RESEARCH GRANT SCHEME

FOOD PLANNING AND MONITORING UNIT, MINISTRY OF FOOD
USAID-EU MEETING THE UNDERNUTRITION CHALLENGE (MUCH) PROJECT, FAO BANGLADESH

NUTRIENT DENSITY AND AFFORDABILITY OF HABITUAL AND DESIRABLE DIETS IN BANGLADESH BY LIFE CYCLE STAGE, REGION, AND VULNERABLE GROUPS

(FINAL REPORT)

This study was financed under the Research Grants Scheme (RGS) of the Meeting the Undernutrition Challenge (MUCH) project of FAO. The purpose of the RGS is to support studies that directly address the policy research needs identified by the Food Planning and Monitoring Unit of the Ministry of Food. The MUCH project is being implemented by the Food and Agriculture Organization of the United Nations (FAO) and the Food Planning and Monitoring Unit (FPMU), Ministry of Food with the financial support of EU and USAID.

Nutrient density and affordability of habitual and desirable diets in Bangladesh by life cycle stage, region, and vulnerable groups

Principal investigator

Dr. Nazma Shaheen, Professor, Institute of Nutrition and Food Science (INFS), University of Dhaka

Co-investigators

1. Dr. Md. Ruhul Amin, Associate Professor, INFS, University of Dhaka
2. Saiful Islam, Assistant Professor, INFS, University of Dhaka
3. Dr. Shafiun Nahin Shimul, Associate Professor, Institute of Health Economics (IHE), University of Dhaka
4. Dr. Syed Abdul Hamid, Professor, IHE, University of Dhaka

Preface

Bangladesh has achieved appreciable success in various fields in the last three decades, especially in its economic growth, food production, health, and nutrition. The population living below the national poverty line appreciably dropped to 20.5% in 2019 from 24.3% in 2016. However, Bangladesh's national poverty rate rose to 29.5% as of June 2020 due to COVID-19, which cost tens of millions of people their jobs and brought them down below the poverty line. Despite remarkable achievement in reducing chronic child malnutrition, especially in the last decade, a little less than a third of young children are stunted, and 9 % are wasted. In addition, less than half of the women of reproductive age consuming less than five food groups out of ten food groups points to the micronutrient inadequacy in their diets. A third of infants and young children have a minimum adequate diversity in their diets again reflective of the lack of critical micronutrients as per the nutritional requirements. Latest estimates from food consumption surveys have shown that the diet composed of different foods is compromised in diet quality according to the definition of "Healthy Diet" by WHO. Most of the people of Bangladesh still have diets that are dominated by rice (contributing to over 66% of the dietary energy), with less amounts of non-cereals and a range of other nutrient-rich foods that are essential for dietary diversity, an important attribute of nutrient adequacy in the diet.

Therefore, the present study was undertaken to reveal a comprehensive picture of the dietary habits, including the nutritional status of individuals by age, sex and region using data sets from two different nutrition surveys, which would identify the dietary nutrient gap and an assessment of the risk of inadequacy of intake.

The updated Food Composition Databases of Bangladesh (FCDB) and Food Composition Table serve as an essential tool for planning interventions in food security, nutrition, and health. FCDBs provide information relating to nutrient composition of foods with specific reference to energy, nutrients, and micronutrients (e.g., protein, fat, carbohydrate, vitamins, and minerals) and other nutritionally important food constituents (e.g., fiber, anti-nutrients, phytonutrients, etc.). To this end, nutrient profiling of individual foods is also a useful method of categorizing foods according to their nutritional composition and identifying which foods are nutrient dense foods, and suitable for the supply of critical nutrients to enable healthy diets. It would be considered as a useful and practical solution for the prevention of nutrient deficiencies among the population who are at risk due to inadequacy of intake of those critical nutrients. Moreover, a clear idea can be obtained from the association between nutrients and the price of foods to identify the nutrient returns for the money spent and develop affordable and healthy food baskets for the population. This will provide guidance for planning food-based interventions being by both public and private sectors.

Acknowledgement

The research team of the "Nutrient density and affordability of habitual and desirable diet in Bangladesh by life cycle stage, region and vulnerable groups" are grateful to the Government of the People's Republic of Bangladesh, Meet the Undernutrition Challenge (MUCH), Food Planning and Monitoring Unit (FPMU), Ministry of Food for the opportunity to conduct the research and Food and Agriculture Organization of the United Nations (FAO) for technical assistance and the European Union (EU) for financing the project. We appreciate the encouragement and support given by Mr. Robert Simpson, FAO Representative in Bangladesh and Naoki Minamiguchi, Chief Technical Advisor of MUCH-FAO project. We place on record the guidance and support extended by Dr. Nur Ahamed Khondaker, Assistant FAO Representative (programme), FAO on the administrative procedures and financial management of the work.

We are sincerely grateful to Dr. Anura V Kurpad, Professor, St. John's Research Institute, Bengaluru, Karnataka, India for his technical guidance to assess the risk of nutrient inadequacy, linear programming for the generation of food baskets for different population groups and Dr. Santu Ghosh, Assistant Professor, St. John's Medical College, Bengaluru, Karnataka, India for his technical support in statistical analysis and interpretation. We acknowledge the contribution of Warren Lee for his technical suggestions and for sharing his valuable time with us to give proper guidance to the present research.

We would like to thank Dr. Lalita Bhattacharjee, Senior Nutrition Advisor, Meeting the Undernutrition Challenge (MUCH), Food and Agriculture Organization of the United Nations (FAO) for her support through providing technical knowledge and valuable suggestions and effective coordination to implement the activities during unprecedented pandemic situations.

We are thankful to Prof. Dr. Sheikh Nazrul Islam, Director, Institute of Nutrition and Food Science (INFS), University of Dhaka for institutional and administrative support for the implementation of this research project.

We are profoundly grateful to all the members of the Technical Advisory Committee (TAC) for guiding us with their helpful comments and valuable time.

TAC: National experts

1. Dr. Tahmeed Ahmed, Executive Director, iccddr,b;
2. Dr. Khalilur Rahman, Director General, Bangladesh National Nutrition Council (BNNC);

3. Dr. Mustafizur Rahman, Line Director, National Nutrition Services, Ministry of Health and Family Welfare (MOHFW);
4. Dr. Ruhul Amin Talukder, Additional Secretary, Ministry of Agriculture (MoA);
5. Dr. Abul Barkat, Professor, Department of Economics, University of Dhaka;
6. Dr. Syed Shahadat Hossain, Professor, Institute of Statistical Research and Training, University of Dhaka;
7. Dr. Zeba Mahmud, Country Director, Alive and Thrive, Bangladesh;
8. Abu Ahmed Shamim, Associate Scientist, Center for Non-communicable Diseases and Nutrition, BRAC James P Grant School of Public Health, BRAC University;
9. Dr. Quamrun Nahar, Senior Research Officer, Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM);
10. Dr. Mostafa Zaman, National Professional Officer, Research, WHO Bangladesh; and
11. Md. Shahiduzzaman Faruki, Director General, FPMU Representative, Ministry of Food (MoF).

TAC: International experts

1. Professor Dr. Anura V Kurpad, Former Head of the Department of Physiology at St John’s Medical College and Division of Nutrition at St. John's Research Institute, Bangalore, India;
2. Dr. Warren T K Lee, Senior Nutrition Officer and Group Leader, FAO Regional Office for Asia and the Pacific, Bangkok, Thailand; and
3. Dr. Lalita Bhattacharjee, Senior Nutrition Advisor, USAID-EU-FAO Meeting the Undernutrition Challenge Project.

Acronyms

AI: Adequate Intake
AMDR: Acceptable Macronutrient Distribution Range
AME: Adult Male Equivalent
ANR: Average Nutrient Requirement
BBS: Bangladesh Bureau of Statistics
BIHS: Bangladesh Integrated Household Survey
CIP2: Bangladesh Country Investment Plan II
CoBN: Cost of Basic Needs
CoD: Cost of the Diet
CoNA: Cost of Nutrient Adequacy
CoRD: Cost of the Recommended Diet
CoRD-FP: Cost of the Recommended Diet - Food Preferences
CPI: Consumer Price Index
CVD: Cardiovascular Disease
DAM: Department of Agricultural Marketing
DFE: Dietary Folate Equivalent
EAR: Estimated Average Requirement
EER: Estimated Energy Requirement
ED: Energy Density
ESD: Energy Sufficient Diet
FAO: Food and Agriculture Organization
FBDGs: Food Based Dietary Guidelines
FBS: Food Balance Sheet
FDS: Food Deficit Scale
FIES: Food Insecurity Experience Scale
FTF: Feed the Future
GoB: Government of Bangladesh
HCES: Household Consumption and Expenditure Surveys
HD: Healthy Diet
HFIAS: Household Food Insecurity Access Scale
HIES: Household Income Expenditure Survey
IFPRI: International Food Policy and Research Institute
IMPS: Integrated Multipurpose Sample
INFS: Institute of Nutrition and Food Science
LRNI: Lower reference nutrient intake
LTI: Lower threshold intake
MAR: Mean Adequacy Ratio
MDGs: Millennium Development Goals
MOFHW: Ministry of Health and Family Welfare

MPA: Mean Probability of Inadequacy
NAD: Nutrient Adequate Diet
NAR: Nutrient Adequacy Ratio
ND: Nutrient Density
NFNSP: National Food and Nutrition Security Policy
NFP: National Food Policy
NIN: National Institute of Nutrition
NMS: National Micronutrient Survey
NNP: National Nutrition Policy
NNR: Naturally Nutrient Rich
NPAN: National Plan of Action for Nutrition
NPAN2: National Plan of Action for Nutrition II
NPNL: Non-pregnant and Non-lactating
NRF: Nutrient Rich Food
NSB: Nutrition Survey of Bangladesh
PA: Probability of Adequacy
PIA: Probability of Inadequacy
PIA: Probability of Inadequacy approach
RAE: Retinol Activity Equivalent
RDA: Recommended Dietary Allowance
SDGs: Sustainable Development Goals
SOFI: State of Food Security and Nutrition in the World Report
SUN: Scaling Up Nutrition
TDF: Total Dietary Fibre
TUL: Tolerable Upper Limit
UNL: Upper Nutrient Level
WFP: World Food Program
WRA: Women of Reproductive Age
WFR: Weighed Food Record
WHA: World Health Assembly

Table of Contents

List of Tables

List of Figures

Executive Summary

Background

Bangladesh has attained remarkable achievements in economy, food security, health, and nutrition. Child stunting reduced from 41.3% in 2011 to 31% in 2017-18 and wasting from 15.6% to 8.4%. Bangladesh is on track towards achieving its child nutrition targets for 2025 as committed in the National Plan of Action on Nutrition-2 (NPAN2), the Country Investment Plan-2 (CIP-2), and Sustainable Development Goals (SDGs). The country is self-sufficient in rice and fish production. However, the country is experiencing the triple burden of malnutrition as manifested by co-existence of undernutrition (e.g., undernourishment (13.0 %), stunting (28%), and wasting (8.4%)), micronutrient deficiencies (e.g., woman anemia (39.9%)), overnutrition (e.g., adult overweight (16.3% in male and 17.8% in female) and adult obesity (2.4% in male and 5.2% in female)), and resulting noncommunicable diseases (e.g., diabetes (around 10%)). To eradicate all forms of malnutrition and achieve food and nutrition security there is a need to create a sustainable, resilient food system for healthy diets that meet the needs of the population both in energy, macro-and micro-nutrients. This requires information on the energy and nutrient content of habitual diets in relation to nutrient adequacy and density to compare them to estimated average requirements (EARs) to identify gaps in nutrient intakes.

However, attaining food and nutrition security is not about just meeting the energy and nutrient needs. It also entails the consumption of culturally appropriate, balanced, and healthy diets as promoted in the food-based dietary guidelines. The unaffordability of sufficient, safe, and nutritious foods is a critical driver of the lack of access to such recommended diets. Therefore, knowing whether the existing food systems in a country can enable translation of the dietary guidelines towards the consumption of recommended diets in an affordable manner is important. There is need to provide evidence to inform policy planning for action to help improve diets as recommended in the dietary guidelines and proposed desirable dietary patterns for Bangladesh. Equally important is the need to identify culturally acceptable nutrient-dense foods from essential and diverse food groups and work out optimum combinations that meet the specifications of healthy diets for populations with varying nutritional requirements at affordable cost.

