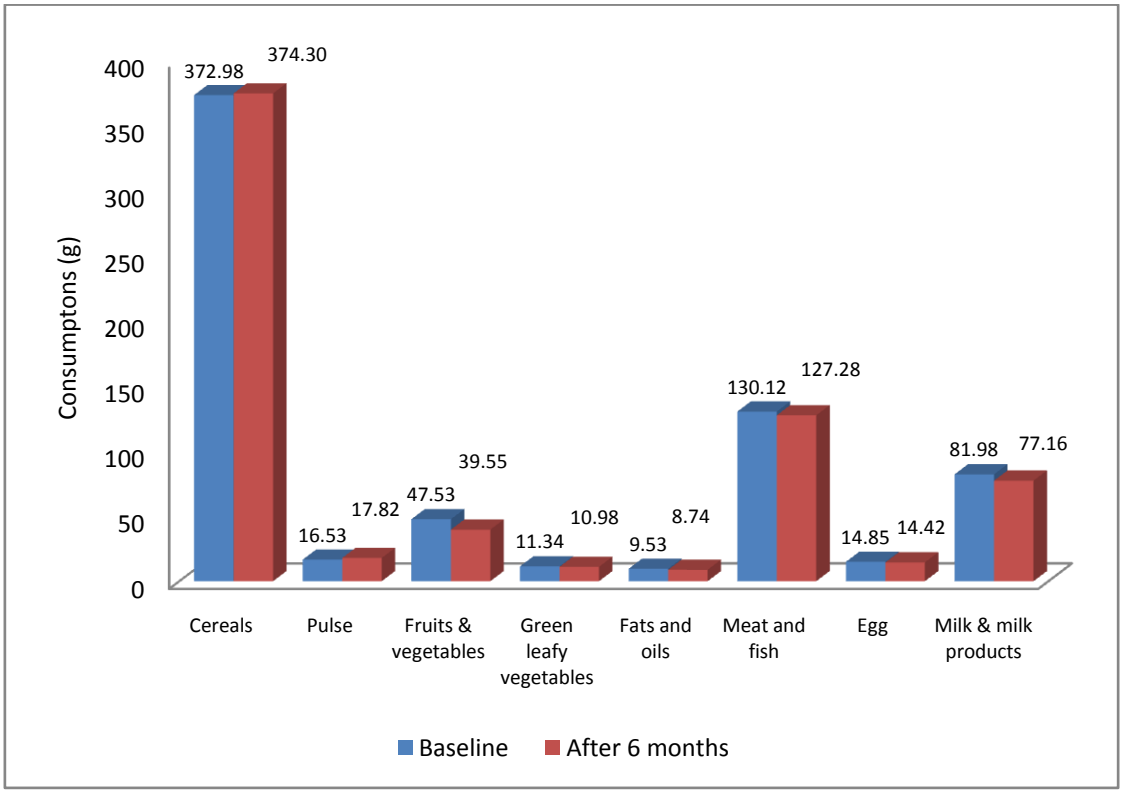


Table 15, 16, 17 describe the changes in the intake of different nutrients from the baseline in all the groups. In terms of macro and micronutrients intakes of the participants of study group 2 showed significant changes after intervention except zinc. In study group 1, significant change was found only in energy intake. Whereas significant decrease in vitamin C intake was noted in control group.

Table 15: Changes in the intake of different nutrients in study group 1 (n=406)

Nutrients			Baseline	After 6 months	*p* value
Macronutrients		Energy (Kcal)	1604.96±341.03	1645.67±398.87	0.040*
		Protein (g)	55.84±14.60	56.78±17.23	0.338
		Fat (g)	29.11±11.73	29.76±13.77	0.334
Micronutrients	**Vitamins**	Vitamin A (µg RE)	275.99±225.86	297.73±353.53	0.296
		Vitamin C (mg)	26.01±17.58	24.99±16.51	0.241
		Vitamin E (mg)	2.85±0.61	2.94±1.09	0.200
		Thiamine (mg)	0.66±0.20	0.68±0.24	0.208
		Riboflavin (mg)	0.78±0.32	0.80±0.42	0.340
		Vitamin B6 (mg)	1.06±0.29	1.06±0.27	0.969
		Niacin (mg)	17.48±6.34	17.60±6.63	0.665
		Folate (µg)	91.67±30.39	95.64±47.64	0.235
	Minerals	Calcium (mg)	298.22±185.56	294.56±193.19	0.512
		Magnesium (mg)	235.24±52.08	238.80±57.23	0.216
		Iron (mg)	7.91±2.57	8.10±2.84	0.137
		Zinc (mg)	10.18±3.06	10.26±3.35	0.594

Table 16: Changes in the intake of different nutrients in study group 2 (n=400)

Nutrients			Baseline	After 6 months	*p* value
Macronutrients		Energy (Kcal)	1635.01±416.71	1681.17±359.72	0.005*
		Protein (g)	58.43±18.36	60.95±16.47	0.001*
		Fat (g)	30.74±12.70	32.60±12.45	0.000*
Micronutrients	**Vitamins**	Vitamin A (µg RE)	215.84±231.13	312.03±248.77	0.000*
		Vitamin C (mg)	20.31±12.04	23.80±12.28	0.000*
		Vitamin E (mg)	2.82±0.90	3.10±0.86	0.000*
		Thiamine (mg)	0.62±0.20	0.70±0.21	0.000*
		Riboflavin (mg)	0.75±0.39	0.96±0.34	0.000*
		Vitamin B6 (mg)	1.11±0.32	1.17±0.29	0.000*
		Niacin (mg)	19.65±7.36	20.20±7.08	0.018*
		Folate (µg)	84.81±29.67	103.34±29.67	0.000*
	Minerals	Calcium (mg)	294.20±271.38	362.71±227.70	0.000*
		Magnesium (mg)	232.52±62.06	252.58±53.66	0.000*
		Iron (mg)	8.22±3.17	8.71±3.04	0.000*
		Zinc (mg)	11.13±3.86	11.35±3.60	0.092

Table 17: Changes in the intake of different nutrients in control group (n=408)

Nutrients			Baseline	After 6 months	*p* value
Macronutrients		Energy (Kcal)	1670.08±377.53	1670.55±338.81	0.977
		Protein (g)	60.64±20.90	60.95±18.58	0.803
		Fat (g)	31.24±15.17	30.44±14.52	0.283
Micronutrients	**Vitamins**	Vitamin A (µg RE)	312.05±309.91	301.10±307.88	0.348
		Vitamin C (mg)	29.73±41.74	23.03±16.16	0.031*
		Vitamin E (mg)	2.99±1.35	2.87±0.80	0.139
		Thiamine (mg)	0.72±0.39	0.72±0.28	0.880
		Riboflavin (mg)	0.80±0.37	0.81±0.46	0.833
		Vitamin B6 (mg)	1.13±0.33	1.12±0.29	0.550
		Niacin (mg)	19.61±8.34	19.48±7.58	0.733
		Folate (µg)	97.30±38.93	95.02±35.26	0.188
	Minerals	Calcium (mg)	318.15±171.04	323.79±263.38	0.715
		Magnesium (mg)	249.65±65.78	249.92±59.60	0.933
		Iron (mg)	8.77±3.63	8.74±3.04	0.896
		Zinc (mg)	11.05±4.19	11.00±3.68	0.785

Table 18 shows different nutrients adequacy among the groups in the baseline and after the intervention. Nutrient adequacy was measured by comparing the nutrient intake with the recommended dietary intake (RDA) of each individual participants of the study. Most of the participants of all groups were inadequate in terms of macro and micronutrients intakes except protein, niacin, magnesium and zinc.

Table 18: Nutrient adequacy in different groups

Nutrients			Study group 1		Study group 2		Control	
			Baseline	After 6 months	Baseline	After 6 months	Baseline	After 6 months
Macronutrients		Energy (Kcal)	12.0%	16.5%	9.8%	11.6%	8.1%	9.3%
		Protein (g)	73.7%	71.4%	69.2%	71.9%	72.7%	77.9%
		Fat (g)	13.5%	14.3%	7.1%	12.3%	15.7%	13.4%
Micronutrients	Vitamins	Vitamin A (µg RE)	12.0%	13.5%	11.0%	17.4%	18.0%	16.3%
		Vitamin C (mg)	16.5%	14.3%	9.0%	11.6%	16.3%	11.0%
		Vitamin E (mg)	0.0%	0.0%	0.0%	0.0%	1.2%	0.0%
		Thiamine (mg)	2.3%	2.3%	1.9%	1.9%	2.9%	2.9%
		Riboflavin (mg)	19.5%	22.6%	14.8%	29.0%	21.5%	21.5%
		Vitamin B6 (mg)	21.1%	22.6%	27.7%	34.8%	27.9%	27.9%
		Niacin (mg)	52.6%	50.4%	67.7%	69.0%	58.7%	59.9%
		Folate (µg)	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%
	Minerals	Calcium (mg)	0.0%	0.0%	0.6%	0.0%	0.0%	0.6%
		Magnesium (mg)	57.1%	56.4%	52.3%	64.5%	62.8%	63.4%
		Iron (mg)	0.8%	0.8%	3.9%	4.8%	3.5%	0.6%
		Zinc (mg)	70.7%	64.7%	73.2%	74.7%	65.7%	60.5%

Chapter 5

5.1 Discussion

5.2 Conclusion

5.3 Recommendations

5.1 Discussion

Good nutrition is important for supporting growth and maximizing learning potential. Nutrition plays an important role on the body's and mind's ability to grow and the performance of our potential learning capacity. The proper nutrition of secondary school students lying under adolescent group is also very important because they play great role in the intergeneration cycle. So, it is important for children to learn about the benefits of good nutrition. Therefore, the Child Nutrition Act views nutrition education as "a matter of highest priority".[134] Nutrition education can be effective in making individuals aware of the importance of a healthy diet. Thus it is logical that agricultural activities in conjunction with nutrition education, would contribute to change in nutritional status among respondent school students. The purpose of the study was to find the effects of two types of interventions on nutritional status of selected rural secondary school students.

The subjects of the study were mostly from low socio-economic status. Most of the participants' fathers were found to be farmer in three groups. However, among other reported occupations, business and small business were common across the groups. Almost all of the participants' mothers were housewives (95%, 96.9% and 93.5% in study group 1, study group 2 and control group respectively). 16.3%, 33.7% and 14.1% respondents' fathers were illiterate; whereas, 14.9%, 10.6% and 10.6% respondents' fathers were found with a minimum level of schooling in study group 1, study group 2 and control group respectively. Percentages of illiterate mothers for study group 1, study group 2 and control group were found 11.9%, 12.8% and 8% respectively. Most of the participants in three groups were Muslim (above 90%). Religion reported other than Islam was only Hinduism. Most of the families were found nuclear rather than the joint type and consisted of 4 to 6 members in three groups. 53.2%, 48.7% and 47.8% respondents belonged to the income group of less than Tk. 3000 in

study group 1, study group 2 and control groups respectively. About half of the participants' monthly per capita income were reported lower than 600 Taka among all the groups. Per capita monthly earned income was also found less than Taka 600 for most of the respondents of rural locations in National Nutrition Survey.[135]

The knowledge, attitude and practice score were compared among the groups over the study period. The KAP percent score were significantly increased in the study group 1 (p <0.001) and study group 2 (p <0.001) after the intervention; no significant change was seen in the control group (p = 0.445). Several studies demonstrated significant increase in the score of nutritional knowledge after imparting nutrition education for the treatment group compared to the control group.[136,137] Although, in the control (p < 0.510) and the study group 1 (p = 0.211) food insecurity followed an increasing pattern; in study group 2 it reduced significantly (p < 0.001). An improvement in household food security through homestead gardening was found by Talukder et al in another study.[138]

The percentages of the study participants having normal BMI increased slightly in study group 1 and 2 after 6 months. Also the prevalence of anemia decreased in these groups after intervention. The findings were totally opposite for the participants of control group; where 89.1% participants' BMI was normal at the baseline which reduced to 87% at the end of the study. The prevalence of anemia also increased in this group after 6 months. In a study in Bangladesh, the nutritional status of intervention groups was found improved after three months of interventions, compared to the comparison group.[101] In another study in India, both anthropometric and biochemical improvement was found after nutrition counseling for four months in experimental group of school girls.[139] Among the anemic participants 2% were iron-deficient at baseline in control group, that increased to 6% at end line. The picture of iron deficiency was different in

study group 1 and 2. In study group 1, 1% decrease in iron deficiency was noted at the end line. The percentage of iron-deficient was same at baseline and end line in study group 2. Helen Keller International has been implementing homestead food production programs coupled with nutrition education among ~ 30,000 households in four countries. Anemia prevalence among children in program house-holds decreased in all the countries.[16]

Mean percentage of the examination marks were found improved in all the groups after intervention. Among them the performance of study group 2 was comparatively better (52.91% at baseline to 65.20% at end line). The changes were highly significant in study group 1 and 2 (p=0.00 and 0.00 respectively). It was also found that the improvement in academic performance in study group 2 was significantly higher compared to study group 1 (p = 0.007) and control group (p = 0.003). However, no significant change was found between study group 1 and control group (p = 1.000). Attendance of the participants of study group 2 increased after intervention and the change was highly significant (p = 0.000). More number of hours was spent in studying at home by all the groups was found after 6 months intervention but the percentage was higher in study group 2 (13%). The percentage of completion homework in time is comparatively better after intervention in study group 2. Shore et al[140] stressed the need for healthy lifestyle intervention and prevention measures to help students work to their full potential. Another study showed that nutritional status of a student has definite relationship with his/her academic achievement.[141]

The dietary diversity score of the participants of study group 2 improved significantly after intervention (p = 0.000). From 4.97 to 5.65. On the other hand, dietary diversity scores of the participants of control and study group 1 decreased significantly (p = 0.006 and 0.000 respectively) after six months. Significant improvement of dietary diversity among intervention group was found from baseline to end line in another study.[142]

There was a significant improvement of food consumption with the duration of intervention in study group 2. In study group 2, significant increase in the dietary consumption of pulse, fruits & vegetables, green leafy vegetables, fats and oils, meat and fish, egg and milk & milk products, were reported. Though significant increase was not round in both study group 1 and control group; significant decrease was found in case of one food group for both. Also in terms of macro and micronutrients intakes of the participants of study group 2, significant changes after intervention were observed. Significant changes in only vitamin C and energy intakes were found in control and study group 1 respectively. The increase in consumption of food group and nutrient intake after intervention was also found in another studies.[143,144] Though the average daily intake of the nutrients increased after intervention in study group 2; still could not meet the level of RDA. Most of the participants of all groups were inadequate in terms of macro and micronutrients intakes except protein, niacin, magnesium and zinc. These results were also in agreement with the findings of Shweta Kumari.[144]

5.2 Conclusion

This research on nutrition education dealt with three types of interventions. Number one nutrition education alone. Number two nutrition education and homestead food production where inputs like seeds, seedlings, fertilizer, chicks and fry were given to the beneficiary households. Number three no intervention. It has been found that only nutrition education was not responding very well but nutrition education together with household food production plus showing of different pictorial, books, leaflets, posters and demonstration improved a lot. They are the rural secondary school students from class six to class ten and these boys and girls are the future generation, future potential human being and future citizens of Bangladesh. So, this study shows that if they are given right food choices, right food behavior they can get better eating habits as well as better nutritional status for themselves. Again, the secondary school children carry messages to their households, to their parents, to their relatives. It has also another impact to their neighboring communities.