Methodology

Food consumption and nutrient adequacy

Secondary analysis was performed to assess food and nutrient consumption from the 'Nutrition Survey of Bangladesh (NSB) 2017-2018', and 'Bangladesh Integrated Household Survey (BIHS) 2015 round 2', and 'HIES-2016' using updated FCT of Bangladesh, 2013 and the updated food composition database, 2018. Dietary datasets were harmonized using established procedures. Individual consumption was estimated from household data of 'HIES-2016' using the Adult Male Equivalent (AME). The percentages of energy consumption from protein, fat, and carbohydrate were calculated and compared with acceptable macronutrient distribution range

(AMDR) (WHO, 2003). Usual intake was calculated by transforming the data following its distribution and adjusting within and between variation with the ANOVA test (NRC, 1986). The probability of inadequacy of nutrient intake was computed using the "Probnorm" function in STATA software. Mean probability of adequacy (MPA) for 12 micronutrients (calcium, magnesium, iron, zinc, thiamine, riboflavin, niacin EQ, vitamin B_6, folate, vitamin B_{12}, L-ascorbic acid, vitamin A (as retinol activity equivalent (RAE)) was calculated by averaging the adequacy of the nutrients. Nutrient adequacy ratio (NAR) was also used to evaluate the diet quality of individuals, and the mean adequacy ratio (MAR) was calculated by averaging the adequacy of the nutrients.

Nutrient profiling

Nutrient density refers to a concept which reflects the content of key nutrients in relation to the energy content of the foods per 100 g edible portion, 100 Kcal, or the serving size of foods. This concept was used for scoring foods and their nutrient profiling to help identify the nutrient-dense foods that can be used to formulate or plan a "Healthy diet". The nutrient density of foods has been calculated within and across food groups by using the nutrient composition of foods in the Food Composition database for Bangladesh. The Energy Density (Kcal per gram of food), Naturally Nutrient Rich (NNR) score (the average of % DVs for 16 nutrients), and Nutrient-Rich Food Index (NRF), which encourage nine crucial nutrients and discourage 3 nutrients, were applied to compute these nutrient density variables that contributed to elaboration of the nutrient profiling process.

Cost and affordability of recommended healthy diets

For estimating costs and affordability of three different-quality diets, retail prices of food items from a market survey were used and the energy and nutrient content values were calculated from the Food Composition Table for Bangladesh. The three reference diets of increasing diet quality are (i) *energy sufficient* diet (ESD) meeting calorie needs for energy balance, (ii) *nutrient adequate* diet (NAD) providing not only adequate calories but also the adequate level of all essential nutrients for a healthy and active life, and (iii) *recommended healthy* diet (RHD) providing, in addition to adequate calorie and essential nutrients, a diverse intake of foods from different food groups based on dietary guidelines in Bangladesh. To gauge affordability, the cost of the RHD was compared against household food expenditure and poverty line estimates. Finally, linear programming was applied to identify the best combinations of foods and their least costs to address the dietary inadequacies of the Bangladeshi population at different stages of their life cycle.

Key Findings

Food consumption and nutrient adequacy

- Cereal consumption dominates the diets of all population sub-groups, rice being the most popular cereal in the country. Wheat is also consumed, but in much smaller amounts, with wheat consumption being higher among richer households and in urban regions. Regarding dietary supply of energy, carbohydrates contributed to around 72%, protein 18%, and fat 10%. The survey also showed that 80% of the population were consuming 55-75% of energy from carbohydrates, 69% consuming 10-15% of energy from protein, and 65% consuming 15-30% of energy from fat. About a third of the total protein (37.14 g) is from high biological value, animal source foods.

- The consumption of almost all food groups including cereals, pulses, vegetables, and meat, was higher in the 2nd or 3rd expenditure quintiles and the consumption of fruits, oil, and animal source foods was higher in the richest group of people. Also, the intakes of these food groups were seen to be higher in the urban localities compared to the rural areas. This trend was observed in all the surveys included in this report. Food consumption levels for all the food groups were highest among adults ranging from 19-50 years.
- Macro and micronutrient intakes were higher among wealthier classes and the male population. Nutrient adequacy levels were alarmingly low for calcium, riboflavin, thiamine, vitamin B_{12} and vitamin A except for niacin and magnesium. Nutrient adequacy levels were overall lower in diets of females than males. Nutrient adequacy level is also found to increase with increased age.
- In children under 2 years of age, the probability of adequacy (PA) is lowest for calcium, thiamine, riboflavin and iron (0-2%), followed by vitamin B_6 (7%), folate (8%), vitamin A (9%), vitamin B_{12} (10%), vitamin C (14%) and zinc (28%). The mean probability of adequacy (MPA) across the 12 micronutrients was 11% for children under 2 years, 24% for adolescent girls (10-14 years), 34% for women of reproductive age, and 20% for pregnant and lactating women. However, the mean adequacy ratio (MAR) approach yielded a higher level of nutrient adequacy than the PA approach. Among the vulnerable groups with MAR across 12 micronutrients was found 46% for children, 64% for adolescent girls (10-14 years), 68% for women of reproductive age, and 62% for pregnant and lactating women.

Nutrient density

- Comparative calculations of nutrient density of different food groups showed that the energy-dense foods were fats (9.0); cereals (3.44), pulses and legumes (3.27) and nutrient-poor as per NRF9.3 except for nuts and seeds.
- Leafy and (ED-0.45; NNR-11.94; NRF9.3-375.97) non-leafy vegetables (ED-0.29; NNR-4.76; NRF9.3-144.76) are energy poor but are the most nutrient-dense food groups among the 15 food groups of the Bangladesh food composition database. Fruits (ED-0.86; NNR-5.58; NRF9.3-87.11) are second-most nutrient-dense foods with less energy density. Fish (ED-1.03; NNR-8.85; NRF9.3-67.37) are noted to be the third most nutrient-dense food in Bangladesh.

- Leafy and non-leafy vegetables, fruits, fish, poultry, eggs have high to moderate nutrient density. Such foods may be suitably indicated in conditions of undernutrition, overweight, and obesity and in the prevention and control of non-communicable diseases.
- Leafy vegetables were found to have the highest nutrient return per taka (e.g., amaranth leaves (slender, green, and red) jute leaves, bottle gourd leaves, Indian spinach, with low energy density. Local seasonal fruits were identified as the least costly in terms of nutrient return per taka.

Cost and affordability of recommended healthy diets

- "Energy Sufficient," "Nutrient Adequate," and "Recommended Healthy" diets would cost 19.2 BDT, 38.2 BDT, and 83 BDT, respectively, in Bangladesh. The cost of a diet increases incrementally as the diet quality rises across all divisions. Overall, "Recommended Healthy" diets cost 133 percent more than diets that only meet the requirements for essential nutrients and more than four times as much as diets that meet only the dietary energy needs through a starchy staple.
- The cost of a desirable and dietary guidelines-based "recommended healthy" diet is much higher than what can be afforded by the people in lowest poverty line in relation to their food expenditure. This makes healthy diets beyond the reach of those living in poverty or just above the poverty line across all divisions. However, households were found to heavily spend their money on cereals (38% of food expenditure) which could otherwise be used to increase their expenditure on healthier, nutritious food items (e.g., animal source protein foods and dairy products). The highest proportion (0.66) of households who cannot afford healthy diets are from the Khulna division, with the fewest in the Chattagram division (0.25). The burden of unaffordability of "recommended healthy" diets was found to be significantly greater in rural (42%) than urban (39%) areas.
- Application of linear programming identified 32 key nutrient-dense foods that comprised the nutritionally adequate, health-promoting, and culturally acceptable, least-costly food baskets designed for different population groups across the life cycle. The identified foods were locally available in the market areas, contained macro or micronutrients in the diets, and were the least expensive compared with alternative foods of similar nutrient composition. Food items that were almost universally included in the food baskets were rice, wheat flour, grass pea, egg (chicken), potato, melon (futi), slender amaranth leaves, water spinach, whole milk, soya oil, and sugar. Other food items in the food baskets included millet (proso), soybean, Bengal gram, radish, amaranth stem, cabbage, sweet potato, colocasia (taro), carambola, banana, red amaranth leaves, green amaranth leaves, radish leaves, jute leaves, Indian spinach, egg (duck), fish (pool barb), palm oil, jackfruit seeds, and jaggery.

Recommendations/Policy implications

- To reduce the micronutrient gap, cereal consumption should be decreased, and pulses, vegetables especially leafy vegetables, nuts and seeds, fruits, and milk and milk products should be increased.
- A robust food-based nutrition education program enhancing dietary diversity should be undertaken through multiple channels to bring about positive changes in rice-based food habits.
- The concept of nutrient density and nutrient density scoring has application in food labeling, nutrition policymaking, dietary interventions, and consumer education. In addition, this scoring system can inform agriculture policy to plan nutrition-oriented production targets and produce nutrient-dense foods as part of its food diversification programs. This will ensure a diversified food supply to help meet dietary nutrient intakes in relation to energy requirements of the population across the lifespan.
- In addition to staples, the cost of foods across a broader set of food groups that constitute healthy diets needs to be decreased and their availability improved. The government would need to pursue diversification policies and interventions around food production especially dairy, fruits, vegetables, and protein-rich foods to reduce prices. In parallel, the government would need to implement policies that support market access allowing the flow of diverse nutritious foods into markets.
- As healthy diets remain unaffordable even in their cheapest form to the poorer populations, nutrition education and behavior change communication (e.g., counseling on specific nutrient-rich foods identified in the least-costly food baskets) should be complemented with social protection programs and food systems policies (e.g., scaling up home production of diverse foods through kitchen gardens) to improve access to and consumption of healthy diets. Poverty lines may need to be reconstructed so that they account for a realistic cost of healthy diets beyond the current principle of meeting only the cost of energy sufficiency.
- Nationwide actions should be undertaken to promote healthy purchasing behavior (i.e., reallocating expenditure share to non-cereal food groups). As households were found to spend on cereals more than they require for a healthy diet, they need to be provided with information (i.e., composition and comparative benefits) on non-cereal foods as integral to healthy diets.
- Updating food-based dietary guidelines for Bangladesh to include age-, sex-, physiological stage-, and physical activity level-specific recommendations could be a fundamental starting point. This should be followed by the provision of appropriate support to increase the use and dissemination of these recommendations among consumers, producers, marketers, programmers, and policymakers.

Chapter 1: Introduction

1.1 Background and significance

Food is known to be central to health and well-being and its implications for healthy diets and human nutrition are profound. Translation of food and nutrients for a "healthy diet" is complex and may vary widely depending on an individual's genetic make-up, environment, and cultural context. In an era where there is coexistence of undernutrition (underweight, stunting and wasting), overweight and obesity, and micronutrient deficiencies as the triple burden of malnutrition, it is essential to adjust diets to meet the needs of the whole population both in energy, macro and micronutrients. This requires estimating the energy and nutrient content of habitual diets, comparing them to estimated average requirements (EARs), and promoting more desirable diets that are affordable across the income spectrum and sustainable in terms of bioavailability, and cultural acceptance. As human nutritional requirements vary across different stages of the life cycle, it is necessary to identify the nutrient gaps in the diet, understand the nutrient density of foods which is an essential attribute of diet quality, and accordingly use nutrient density as a means to plan diets for distinct groups across the life span.

Techniques such as nutrient profiling help to discover nutrient-rich, reasonably priced, and sustainable foods to calculate nutrient density of foods. Creating new metrics of affordability and finding foods that grant the most nutrients per currency spent is possible because of the placing of food price in nutrient density calculations (Darmon et al., 2005; Maillot et al., 2008). Nutrient profiling of foods is becoming a core criterion for verifying and validating nutrient content and health claims of foods, regulating nutrition labels, as well as marketing and promotion of healthy foods for children (Drewnowski & Fulgoni, 2008). Nutrient profiling systems can be employed in meals, menus, and diets which show how the notion of nutrient density goes into total diet quality as well informs the economic aspect of food selection (Drewnowski et al., 2008; Miller et al., 2009). The nutrient density method demonstrates its potential of guiding the eating of nutrient-dense foods which is reportedly linked to a moderately decreased threat of CVD, diabetes, and all-cause mortality (Chiuve, Sampson & Willet, 2011). Streppel et al. (2014) studied the relations between the NRF9.3 index and the occurrence of cardiovascular disease (CVD) events and all-cause mortality and observed that the NRF9.3 index score was inversely linked with all-cause mortality. To classify reasonably priced nutrient-rich foods that are part of the typical US diet, the NRF9.3 is found to be the only index connected to US food prices (Drewnowski and Fulgoni, 2014). Nutrient profiling helps consumers to create healthier food choices. However, there are sporadic examples of 'nutrient profiling' of foods consumed in Bangladesh, notably for rice, but there is no evidence available yet on the nutrient density of typical diets.

FAO (2017) has been providing estimates of per capita supply for food items across countries, both in terms of quantity and, through the application of food conversion factors, in terms of caloric value, protein, and fat content which can then be derived by dividing by the country's population. These per capita estimates of caloric value for individual food products are then summed to obtain the total daily per capita Dietary Energy Supply (DES) of a country. The micronutrient supply of countries from food balance sheets of tremendous importance to inform food diversification policies and to analyze dietary diversity from food supply for consumption.

Beal et al. (2017) estimated global micronutrient food supplies of eight vitamins and six minerals, their bioavailability, and prevalence of inadequate intake. Arsenault et al. (2015) estimated the micronutrient content of Bangladeshi food supplies using data from national food balance sheets. Fielder (2015), using the 2010 BBS HIES, looks at the adequacy of farming households' nutrient availability and nutrient intake status and interprets that domination of agriculture and diet by rice is a major constraint to improving nutrition in Bangladesh.

While nutrition profiling and identification of appropriate diets with required nutrients are essential, it is also crucial to understand whether that basket is affordable especially for the vulnerable groups. Based on the EAT-Lancet's first global benchmark diet (EAT Lancet Commission Report 2019) capable of sustaining health and protecting the planet, Hirvonen et al (2020) conducted affordability estimates for 159 countries. They consider the EAT-Lancet's recommended benchmark affordable if the minimum costs required for that basket are less than the income earned. A similar approach has been attempted to develop an affordability index through the Affordability of Nutritious Diets in Africa (IANDA) project (INDDEX Project, 2018). They used wages instead of income to develop the affordability index. Their version of the definition of poverty, however, does not go with the widely applied poverty definition-where Cost of Basic Needs (CoBN) is used to measure poverty, and food is a major but not the only component. Therefore, a basket would be unaffordable even if it costs less than income, but it exceeds the money spent on food. HIES (2016) also used CoBN along with other definitions, such as the food poverty index.

To understand whether a particular food basket is affordable, it is essential to first estimate the minimum costs required to achieve the target nutrients within the food items available and at the market price. Use of linear programming is suggested and has been applied in this regard. For example, Parlesak et al (2016) developed similar guidelines for WHO that are used for Romania. Rana and Haque (2018) also applied the same technique for Bangladesh.

Attaining food and nutrition security is not just about meeting the energy and nutrient needs alone. It also requires the consumption of culturally appropriate, balanced, and healthy diets as recommended in the food-based dietary guidelines. The unaffordability of sufficient, safe, and nutritious foods is a critical driver of the lack of access to such recommended diets. Therefore, knowing whether the existing food systems in a country can bring the dietary guidelines based recommended diet within the reach of the population is of preeminent importance to inform policy actions and to help improve diets, as recommended in the dietary guidelines.

1.2 Research justification

Nutrient-dense foods are those that supply comparatively more nutrients than calories (Drewnowski and Fulgoni, 2014). During nutritionally vulnerable stages of life such as pregnancy, infancy, early childhood, and old age receiving good nutrition is very critical (Troesch et al., 2015). The nutrient density method points to the potential of its use in eating nutrient-dense foods given the links to a moderately decreased threat of CVD, diabetes, and all-cause mortality (Chiuve, Sampson and Willet, 2011). Nutrient density considerations are also used while developing dietary guidelines that assist food and agriculture planning to promote the production and consumption of nutrient-dense foods. Also, it can be introduced through nutrition platforms for wider dissemination and advocacy for wiser food choices and healthy meal planning. The intake of nutrient-dense foods, recognized by a precisely proved nutrient density profiling system, could be one of the guiding principles for people to adopt healthy diets (Miller et al., 2009).

With regards to encouraging vulnerable groups to switch to nutrient-dense diets, studies have looked at the effects of introducing complementary and supplementary foods into the diets of children among others. Rose (2016) carried out a cost-benefit analysis for a set of nine standard nutrition direct interventions that have an effect on stunting, whether it was the main purpose of the intervention or not, and found them to offer substantial economic benefits relative to the costs. However, he points out, that further research is needed on existing local nutrition programs that can more precisely identify the costs including that of targeting and the benefits.

Additional evidence is necessary to gauge the nutrient density of typical foods and diets consumed including that of vulnerable groups and identify desirable diets. Measuring the nutrient density of typical diets of reference groups and mapping them against their cost will also help guide consumers towards the most 'efficient' foods in terms of nutritional returns. The Government may also use this information to influence the planning of a minimum affordable food basket and stimulate the production of certain nutrient-dense foods. There is also the need to consider cultural acceptability of the foods (Perignon et al. 2018).

This study has employed the most recent data on nutrient consumption to identify the dietary pattern at the population level (by specific age group, physiological condition, and by location), and the nutrient composition of Bangladeshi foods as well as the nutrient profile of each consumed food to identify the most potent candidates for supplying the essential nutrients in the diet. At the same time, food price and expenditure data are needed to assess the affordability of the naturally nutritious foods by life cycle stage.

1.3 Bangladeshi policy context

Diets are being increasingly recognized as a major determinant of food and nutrition security. The main criterion that decides whether a diet is appropriate is the spectrum of foods consumed. Amidst a complex and overarching policy environment, strategies are being implemented to address the continuum of food systems and integrated issues of food and nutrition security to prevent and control the wide spectrum of malnutrition in Bangladesh. As part of improving diets, it is essential to adjust the diets to meet both the needs energy and nutrients of the whole population. This requires estimating the energy and nutrient content of habitual diets, comparing them to estimated average requirements (EARs), and promoting more desirable diets that are affordable across to income levels. Because of the different nutritional needs of humans at different stages of their lives, it is essential to identify gaps in the nutrition density of individuals' diets at different stages of their life cycle.

This study is expected to serve as an important output to contribute to enhancing nutrient adequacy of diets as part of our support to the government's nutrition sensitive policies and strategies on food systems by proposing cost-effective interventions to popularize nutritious diets among nutritionally vulnerable population groups (National Food and Nutrition Security Policy, NFNSP, 2020). Estimating the cost of and affordability of nutritious diets by region and residence would help inform the policymakers to formulate nutrition-focused action plans and interventions. Measuring the nutrition density of typical diets of reference groups and mapping them against their cost will also help guide consumers towards the most 'efficient' foods in terms of nutritional returns. The Government may also use this information to influence the planning of a minimum affordable food basket and stimulate the production of certain nutrient-dense foods, which is a policy priority on dietary diversification for the government.

1.3.1 Poverty and consumption (food security)

Bangladesh has come a long way from being a chronic food deficit country in the 1970s. In the last three decades, though the population has increased by more than double, the food (cereals) production has tripled and kept pace with population growth. It is fair to say that Bangladesh has attained food self-sufficiency in terms of calorie availability. The Household Income Expenditure Survey (HIES 2016) survey estimated that per capita calorie intake which was 2,318 kcal per day in 2010 decreased to 2210 kcal per day in 2016, which was comfortably higher than the estimated minimum requirement of 2,122 kcal per day. Moreover, people are now moving towards nutrient-rich diets rather than only energy-dominating ones. According to a World Bank report, the average consumption of starchy staples and pulses has declined by 7 percent and 32 percent from 1985 to 2010, though the decline in pulses is to the detriment of not gaining from the nutritional benefits of pulses in cereals-based diets. On the other hand, consumption of oil and meat has increased more than double to 169 percent and 124 percent, a matter of potential concern. Fruit consumption has also doubled over the period increasing by 91 percent, while vegetable consumption increased only by 24 percent. However, the changes in food consumption between 2010 and 2016, suggest that improvements in diets are slowing and need acceleration. Consumption of protein-rich food groups still fell below the recommended amount by 58 percent along with vegetables and fruits by 23 and 65 percent, respectively (World Bank, 2019).

Along with improvements in food production Bangladesh has also succeeded in reducing poverty. According to the report of the Household Income Expenditure Survey (HIES, 2016), poverty rates in both rural and urban areas have reduced in 2016 as compared with 2010. Poverty in urban areas was 7.7% in 2010 compared with 7.6% in 2016 and in rural areas was 21.1% in 2010 compared with 14.9% in 2016. Using the upper poverty line, the incidence of poverty is estimated at 24.3% at the national level, 26.4% in rural areas, and 18.9% in urban areas (HIES 2016). And by using the lower poverty line, the incidence of poverty is estimated at 12.9% at the national level, 14.9% in rural areas, and 7.6% in urban areas. The gradual reduction in the poverty rate was higher in rural areas compared to urban areas. In rural areas, the reduction was 3.7 times higher than in urban areas.

Despite the impressive gains made in reducing poverty and improving consumption over the past few decades, many people remain food insecure. The prevalence of severe food insecurity based on the Food Insecurity Experience Scale (FIES) was 10.6% in 2017-19 with moderate food insecurity on a three-year average for 2016-18 and 2017-19 being 31.5%. Food Security and Nutrition Surveillance Project used Food Consumption Score (FCS) to capture the dietary diversity of the households and observed that despite substantial reduction in food insecurity there has been little reduction in the proportion of households consuming poor or borderline diets between 2011 and 2014 (HKI/JPGSPH, 2015).

1.3.2 Micronutrients and protein-energy deficiencies

Bangladesh has made remarkable progress in reducing child undernutrition by a third in the last three decades but micronutrient deficiencies especially of vitamin A, iron (Fe), folic acid, calcium (Ca), zinc (Zn), and iodine remain significant nutritional problems. Micronutrient deficiencies in Bangladesh especially among children and women of reproductive age are still a challenge. Around 50% of women of reproductive age suffer from micronutrient malnutrition of varying forms and around 74% of urban children aged under five years (about 3.1 million) have at least one micronutrient deficiency (vitamin A, zinc, or iron).

Among several micronutrient deficiencies, anemia continues to present a major challenge among target groups and needs to be reduced. Half of the pregnant women are anemic which results in low birth weight in children. The prevalence of anemia among non-pregnant and non-lactating (NPNL) women is 26%, down from 33% in the national micronutrient survey (NMS, 2011-12). The prevalence of anemia among total preschool-age children is 33.1% nationally, and 37% and 22.8% in the rural and urban strata specifically. The prevalence of anemia in school-age children is 19.1% among children aged 6-11 years and 17.1% among children aged 12-14 years. Moreover, the prevalence of iron deficiency is 10.7%, 9.5%, and 7.1% for preschool, school-age, and NPNL women respectively.

Zinc, another vital micronutrient, that is essential for both immunity and cognitive development is deficient in large portions of children and women. According to NMS, 2011-12 zinc deficiency afflicts 44.6% of preschool children and 57.3% of NPNL. Despite making tremendous improvement in Iodine deficiency through salt iodization about 40% of school-aged children and 42% of women suffer from iodine deficiency (NMS, 2011-12). Subclinical vitamin A deficiency is 20.5% and. The prevalence of vitamin D deficiency is 39.6% for preschool children, 45.5% for school-aged, and 71.5% for NPNL based on serum vitamin D level (50.0mmo/L). The prevalence of calcium deficiency is 24.4% for preschool children, 17.6% for school-aged children, and 26.3% for NPNL (NMS, 2011-12).