However, it can be said that this nutrition intervention program positively influenced dietary behavior which can be easily under stood by individual dietary diversity score (IDDS) of different groups. Again, it had careful monitoring and the whole process of giving inputs and interventions went on only for few months. But it needs long term intervention for a sustainable development of broad government inputs in agriculture, poultry and fisheries sectors. So, all these things together in the communities can improve nutritional status of the beneficiary people. This is just a direction that nutrition education with household food production inputs with both practical and theoretical aspects shown that it was a very good method of letting the children be influenced in their food behavior and having better nutritional status. In fact it is the new finding of this community nutrition research which nobody had carried out in Bangladesh before. The findings also support the important link between nutrition and learning potential.

There is a relationship between the dietary pattern of the school going children and their academic performance. When children are not receiving proper nutrition through adequate food, they are unable to reach full potential of their academic targets. Through nutritional messages one can help school-aged children to develop healthy eating habits, which in turn improve their nutritional status. Thus nutritional status of school going children and their academic achievements are interdependent.

Nutrition education makes a difference in making healthy eating choices for students, parents and the community. A secondary school is an institution of education and learning which supports the role of nutrition in the academic achievements. The education policy may also incorporate all secondary school students be given exposure of importance of good nutrition to adopt good eating habits which ultimately help them for better performance throughout life cycle.

5.3 Recommendations

The link between food and health has been well documented by numerous studies. Nutritional intake affects energy levels, physical stamina, mood, memory, mental clarity and emotional & mental well being. To facilitate dietary behavior changes, education is an effective beginning. Diet diversification is arguably the most sustainable and affordable strategy to improve nutrition for the majority of the population – particularly the poor. Therefore, homestead food production would be a good means to improve household food security. Nutrition education and HFP program have positive impact on nutritional status of the participants of study group 2 (got nutrition education and homestead food production inputs). Nutrition education along with homestead food production might contribute to have a difference in making healthy eating choices; which in turn played an important role for the improvement in dietary pattern and nutrient intake of participants of study group 2. An improvement in household food security was also found for the same group. Findings from this study show that nutrition intervention programs can positively influence nutrition knowledge and dietary behavior of the students which ultimately improve the nutritional status of them.

After observing, assessing and comparing the situation of the rural secondary school students of different groups, the followings may be recommended –

- Nutrition education should be disseminated among secondary school students as well as in mothers of them.
- Homestead food production programs should be implemented successfully among the households of school students by government and non-government organizations.
- Long term interventions in agriculture, poultry and fisheries should be provided for more positive impact on nutritional status of the

secondary school students by government and non-government organizations.

- Severely malnourished school students should be identified and brought under supplementary feeding program as early as possible.
- Anemic school students should be identified and suggested to take iron rich foods along with citrus fruits.
- Secondary school curriculum though contains few inputs on nutrition and dietary intake, but more emphasis on practical aspects of household food production (HFP) integrated with nutritional awareness should be incorporated for better food behaviour of the students.
- National Nutrition Policy 2015 (Annexure 7.1.3) should be followed to improve the nutritional status of the secondary school students.

Chapter 6

References

6.1 References

1. World development report 2000/2001. Attacking Poverty. Washington, DC: World Bank.
2. Banerjee Sand Biswas DK. Studies on the nutritive value of cooked diet consumed by students of Eden Hindu Hostel. *Ind. Jr. Med. Res*. 1975; 45, 411.
3. Bangladesh Bureau of Statistics. Statistical year book of Bangladesh. Dhaka: Statistics Division, Ministry of Planning, Government of the Peoples Republic of Bangladesh, 1998.
4. Public health at a glance – adolescent nutrition 2003. (http://web.worldbank.org/ wbsite/external/topics/exthealthnutritionandpopulation, accessed on 22 June 2008).
5. Rees JM, Christine MT. Nutritional influences on physical growth and behaviour in adolescence In: Adams G, ed. Biology of Adolescent Behaviour and Development. Thousand Oaks, CA: Sage Publications, 1989; 139-62.
6. Eveleth PB, Tanner JM. Worldwide Variation in Human Growth, 2nd ed. Cambridge: Cambridge University Press, 1990.
7. Alam N, Roy SK, Ahmed T and Ahmed AMS. Nutritional status, Dietary Intake, and Relevant Knowledge of Adolescent Girls in Rural Bangladesh. *Jr. Health Popul. Nutr.* 2010 Feb; 28(1), 86-94.
8. HKI. Homestead food production model contributes to improved household food security, nutrition and female empowerment-experience from scaling – up programs in Asia (Bangladesh, Cambodia, Nepal and Philippines). *Nutritional Bulletin*. 2010; 8 (1), 1-8.
9. WFP. Bangladesh Household Food Security and Nutrition Assessment Report 2009. World Food Program Office, Dhaka, Bangladesh, 1-188 pp.

10. West KP Jr. Extent of vitamin A deficiency among preschool children and women of reproductive age. *Jr. of Nutr*. 2002; 132 (Supplement 9), 2857S-2866S.
11. West KP Jr. & Darnton – Hill I. Vitamin A deficiency. In Nutrition and health in developing countries, ed. RD Semba and MW bloem. Totowa, NJ, USA: Human Press, 2008.
12. Rastogi R & Mathers CD. Global burden of iron deficiency anaemia in the year 2000. In Global burden of disease 2000. Geneva : World Health Organization.
13. Hess SY & King JC. Effects of maternal zinc supplementation on pregnancy and lactation outcomes. In International zinc nutrition consultative group technical document 2 : Systematic reviews of zinc intervention strategies, ed. K Brown and SY Hess, Food and Nutrition Bulletin Supplement, 2009; 30 (1), S60 – S78. Boston, Mass, USA: United Nations University Press.
14. Black R, Allen L, Bhutta Z, Caulfield L, de Onis M, Ezzati M, Mathers C & Rivera J. Maternal and child undernutrition: Global and regional – exposures and health consequences. *The Lancet.* 2008; 371 (9608), 243 – 260.
15. Stoltfus R, Mullany L & Black R. Iron deficiency anaemia. In comparative quantification of health risks: Global and regional burden of disease attributable to selected major risk factors, ed. M Ezzati, A Lopez, A Rodgers and C Murray. Geneva: World Health Organization, 2004.
16. Talukder A, Haselow NJ, Osei Ak, Villate E, Reario D, Kroeum H, Sokhoing L, Uddin A, Dhunge S & Quinn V Homestead food production model contributes to improved household food security and nutrition status of young children and women in poor populations. Lessons learned from scaling – up programs in Asia (Bangladesh, Cambodia, Nepal and Philippines) *Field Actions Science Reports*. Special Issue 1 (2010); Urban Agriculture.

17. Kurz KM, Johnson – Welch C. The nutrition and lives of girls in developing countries: findings from the nutrition of adolescent girls research program. Washington, DC: International Center for Research on Women, 1994.
18. Abdullah M, Wheeler EF. Seasonal variations, and the intra – household distribution of food in a Bangladeshi village. *Am J Clin Nutr.* 1985; 1, 83 – 92.
19. Kiess L, Moench – P fanner R & Bloem MW. Food based strategies: Can they play a role in Poverty alleviation? *Food Nutr Bull.* 2001; 22, 436 – 442.
20. Popkin BM, Lim – Ybanez M. Nutrition and school achievement. *Soc Sci Med.* 1982; 16, 53 – 61.
21. Jamison DT. Child malnutrition and school performance in China. *J Dev Econ.* 1986; 20, 299 – 309.
22. Johnston FE, Low SM, Baessa YD, MacVean RB. Interaction of nutritional and socioeconomic status as determinants of cognitive development in disadvantaged urban Guatemalan children. *Am J Phy Anthropol.* 1987; 73, 501 – 506.
23. Taras H. Nutrition and student performance at school. *J Sch Health.* 2005; 75, 199 – 213.
24. Meyers AF, Sampson AE, Weitzman M. Nutrition and academic performance in school children. *Clin Appl Nutr.* 1991; 1, 13 – 25.
25. Galal O, Hulett J. The relationship between nutrition and children's educational performance : a focus on the United Arab Emirates. *Nutr Bull.* 2003; 28, 11 – 20.
26. Kretchmer N, Beard JL, Carlson S. The role of nutrition in the development of normal cognition. *Am J Clin Nutr.* 1996; 63 (suppl 1), 997 – 1001.
27. Gerber M. The comprehensive approach to diet : a critical review. *J of Nutr.* 2001; 131 (Suppl 11), 3051 – 3055.

28. ADA : Statement Promoting Healthy Eating Behaviours : The role of school environments. Washington, DC: USDA, Food, Nutrition and Consumer Services, 1999.
29. Aldinger CE & Jones JT. Healthy Nutriton: An essential element of a health – promoting school. WHO Information series on school Health. Document four. Geneva : WHO, 1998.
30. Aranceta J. Nutricion Comunitaria, 2ª edicion, 2001; pp. 1 – 284. Barcelona : Masson.
31. Baranowski T & Stables G. Process evaluations of the 5 – a – day projects. *Health Educ. Behav.* 2000; 27, 157 – 166.
32. Birch LL & Fisher JO. Development of eating behaviours among children and adolescents. *Pediatrics.* 1998; 101 (Suppl), 539 – 549.
33. Healthy People 2000. p. 251.
34. Lytle LA. Nutrition education for school – aged children. *J Nutr. Educ.* 1995; 27, 298 – 311.
35. Hoelscher DM, Evans A, Parcel GS et al. Designing effective interventions for adolescents. *J Am Diet Assoc.* 2002; 102 (Suppl), S 52 – S 63.
36. Contento JR, Randell JS & Basch CE. Review and analysis of evaluation measures used in nutrition education research. *J Nutr Educ Behav.* 2002; 34, 2 – 25.
37. Wardle J, Parmenter K & Waller J. Nutrition knowledge and food intake. *Appetite.* 2000; 34, 1 – 8.
38. Vareecken CA, Van Damme W & Maes L. Measuring attitudes, self – efficacy and social and environmental influences on fruit and vegetables consumption of 11 and 12 year old children : Reliability and Validity. *J Am Diet Assoc.* 2005; 105, 257 – 261.
39. Contento IR. The effectiveness of nutrition education and implications for nutrition education policy, programs and research : A review of research. *J Nutr. Educ.* 1995; 127 (5), 284 – 286.

40. Belansky ES, Romaniello C, Morin C et al. Adapting and implementing a long – term nutrition and physical activity curriculum to a rural, low – income, biethnic community. *J Nutr Educ Behav.* 2006; 38, 106 – 113.
41. Yoon HS, Yang HL & Hcr ES. Effect of nutrition education program on nutrition knowledge, dietary diversity of elementary school children, *Korean J Comm Nutr.* 2000; 5 (3), 513 – 521.
42. Rasanen M, Lehtinen J, Niinikoski H et al. Dietary patterns and nutrient intakes of 7 – year – old children taking part in atheroselerosis prevention project in Finland. *J Am Diet Assoc.* 2002; 102, 418 – 524.
43. Stewart JA, Dennison DA, Kohl WH et al. Exercise level and energy expenditure in the TAKE 10! In – class physical activity program. *J Sch Health.* 2004; 74 (10), 397 – 400.
44. Perez – Rodrigo C & Aranceta J. Nutrition education in schools : experiences and challenges. *Eur J Clin Nutr.* 2003; 57 (Suppl), S 82 – S 85.
45. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L & Sachdev HS. Maternal and child undernutrition: Consequences for adult health and human capital. *Lancet,* 2008; 371 (9609), 340 – 57.
46. Bloem MW, Moench – P fanner R & Kiess L Combating Micronutrient Deficiencies – An important component of poverty reduction. *Biomed Environ Sci.* 2001; 14, 92 – 97.
47. De Pee S, Bloem MW & Kiess L. Evaluating food – based programmes for their reduction of vitamin A deficiency and its consequences. *Food Nutr Bull.* 2000; 21, 232 – 238.
48. Ruel MT & Levin CE. Assessing the potential for food – based strategies to reduce vitamin A and iron deficiencies: A review of recent evidence. Food Consumption and Nutrition Division Discussion Paper no 92. International Food Policy Research Institute, Washington DC, 2000.
49. West CE, Eilander A & Van Lieshout M. Consequences of revised estimates of carotenoid bioefficacy for dietary control of vitamin A deficiency in developing countries. *J of Nutr.* 2002; 32, 2920S – 2926S.