Apart from micronutrients deficiency, undernourishment in Bangladesh remains at 13.0% in 2019 according to the FAO estimates. The COVID-19 crisis may further worsen this situation with the first and hardest impact on the most vulnerable. Undernutrition among children under ages five has continued to reduce; but the prevalence of stunting and wasting remain at 28% and 8.4%, respectively, in 2018 (Bangladesh Demographic and Health Survey, 2017-18).

1.3.3 Food and nutrition policy environment

The Government of Bangladesh has undertaken several programs and policies for reducing malnutrition and micronutrient deficiencies through promoting nutrition-intensive strategies as well as integrated multi-sectoral actions. Bangladesh's Second Country Investment Plan (CIP2) 2016-2020 formulated by the Ministry of Food in partnership with 17 ministries is a comprehensive inter-sectoral plan on Nutrition-Sensitive food Systems to tackle hunger and malnutrition. It emphasizes developing nutrition-sensitive food systems by prioritizing investments in each stage of the food supply chain along with ensuring a safe and nutritious food system for Bangladesh. The prime goal is to ensure improved food and nutrition security for all-around all times of the year through sustainable and well-organized economic and institutional infrastructure. The CIP's strategic objective is to ensure availability, affordability, and nutritional quality of foods and make people aware of healthy diets to make educated food choices.

The National Food Policy (NFP) 2006 and the National Food Policy Plan of Action 2008 – 2015 endorsed by the Government of Bangladesh among its objectives highlighted safe and adequate nutrition for all especially women and children as well as to develop a longstanding national plan for confirming balanced food in constructing a fit nation. The National Nutrition Policy (NNP, 2015) is another major policy instrument of Bangladesh that aims to improve the nutritional status of the people, especially vulnerable groups, including mothers, adolescent girls, and especially under-five children. It aims to prevent and control malnutrition, and to accelerate national development by raising the standard of living. National Nutrition Policy 2015 specifically emphasizes ensuring proper nutrition of people by identifying causes of malnutrition. This policy works to implement and strengthen the existing strategy, build a new strategy, and provide direction to the improvement of the nutrition status of the people of Bangladesh. The second objective is to ensure the availability of adequate, diversified, and quality safe food and promote healthy feeding practices. The Second National Plan of Action for Nutrition (NPAN2) has been designed to enable the Government of Bangladesh (GoB) to fulfil the global commitments like Sustainable Development Goals (SDGs), Scaling Up Nutrition (SUN), Second International Conference on Nutrition (ICN2), and World Health Assembly (WHA) among others.

More recently, the Government of Bangladesh has decided to develop a new National Food and Nutrition Security Policy (NFNSP) to cover the period 2020-2030 in synchronization with the target year for SDGs. National Food and Nutrition Security Policy (NFNSP) is also expected to inform the implementation of the 8th and the 9th Five Year Plans. The goal of the National Food and Nutrition Security Policy of Bangladesh (NFNSP) is to improve the food and nutrition security status to the level needed to achieve the Food and Nutrition Security (FNS)-relevant SDG targets and fulfill related national and international commitments by 2030 as well as driving commitment within the UN Decade of Action on Nutrition, 2016-2025.

1.4 Specific Objectives

1.4.1 Objective-1: Assessment of the current food consumption of Bangladeshi population by life cycle stage and region

This objective aims to perform secondary analysis of food and nutrient consumption from 'Nutrition Survey of Bangladesh (NSB) 2017-2018', 'Bangladesh Integrated Household Survey (BIHS) 2015 round 2', and 'HIES-2016' using updated FCT of Bangladesh (2013, 2018) at the household level and individual level based on indicators. It also aims to calculate the percentages of energy consumption from protein, fat, and carbohydrate in accordance with acceptable macronutrient distribution range (AMDR) (WHO, 2003).

1.4.2 Objective-2: Estimating adequacy of energy and nutrient intakes of Bangladeshi population by life cycle stage and region

This objective aims to calculate usual intake by transforming the data following its distribution and adjusting within and between variation with the ANOVA test (NRC, 1986). And then it aims to estimate the adequacy of energy, macro, and micronutrient intakes. Further, it aims to compute the probability of inadequacy (PIA) of micronutrient intake using the "Probnorm" function in STATA software. We calculated the mean probability of adequacy (MPA) for 12 micronutrients (calcium, magnesium, iron, zinc, thiamine, riboflavin, niacin EQ, vitamin B_6, folate, vitamin B_{12}, L-ascorbic acid, vitamin A (as retinol activity equivalent (RAE)) by averaging the adequacy of the nutrients. We also used nutrient adequacy ratio (NAR) to evaluate the diet quality of individuals and calculated the mean adequacy ratio (MAR) by average the adequacy of the nutrients. The probability approach was used for analyzing the adequacy of the 12 selected micronutrients by age, and sex, vulnerabilities.

1.4.3 Objective-3: Nutrient profiling of foods by using the nutrient composition of foods

This objective aims to calculate Nutrient Density (ND), Energy Density (ED), Naturally Nutrient Rich Score (NNR), and Nutrient Rich Food Score (NRF index) for the food listed in the FCT which in turn will help identify and promote healthy food basket for Bangladeshi population.

1.4.4 Objective-4: Cost of a nutritious/recommended diet in Bangladesh by region and its affordability by region

Achieving a healthy diet will only be possible if we ensure that people have enough food to eat and that what they are eating is nutritious. However, one of the biggest challenges to achieving this is the cost and affordability of healthy diets. Thus, this objective estimates the cost and affordability of three different levels of diet quality in Bangladesh and examine how they vary with geographical location and residence. The objective further aims to analyze the relative differences in cost and affordability moving from a diet that is ‘energy sufficient’ to one that is ‘nutrient adequate’ and then to one that is ‘healthy’.

1.4.5. Objective-5: Identification of least-costly food basket by life cycle stage

This objective aimed to identify the bundle of Bangladeshi food items and calculate the amounts to be consumed so that this basket meets the daily nutritional recommendations at the lowest possible cost. Even when people know what foods to eat, economic reasons largely limit their consumption of foods rich in essential nutrients. Costs of foods were calculated for each of the population groups across the life cycle stages including those with special needs (i.e., pregnancy and lactation). While doing so, we took into consideration the recommended dietary guidelines for the Bangladeshi population. We also aligned our exercise with the prevailing dietary habits particularly in relation to the composition of staples (e.g., rice) customarily consumed in a typical Bangladeshi diet.

Chapter 2: Methodological Literature

2.1 Dietary assessment methods and indicators

Worldwide, nutrition experts agree that a single indicator cannot capture all the dimensions of food security and dietary adequacy. Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996). For global assessments, single food security indicators are used without adequate consideration of all the dimensions of food security being captured by their chosen metric. In general, food security metrics reflect the three broad areas of availability, access, and utilization (USAID, 1992; Webb & Rogers, 2003). The following are considered 'diet-related food security indicators' in that they measure whether food is sufficiently available, accessible, and utilizable to meet consumption needs.

24-hour Dietary Recall (24HR)

By inquiring about the type and quantity of food and beverages ingested during the preceding 24-hour period, the 24-hour Dietary Recall (24HR) approach provides comprehensive, quantitative information on individual diets. As they are quick, culturally sensitive, and offer quantitative data on both foods and nutrients, 24HRs are frequently used in low- and middle-income countries (Gibson & Ferguson, 2008). The multiple pass 24HR technique is used in the international standard approach, in which the respondent recalls foods and beverages consumed—and their quantities—in the past 24 hours.

24HR data can be used to assess dietary patterns, food groups, or nutrient intake. The food data must be matched with nutrient information from a food composition database to calculate the nutrient content. A single 24HR yields an estimate of the mean intake of foods and nutrients, whereas collecting a second 24HR on a subset of the population allows for an assessment of 'usual intake.' In comparison to FFQs or estimates obtained from HCES, this method offers a higher degree of accuracy in assessing food and nutrient intake. However, due to the complexities of 24HR surveys, the enumerators must undergo extensive training to minimize errors in data collection. It is often difficult for responders to accurately recall the quantity of food they consumed and is a relatively large source of error in 24HRs.

Dietary diversity

Dietary diversity is especially important in populations with starchy staples diet, where micronutrient deficiency is more prevalent (Ruel, 2003). Dietary diversity can be assessed at both the household and the individual levels, with higher scores indicating a more diverse diet. Dietary diversity scores do not yield quantitative information on dietary intake or nutrient adequacy. Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods and is also a proxy for nutrient adequacy of the diet of individuals. To this end, individual dietary diversity scores aim to reflect nutrient adequacy. The most common method of measuring dietary diversity for a household or individual consists of assessing a variety of specified food groups consumed during a specific recall period; While there is no information on the quantity of foods consumed, minimum dietary diversity scores established for women's diets serve as a valid indicator to evaluate micronutrient inadequacy (FAO, 2021) and can be adapted at individual levels. Assessment of dietary diversity requires very few resources and are generally simple to calculate and apply.

Food Composition Databases

Food Composition Databases (FCDB), also known as Food Composition Tables (FCT), are databases that contain information on the nutrient content of foods. FCDBs are a required input to convert foods from food consumption data to nutrient intakes. FCDBs can be used for nutrient analysis of foods from dietary consumption surveys, nutrition labeling, and informing nutrition-sensitive agricultural policies, among other things (Charrondiere et al., 2011). Food composition data may be used for several purposes, including matching foods with nutrients from dietary assessment data for analysis, nutrition labeling, legislation, and nutrition-sensitive agriculture. However, discrepancies in the FCDBs values rely on the selection of analytical methods used, quality control in estimates through internal standard, certified reference materials, use of relevant factors during conversion, national representations of samples (application of composite sample, and food description according to INFOODS guidelines (http://www.fao.org/infoods/infoods/standards-guidelines/en/)

Household Consumption and Expenditure Surveys (HCES)

HCES has long been used for poverty monitoring, but it is now being utilized more often for food security and nutrition-related investigations. The results of HCES are useful in a variety of contexts. Their primary purpose is to yield data for poverty monitoring, national accounts calculations, and as an input for consumer price indices (Smith et al., 2014). However, there is a growing interest in using the food consumption module from HCES as a source of nationally representative data for evaluating food security and nutrition. One of the major limitations of using HCES is that the consumption modules vary by countries, which means that not all HCES data lend themselves to the same food security and nutrition analyses, and cross-country comparisons can be erroneous.

HCES is usually representative at the national level, although it can also be representative at the provincial and district levels. It is collected every three to five years, allowing for trend analysis. HCES data on food consumption is a valuable source of information on food security and nutrition. Due to issues with the structure of some consumption modules (e.g., no information on food consumed away from home), the data may not be insufficient for certain food security and nutrition studies as it lacks information on intra-household distribution. Some HCES only measure 'apparent consumption' which is based on acquisition data, rather than actual consumption. Many HCES fail to account for seasonal variation.

Weighed Food Record (WFR)

WFR is frequently used to validate other dietary assessment methods such as Food Frequency Questionnaires and 24-hour Dietary Recalls. Due to the high cost and time investment of WFR, they are more commonly used to collect data for small, non-representative samples. WFR mandates that all foods and beverages be weighed at the time of consumption by the respondents or enumerator rather than asking respondents to recall their consumption, as is done in the 24-hour quantitative recall, or 24HR).

Any plate waste must also be recorded, as well as a description of the food, cooking techniques and brand names. Since each food item is weighed, WFR is regarded the most precise approach for quantifying food intake as it eliminates issues related to portion size estimation through recall. Because of WFR's high degree of accuracy, they are frequently employed as the reference technique in validation studies of other dietary assessment techniques.