50. Landauer K, Brazil M (eds). Tropical home gardens. Selected Papers from an international workshop at the Institute of Ecology, Padjadjaran University, Indonesia. Tokyo: United Nations University Press, 1985.
51. Soleri D & Cleveland DA. Household garden as a development strategy. *Hum Org.* 1987; 46, 259 – 70.
52. Marsh R. Building on traditional gardening to improve household food security. *Food Nutr. Agric.* 1998; 22, 4 – 9.
53. Kiess L, Moench – Pfanner R & Bloem MW. Food – based strategies : Can they play a role in poverty alleviation? *Food Nutr Bull.* 2001; (Appendix 1, P 11).
54. Bangladesh Poverty Assessment. Poverty Reduction and Economic Management Sector Unit, South Aisa Region, World Bank. Washington, DC, 2003.
55. Repositioning nutrition as central to development : a strategy for large scale action. Washington, DC : World Bank, 2006.
56. Dreizen S, Spirakis CN, Stone RE. A comparison of skeletal growth and maturation in undernourished and well – nourished girls before and after menarche. *Journal of Pediatrics.* 1967; 70, 256 – 63.
57. Chawla S. Effect of Nutritional status on physical work capacity of school going Girl, M.Sc. Thesis, Ludhiyana, Punjab Agriculture University, 1992.
58. Ishigaki S and Sujuki J. A study on Nutrient intake and calorie consumption of Girl students, *Japan Journal of Nutrition.* 1975; 33, 79.
59. HKI / IPHN. Homestead food production : The potential and opportunity to improve the food security and rural livelihood in Barishal Division. Homestead Food Production Programme Bulletin No. 3 (April, 2006); 1 – 4 pp.
60. HKI / IPHN. Homestead food production : The potential and opportunity to improve the food security and rural livelihood in Barishal Division. Homestead Food Production Programme Bulletin No. 4 (April, 2006) ; 1 – 4 pp.

61. Ruel MT. Can food – based strategies help reduce vitamin A and iron deficiencies? A review of recent evidence. Washington, DC. International Food Policy Research Institute, 2001.
62. Berti PR, Krasevec J & FitzGerald S. A review of the effectiveness of agriculture interventions in improving nutrition outcomes. *Public Health Nutrition.* 2004; 7 (5), 599 – 609.
63. From agriculture to nutrition: Pathways, synergies and outcomes. Washington DC. The World Bank, 2007.
64. Strategy for improved nutrition of children and women in developing countries. New York: UNICEF, 1990.
65. The state of the world's children 1998. New York: UNICEF, 1998.
66. MDG1: eradicate extreme poverty and hunger, World Health Organization, 2013. Available from: http//www.who.int/topics/millennium_development_goals/ hunger/en/index.html. Accessed 24 April, 2016.
67. Black RE, Allen L H, Bhutta Z A et al. for the Maternal and Child Undernutrition Group. Maternal and child undernutrition: global and regional exposures and health consequences. *The Lancet.* 2008; 371, 243 – 260.
68. Bhutta Z A, Das J K, Rizvi A, Gaffey M F, Walker N, Horton S, Webb P, Lartey A, Black R E. Lancet Nutrition Interventions Review Group; Maternal and Child Nutrition Study Group. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? *The Lancet.* 2013; 382 (9890), 452 – 477.
69. Hoddinott J, Harold A, Jere R B Haddad L, Horton S. The Economic Rationale for Investing in Stunting Reduction. GCC Working Paper Series. GCC 13 – 08, 2013.
70. Ruel M T, Alderman H. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *The Lancet.* 2013; 382 (9890), 536 – 51.

71. From agriculture to nutrition. Pathways, synergies and outcomes. Washington, DC: The International Bank for Reconstruction and Development, World Bank, 2007.
72. Gillespie S, Harris J, Kadiyala S. The agriculture-nutrition disconnect in India: what do we know? IFPRI Discussion Paper 01187. Washington, DC: International Food Policy Research Institute, 2012.
73. Leroy JL, Ruel M, Verhofstadt E, Olney D. The micronutrient impact of multisectoral programs focusing on nutrition: examples from conditional cash transfer, microcredit with education, and agricultural programs. Innocenti Review, 2008.
74. De-Regil L M, Fernandez-Gaxiola A C, Dowswell T, Pena-Rosas J P. Effects and safety of periconceptional folate supplementation for preventing birth defects. Cochrane Database Systematic Reviews. 10: CD007950, 2010.
75. Pena-Rosas J P, De-Regil L M, Dowswell T, Viteri F E. Daliy oral iron supplementation during pregnancy. Cochrane Database Systematic Reviews. 12: CD004736, 2012.
76. Haider B A, Bhutta Z A. Multiple-micronutrient supplementation for women during pregnancy. Cochrane Database Systematic Reviews. 11: CD004905, 2012.
77. Hofmeyr G J, Lawrie T A, Atallah A N, Duley L. Calcium supplementation during pregnancy for preventing hypertensive disorders and related problems. Cochrane Database Systematic Reviews. 8: CD001059, 2010.
78. Zimmermann M B. The effects of iodine deficiency in pregnancy and infancy. *Paediatric Perinatal Epidemiology.* 2012; 26 (suppl 1), 108 – 17.
79. Imdad A, Bhutta Z A. Maternal nutrition and birth outcomes : effect of balanced protein-energy supplementation. *Paediatric Perinatal Epidemiology.* 2012; 26 (Suppl 1), 178 – 190.
80. Debes A K, Kohli A, Walker N, Edmond K, Mullany L C. Time to initiation of breastfeeding and neonatal mortality and morbidity: a systematic review. *BMC Public Health.* 2013; 13 (Suppl 3), S19.

81. Marriott B P, White A, Hadden L, Davies J C, Wallingford J C. World Health Organization (WHO) infant and young child feeding indicators: associations which growth measures in 14 low-income countries. *Maternal Child Nutrition*, 2012; 8(3), 354 – 370.

82. Imdad A, Herzer K, Mayo-Wilson E, Yakoob M Y, Bhutta Z A. Vitamin A supplementation for preventing morbidity and mortality in children from 6 months to 5 years of age. Cochrane Database Syst Rev. 12: CD008524, 2010.

83. De-Regil LM, Jefferds MED, Sylvetsky AC, Dowswell T. Intermittent iron supplementation for improving nutrition and development in children under 12 years of age. Cochrane Database Systematic Reviews. 12: CD009085, 2011.

84. Yakoob M Y, Theodoratou E, Jabeen A et al. Preventive zinc supplementation in developing countries; impact on mortality and morbidity due to diarrhea, pneumonia and malaria. *BMC Public Health.* 2011; 11 (suppl 3): S23.

85. Iannotti L, Cunningham K, Ruel M. Improving diet quality and micronutrient nutrition: homestead food production in Bangladesh. Intl Food Policy Res Inst, 2009.

86. Wang D, Stewart D, Chang C, Shi Y. Effect of a school-based nutrition education program on adolescents' nutrition – related knowledge, attitudes and behaviour in rural areas of China. *Environmental health and preventive medicine.* 2015; 20(4), 271.

87. Khan Z, Rafique A G, Qureshi H, Badruddin H S. A nutrition education intervention to combat undernutrition: experience from a developing country. ISRN nutrition, 2013.

88. Olney D K, Talukder A, Iannotti L L, Ruel M T, Quinn V. Assessing impact and impact pathways of a homestead food production program on household and child nutrition in Cambodia. *Food and Nutrition Bulletin.* 2009; 30(4), 355 – 369.

89. Girard A W, Self J L, McAuliffe C, Olude O. The effects of household food production strategies on the health and nutrition outcomes of women and young children: a systematic review. *Paediatric and Perinatal Epidemiology.* 2012; 26(s1), 205 – 222.

90. Kabahenda M K. Effect of nutrition education on nutritional status and growth of young children in western Uganda (Doctoral dissertation, uga), 2006.

91. Shree NDA and Hiremath SU. Impact of distance education on rural girls – An experimental study. *Journal of Educational Research and Extension.* 2006; 43(4), 18 – 22.

92. Srivastava R, Kochhar A, Sachdeva R. Impact of nutrition counseling on blood profile and knowledge of juvenile diabetes. *Ind J Nutr Dietet.* 2007; 44, 501 – 8.

93. Wallen M & Davis K. Should nutrition education be taught in physical education?. *Journal of Physical Education, Recreation & Dance*. 2010; 81(1), 4 – 7.

94. Sajjan J, Kasturiba B, Naik RK, Bharati PC. Impact of child to child nutrition education intervention on nutrition knowledge scores and hemoglobin status of rural adolescent girls. *Karnataka Journal of Agricultural Sciences.* 2012; 24(4).

95. Bakshi N & Singh K. Fruit and vegetable consumption pattern among adolescent school children (13-14 years) and nutritional counseling for their promotion. *Indian J Nutr Diet.* 2012; 49, 532 – 539.

96. Oldewage-Theron W H & Egal A. Impact of nutrition education on nutrition knowledge of public school educators in South Africa: A pilot study. *Health SA Gesondheid.* 2011; 17(1), 1 – 8.

97. Masset E, Haddad L, Cornelius A, Isaza – Castro J. Effectiveness of agricultural interventions that aim to improve nutritional status of children: systematic review. *BMJ* 2012; 344, d8222.

98. Bushamuka V N, de Pee S, Talukder A, Kiess L, Panagides D, Taher A, Bloem M. Impact of a homestead gardening program on household food security and empowerment of women in Bangladesh. *Food and Nutrition Bulletin.* 2005; 26(1), 17 – 25.

99. de Pee & Bloem W. The bioavailability of (pro) vitamin A carotenoids and maximizing the contribution of homestead food production to combating vitamin A deficiency. *International Journal for Vitamin and Nutrition Research.* 2007; 77(3), 182 – 192.

100. Hillenbrand E. Transforming gender in homestead food production. *Gender & Development.* 2010; 18(3), 411 – 425.

101. Roy SK, Fuchs GJ. Mahmud Z, Ara G Islam S, Shafique S, Akter SS & Chakraborty B. Intensive nutrition education with or without supplementary feeding improves the nutritional status of moderately-malnourished children in Bangladesh. *Journal of Health, Population and Nutrition.* 2005; 320 – 330.

102. Walsh CM, Dannhauser A & Joubert G. The impact of a nutrition education programme on the anthropometric nutritional status of low-income children in South Africa. *Public Health Nutrition.* 2002; 5(1), 3 – 9.

103. Bautista A, Barker PA, Dunn JT, Sanchez M & Kaiser D L. The effects of oral iodizez oil on intelligence, thyroid status, and somatic growth in school- age children from an area of endemic goiter. *The American journal of clinical nutrition.* 1982; 35(1), 127 – 134.

104. Crombie IK, Todman J, Kennedy RA, McNeill G & Menzies I. Effect of vitamin and mineral supplementation on verbal and nonverbal reasoning of school children. *The Lancet.* 1990; 335 (8692), 744-747.

105. Lynn R & Harland EP. A positive effect of iron supplementation on the IQs of iron deficient children. *Personality and Individual Differences.* 1998; 24(6), 883 – 885.

106. Faber M, Phungula MA, Venter SL, Dhansay MA & Benade AS. Home gardens focusing on the production of yellow and dark – green leafy vegetables increase the serum retinol concentrations of 2–5–y– old children in South Africa. *The American Journal of Clinical Nutrition.* 2002; 76(5), 1048 – 1054.

107. Growdon JH & Wurtman RJ. Contemporary nutrition: nutrients and neurotransmitters. *New York State Journal of Medicine.* September, 1980.

108. Colby – Morley E. Neurotransmitters and nutrition. *Orthomolecular Psychiatry.* 1981; 12, 38 – 43.

109. Wood M. Studies probe role of minerals in brain function. *Agriculture Research.* 2001; 49, 10.

110. Erikson J. Brain food: the real dish on nutrition and brain function. *WisKids Journal.* November/December, 2006.

111. Wolpert S, Wheeler M. Food as brain medicine. UCLA Magazine Online. 2008; Retrieved from http://magazine.ucla.edu

112. Wolfe P, Burkman A & Streng K. The science of nutrition. Educational Leadership. March, 2000.

113. Lahey M, Rosen S. Dietary factors affection learning behavior. 2010. Retrieved from http://childrensdisabilities.info

114. Zhang J, Hebert J & Muldoon M. Dietary fat intake is associated with psychosocial and cognitive functioning of school – aged children in the united states. *The Journal of Nutrition.* 2005; 135, 1967 – 1973.

115. Kar B, Rao S & Chandramouli B. Cognitive development in children with chronic protein energy malnutrition. *Behavioral and Brain Functions.* 2008; 4:31, doi: 10.1186/1744 9081 – 4 – 31.

116. Li Y, Dia Q, Jackson J & Zhang J. Overweight is associated with decreased cognitive functioning among school – age children and adolescents. *Obesity.* 2008; 16, 1809 – 1815.

117. Halterman J, Kaczorowski J, Aligne C, Auinger P & Szilagyi P. Iron deficiency and cognitive achievement among school – aged children and adolescents in the united states. *Pediatrics.* 2001; 107(6), 1381 – 1386.

118. Chan YH. Randomised Controlled Trials (RCTs) – Sample Size: The Magic Number? *Singapore Medical Journal.* 2003; 44 (4): 172 – 174.
119. R Core Team, R: A Language and environment for statistical computing. R foundation for Statistical Computing, Vienna, Austria, 2013. URL https//www.r-project.org/.
120. Macias YF & Glasauer P. Guidelines for assesing nutrition – related Knowledge, Attitudes and Practices-KAP Manual, Food and Agriculture Organization of the United Nations, Rome, 2014.
121. Coates J, Swindale A & Bilinsky P. Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access Indicator Guide, Food And Nutrition Technical Assistance (FANTA III), Version 3, August 2007.
122. Jelliffe D B and Jelliffe EFP. Community Nutritional Assessment, Oxford University Press, 1989; p. 68-78.
123. Onis MD, Onyango A W, Borghi E, Siyam A, Nishida C and Siekmann J. Development of a WHO growth reference for school – aged children and adolescents. *Bull World Health Org.* 2007; 85, 660 – 667.
124. Reference and selected procedures for the quantitative determination of hemoglobin in blood: approved standards. 2nd ed. Villanova, PA, National Committee for Clinical Laboratory Standards, 1994.
125. White D, Kramer D, Johnson G, Dick F and Hamilton H. Estimation of serum ferritin by using enzyme immunoassay method. *Am J Clin Path.* 1986; 72, 346 – 351.
126. Tietz Ed. NW. Clinical Guide to Laboratory Tests. 3rd ed. W B Saunders Company, Philadelphia, PA 19106, 1995.
127. Ali SMK & Pramanik MMA. Conversion factors and dietary calculations. Institute of Nutrition and Food Science, University of Dhaka, Dhaka, 1991.
128. Shaheen N, Rahim ATMA, Mohiduzzaman M et al. Food composition Table for Bangladesh, Institute of Nutrition and Food Science and Centre for Advanced Research in Science, University of Dhaka, Dhaka, 2013.

129. Human energy requirements; Report of a Joint FAO / WHO / UNU Expert consultation. FAO Food and Nutrition Technical Report Series No. 1, FAO, Rome, 2004.
130. Protein and amino acid requirements in human nutrition (Vol. 935), World Health Organization and United Nations University, 2007.
131. Fat and fatty acids in human nutrition. Joint, FAO and Consulation, W.E. *Ann Nutr Metab.* 2009; 55 (1 – 3), pp. 5 – 300.
132. Vitamin and mineral requirements in human nutrition. Joint, FAO and World Health Organization, 2005.
133. Swindale A & Bilinsky P. Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide, Food And Nutrition Technical Assistance (FANTA III), Version 2, September 2006; p. 10 (Children's Dietary Diversity Score Indicator Food Groups).
134. U.S. Public Law 103-448. 103d cong., 2 Nov. 1994.
135. Jahan K & Hossain M. Nature and Extent of Manlnutrition in Bangladesh, Bangladesh National Nutrition Survey, 1995 – 96, part – II, July, 1998; p. 68.
136. Lytle L. Nutrition Education for School – Aged children : A review of Research. Washington, DC: Office of Analysis and Evaluation, 1994; 1 – 63.
137. Powers AR, Barbara J, Struempler, Guarino A, Parmer SM. Effects of a Nutrition Education Program on the Dietary Behavior and Nutrition Knowledge of Second – Grade and Third – grade Students, *J School Health.* April 2005; 75 (4), 129 – 133.
138. Talukder A, De Pee S, Taher A, Hall A, Moench – Pfanner R & Bloem M W. Improving food and nutrition security through homestead gardening in rural, urban and peri-urban areas in Bangaldesh. Leusden: Resource Centre in Urban Agriculture & Forestery, UA-Magazine, 2001; 45 – 46.
139. Sharma S & Chawla PK. Impact of Nutrition Counselling on Anthropometric and Biochemical Parameters of School Girls (7-9 Years). *Anthropologist.* 2005; 7 (2), 121 – 125.

140. Shore S, Sachs M, Lidicker J, Brett S, Wright A & Libonati J. Decreased scholastic achievement in overweight middle school students. *Obesity*. 2008; 16, 1535 – 1538.
141. Ghosh S, Rakshit S & Bhattacharya M. Academic Performance and Nutritional Status – A Case Study on College Students in North Tripura. *J Res & Meth in Edu*. 2013; Vol 1, Issue 4 (May – Jun), 57 – 68.
142. Tamiru D, Argaw A, Gerbaba M et al. Improving dietary diversity of school adolescents through school based nutrition education and home gardening in Jimma Zone: Quasi experimental design, *Eating Behaviors*. 2016; 23, 180 – 186.
143. Naghashpour M, Shakerinejad G, Lourizadeh MR et al. Nutrition Education Based on Health Belief Model Improves Dietary Calcium Intake among Female Students of Junior High Schools. *J Health Popul Nutr*. 2014; September 32 (3), 420 – 429.
144. Kumari S. Impact of Nutritional Education on Nutrient Adequacy of High School Children studying in Kendriya Vidyalaya Gannipur, Muzaffarpur. PhD Thesis, Bihar University, Muzaffarpur, Bihar, India.

Chapter 7

Annexure

7.1 Annexure

7.1.1 Operational Definitions

Adolescent: World Health Organization defines adolescents as young people aged 10-19 years.

Anemia : The condition of having less than the normal number of red blood cells or less than the normal quantity of hemoglobin in the blood. The oxygen-carrying capacity of the blood is, therefore, decreased.

ANOVA : Analysis of variance is the separation of the variance ascribable to one group of causes from the variance ascribable to other groups.

Anthropometry : This is the technique that deals with the measurement of the size, weight and proportions of the human body. The anthropometric measurements taken in this study are height or length and weight.

Biochemical Assessment: It refers to measurement of a nutrient in biological fluids or tissues, measurement of the urinary excretion rate of the mutrient and measuring the production of an abnormal metabolite or changes in the activities of certain enzymes or blood components dependent on a nutrient. In the study, hemoglobin and serum ferritin level was measured from blood collected from study population.

BMI : It is used to measure thinness or obesity. It is defined as weight in kilograms divided by height in meters square (kg/m^2).

Food Frequency : This is a special method to determine the evaluation of the diet and is conducted by a written food check-list to know the daily, weekly or monthly usual food intake pattern of an individual.

Food Insecurity: Food insecurity is a situation of limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways.

Frequency Distribution : The most important form of tabulation from a statistical point of view is what is called a frequency distribution. In this process raw data are grouped into classes or groups of appropriate sizes and the number of observations belonging to each class are recorded. The width of a class is called the class interval and the number of observations in a particular class is called class frequency or simply frequency. When a set of data is arranged in this way it is called a frequency distribution.

Homestead Food Production: Homestead gardening including the production of animal foods, for example poultry keeping, small animal husbandry and / or fish ponds is called homestead food production.

Individual Dietary Diversity: Individual dietary diversity, defined as the number of unique foods consumed by an individual over a given period.

Macronutrients: The nutrients essential in large amounts to the growth of our body; e.g. carbohydrate, protein and fat.

Malnutrition: Faulty nutrition due to inadequate or unbalanced intake of nutrients or their impaired assimilation or utilization.

Micronutrients: The nutrients essential in minute amounts to the growth of our body; e.g. vitamins and minerals.

Nutrition : It is a dynamic process concerning with ingestion, digestion, absorption and assimilation (metabolism) of food substances by which growth, repair and maintenance of activities in the body as well as a whole or in any of its parts are accomplished.

Nutrition Education: Any set of learning experiences designed to facilitate voluntary adoption of eating and other nutrition related behavior, conducive to health and well-being.

Nutrition Intervention: Nutrition interventions refer to those programs and approaches that have an impact on nutritional outcomes and address the causes of undernutrition.

Nutritional Status: The condition of the body resulting from the utilization of the essential nutrients available to the body is termed as nutritional status.

Paired t-test: The difference of means test for comparing the means of two paired or dependent groups to determine whether there is a difference between them is called paired t-test.

Standard Deviation: The variance of a set of data is defined as the square of the standard deviation.

Twenty four-Hour Recall Method: This is a method to recall the subject's exact food intake during the previous twenty four-hour period or preceding day. Detailed descriptions of all foods and beverages consumed, including cooking methods. Vitamin and mineral supplement use is also noted. Quantities of foods consumed are usually estimated in household measures.

Undernutrition: Deficient bodily nutrition due to inadequate food intake or faulty assimilation.

Z-score: The Z-score or standard deviation unit is defined as the difference between the value for an individual and the median value of the reference population for the same age or height, divided by the standard deviation of the reference population.

7.1.2 Questionnaire

Institute of Nutrition and Food Science

University of Dhaka

Comparison between nutrition education intervention and nutrition education & homestead food production on nutritional status among selected rural secondary school students

Id No.		**Date of Interview**	/ /

Type of respondent	Study group – 1 (Given only NE)	1
	Study group – 2(Given both NE & inputs of HFP)	2
	Control group	3

Interviewers Name and Signature	Name	Signature

A. General Information

No.	Questions	Coding categories	Code
1	Respondents name		
2	Respondents birthday	_____Years _____Months	
3	Respondents sex	l=Male 2= Female	
4	Name of School		
5	Class		
6	Roll no		
7	Father's name		
8	Father's occupation	1= Farmer 2= Fisherman 3= Boatman 4= Small business 5= Day labourer 6= Rickshaw puller / Van driver 7= Motor car driver 8= Service 9= Business 10= Others (Specify .....)	[____]
9	Father's education level	1= Illiterate 2= Can sign only name 3= Can read and write 4= Class I-V 5= Class VI- VIII 6=Class lX-SSC 7=HSC 8= Graduate	[____]

		9= Others (Specify .....)	
10	Mother's name		
11	Mother's occupation	1= Housewife 2= Industry worker 3= Day labourer 4= Service 5= Small business 6= Others (Specify .....)	[____]
12	Mother's education	1= Illiterate 2= Can sign only name 3= Can read and write 4= Class I-V 5= Class VI- VIII 6=Class lX-SSC 7=HSC 8= Graduate 9- Others (Specify .....)	[____]
13	Religion	l=Muslim 2=Hindu 3=Christian 4=Buddhist 5=Others (Specify .....)	[____]

B. Socio - economic Information

14	How many members are there in your family?		[____]
15	How many members are below 5 years?		[____]
16	What type of your family is?	1= Nuclear family 2= Joint family 3= None	[____]
17	How many earning members are there in your family?		[____]
18	What is your monthly family income?		[____]
19	Where do you live in?	1=Own house 2=Rental house 3= Stay in other's land / house	[____]
20	Type of house?	1= Kacha 2= Tin shade 3= Semi pucca 4= Building	[____]
21	How many rooms are there in your house?	1= One 2= two 3= Three 4= More than three	[____]
22	What is the source of light in your house?	1= Kerosine lamp 2= Electric bulb	[____]
23	Is there any separate Kitchen in your house?	1= Yes 2= No	[____]

24	Which of the following utensils are there in your house? 1 = Yes 2 = No	Radio	
		Television	
		Mobile phone	
		Refrigerator	
		Almirah / Wardrobe	
		Table - chair	
		Clock	
		Bicycle	
		Motorcycle	
		Engine boat	
		Tractor/Power Tiller	
		Water pump	
		Bed	
25	Do you have any of the following land - assets? l =Yes 2 = No	Any other land except own house	
		Cultivable land	
		Bamboo bush	
		Pond / exclosure	
		None	
26	Source of drinking water?	1= Tube- well 2= Tap water 3= Pond water 4= Others (..... Specify)	[____]
27	What is the percentage of monthly family food expenditure out of your monthly family income?	1= 40% 2= 50% 3= 60% 4= Above 60% 5= Others (..... specify)	[____]

28	How many school going children are there in your family?		[____]
29	What is your educational expenditure in a month?	1= Up to Tk. 500 2=Tk. 501- Tk. 1000 3= Tk. 1001- Tk. 1500 4= Above Tk. 1500	[____]
30	What is your monthly medical expenditure?	1= Upto Tk. 300 2=Tk. 301-Tk. 600 3=Tk. 601 -Tk. 900 4= Above Tk. 900	[____]

C. Food intake pattern and nutritional aspects of the students

31	What type of food do you prefer most?	1= Continental 2= Snacks 3= Homemade 4= Others (Specify .....)	[____]
32	Which factor do you consider important while preferring the food?	1= Food availability 2= Price 3= Nutritional value 4= Taste 5= Others (Specify .....)	[____]
33	Do you know, what is nutrition?	l=Yes 2= No 3= A little bit	[____]
34	Do you know what is balanced diet?	1= Yes 2= No 3= A little bit	[____]
35	If yes, or a little bit, then tell me how can you make a balanced diet?	1= Cereal, vegetables, fish / meat and fruit	[____]