National energy available from non-staples

The available energy from non-staples is an indicator calculated at the national level that estimates the proportion of all calories derived from non-staple food products in the food supply (i.e., all food items, excluding tubers and grains). Staple foods are generally easily accessible as they are cheap and are also the least nutrient-dense. Diets based predominantly on staple foods have been linked to micronutrient deficiencies and lack of dietary diversity. To calculate this indicator, the food supply (kcal/capita/day) must first be calculated for non-staple goods. The indicator for energy available from unstable (% kcals non-staples) can then be calculated using the following fraction:

$$\frac{Food\ supply\ of\ all\ non\text{-}staple\ foods\ (kcal/capita/day)}{Food\ supply\ of\ all\ foods\ (kcal/capita/day)} \times 100\ (to\ express\ as\ a\ percent)$$

This indicator is easily calculated and compared across time and location due to the availability and comprehensiveness of FBS data (FAOSTAT). Another merit of this indicator is that it is simple to interpret and does not suffer from sampling and reporting biases associated with dietary recall data (Lele et al., 2016). However, a downside of this indicator is that it does not reflect actual consumption of non-staple foods, but rather the availability of these foods in a certain country. In addition, it cannot be disaggregated by sex, age, or by any geographic scale smaller than the national level, as it is a national-level estimate.

Population shares with adequate nutrients

Using both individual-level dietary intake data and Food Balance Sheet (FBS) data, this indicator of diet quality predicts a population's nutrient adequacy. Rather than relying only on the energy availability, this indicator aims to better understand the level of consumption of key nutrients within a population. This national estimate is generated as the sum of supply factors (production volume, import quantity, and inventory changes) minus the components of utilization (export quantity, food manufacturing, feed, seed, waste, and other uses). This indicator is used to determine the proportion of people within a population who are consuming key nutrients at or above an acceptable level, such as the EAR, as outlined by the US Institute of Medicine (Arsenault et al., 2015).

The information derived from this indicator can be used to detect gaps in nutrient availability in the food supply and population requirements, indicating nutrient availability in the food supply of a population and may be useful in targeted interventions to promote the intake and availability of foods that are major sources of certain nutrients in the food supply. This indicator has the advantage of being able to offer a national-level assessment of diet quality that requires less cost and effort than a nationally representative individual-level dietary survey. However, this method may not be suitable for assessing iron intakes, since requirements are not normally distributed, and determining iron bioavailability is difficult without information on the whole diet.

Total individual macronutrient intake

This indicator quantifies the percentage of caloric intake from the three major macronutrient groups: protein, fats, and carbohydrates to measure individual nutrient intake. These three nutrients each serve a distinct and crucial role in the body, and they all are essential for proper growth, development, and cognitive and physical functioning.

Survey data must be obtained from a 24-hour Dietary Recall, a Weighed Food Record, or a Food Frequency Questionnaire (FFQ) to estimate an individual's caloric intake from the three macronutrients. The total grams of each macronutrient are added together, and the caloric value of each is calculated using the following equation:

Calories (Kcal) = [Protein (g) × 4] + [Fats (g) × 9] + [Av. Carbohydrates (g) × 4] + [Fiber (g) × 2] + [Alcohol (g) × 7]

Total Carbohydrates = [Available Carbohydrates + Fiber]

Finally, the proportion of calories from each macronutrient is calculated by dividing the calories from each by the total calories consumed.

Individual macronutrient intake is a useful indicator for assessing the dietary intake and quality (especially balance) of population subgroups, such as pregnant and lactating women, as well as for determining how food resources are distributed among household members (Ferro-Luzzi, 2002). These statistics can also help to contextualize changes in diet composition that have been observed in in low- and middle-income countries as a result of demographic and economic transition, when s individuals consume a higher percentage of their calories from fat (Popkin, 2001). This indicator has the benefit of allowing researchers to estimate a person's intake of specific macronutrients, helping them correlate findings with individual health outcomes and demographic information, such as religion, age, gender, education, or any other variables of interest (Ferro-Luzzi, 2002). However, one limitation of this indicator is that it does not offer information on the whole diet or whether consumption levels are adequate and within a healthy range (IOM, 2000).

Total individual micronutrient intake

This indicator measures individual consumption of a particular nutrient (e.g., vitamin A, thiamine, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, vitamin C, calcium, iron, zinc) and may be coupled with additional data to calculate insufficient micronutrient intake or prevalence of (adequacy or) inadequacy.

Data from a 24-hour Dietary Recall method, a Weighed Food Record, or a Food Frequency Questionnaire (FFQ) are required to estimate individual daily intake of micronutrients. The quantity of each micronutrient of interest included in the reported foods is determined using the weight of foods consumed and a Food Composition Table (FCT). Phytates and other factors that limit the absorption of key nutrients such as iron and zinc should be considered if information is available in the FCT taken into consideration.

Individual micronutrient intake can be used to determine the need for, or the effectiveness of nutrient-specific interventions including fortification and supplementation, which can be beneficial for specific population subgroups, such as pregnant and lactating mothers. Furthermore, this indicator might give information on the dynamics of intra-household food distribution if micronutrient intake data are available for all household members; however, it cannot be used to assess the adequacy of intake on its own.

2.2 Assessing adequacy of energy and micronutrient intakes

Several countries recommend nutrient intakes for their populations, which are used to plan and evaluate the nutrient intakes of healthy people. Nutritional policies, food regulations, and nutritional programs are based on these nutrient intake recommendations.

Two of the Nutrient Intake values (NIV's) were recommended for comparability across all countries for specific life stages and genders: average nutrient requirement (ANR) which is equivalent to the Estimated Average Requirement (EAR) and Upper Nutrient Level (UNL) equivalent of the Tolerable Upper Limit (TUL). An additional term that is used is the Acceptable Macronutrient Distribution Ranges (AMDR). The AMDR is a range of macronutrient intakes that is associated with a reduced risk of chronic diseases, but at the same time, provides adequate intakes of essential nutrients. It is usually expressed as a percentage of energy, with a lower and upper limit (NIN, 2020).

Estimated Average Requirement (EAR): Refers to the average daily nutrient intake level estimated to meet the requirements of half of the healthy individuals in a particular life stage and gender group. It is used primarily to evaluate populations or groups.

Recommended Dietary Allowance (RDA): Refers to the daily dietary nutrient intake level that is sufficient to meet the nutrient requirements of nearly all (97–98 percent) healthy individuals in a particular life stage and gender group. This is derived from the ANR/EAR as the mean plus 2 standard deviations (SD) of the distribution of requirements. The term is used to primarily evaluate individual diets. The RDA is inappropriate for dietary assessment of groups as it is the intake level that exceeds the requirement of a large proportion of individuals within the group. The latest Recommended Dietary Allowances for Indians for the first time include the Estimated

Average Requirements (EAR) and the Tolerable Upper Limits (TUL) of nutrients along with RDAs for Indians. Given the commonalities of diets, foods consumed and nutritional and metabolic profiles across the Asian region, notably South Asia, the updated EARs provide average daily nutrient intake levels estimated to meet the requirements of half of the healthy individuals in a particular life stage and gender group. These are very useful in evaluating the nutritional status of populations or groups, across South Asia (RDA for Indians 2020).

Tolerable Upper Level (TUL)/Upper Nutrient Level (UNL): Refers to the highest average daily nutrient intake level that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the risk of adverse effects will increase.

Adequate Intake (AI)/Safe Intake: These values are used when ANR or RDA cannot be determined. The Safe intake or AI is the recommended average daily intake level based on observed or experimentally determined approximations or estimates of nutrient intake by a group of apparently healthy people that are assumed to be adequate.

Lower reference nutrient intake (LRNI)/ *Lower threshold intake* (LTI): Refers to a value derived from the ANR/EAR and is calculated as the ANR/EAR minus two SDs of the distribution of requirements.

Calculating the risk of nutrient inadequacy

To identify the proportion of the population at risk of inadequate intake, statistical methods such as the probability approach and the EAR cut-point method are used. To do this, a minimum number of three 24-hour recalls (preferably collected on two non-consecutive weekdays and one weekend) are needed from a representative subsample of the population being surveyed (NIN, 2020).

Probability of Inadequacy Approach (PIA)

In the probability approach, a continuous risk (of inadequacy) curve is constructed by plotting the probability of nutrient inadequacy for any given nutrient intake. The lower levels of intake can have a probability of inadequacy greater than 50%, which declines with increasing intake of the nutrient. The usual intake distribution is overlapped against the probability plot, to determine the proportion of the population with a probability of an inadequate intake (PIA). Steps in this method are as follows (NIN, 2020):

First, a parametric probability distribution of usual intake must be estimated based on a sample of average daily intake of the nutrient from the population of interest. There are two possibilities: (a) If the intake distribution is symmetric, it can be approximated by a normal probability distribution. The sample mean and sample SD would be the estimate of the mean ($\hat{\mu}$) and SD ($\hat{\sigma}$) of the normal distribution; (b) If an asymmetric distribution shape is present, one can identify a suitable probability distribution that approximates the intake data better, by maximum likelihood estimation (MLE). However, for a positively skewed shape that occurs in the distribution of many nutrient intakes, a log-normal probability fits well most of the time. The sample mean and SD in log scale would be the parameters of the lognormal distribution.

Second, the SD of nutrient requirement can be obtained from the relevant nutrient requirement chapter. One can use the RDA value to obtain the SD as well, as below. As stated above, if the distribution is normal, the mean and SD of the distribution can be taken as follows:

$\hat{\mu}$ = EAR; $\hat{\sigma}$ = (RDA − EAR)/1.96

If the distribution is lognormal, the parameters can be obtained as follows

$\hat{\mu}$ = log(EAR) ; $\hat{\sigma}$ =log(RDA) − log(EAR)/1.96

Fourth, the probability of risk of inadequacy in the population is calculated as follows:

$$\mathrm{PIA} = \frac{1}{n}\sum_{i=1}^{n} r(x_i)$$

Once the PIA is calculated for each nutrient, the mean probability of inadequacy (MPIA) is calculated by averaging all the PIA values together.

Probability of Adequacy (PA)

The probability of adequacy (PIA) of nutrient intake was computed using the “Probnorm” function, and the mean probability of adequacy (MPA) is calculated by averaging all the PA values together.

Mean Adequacy Ratio (MAR)

MAR is another indicator used to evaluate the diet quality of individual intake of nutrients. This index quantifies the overall nutritional adequacy of a population based on an individual’s diet using the current recommended allowance for a group of nutrients of interest (Hatloy et al., 1998). Once the NAR is calculated for each nutrient, the MAR is calculated by averaging all the NAR values together, as demonstrated in the equation below:

$$\mathrm{MAR}= \frac{Sum\ of\ NAR}{Number\ of\ nutrients} \times 100\ (if\ representing\ as\ a\ percentage)$$

One strength of this indicator is that it allows researchers to consider and communicate a population’s overall nutritional adequacy. Rather than focusing on specific nutrients that may not alone indicate healthy diet composition. However, this indicator is based on RDAs or RNIs, which are estimates of the necessary nutrient intake to meet requirement of 97-98% of healthy people. It may vary for some nutrients (like zinc and iron) depending on the assumed absorption, which can differ depending on the type of food consumed (Institute of Medicine, 2006). Thus, even a MAR of 1 (meaning requirements of all nutrients are met) does not guarantee that a population's needs are met nor that individuals within the population can adequately absorb and use the nutrients.

2.3 Finding nutrient-dense foods: application of nutrient profiling

The scientific scoring method for ranking foods based on their nutrient composition is nutrient profiling which is rapidly becoming the focal point for health claims, as well as marketing and promoting to children, and in nutrition labeling (Drewnowski and Fulgoni, 2008). Nutrient profiling of foods helps to discover nutrient-dense foods. This scientific process (Tetens et al., 2007) classifies foods following their nutritional composition (WHO, 2010) and its aim is to identify nutrient-rich foods. Nutrient rich foods are usually those foods that contain more nutrients compared to calories and are low in fat, sugar, and salt (Drewnowski, 2016). The ratio of the quantity of beneficial nutrients compared to the food's calorie per reference amount usually consumed is defined as the nutrient density standard by FDA. Foods that provide more nutrients compared to energy to the whole diet are nutrient-dense foods (FDA, 2004).