		2= Cereal, vegetables and fruit 3= Cereal, dal and meat / fish 4= Cereal, egg and meat / fish 5= Not applicable	
36	Balanced diet is necessary for proper nutrition and good health. Is it true?	l=Yes 2= No 3= Don't know	[____]
37	What will be the problem if you do not take the balanced diet?	1= Body becomes weak 2= Pain in the body 3= Become sick 4= Others (Specify .....)	[____]
38	Do you have any idea about nutritious food?	l=Yes 2= No	[____]
39	Do you think that your food is enough nutritious?	l=Yes 2= No 3= Don't know	[____]
40	Is there any difficulty in nutrition if we take a little or a large amount of vegetables and fruits?	l=Yes 2= No 3= Don't know	[____]
41	Do you know about nutritional deficiency diseases?	l=Yes 2= No	[____]
42	If yes, then what are the most common nutritional deficiency diseases?	1= Night blindness, Anemia, Marasmus, Kwashiorkor, Goiter 2= Diarrhoea, Jaundice, TB, Malaria 3= Beriberi, Scurvy, Osteoporosis, Osteomalacia 4= others (Specify .....) 5= Not applicable	[____]

43	Which type of food can prevent goiter?	1= Iodised salt, marine fish 2= Vegetables / fruits 3= Know a little bit 4= Don't know	[____]
44	Do you take iodised salt?	1= Yes 2= No	[____]
45	If no, then why don't you take iodised salt?	1= Costly 2= Not sold less than 1 Kg 3= Don't like 4= Don't know anything about iodised salt 5= Not applicable	[____]
46	Which food gives energy to our body?	1= Rice 2= Fish 3= Vegetables 4= Don't know	[____]
47	Which food is necessary for the development of the body?	1= Rice 2= Fish 3= Vegetables 4= Don't know	[____]
48	Which foods are necessary to protect diseases?	1= Vegetables and fruits 2= Egg, milk 3= Fish, meat 4 = Don’t know	[____]
49	Which foods are necessary to protect scurvy?	1= Fish 2= Guava 3= Meat 4= Don't know	[____]

50	What is the necessity to use sufficient oil in cooking?	1= To boil 2= To make tasty 3= For the absorption of fat soluble vitamins 4= For the absorption of water soluble vitamins 5= Don't know	[____]
51	Which of the following foods is vitamin - A rich food?	1= Vegetables 2= Pulses 3= Milk 4= Rice 5= Don't know	[____]
52	Do you know, what is the main nutrient of fish?	l=Yes 2= No	[____]
53	If yes, then write the name of additional nutrient of a marine fish?	1= Iodine 2= Iron 3= Vitamin 4= Don't know 5= Not applicable	[____]
54	Which of the following foods are essential to maintain iron level of the body?	1= Very costly food 2= Vegetables and fruits 3= Rice, fish, egg, milk 4= Balanced diet 5= Don't know 6= Others (specify.....)	[____]

55	Which foods prevent night blindness?	1= Green leafy vegetables, yellow fruits, small fish, liver 2= Know a little bit 3= Don't know	[____]
56	When do you feel that you have taken sufficient food?	1= Self-satisfaction 2= When I lose my appetite	[____]
57	Do you think fast food and snacks are beneficial for health?	l=Yes 2= No	[____]
58	Do you know about personal hygience and cleanliness?	l=Yes 2= No	[____]
59	What water you use for personal hygience and cleanliness?	1= River/Pond/Ditch/Well 2- Tube well /Tap 3= Don't know 4= Others (specify.....)	[____]
60	What is the ideal source of defecation?	1= In a latrine 2= In water sealed sanitary latrine 3= Don't know 4= Others (specify.....)	[____]
61	What is the ideal place to dispose household garbage?	1= Anywhere 2= In a fixed common place / garbage bin 3= Don't know 4= Others (specify.....)	[____]
62	What is the ideal way to wash hands after touching feces?	1- With soap and water 2= With mud / ash and water 3= With plain water 4= Don't know	[____]

63	Do you know, why diarrhoea occurs?	1= Don't know *2*= If not maintained the hygienic condition and taken the rotten food 3- Know a little bit	[____]
64	What measures should you take to prevent diarrhoea?	1= Home-made saline 2= Packet of ORS 3= Rice saline 4= Medicine 5= Others (specify ……)	[____]
65	How many times you take saline when diarrhoea occurs?	1= Each time after coming from the toilet 2= once in a day 3= thrice in a day 4= don't know	[____]

D. Household Food Insecurity Access Scale for measuring food security

No.	Question	Response Options	Code
66	In the past four weeks, did you worry that your household would not have enough food?	0 = No (skip to Q 67) l=Yes	[____]
67	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	[____]
68	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q 69) l=Yes	[____]
69	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	[____]
70	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No(skip to Q 71) 1 = Yes	[____]

71	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	[____]
72	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0=No (skip to Q 73) l = Yes	[____]
73	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	[____]
74	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No(skip to Q 75) 1 = Yes	[____]
75	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	[____]

76	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q 77) 1 = Yes	[____]
77	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	[____]
78	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No(skip to Q 79) 1 = Yes	[____]
79	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	[____]
80	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q 81) 1 = Yes	[____]

81	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	[____]
82	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (questionnaire is finished) 1 = Yes	[____]
83	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	[____]

E. Anthropometric Measurement

84	Weight (Kg)	[____]
85	Height (cm)	[____]

F. Biochemical Indicator

86	Level of Hemoglobin (g/dl)	[____]
87	Serum Ferritin (ng/ml)	[____]

G. School Performance

88	Total marks of Half-yearly/ Annual exam		[____]
89	Total marks obtained in Half-yearly /Annual exam		[____]
90	Total CGPA in Half - yearly / Annual exam		[____]
91	CGPA obtained in Half-yearly /Annual exam		[____]
91a	Number of hours studying at home	1= 1-2 hours 2= 2-3 hours 3= More than 3 hours	[____]
91b	Complete homework in time?	1= Always 2- Mostly 3= Sometimes 4= Rarely	[____]
91c	Total number of classes in last six months		
91d	Total number of classes attended in last six months		

H. Dietary Assessment

92	How was yesterday in respect of food intake?	1 = As usual normal day 2= Festival 3= Sick	[____]

H1. Food intake of secondary school students in last 7 days by food frequency questionnaire

	Name of Foods		Response option	Code
93	Energy yielding foods	Rice	1= Never 2 = 1-3 times 3= 4-6 times 4= 7 or more than 7 times	
94		Maize		
95		Bread		
96		Fats and oils		
97	Disease preventing foods	Green leafy vegetables		
98		Yellow vegetables		
99		Fruits		
100	Body building and developing foods	Pulses/Legumes		
101		Fish		
102		Meat		
103		Egg		
104		Milk		
105		Milk Products		

ID No.	

H2. Food intake of secondary school students by 24 hour recall method

Time	Food Menu Description	Name of ingredients	Portions /Serving size	Food code (FCT by NS)	Raw weight after cleaning (gm)
Breakfast					
Mid morning snacks					
Lunch					
Afternoon snacks					
Dinner					
Late night snacks					

7.1.3 National Nutrition Policy 2015

Nutrition Is the Foundation for Development

1. Introduction

Nutrition is an important determinant of physical growth, mental development and good health for every human. When foetal growth is compromised in the mother's womb because of undernourishment; a child is born with low birth weight. In young children, stunting, wasting, underweight and micronutrient deficiency are signs of malnutrition. In addition, malnutrition represents a major cause of child mortality. Undernutrition is an important indicator of malnutrition, although overweight and nutrition-related non-communicable diseases also are on the rise in the country. Overall, a malnourished child grows up with multiple physical and mental limitations; as a result, it becomes difficult for her/him to contribute to society and national development as an adult.

Nutrition also is a basic human right, with both equity and' equality related to eliminating malnutrition and ensuring human development. In all, the Government of the People's Republic of Bangladesh is committed to improving the nutritional status of the people. The Constitution of Bangladesh cites nutrition in Article 18 (1), describing the principles of State governance: "...the State shall regard raising the level of nutrition and improvement of public health as among its primary duties..." Nutritional status in Bangladesh already has improved following formulation of the national Food and Nutrition Policy in 1997. Even so, nutritional status of the population has not reached expected levels.

In both urban and rural areas across the country, overweight, obesity, high blood pressure, diabetes, heart attack, stroke, cancer and osteoporosis are considered key nutrition-related issues. Lack of physical activity or physical labour, inappropriate food habits, and a sedentary lifestyle are all major emerging factors, making formulation of a new nutrition policy necessary.

To improve overall nutritional status, new evidence in development programming, as well as strategy development and implementation, has been useful in preparing the Bangladesh National Nutrition Policy 2015. The policy takes into consideration both global policies such as ICN2 and relevant national policies in areas such as health, food, agriculture, environment and education, reflecting the multisectoral nature of ensuring nutrition.

2. Background

Childhood malnutrition in Bangladesh has been decreasing only slowly. The most common form of undernutrition is stunting, the result of chronic undernourishment; a stunted child, who is more than two standard deviations below median height for age, is prone to recurrent infections that hinder her/his brain development. In Bangladesh, 2 out of 5 children younger than age 5 years are stunted, with levels twice as high among the poor as among the wealthy. Annual rates of reduction of stunting between 2004 and 2014 were only 1.5 percent.[1]

About 14[11] percent of under-5 children in Bangladesh are wasted, or more than two standard deviations below median weight for height, which is the result of acute malnutrition. About 450,000 young children in the country, or 3.1 percent,[1] suffer from the most serious form of wasting, known as severe acute malnutrition. Those who survive frequently suffer compromised mental development. Lastly, having less weight for age and sex is known as underweight, a condition that also affects children in Bangladesh.

The absence of appropriate child feeding and nutrition practices is the primary reason for childhood malnutrition in Bangladesh. Internationally recognized infant and young child feeding and nutrition guidelines

[1] Bangladesh Demographic and Health Survey, 2011.

recommend breastfeeding be started within one hour after birth; the baby be exclusively breastfed up to age 6 months (180 days); and the baby be given home-cooked, nutritious complementary food between 6 months and 2 years of age along with breastfeeding. However, the percentage of exclusive breastfeeding up to age 6 months in Bangladesh, while improving, stands at only 55 percent. Moreover, only 23 percent of children aged 6-23 months receive a minimum acceptable diet.[1]

At the same time, 1 in 4 adolescent girls in Bangladesh are undernourished, while 1 in 8 women of reproductive age is stunted. During delivery, stunted women are at higher risk of complications; in addition, the risk of intra-uterine growth retardation is high and, as a result, newborns of these women are more likely to be underweight and very frequently are low birth weight. Early marriage and early pregnancy contribute significantly to these conditions, because stunting thus passes from generation to generation, a vicious cycle of undernutrition is perpetuated. There are differences in undernutrition between rural and urban areas, women and children living in urban slums are especially worse off.

Among women, rates of overweight and obesity are increasing. The incidence of chronic diseases, including type 2 diabetes, high blood pressure and heart diseases, likewise are on the rise in the country because of overweight and obesity. Overweight also is found among people living below the poverty level and is particularly rising among people living in urban slums.

Although micronutrients play an important role in physical and mental development, micronutrient deficiency in Bangladesh also is very high, especially with regard to Vitamin A, iron, iodine, zinc. Vitamin B12, and folic acid. For example, high proportions of under-5 children and of women suffer from anaemia because of deficiencies of iron, folic acid and Vitamin

B-12 in their food. In all, anaemia causes health risks among women, reduces iron reserves in children, and ultimately burdens the national economy.

The Government of the People's Republic of Bangladesh has taken the initiative to mainstream nutrition into public health and family planning services, with the aim of improving the nutrition situation of the country. Strategies for ensuring nutrition also are being adopted in other sectoral policies outside the health sector. This National Nutrition Policy thus reflects the commitment of the State as a whole to improve the nutritional status of the population.

3. Vision

The people of Bangladesh will attain healthy and productive lives through gaining expected nutrition.

4. Goal

The goal of the National Nutrition Policy is to improve the nutritional status of the people, especially disadvantaged groups, including mothers, adolescent girls and children; to prevent and control malnutrition; and to accelerate national development through raising the standard of living.

5. Objectives

5.1 Improve the nutritional status of all citizens, including children, adolescent girls, pregnant women and lactating mothers

5.2 Ensure availability of adequate, diversified and quality safe food and promote healthy feeding practices

5.3 Strengthen nutrition-specific, or direct nutrition, interventions

5.4 Strengthen nutrition-sensitive, or indirect nutrition, interventions

5.5 Strengthen multisectoral programmes and increase coordination among sectors to ensure improved nutrition

6. Strategies

6.1 Improve the nutritional status of all citizens, including children, adolescent girls, pregnant women and lactating mothers

Strategies to achieve this objective are:

6.1.1 Ensure nutrition security for all citizens

Availability, access and utilization of nutritious food play important roles in overall improvement of nutrition for individuals and families alike. The National Nutrition Policy aims to ensure appropriate nutrition through securing a safe and balanced diet during all phases of the life cycle.

6.1.2 Ensure required nutrition at all stages of the life cycle

Ensuring required nutrition at all stages of the life cycle is a continuous process. The vicious cycle of malnutrition starts with chiidbearing, through malnourished mothers giving birth to malnourished babies, which subsequently affects all phases of the life cycle and even future generations. The National Nutrition Policy has stressed the following life-cycle strategies to mitigate this intergenerational effect of malnutrition:

6.1.2.1 Ensure appropriate and adequate nutrition for all pregnant women and lactating mothers throughout pregnancy, so that healthy children are born with expected birth weight.

6.1.2.2 Ensure that mothers are able to exclusively breastfeed their children up to y6 months of age and continue breastfeeding through age 2 years, by ensuring a supportive family environment, services and regulatory safety net.

6.1.2.3 Following exclusive breastfeeding till age 6 months to ensure an appropriate nutritional foundation for all newborns and very young children, ensure the start of complementary food after age 6 months

together with breastfeeding, and ensure continuation of breastfeeding up to age 2 years.

6.1.2.4 Ensure the availability of adequate and safe nutritious food for growth and development of adolescent girls and boys, including through prevention of early marriage, to develop a healthy and productive future generation.

6.1.2.5 Ensure appropriate nutrition for adults and elderly persons suffering from malnutrition-related non-communicable diseases.

6.1.2.6 Take steps to ensure regulation of unabated marketing of processed and commercial food items, given that the food habits of people, especially children, are at stake and influenced by advertisement of such foods. As a result, obesity, diabetes and other chronic non-communicable diseases have become an epidemic in the country. Encourage appropriate food habits and a healthy lifestyle.

6.1.2.7 Ensure easy availability and the best utilization of family planning methods to prevent early marriage, delay pregnancy and space births.

6.1.3 Ensure adequate nutrition for disadvantaged groups

The nutrition status of disadvantaged groups is particularly affected during illnesses and natural and manmade disasters. Programmes based on the National Nutrition Policy will:

6.1.3.1 Ensure the adoption of nutrition programmes targeting people living in poor rural and urban areas and in remote locations identified through nutrition surveillance. Give special targeting to those who have very limited access to food and are unable to earn.

6.1.3.2 Ensure adequate nutrition for the people in emergencies (natural disaster, epidemic or conflict), as well as ensure the inclusion of basic nutritional needs of affected people in disaster preparedness plans. Further, ensure application of the related Act [Breastmilk substitute, infant food, commercially prepared complementary food and the accessories thereof (Regulation of Marketing) Act 2013].

6.1.3.3 Ensure adequate nutrition during and after illness of people suffering from chronic diseases, including those who are living with tuberculosis and HIV/AIDS.

6.2 Ensure availability of adequate, diversified and quality safe food and promote healthy feeding practices

On average, the energy gap between need and intake for a typical adult Bangladeshi is 82 kitocalories (2,400 kilocatories[2] vs. 2,318 kilocalories[3]). These figures are calculated based on level of physical activity, basal metabolic rate and expected body weight. However, energy intake also may differ based on socioeconomic status, urban/rural location, and food security status.

Diets of Bangladeshi people are comprised mostly of cereals, which provide 70 per cent of energy requirements. In all, the dietary menu does not contain adequate meat, milk, vegetables and fruits, so that nutritional needs are not met. The absence of quality protein and micronutrients is evident.

Strategies to increase food diversity

The main strategy to increase food diversity is to raise the awareness of people in both rural and urban areas with regard to the importance of such diversity and taking of a well-balanced combination of macro- and micronulrients. In addition to nutrition education, behaviour change communication is to be ensured.

[2] FAO/WHO recommended daily energy requirement.
[3] Household income and Expenditure Survey Report 2010.

The Government will encourage food-based strategies to achieve food variety, emphasizing the agricultural sector, including fisheries and livestock. In addition, it will create awareness among rural and urban people through the provision of information on the importance of food diversity, along with increasing the availability of food.

Strategies to be taken up for achieving food diversity and emphasizing the important role of the agricultural sector are:

6.2.1 Encourage coordinated homestead gardening and small-scale livestock and poultry rearing, at family level or collectively, to increase the availability of diverse, safe and nutritious food.

6.2.2 Initiate a special behaviour change communication programme to create awareness of the need to avoid processed food, excess salt, saturated fat and transfat.

6.2.3 Encourage local production and indigenous varieties of crops, fruits and vegetables to promote biodiversity and uninterrupted food diversity

6.2.4 Encourage enhanced nutritional value through the combination of different types of food, given that an appropriate such combination is important for achieving food diversity.

6.2.5 Improve, encourage and accelerate clean and hygienic food preparation practices so that safe and quality food consumption is increased and nutrition quality in food is restored. Encourage food preparation and preservation using local and appropriate technologies to ensure availability of food throughout the year.

6.2.6 Ensure the supply of the required amount of animal protein through the promotion of the cultivation of small fish such as *mola*, *dhela* and *puti* in homestead water bodies to meet the nutritional needs of rural families.

6.2.7 Supply supplementary food to affected populations during disasters and times of severe food insecurity.

6.2.8 Initiate a food fortification programme and expand its use and perimeter (including, e.g.. iodine in edible salt. Vitamin A in edible oil, and enriched main food for children, cooked at home with mixed micronutrients).

6.2.9 Popularize the effective consumption of fats, carbohydrates and micronutrients to control malnutrition, overweight and micronutrient deficiencies.

6.2.10 Reduce stunting, wasting and micronutrient deficiencies through diversifying food production and ensuring a variety of food intake by children and their families.

6.3 Strengthen nutrition-specific, or direct nutrition, interventions

Two interdependent nutrition-related programmes are being implemented in Bangladesh: nutrition-specific (direct) interventions and nutrition-sensitive (indirect) interventions. Nutrition-specific or direct interventions for children include the promotion of: (a) exclusive breastfeeding during the first 6 months after birth; (b) providing complementary food after age 6 months, appropriately prepared at home, alongside breastfeeding; (c) washing hands with soap before feeding a child;, (d) Vitamin A supplementation for children every 6 months; (e) supplementation with other micronutrients; (f) providing zinc as part of diarrhoea treatment, and (g) treatment of moderate or severe acute malnutrition. For adolescent girls and women, their nutritional status is being improved through: (a)

behaviour change communication to provide nutritional knowledge through counselling at family level; (b) provision of iron, folic acid or multiple micronutrients as supplements, as appropriate; (c) promotion of the use of iodized salt; (d) promotion of the use of calcium during pregnancy as a supplement; and (e) preventative activities in educational institutions and communities to avert incidences of overweight and obesity.

Strategies adopted to expand nutrition-specific (direct) programmes include:

6.3.1 Motivate mothers to: (a) take appropriate nutritious food during pregnancy; (b) to gain adequate weight during pregnancy: (c) ensure taking of micronutrient supplements, especially iron-folic acid, during pregnancy and lactation period, as applicable; (d) prevent infection and ensure appropriate treatment; (e) reduce physical labour during pregnancy and ensure appropriate rest; and (f) bring about behavioral changes, including avoiding tobacco products and smoking, during pregnancy.

6.3.2 Promote the consumption of adequate quantities of nutritious food to prevent malnutrition in lactating mothers and ensure appropriate care to children.

6.3.3 Start breastfeeding within one hour of birth to ensure appropriate care to the newborn, with exclusive breastfeeding up to age 6 months; and encourage the provision of complementary food from age 6 months 3-4 times a day, prepared at home (combining at least four food groups), with continuation of breastfeeding up to age 2 years.

6.3.4 Immediately treat any infection that may have adverse effects on nutrition.

6.3.5 Treat moderate and severe acute malnutrition both at health centres and in the community.

6.3.6 Ensure care through families and communities for physical growth and mental development of children, and motivate the ensuring of a supportive environment for child development.

6.3.7 Ensure intake of adequate varieties of food for adolescent girls and boys for their appropriate growth, so that they can develop as adults with expected height and weight.

6.3.8 Extend and strengthen nutrition education in educational institutions.

6.3.9 Ensure availability of food enriched with energy, protein and micronutrients for elderly persons.

6.3.10 Scale up nutrition-specific programmes in rural areas, through coordination between non-Government organizations and the Ministry of Health and Family Welfare, as well as through primary health care services in urban areas under the Ministry of Local Government, Rural Development and Cooperatives.

6.3.11 Scale up nutrition-specific or direct programmes for marginalized persons in urban slums and people in hard-to-reach locations.

6.3.12 Change behaviours through strengthened nutrition counseling, information and education. Undertake intensive communication through all media, Involving all stakeholders, to raise public awareness on maintaining a balanced diet, the nutritional value of food, and physical activity and exercise. In the light of experiences with successful national programmes

such as family planning, immunization and distribution of oral saline solution, develop a plan for a nutrition and food security campaign through the mass media, and allocate resources for this purpose.

6.3.13 Build knowledge about appropriate micronutrient-enriched family foods and promote increased consumption.

6.3.14 Make the existing health system universal, utilize the system effectively, and estimate effective manpower needs for the purpose—particularly including the number of health workers to be employed at community clinics and union health centres, as well as assessment of their skills and identification of their training needs - so that the ratio between health workers and beneficiaries is maintained and nutrition services can be scaled up.

6.3.15 Provide the required number of health workers through filling of all vacant posts and ensuring of required supplies. Develop local-level health facilities, such as community clinics, union sub-centres, family welfare centres and *upazila* health complexes, to be suitable for providing nutrition services.

6.3.16 Mainstream nutrition services appropriately with health services, through effective coordination between health and family welfare workers at grassroots level.

6.3.17 Ensure improved services, through increasing the accountability of Government and non-Government nutrition service providers at all levels to meet people's expectations.

6.3.18 Develop and establish a strong national monitoring and evaluation system to ensure accountability with regard to nutrition services.

6.3.19 Conduct a needs assessment for a comprehensive work plan and appropriate allocation of resources.

6.3.20 Appoint nutritionists in hospitals and in public health nutrition programmes.

6.4 Strengthen nutrition-sensitive, or indirect, interventions

Issues of malnutrition, particularly tow birth weight and stunting, cannot be controlled through nutrition-specific programmes only. In turn, this necessitates the addition of nutrition-sensitive interventions, especially with regard to food security, female education and empowerment, increased employment opportunities, hygiene and sanitation, agriculture, and expansion of social safety nets.

Strategies to be adopted to expand nutrition-sensitive (indirect) interventions include:

6.4.1 Enhance food security at household level. Publicize and promote food-based dietary guidelines. Ensure informed food selection and consumer rights.

6.4.2 Encourage investment in nutrition-sensitive agriculture to produce fruits, vegetables, chicken, fish, fish products, milk and meat.

6.4.3 Increase the rate of female education and women's empowerment Create employment opportunities for women, and encourage the delay pregnancy until at least age 20 years.

6.4.4 To combat different types of infection (diarrhoea, pneumonia, environmental enteropathy) that adversely affect child nutrition, motivate

people to .follow hygiene practices, especially washing hands with soap. Also ensure safe drinking water and strengthen the sanitation system to reduce the risks of these infections.

6.4.5 Engage all relevant Ministries, Divisions, institutions, civil society and non-government organizations in nutrition interventions.

6.4.6 Accelerate research activities to increase production of non-cereal agricultural products, such as pulses, fruits and vegetables.

6.4.7 Initiate new programmes and strategies to implement nutrition programmes involving all concerned Ministries and agencies (e.g. food, agriculture, education, fishery and livestock, local government, women and children affairs, disaster and relief).

6.4.8 Coordinate nutrition-sensitive programmes to be implemented under Ministries such as Agriculture, Food, Fishery and Livestock, Women and Children Affairs, Education, Industry and Local Government, Rural Development and Cooperatives, among others.

6.5 Strengthen multisectoral programmes to ensure countrywide efforts toward ensuring nutrition, including necessary financing for such programmes. Increase Joint efforts and coordination among sectors/Ministries/ non-government organizations and development partners with regard to social safety nets, women's empowerment, education, and water, sanitation and hygiene, among others. Prepare a National Plan of Action (with costing, indicators and targets) for the next decade. Strategies to achieve this objective include:

- Strengthen nutrition-specific (direct) and nutrition-sensitive (indirect) programmes.

- Involve human resources in renewed nutrition efforts, including effective supervision and monitoring of nutrition services.
- Support increased coordination among relevant programmes, including with regard to social safety nets, education and women's empowerment.
- Monitor and evaluate implementation of nutrition programmes Enhance knowledge and skills of human resources involved in nutrition programmes through appropriate trainings.
- Mainstream nutrition education in all types of training programmes and in general educational curricula.
- Conduct nutrition-related research and collect and analyze disaggregated data, providing feedback.

6.5.1 Ensure joint work by the Ministries of Local Government, Rural Development and Cooperatives and Health and Family Welfare in malnutrition-stressed urban areas, especially urban slums.

6.5.2 Implement interventions in all educational institutions and communities, in both rural and urban areas, to reduce overweight and obesity. Encourage physical labour and exercise.

6.5.3 Strengthen cooperation and coordination among the Ministry of Health and Family Welfare, international organizations, development partners, educational and research institutions, non-Government organizations and concerned Ministries toward development and implementation of multisectoral nutrition programmes in the areas of nutrition security, safety nets for marginalized communities, hygiene and sanitation, and employment generation.

6.5.4 Jointly implement nutrition programmes through strengthened partnerships and coordination between Government institutions and non-Government organizations and institutions.

6.5.5 Include issues of nutrition in the National Social Security Strategy paper, particularly with regard to food diversity in food-related programmes. Initiate nutrition programmes targeting ultra-poor and deprived communities, and link up nutrition programmes with other social safety net programmes.

6.5.6 Strengthen research activities on nutrition in the Bangladesh context so that policymakers are informed about nutrition programmes and strategies and able to make decisions accordingly. In addition, undertake action-oriented research.

6.5.7 Strengthen research activities to boost production of non-cereal crops. Increase food security for the ultra-poor through appropriate food preservation methods.

6.5.8 Strengthen the enforcement of laws against the adulteration of food and raise public awareness on the issue.

6.5.9 Adapt food security, employment and disease management strategies in line with the situation related to climate change in Bangladesh.

6.5.10 Strengthen the National Nutrition Council, with the Honourable Prime Minister as the Chair, to review the nutritional situation of the country and implement/coordinate multispectral programmes.