Nutrient density

Foods that provide more nutrients compared to energy to the whole diet are nutrient-dense foods (FDA, 2003). Several methods are in use to define the nutrient density of a food. The assessment of the nutrient quality of different food items by grading them on their nutrient composition is called the nutrient-rich food (NRF) index which reflects the nutrient density of the total diet (Streppel et al., 2014). Several methods are in force to mold the nutrient density of a food. Nutrient density is usually described as the concentration of nutrients per 100 kcal of food, alternatively, it can be expressed as per 100 g or serving size of the food (Drewnowski, Maillot, and Darmon, 2005). Most designs have depended on nutrient-to-calorie ratios. While expressed per 100 kcal, it characterizes the proportion of nutrients to energy. Several methods are in force to mold the nutrient density of a food. Existing NP approaches are mainly nutrient based, and they do not take account of such issues as nutrient balance, nutrient interactions, or bioavailability. Several key points in developing nutrient density models have been recognized. Firstly, nutrients to encourage and nutrients to limit are chosen based on nutrients of public health concern and are acknowledged through studies of dietary patterns of a population. Overall, nutrient bioavailability has not been considered, even though it should be. Bioactive compounds such as polyphenols, flavonoids, and other antioxidants, are not characteristically involved in nutrient profiling models, mainly because of their deficiency in comprehensive nutrient data and Dietary Reference Intake values (Williamson & Holst, 2008). Protein quality can be different for animal and plant sources, also Bioavailability of iron and calcium from animal sources is higher compared to iron and calcium from some plant sources (National Institutes of Health, 2018). Compensatory nutrient profiling schemes equalize beneficial nutrients in contrast to nutrients to limit where non-compensatory models emphasize only on nutrients to limit (Drewnowski, 2017).

How nutrient density is calculated?

The assessment of the nutrient quality of different food items by grading them in relation to their nutrient composition is termed as the nutrient-rich food (NRF) index and this reflects the nutrient density of the total diet (Streppel et al., 2014). In the National Health and Nutrition Examination Survey, Fulgoni et al. (2009) contrasted various NRF indicators against the HEI-2005. They observed that NRF9.3 which includes protein, fiber, vitamin A, C, E, Ca, Fe, Mg, K, and LIM Saturated fat, added sugar, Na; described the utmost variation from HEI and could be promptly expected to categorize foods on the basis of nutrient density. They obtained daily HEI scores as well as daily Nutrient Rich Food (NRFn.3) values following different criteria. Nutrient quantities were measured as a percent of reference DV for all indices for each Reference Amounts Customarily Consumed (RACC) and per 100 kcal (Fulgoni et al., 2009). Some nutrient density score models are listed in Table 1.

Reference amounts

Different methods, as well as different reference amounts, are available for calculating nutrient density. Key nutrient contents in Nutrient profiling models are calculated for each 100g, 100kcal or per serving (Drewnowski and Fulgoni, 2014) each reference amounts having their advantages and drawbacks. The 100 g/100 ml reference value can simply compare foods of the same category, simple for regulator and industry and 100g is internationally acknowledged except USA (per serving) but this reference value does not take into account energy content, and health recommendations, it is difficult to understand for consumers (Tetens et al., 2007) and overlooks the often-considerable diversities of portion size and could castigate foods eaten in lesser amounts (Drewnowski et al, 2009). In the United States, Reference Amounts Customarily Consumed (RACC) is used by FDA based on dietary survey data. RACC standards reveal real-life eating schemes having significant and straight purposes to food labeling (Drewnowski et al, 2009). 100kcal based models associate with some nutrition recommendation reflecting reference daily energy requirements based on age groups, gender, individuals, etc.; however, this method is tough to understand for users as well as regulators (Tetens et al., 2007). 100 kcal reference values assign the maximum scores to foods having the highest water content with the lowest energy density (Drewnowski et al, 2009).

Nutrient Rich Food Index (NRF)

Nutrient Density Index is an attribute of nutrient profiling models, balancing nutrients to encourage against 3 nutrients to limit (saturated fats, sugars, and sodium), that uses 100 kcal as the base of calculation. The Nutrient-Rich Foods (NRF) Index was developed, and this model strictly followed the United States' regulatory guidelines articulated by the US Food and Drug Administration (FDA). Especially the choice of beneficial nutrients shadowed federal policies and standards, and foods were described as "healthy" by the FDA on their protein, fiber, vitamins A and C, calcium, and iron content. Foods are prohibited by the FDA from approving nutrition and health privileges when they comprise more than stated quantities of fat, trans fat, saturated fat, cholesterol, or sodium and added sugar. Numerous reappearances of the scoring system are in existence and they differ in the number of positive nutrients incorporated, fluctuating from 6 (NRF 6.3) to 15 (NRF 15.3). The NRF score can be functional to distinct foods as well as to entire diets. The NRF index 9.3, originally developed in 2006 was based on the content of protein, fiber, calcium, iron, potassium, magnesium, vitamin A, vitamin C, vitamin E, saturated fats, sugars, and sodium, everything stated per 100 kcal of food. Other alternatives of the NRF family of scoring models are present, where the digit of nutrients to encourage ranges from 5 to 23 (Fulgoni, Keast and Drewnowski, 2009). Nutrient Profiling models calculating nutrient density per 100 g of food, are more strongly based on energy density instead of nutrient density per 100 kcal (Drewnowski, Maillot, and Darmon, 2009). The NRF index passes up these difficulties and offers a well-adjusted picture of the general nutrient density of a food. The NRF systems, based on unweighted sums of percent daily values, subtracted negative (LIM) from positive (NRn) subscores (NRn – LIM).

Nutrient Rich Food Index (NRF9.3)

Various models of the nutrient-rich food index (NRF) algorithm have been established on a variable sum of nutrients to encourage (n = 5–23) and consistently 3 nutrients to limit (sodium, saturated fat/TFA, added sugar) (Table 1). The variant NRF 9.3 model encourages 9 nutrients to which are protein, fiber, vitamin A, vitamin E, vitamin C, calcium, magnesium, potassium, and iron, and discourages or limits 3 nutrients which are saturated fat, added sugar, and sodium. NRF 9.3 is based on the sum of the percentage of daily values for 9 nutrients to encourage minus the sum of the percentage of the maximum recommended values for 3 nutrients to limit. Where all daily values were calculated per 100 kcal and capped at 100%.

Necessity of nutrient profiling

Diet quality can play an incredibly significant role in food-based programs and decreasing micronutrient deficiency. The low energy and less diversity in foods among the women and young children in rural Bangladesh reflect the magnitude of micronutrient inadequacy among this group (Arsenault et al, 2013). Inadequate micronutrient intake is largely held responsible for many adverse health outcomes such as birth defects, cognition impairment, growth restriction, increased morbidity, and mortality. It is evident that poor diet quality, repetitive diets, and little diversity in diets are causing micronutrient deficiency and related public health problems in Bangladesh. Assessing the amounts of foods and nutrients eaten by the population is significant for planning food-based programs (Black et al., 2006). Which foods are 'healthy foods' as per nutrient content claims by the Food and Drug Administration 'Good Source' are those that comprise 10-19% of DV and are applied to represent protein, vitamins, minerals, dietary fiber, or potassium, but not carbohydrate. 'Excellent source, high source, rich source' are those that include 20% or more of the DV and applied to define protein, vitamins, minerals, dietary fiber, or potassium, but not carbohydrate. 'More, added, extra, plus', are those that contain 10% or more of the DV and may only be applied for protein, vitamins, minerals, dietary fiber, or potassium. 'High potency' defines distinct vitamins or minerals available in food at 100% or more of the RDI per RACC. 'Free, zero, no, without' are those that contain less than 5 calories; total fat less than 0.5 g; saturated fat less than 0.5 g; trans-fat less than 0.5 g; cholesterol less than

2 mg; sodium less than 5 mg; sugars less than 0.5 g (per reference amount and per labeled serving) 'Low, few, low source ' are those that contain less than 40 calories (per 50g if reference amount is small); total fat less than 3 g; saturated fat less than 1 g (with less than 15% calories from saturated fat); cholesterol less than 20 mg; sodium less than 140 mg; sugars: not defined (Drewnowski and Fulgoni, 2008).

Nutrient profiling helps to discover nutrient rich, reasonably priced, and sustainable foods. Creating new metrics of affordability and finding foods that grant the most nutrients per currency spent is possible as the result of the placing of food price in nutrient density calculations (Darmon et al., 2005; Maillot et al., 2008). Good nutrition is particularly important during the entire life course to uphold health and well-being. Nowadays, nutrient profiling of foods is rapidly becoming the core for health claims (Drewnowski and Fulgoni, 2008). Study on the relations between the NRF9.3 index and the occurrence of cardiovascular disease (CVD) events and all-cause mortality, Streppel et al. has observed that the NRF9.3 index score was inversely linked with all-cause mortality. The adjusted links amid the NRF9.3 index score and mortality were stronger in women than in men. The NRF9.3 index score tended to be inversely associated with the occurrence of CVD (Streppel et al., 2014). Much of the population does not follow a healthy diet (Krebs-Smith et al., 2010). The nutrient density method shows potential since eating nutrient-dense foods was linked to a moderately decreased threat of CVD, diabetes, and all-cause mortality (Chiuve, Sampson and Willet, 2011). Developing Dietary Guidelines to assist people in selecting more nutrient-dense foods; nutrient density profiling system should be introduced as a nutrition platform. The intake of nutrient-dense foods, recognized by a precisely proved nutrient density profiling system, could be the guiding principle for people to follow healthy diets (Miller et al., 2009). Nutrient profiling has offered the scientific foundation for regulation, education, and product reformulation by the nourishment industry. This is a useful tool that can be used along with dietary interventions to improve diets and is very significant in food labeling systems serving customers a better knowledge about the nutrient composition of foods.

Nutrient Profiling on Economy

Nutrient profiling systems can be employed in meals, menus, and diets which shows the way nutrient density notion goes into total diet quality as well as the economical side of food selection activities (Drewnowski et al., 2008; Miller et al., 2009). In order to express the essential information regarding nutritional qualities of foods as well as beverages to the customer, nutrient profiling is the effective approach (Drewnowski and Fulgoni, 2008; Fulgoni, Keast and, Drewnoski, 2009; Drewnowski et al., 2008; Miller et al., 2009). Among the obstructions of the following healthy diet food prices and diet, costs are worth mentionable, particularly by the low-income buyer. It has been evident by studies in marketing (Lennernäs et al., 1997), economics (Basiotis et al., 1983; Putnam et al., 2002), consumer behavior (Cabanac, 1995, French, 2003**)**, and nutritional epidemiology (Drewnowski and Darmon, 2005) that buying and consumption of food is affected by food prices (Maillot et al., 2007). Earlier diet modeling studies propose that food cost limitations especially orient food selections toward energy-dense foods with low in necessary nutrients (Darmon, Ferguson and Briend, 2002; Darmon, Ferguson and Briend, 2003). In order to help consumers to keep up a healthy diet providing adequate nutrients and energy and to make the nutrient profiling method more effective by the food industry, it is now suggested to develop further one of the current scores (NRF) (Eggersdorfer, Peter and Weber, 2016). The NRF9.3 system has already been used within the comprehensive set of dietary education and guidance. The NRF9.3 is being used in studies of cost-effective nutrition, food choices, also take in value for money (WHO, 2011). To classify reasonably priced nutrient-rich foods that are part of the typical US diet the NRF9.3 is found to be the only index connected to US food prices (Drewnowski and Fulgoni, 2014). Nutrient profiling helps customers to generate more healthy food choices.

Nutrition quality indices

Quality of the total diet is important against which nutrition quality indices must be tested and validated. These indices should consider nutrients acknowledged to be positive to health and nutrients to limit (LIM), based on scientific accord or reliable reports (Fulgoni et al., 2009). The aim of multifactorial nutrient density scores is to encapsulate the numerous nutritional points of a specific food (Drewnowski and Fulgoni, 2008; Fulgoni et al., 2009; Darmon et al., 2005) where high scores are given to wholesome, nutrient-rich foods, but foods providing calories and insufficient nutrients assigned lower scores (Drewnowski and Fulgoni, 2008). Several nutrient profiling designs have been established.

Table 1. Summary of beneficial nutrients and nutrients to limit use in certain nutrient profile schemes.

Score	Macronutrients	Vitamins	Minerals	Nutrients to limit	Reference
Nutritional Quality Index (NQI)	Protein, fiber, MUFA, carbohydrate	Vita A, C, thiamine, riboflavin, B6, B_{12}, niacin	Ca, Fe	Cholesterol, fat, saturated fat	Hansen, Wyse, and Sorenson, 1979
Naturally Nutrient Rich (NNR)	Protein, fiber, MUFA	Thiamine, riboflavin, B_{12}, folate, Vit A, C, D, E	Ca, Fe, Zn, K		Zelman and Kennedy, 2005 and Drewnowski, 2005
Nutrient for Calorie (NFC)	Protein, fiber	Vit A, C, E, B_{12}	Ca, Fe, Zn, Mg, K, P	Saturated fat, Na	Zelman and Kennedy, 2005

Calories for Nutrient (CFN)	Protein	Vit A, C, thiamine, riboflavin, niacin, B_6, B_{12}, folate	Ca, Fe, Zn, Mg	Lachance and Fisher, 1986
Nutrient Density Score NDS5	Protein, fiber	Vit C	Ca, Fe	Maillot et al., 2007
Nutrient Density Score NDS6	Protein, fiber	Vit A, C	Ca, Fe	Darmon et al., 2005
Nutrient Density Score NDS9	Protein, fiber	Vit A, C, E	Ca, Fe, Mg, K	Darmon et al., 2005
Nutrient Density Score NDS23	Protein, fiber, linoleic, linoleic acids, DHA	Vit A, C, D, E, thiamine, riboflavin, niacin, B_6, B_{12}, folate	Ca, Fe, Zn, Mg, K, Cu, I, Se	Maillot et al., 2007

Naturally Nutrient Rich Foods

The Naturally Nutrient Rich score is the unweighted mean of percent daily values for 15 positive nutrients, counting fiber. Although the score did not directly consider the foods' content of fat, sugar, or salt, the fact that it calculated per calorie meant that the more energy-dense foods with high sugar and fat content received lower scores. The calculations capped percent DVs, so that the contribution of any single nutrient would not contribute disproportionately to the total score (Drewnowski et al., 2008).

Energy Density

Energy density and nutrient density score are inversely correlated which validates the commonly acknowledged concept that energy-dense foods are likely to be nutrient-poor. Fruits and vegetables have the maximum nutrient density score since they are nutrient-rich concerning their low energy substance. They similarly have a comparatively high nutrient-to-price ratio which shows that they supply nutrients at an affordable price while competing with other foods. Fruits and vegetables are a costly dietary energy source, and they arrange for key nutrients at an affordable cost (Darmon et al., 2005). Energy density epitomizes the energy content of a regular weight or volume of food or beverage (kcal/100 g). Foods having a high energy density are inclined to be dry but foods with a low energy density have high water content. A strong association between a nutrient profiling scheme and energy density would specify that the model deals with severely dry foods, supporting in its place foods with high water content. A very sound association would signify that the model basically follows the energy density of foods, instead of their nutritional value (Drewnowski, 2017). The range of energy density in foods flows from water (0 kcal/100 g) to wholesome carbohydrates or protein (400 kcal/100 g) to oil (900 kcal/100 g). For example, coarse sugar has no water and is the pure form of carbohydrate, thus its energy density is 400 kcal/100 g, whereas the energy density of a sugar-sweetened beverage is about 40 kcal/100 g since it comprises sugar and water (Drewnowski et al., 2019).

2.4 Analyzing cost and affordability of a nutritious/recommended diet

The first step in estimating the cost of diets is to determine the most appropriate set of food prices. There are several sources of collecting food prices such as from Bangladesh Bureau of Statistics (BBS), Department of Agriculture Marketing (DAM), and household income and expenditure surveys. Bangladesh Bureau of Statistics regularly collects, and monitors food prices and has the responsibility of constructing the Consumer Price Index (CPI). CPI data demonstrates existing food price monitoring data and are less time-consuming and complicated to use than household survey data. The limitation of using CPI data is they only collect the price of a limited number of food items and the data is not easily accessible. For example, Dizon and Herforth while estimating the cost of recommended diet in Bangladesh used household and expenditure survey data of 2016 as CPI data was not available from the government during their study period (Dizon and Herforth, 2019). Another source of getting food prices that most studies use is household income and expenditure survey (HIES) data. “Fill the Nutrient Gap” by FAO and “The Cost of a Nutritious Diet” by the World Bank both the studies used HIES, 2016 data for their analysis. The constraint to use household survey data is they are less frequently collected often after 5 to 6 years and do not give the actual or latest price trend. The last household survey data of Bangladesh is of 2016 and now in 2021, the prices have changed greatly. Thus, in our analysis of the cost of the diets we did not use any of the sources, rather we used the actual market price of the foods that we collected in January 2021. There is another good source of price data that we could have used is the Department of Agriculture Marketing. The limitation of using DAM price is they do not provide a detailed description of the food items; therefore, it is challenging to match the items with the Food Composition Table (FCT).

Apart from the methods we used in our analysis, there are a few different methods for estimating the cost of a “nutritious” or “healthy” diet. The oldest method was developed by Stigler (1945) and it uses linear programming to choose a diet from a list of foods that minimizes the cost of meeting a set of nutritional requirements. Recently this method has been more updated that uses the “Cost of Nutrient Adequacy” metric by Masters et al. (2018) and the “Cost of the Diet” (CotD), a method and software developed by Save the Children (Deptford et al., 2017). Though these methods are beneficial to highlight the least cost nutrient-dense foods and which nutrients add to the cost most, the focus on only nutrients has several weaknesses. One longstanding concern is that linear programming approaches may produce unrealistic and unpalatable least-cost diets leading to further need of incorporating food preferences (Deptford et al., 2017). Moreover, nutrient-dense foods cannot alone satisfactorily ensure sound health and overall health protection without considering the importance of non-nutrient bioactive components of foods including antioxidants, fibers, and phytochemicals. One of the major drawbacks of these methods is consumers not always consider the nutritional value of the items rather they focus more on their food preferences or dietary behavior as well as accepted culture and norms of their specific area. Therefore, for calculating the cost of a healthy diet or recommended diet it is imperative to use dietary guidelines.

Calculating the cost of recommended (CoRD) diet uses a recommended number of servings and serving sizes according to the food based dietary guidelines (FBDG) of a country (Dizon, and Herforth, 2019). Thus, we have used this method for our estimation of cost of diets. This method uses the cheapest foods under each food group to estimate the minimum cost to meet recommended diet for an adult person. However, it does not mean that the lowest cost items are consumed significantly as it largely depends on individual food preference and local food tastes. To address food preferences there is a modified method called CoRD-FP (Cost of the recommended diet food preferences) which estimates the additional cost of acquiring a healthy diet that reflects food preferences within each food group. The main difference between the CoRD and CoRD-FP is that in estimating the latter, the price per edible gram for each food group base not on the lowest-cost food items in that group, but rather on the weighted price of a potentially larger basket of commonly-consumed foods in each food group (IFRPI, 2019).

Apart from using the poverty line and household food expenditure another available measure of affordability compares the cost of each diet with the estimated income distribution in a given country. In this measurement, a diet is regarded as unaffordable when the cost exceeds 63 percent of the average income in a given country. Percentages are then multiplied by the population in each country, to arrive at the estimated number of people who cannot afford a given diet in a given country. Another method that was used in an article of India, estimated affordability of the diet by calculating a gender-district-time-wage ratio “CoRD/wage ratio”. This ratio was calculated by dividing the cost of a healthy diet by cash wage earnings of both men and women in that specific area in a given time period (Raghunathan et al., 2021).

Several studies have been conducted by using the mentioned methods to estimate the cost and affordability of diets in Bangladesh. In 2019, the World Food Program (WFP) in the Fill the Nutrient Gap report analyzed the cost of energy sufficient diet and nutrient adequate diet in Bangladesh. They used the data on food prices and household food expenditure from the household food and expenditure survey (HIES, 2016) to estimate the minimum cost and affordability of a nutritious diet. The study found that the cost of a nutrient adequate diet is more than twice as expensive as a diet meeting only energy requirements. The lowest cost nutrient adequate diet was 174 BDT per day, whereas the energy sufficient diet needs 80 BDT per day for a household. The study further focused on the cost of diets across the lifecycle and found the cost of nutritious diets starting from children under 1 year through school-going children to adults and up to the elderly. The cost of nutrient adequate diets ranged from 10 BDT to 49 BDT for different age groups (WFP, 2019).

The lowest cost nutritious diets for households in the villages of Rangpur division in 2007 were previously estimated (Save the Children, 2007). The results showed that the cost of a nutritious diet was higher in the lean season and the rainy season which was 71 BDT and 67 BDT respectively for a family. And the total average daily cost of a nutritious diet is 61 BDT for a family. The report estimated the affordability of the diet and found out about 79% of households cannot afford the lower range of the diet and 89% of households cannot afford the upper range (Save the Children, 2007). The report of the World Bank also estimated the cost and affordability of a healthy diet in Bangladesh. It reported that to meet the requirements of a healthy diet it would cost 58 BDT per day and the cost of the diet in line with Bangladesh food-based dietary guidelines is unaffordable for 53% of households (Dizon et al., 2021). They estimated affordability by comparing the cost of a diet with the household expenditure survey of 2016. While computing the cost of a healthy diet they used Bangladesh food-based dietary guidelines of 2013 which was later updated. In our estimation of the cost of a healthy diet, we have used the current food-based dietary guidelines of Bangladesh published in 2015. The recent dietary guidelines provide more quantitative information and aims to specific serving recommendations.

An updated image of the 2015-Dietary Guidelines for Bangladesh, the version which has been used in this study to calculate cost of RHD, have been represented in a form of a pyramid (Figure 1) containing eight food groups such as (1) Cereals; (2) Pulses; (3) Vegetables; (4) Fruits; (5) Meat, fish, and egg; (6) Milk and milk products; (7) Fats and oils; and (8) Sugar. In terms of consumption, the food pyramid was divided into five levels where at the bottom of the pyramid is rice, bread, and other cereals to be eaten liberally. On the second level, one finds vegetables and fruits to be eaten liberally too. Then come fish, meat, eggs, and pulses followed by milk and dairy products, all to be eaten in moderation. Fats, oils, and sugar are at the apex of the pyramid and should be eaten sparingly. The guidelines provide a description of a healthy diet that includes specific serving sizes and a minimum and a maximum number of servings from each food group to be eaten in a day for a healthy adult. The guideline of Bangladesh lists leafy and non-leafy vegetables in the same group; however, it instructs that at least one green leafy vegetable should be consumed. So, we separated them into two groups to make sure we meet this condition. We excluded foods under the categories of spices, beverages (except milk) and sweets in calculating the cost of recommended diet as these are not required in the recommended diet of Bangladesh.