7. Conclusion

The National Nutrition Policy 2015 has given importance to ensuring appropriate nutrition through identification of its different causes. This Policy will provide the necessary direction to implement and strengthen existing strategies, as well as to develop new strategies .to improve the people's nutritional status in Bangladesh.

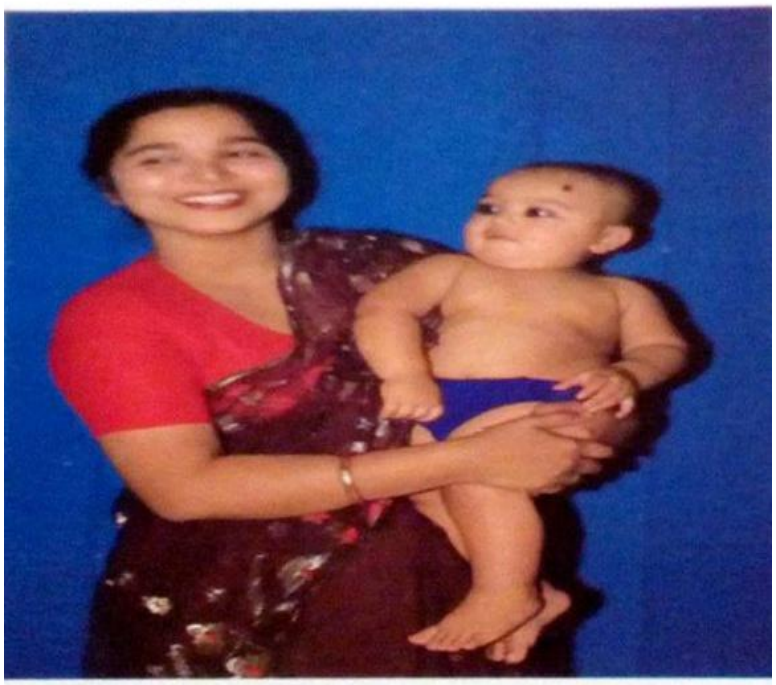
Indicators for achieving optimal nutrition:

- Increase the initiation of breastfeeding in the first hour of life
- Increase the rate of exclusive breastfeeding in infants younger than age 6 months
- Increase the rate of continued breastfeeding in children aged 20 to 23 months
- Increase the proportion of children aged 6-23 months receiving a minimum acceptable diet
- Reduce the rate of low birth weight
- Reduce stunting among under-5 children
- Reduce wasting among under-5 children
- Reduce the proportion of underweight among under-5 children
- Reduce the rate of severe malnutrition among children
- Reduce malnutrition among adolescent girls
- Increase Vitamin A coverage
- Reduce malnutrition among pregnant women and lactating mothers
- Increase the rate of iodized salt intake
- Reduce maternal overweight (BMI>23)
- Reduce the rate of anaemia among women

7.1.4 Major Visual Materials used in nutrition education sessions


সঠিক খাদ্যাভ্যাস সুস্থ জীবন
শাক-সব্জি ধুয়ে বড় করে কাটুন
এবং
তেল দিয়ে রান্না করে প্রতিদিন খান
প্রত্যেক বসত বাড়িতে শাক সব্জি ও ফলের বাগান করুন
পুষ্টি ও খাদ্যবিজ্ঞান ইনস্টিটিউট
ঢাকা বিশ্ববিদ্যালয়

পুষ্টি পরিচয়



মোঃ আমিনুল হক ভূইয়া
ডাঃ মোঃ মজহারুল হক চৌধুরী
ডক্টর মোঃ আবদুল মালেক


অপুষ্টিজনিত রোগ ও প্রতিরোধে খাদ্য সামগ্রী
অপুষ্টিজনিত রোগ
রোগাক্রান্ত ব্যক্তি
প্রতিরোধে খাদ্য সামগ্রী
প্রাণীজ
উদ্ভিজ
হাড্ডিসার রোগ
গা-ফোলা রোগ
রাতকানা রোগ
রক্ত স্বল্পতা
ঠোঁটের কোনায় ঘা
ঘ্যাগ বা গলগন্ড
খাদ্য নিরাপত্তার জন্য বিশেষ কর্মসূচী প্রকল্প

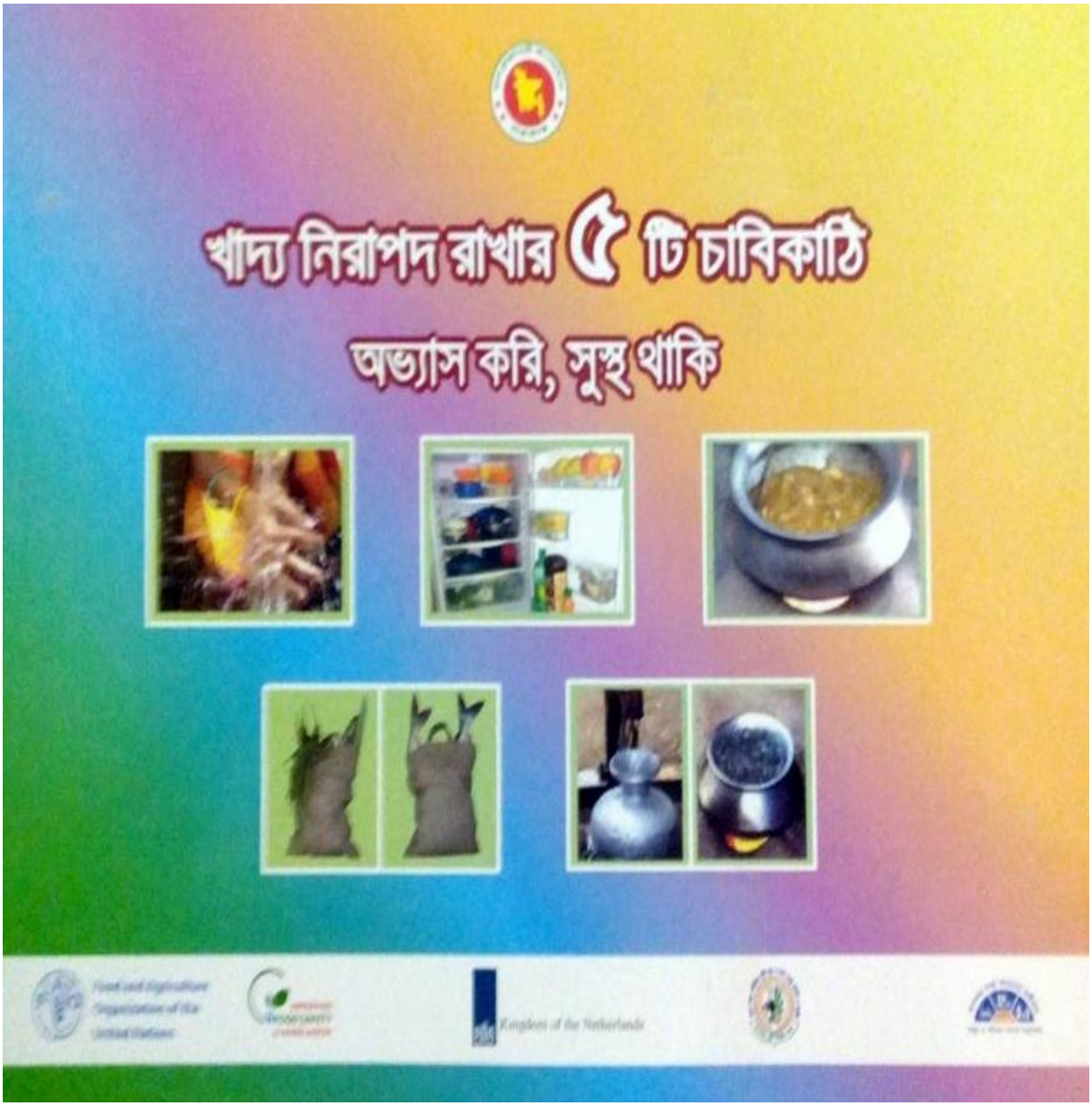

বুদ্ধিদীপ্ত
থাকতে চাই
আয়োডিনযুক্ত
লবণ খাই
লবণে সঠিক মাত্রায় আয়োডিন আছে কিনা
তা বাড়িতে নিজেই পরীক্ষা করুন
বুদ্ধিদীপ্ত থাকতে চাই
আয়োডিনযুক্ত লবণ খাই
BSCIC
IPHN
unicef
USAID


কিশোর-কিশোরীদের
স্বাস্থ্য রক্ষায় এগিয়ে আসুন
স্বাস্থ্যই সকল সুখের মূল
স্বাস্থ্য ভাল থাকলে শরীর ও মন ভাল থাকে
স্বাস্থ্য ভাল থাকলে ভালভাবে খাওয়া ও নিদ্রা উপভোগ করা যায়
স্বাস্থ্য ভাল থাকলে বেশী কাজ ও পরিশ্রম করা যায়
স্বাস্থ্য ভাল থাকলে পড়াশুনা করতে ও অন্যান্য কাজ করতে ভাল লাগে
স্বাস্থ্য ভাল রাখতে হলে
কৈশোর বয়স থেকেই স্বাস্থ্য, পারিবারিক এবং সামাজিক নিয়ম মেনে চলার অভ্যাস করতে হবে
কিশোর-কিশোরীদের বেশী করে পুষ্টিকর খাবার খেতে হবে
কিশোরীদের মাসিক শুরু হবার পর আয়রন বড়ি খেতে হবে
কিশোর-কিশোরীদের শরীর, মন ও পোষাক পরিচ্ছন্ন রাখতে হবে
১০-১৯ বছরের সকল কিশোরীদের ৫টি টিটি টিকা নিতে হবে
মাসিক নিয়মিত হলে কোন ধরণের দুশ্চিন্তা করার কারণ নাই
১৮ বছর পূর্ণ হওয়ার আগে কিশোরীদের বিবাহ দেয়া বেআইনী
গর্ভবতীদের স্বাস্থ্য পরীক্ষার জন্য নিকটবর্তী স্বাস্থ্য কেন্দ্রে নিয়ে যান
ঘর গৃহস্থালী পরিষ্কার রাখতে হবে
কিশোর-কিশোরীসহ পরিবারের সবাই জলাবদ্ধ পায়খানা ব্যবহার করবেন
পরিবারের সবাই খাওয়ার আগে সাবান দিয়ে হাত ভালভাবে পরিষ্কার করবেন
আর্সেনিকযুক্ত নলকূপের পানি অথবা সিদ্ধ করে পানি পান করবেন
মাদক গ্রহণ মেধা ও শরীর ক্ষয় করে। সামাজিক অবক্ষয় অনাচার সৃষ্টি করে। শিরার মাধ্যমে মাদক গ্রহণ এইচআইভি/এইডস সংক্রমণের মূল কারণ
ধুমপানের ফলে ক্যান্সার, উচ্চরক্তচাপ, যৌন ক্ষমতা, শ্বাসকষ্টের রোগ ও ক্ষুধা হ্রাস পায়
স্বাস্থ্য শিক্ষা ব্যুরো, স্বাস্থ্য অধিদপ্তর
স্বাস্থ্য ও পরিবার কল্যাণ মন্ত্রণালয়


অবিবাহিত কিশোরী মেয়েদের স্বাস্থ্য ও পুষ্টি অবস্থা উন্নয়নে পুষ্টি শিক্ষা
কৈশোরের বয়ঃসন্ধিকালে পর্যাপ্ত পরিমাণে ভাত, ডাল, রুটি, শাকসবজি ও ফলসহ প্রতিদিন সুষম খাবার গ্রহণ করুন।
কৈশোরকালিন সময়ে মেয়েদের লৌহজনিত এবং অন্যান্য ভিটামিন সমৃদ্ধ কলিজা, রঙিন শাকসবজি ও রঙিন ফল খেতে হবে।
মাসিক চলাকালীন সময়ে স্যানিটারি প্যাড ব্যবহার করাই সর্বোত্তম।
সীমিত অর্থনৈতিক সামর্থ্যের কারণে পরিষ্কার কাপড় বারবার ধুঁয়ে মাসিকের সময় ব্যবহার করা যাবে।
সমবয়স্ক মেয়েদের সঙ্গে মেলামেশায় শারীরিক ও মানসিক বিকাশ হয়।
কৈশোরকালিন সময়ে কৌতুহলবশতঃ মাদক গ্রহণসহ অন্যান্য বদভ্যাস পরিহার করতে হবে।
পুষ্টি ও খাদ্য বিজ্ঞান ইনস্টিটিউট
ঢাকা বিশ্ববিদ্যালয়
২০১১

স্মরণীয় পুষ্টি তথ্য

১.	✔অন্তঃস্থা শক্তি পেতে হলে তাতের পরিমাণ কমিয়ে মিষ্টি আলু ও আটার রুটি বেশি করে খান।
২.	✔কমলা, আপেলের চেয়ে আমলকি ও পেয়ারাতে অনেক গুণ বেশি ভিটামিন 'সি' আছে।
৩.	✔শিশুকে রাতকানা রোগ থেকে বাঁচাতে হলে পাকা আম, কাঁঠাল, পেঁপে ও সবুজ শাক বেশী করে খাওয়ান।
৪.	✔কলা ও চিনিতে কৃমি হয় না, হয় অপরিচ্ছন্ন পরিবেশ ও নোংরা খাবার থেকে।
৫.	✔শাক - অবশ্যই ছোট টুকরো করে না কেটে বড় বড় টুকরো করে কাটুন এবং ঢেকে রান্না করুন।
৬.	✔শাক - অবশ্যই কাটার আগে ধুয়ে নিন, কেটে ধোবেন না এবং সিদ্ধ করে তার পানি ফেলে দেবেন না। এতে প্রচুর পুষ্টি উপাদানের অপচয় হয়।
৭.	✔চাল ও ডালের আমিষ পরস্পরের সম্পূরক; তাই চাল ও ডালের সংমিশ্রিত খাবার শরীরের বৃদ্ধি ও ক্ষয়পূরণে বেশী উপকারী।
৮.	✔কোন একক খাদ্যই প্রয়োজনীয় সব ক'টি পুষ্টি উপাদানের শারীরিক চাহিদা পূরণ করতে পারে না, তাই সুষম খাদ্য গ্রহণ করতে হলে বিভিন্ন রকমের খাবার খাওয়া উচিত।
৯.	✔জনজন্ড বা অন্ধত্ব রোগ প্রতিরোধের জন্য আয়োডিনযুক্ত লবণ খান।
১০.	✔ভিটামিন 'সি' তাপে নষ্ট হয়ে যায়, তাই ভিটামিন 'সি' পেতে হলে প্রতিদিন টাটকা ফল খাওয়ার অভ্যাস করুন।
১১.	✔এনিমিয়া বা রক্তস্বল্পতা প্রতিরোধের জন্য চনাই বা আয়রন সমৃদ্ধ খাবারের পাশাপাশি ভিটামিন 'সি' জাতীয় খাবার খান।
১২.	✔ভিটামিন 'এ' সমৃদ্ধ খাবার রান্নার সময় একটু বেশী তেল দিয়ে রান্না করুন; এতে ভিটামিন 'এ' সহজেই দেহে শোষিত হবে।


খাদ্য নিরাপদ রাখার ৫ টি চাবিকাঠি
অভ্যাস করি, সুস্থ থাকি


Family Farming:
Feeding the world,
caring for the earth
World Food Day - 16 October 2014
বিশ্ব খাদ্য দিবস ২০১৪
১৬ অক্টোবর
পারিবারিক কৃষি :
প্রকৃতির সুরক্ষা, সবার জন্য খাদ্য
কৃষি মন্ত্রণালয়

হাত ধোয়ার অভ্যাস করি

সুস্থ জীবন গড়ে তুলি

হাত না ধুলে কি হয়?

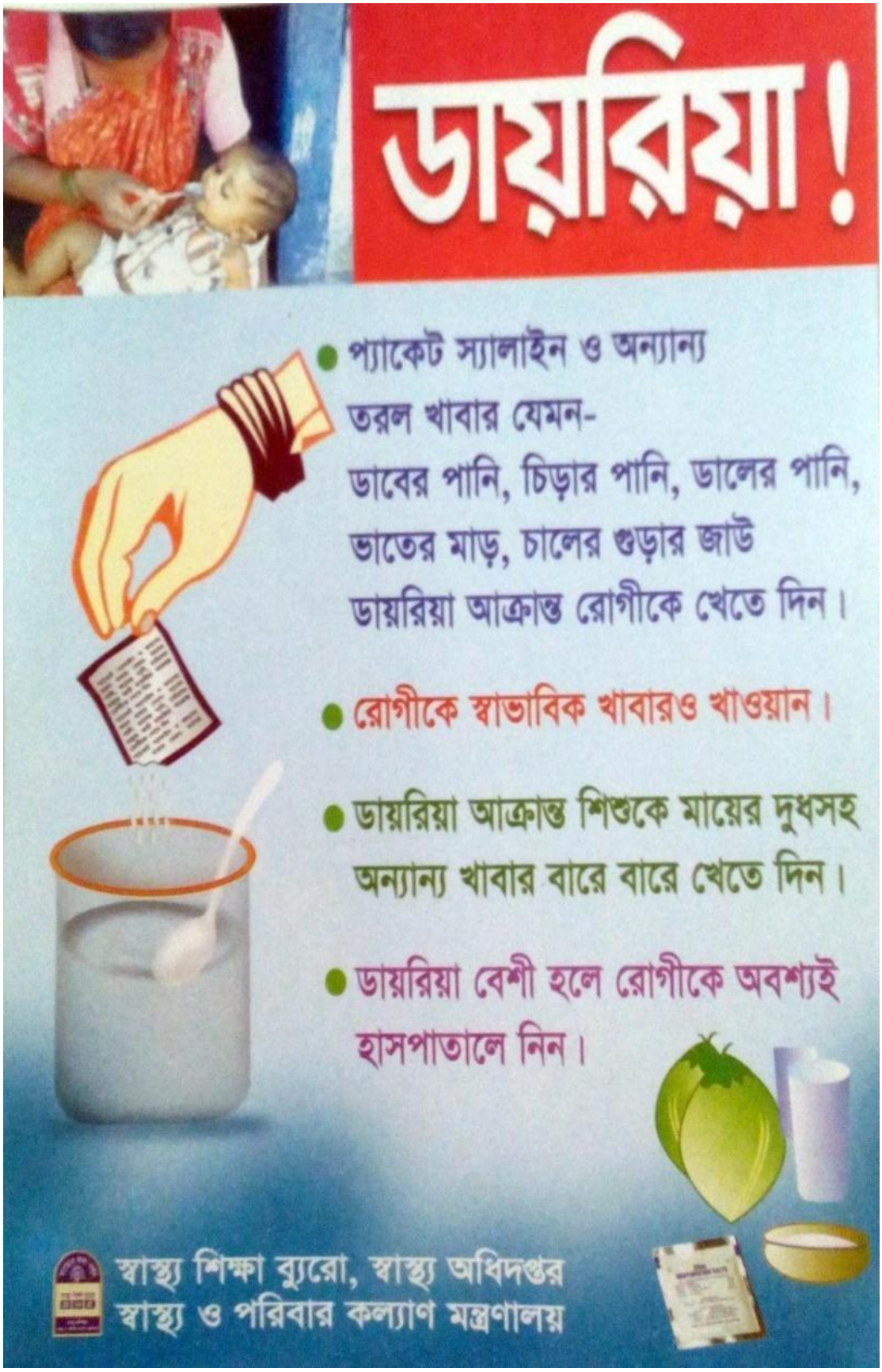
হাতের ময়লা খাবারের সাথে মিশে পেটে যায়, এ কারণে বিশেষ করে শিশুরা বেশির ভাগ সময় পেটের রোগে ভুগে

আসুন

অন্তত: ৬টি সময়ে সাবান ও নিরাপদ পানি দিয়ে হাত ধোয়ার অভ্যাস করি, সুস্থ থাকি

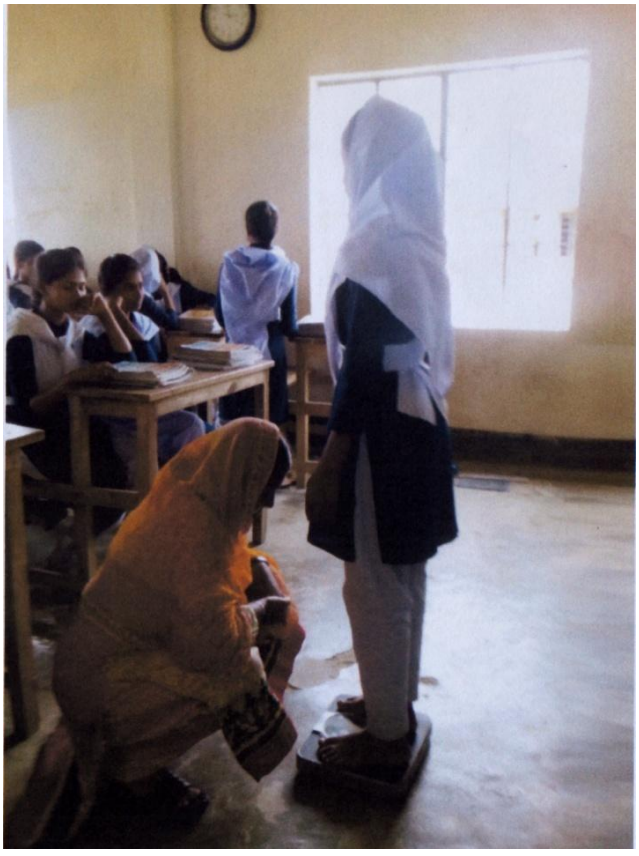
- খাবার তৈরির আগে
- খাবার পরিবেশনের আগে
- শিশুকে খাওয়ানের আগে
- নিজে খাবার আগে
- পায়খানা থেকে ফিরে এবং
- শিশুকে শোচানোর পরে

স্বাস্থ্য শিক্ষা ব্যুরো, স্বাস্থ্য অধিদপ্তর
স্বাস্থ্য ও পরিবার কল্যাণ মন্ত্রণালয়

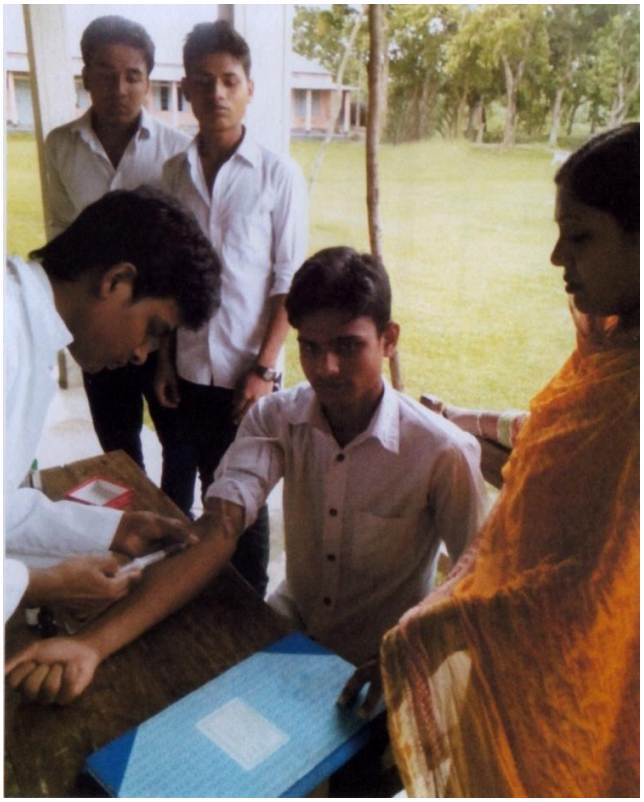

ডায়রিয়া!
প্যাকেট স্যালাইন ও অন্যান্য তরল খাবার যেমন-
ডাবের পানি, চিড়ার পানি, ডালের পানি,
ভাতের মাড়, চালের গুড়ার জাউ
ডায়রিয়া আক্রান্ত রোগীকে খেতে দিন।
রোগীকে স্বাভাবিক খাবারও খাওয়ান।
ডায়রিয়া আক্রান্ত শিশুকে মায়ের দুধসহ
অন্যান্য খাবার বারে বারে খেতে দিন।
ডায়রিয়া বেশী হলে রোগীকে অবশ্যই
হাসপাতালে নিন।
স্বাস্থ্য শিক্ষা ব্যুরো, স্বাস্থ্য অধিদপ্তর
স্বাস্থ্য ও পরিবার কল্যাণ মন্ত্রণালয়

7.1.5 Few pictures of study at field level

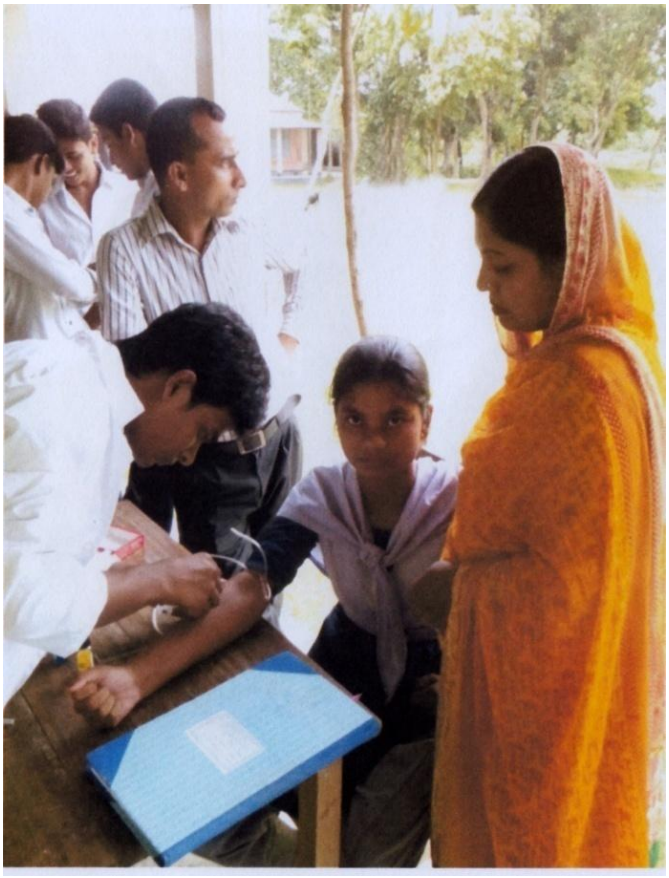
Data Collection



Anthropometric measurement



Collection of blood samples (boys)



Collection of blood samples (girls)

Nutrition education session (using visual materials)

Nutrition education session (practical food demonstration)

Homestead food (vegetables) production

Homestead fish production

7.1.6 Map of Kishoreganj district showing the study secondary schools

: Kishoreganj district headquarter

: Upazila headquarters of Kishoreganj district

: Study secondary schools of Kishoreganj district

7.1.7 A section of smiling secondary school students in one of lactions of Kishoreganj district