2.5 Use of linear programming to develop culturally acceptable nutritionally adequate least-cost food basket

Diets of the population in low-income settings like Bangladesh are frequently lacking in essential micronutrients in addition to that of protein and energy (UNICEF, 2013). For those with increased needs of growth (e.g., children and adolescents) and for women in pregnancy and lactation, these deficiencies of energy and/or micronutrients are more severe (Ahmed et al., 2016; Akter et al., 2021; Arsenault et al., 2013). The reason for this dietary deficiency might be the result of either a lack of foods that are rich in essential nutrients or people's inability (i.e., economic and or educational) to select and consume nutrient-rich foods when they do exist. If the Bangladeshi food system is really lacking in supplying nutrient-rich foods, then it is obvious that the government should do more through its agricultural programs (e.g., fortifying foods and introducing high-nutrient-yielding varieties) to increase the availability of these foods. But an alternative possibility is to make people educated about their choice of food items when they decide to produce, purchase, and consume. Realization of this latter possibility requires having a concrete answer to a complex question: what is the most appropriate composition of the food baskets that come at the lowest

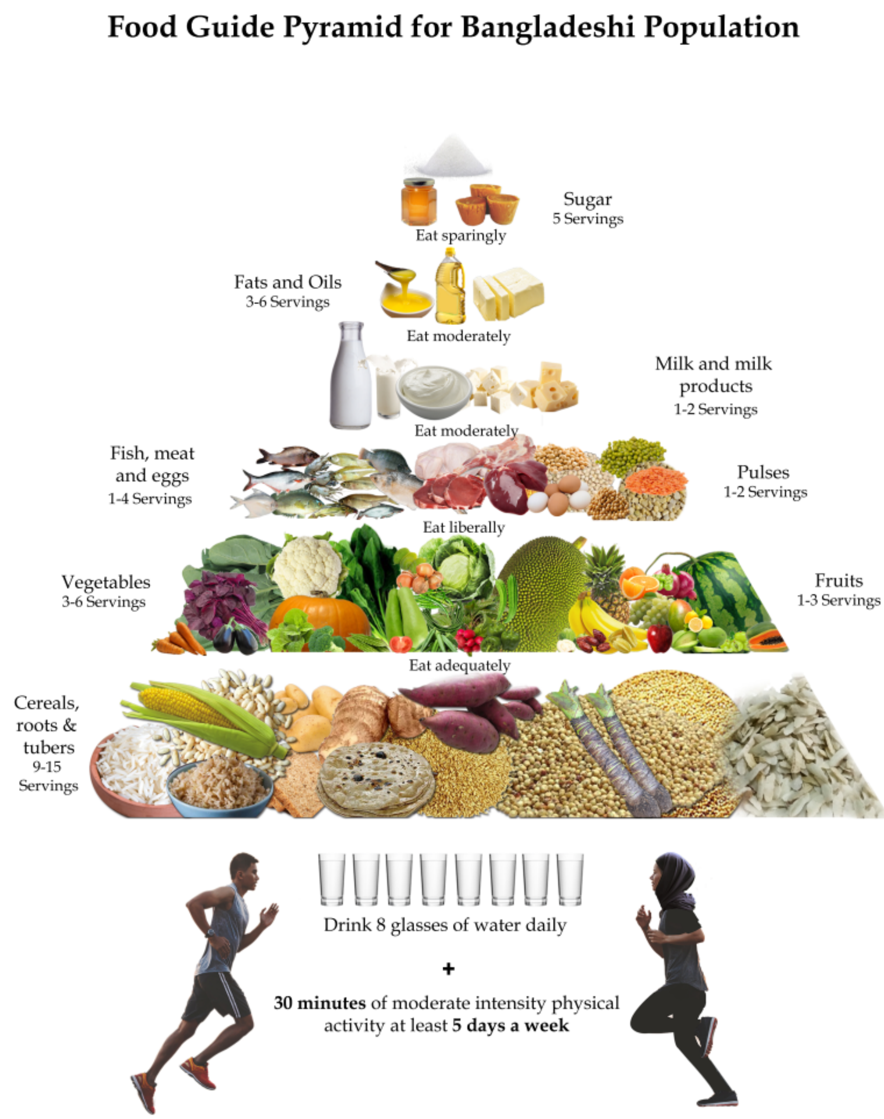


Figure 1. Dietary Guidelines for Bangladesh, 2020

possible cost and concurrently meets the nutritional requirements of a person based on his/her sex, physical activity level and/or extra requirements for growth, pregnancy, or lactation and concurrently. The field of operational research includes various sophisticated analytical methods capable of identifying optimal solutions to the multidimensional complexity posed by this question (INFORMS, 2021).

Diet modeling, also known as "mathematical diet optimization" or simply as "diet optimization" was first exercised by Georges Stigler back in the 1940s (Stigler, 1945). The objective of Stigler's "diet problem" was to identify a combination of food items that meet daily nutrient requirements at minimum cost. The mathematical technique that solves this "diet optimization" is called linear programming (HREŢCANU, 2010). Generally, there are three parameters that are employed in the linear programming technique: objective function, decision variables, and constraints. The food items available for the linear programming technique to choose from in a particular amount for a particular diet problem are the decision variables. The cost of the diet calculated by the linear programming technique is the objective function. Constraints are inequalities or equations (e.g., minimum requirements of key nutrients and maximum/minimum amount of a food item/group) that the linear programming must have to be compatible with. Thus, in the case of least-cost food baskets, linear programming identifies unique combinations of food items in particular amounts to minimize the cost of a diet that fulfills the nutritional recommendations of a particular person.

Linear programming techniques for solving diet optimization problems are increasingly being used in the field of public health nutrition both in high- and low-income countries (Gazan et al., 2018). It has helped researchers assessing the feasibility of achieving the nutritional recommendations (Martin, 2002), estimating the minimum cost of a diet that is nutritionally adequate (Baldi et al., 2013; Chastre et al., 2007; Maillot et al., 2010), identifying the optimal combination of foods required to meet nutritional adequacy with minimum deviation from the current diet (Darmon et al., 2002; Cleveland et al., 1993), and identifying food combinations that limit environmental impact after meeting nutritional recommendations and deviating minimum from the prevailing diet (Perignon et al., 2016). Parlesak et al. (2016) used linear programming to develop a range of nutritionally adequate and health-promoting food baskets at the lowest possible costs that would address both micronutrient inadequacies and nutrition-related non-communicable diseases. Furthermore, Lauk et al. (2020) employed linear programming to help develop dietary guidelines at affordable prices in Estonia. Building on these works, we employed linear programming to identify the best combinations of foods and their least costs to address the dietary inadequacies of the Bangladeshi population at different stages of their life cycle.

Chapter 3: Methodology

3.1 Evaluation of Food consumption and Dietary Adequacy

Dietary Surveys

INFS-17/18 Survey

The sampling frame is based on the first national nutrition survey in 1974-1975, supplemented by a 30 (village) X 30 (Households) addition (selected statistically from among the sites visited in 2007/08 following Probability Proportion to Size method) to increase the representativeness of the population and a focus on the urban residents. The 1974-75 survey borrowed the sampling frame from the 1974 Bangladesh Fertility Survey sponsored by the World Fertility program that followed a multistage sampling method to select villages from the then four administrative divisions and 17 districts of the country. At stage one, from a total of approximately 5000 census circles in the 1074 Bangladesh census (approximately 68,000 villages), a sample of 160 census circles was selected at random. The list of these 160 census circles, each containing 10-14 villages, was then arranged into four groups according to the then four administrative divisions of the country. At stage two, three census circles were selected in each of these divisions, in a systematic sampling method based on the total population of the census circles, used in that division. At stage three- from each of the three census circles per division identified in Stage two, a single village was selected at random. These twelve villages from 14 out of 17 districts in four of the then administrative divisions formed the sample for the 1975-76 survey, and the 1981-82 survey was repeated in those villages. In addition, to study seasonal effects in nutrition in rural populations, two villages, one in each in Dhaka and Mymensingh districts, were selected based on their cropping patterns, accessibility during monsoon season, and their representativeness in 1981-82. The 2001/02 Nutrition Survey was repeated on all these fourteen villages and on all the households' splits off irrespective of their location within Bangladesh. The number of villages that way was increased to 411. In this survey, a total of another 700 new households (50 from each village) was statistically selected, and the total number of households thus was increased to 2011.

This 2017/18 survey included all the surviving men and women from the previous surveys (81-82; 2001-02; 2007-2008) regardless of their location in Bangladesh, and an additional sample of 30 village X 30 households from among the 699, 2007/08 villages are included in the survey to increase the representativeness of the population and a focus on the urban residents. These villages are selected statistically from among the sites visited in 2007/08 following the Probability Proportion to Size (PPS) method. This study included the food consumption of 3541 individuals of 841 households from the sample of 30 village X 30 households.

BIHS-2015 Survey

The BIHS is a comprehensive nationally representative three-round panel survey conducted by the International Food Policy Research Institute (IFPRI) with support from the US Agency for

International Development (USAID). First-round was conducted in 2012, followed by a second round in 2015 and the third round in 2018.

This survey used a two-stage stratified random sampling technique under the framework of Integrated Multipurpose Sample (IMPS) design and it includes both household survey and individual-level 24HR dietary estimates from the same individuals. BIHS data are publicly available, and household-level dietary data further meet the International Household Survey Network (IHSN) reliability and relevance assessment criteria. BIHS has a total of 6,503 households including 27,285 individuals (47.6% men, 0–120 years, mean age 26.6 (SD: 19.9) years. Of those, 5,503 households were representative of rural Bangladesh and 2,040 of southwest Bangladesh as part of the Feed the Future (FTF) global hunger and food security initiative; 1,040 households contributed to the representativeness of both national and FTF zone samples. We have taken a second round conducted in 2015 survey datasets for this study. Around 10% of households were visited again for the dietary data collection within one or two weeks.

HIES-2016 Survey

Household Income and Expenditure Survey is a nationally representative survey, and it has been conducted by the Bangladesh Bureau of Statistics (BBS) with a five-year interval. Recent HIES-2016 of Bangladesh was published in 2019. The HIES 2016 data is divided into division levels as 20 strata as rural (8), urban (8), and city corporation (4), excluding new two cities (Mymensingh and Rangpur), Barishal and Sylhet, as they are shown similar characteristics as urban. Data were also divided into districts level as 132 sub-strata, rural (64), urban (64), and City (4). District level weightage is provided in the data from a sample to a population. A total of 46080 households were sampled in Bangladesh. There are 2304 primary sampling units (PSU), 36 PSU per district, and each PSU consists of 20 households.

HIES-2016 food consumption data was examined thoroughly and analyzed to present food consumption at the division level focusing on under 2, preadolescents (10-14 years), and women of reproductive age (15-49 years).

We have taken the food expenditure part of the HIES survey. HIES collected a weighted food record for the consecutive 14 days consumed by the households. Households' food record was averaged for one day while members of the household were assigned AME following their age and sex. We did not get the lactating and pregnancy information, so we assumed them as normal. Moderate physical activity was considered for all the members. The average intake of the household was divided by the total of those households to calculate the per capita intake of an adult. To calculate the age and sex-specific intake of an individual, we have multiplied the per capita intake with the AME of an individual. Since the data was not available at the individual level, nutrient adequacy was not calculated. In fact, the analyzed results reveal food accessibility at the household level.

Data Processing and Management

Dietary data along with background data were harmonized to produce analytical data sets using several steps. The key steps were a) retrieval of the dataset, involving the identification and retrieval of relevant dietary, socio-demographic, and socioeconomic variables from INFS, BIHS, HIES datasets; b) matching food items, to understand the contributions of individual food items and groups of foods to households' nutrient intakes, the reported foods were matched with corresponding food items in the Food Composition Table (FCT) for Bangladesh developed by the Institute of Nutrition and Food Science Centre for Advanced Research in Sciences at the University of Dhaka (Shaheen et al., 2013). Individual foods that were not identified in the Bangladesh FCT were matched with foods from the regional FCTs; c) classification of different food items to food groups (e.g., fruits, vegetables) was based on FCT-2013 and HIES reporting; d) household food and nutrient consumption was individualized by AME; e) final dataset preparation, the final analytical dataset was prepared through cleaning, processing, shaping and merging the datasets through data processing. Software programs such as SPSS, STATA, and Excel were used for processing and managing the data.

The AME method was used for individualizing household consumption. This method assumes that the intra-household food distribution is proportional to the individual's share of total household energy requirements, and as such household members do not receive an equal share of the food available for consumption. The energy requirements of household members of different ages, sex, and status (pregnant/ lactating women) were expressed in proportion to an adult male's energy requirements. The AME used for other studies in Bangladesh was used for this study (Waid et al., 2017)

Development of nutrient analytic file

To understand the contributions of individual food items and groups of foods to households' nutrient intakes, the first step was to match the reported foods with corresponding food items in the Food Composition Table for Bangladesh developed by the Institute of Nutrition and Food Science Centre for Advanced Research in Sciences at the University of Dhaka. Based on this approach, 81% of food matches were made using the Bangladesh FCT, and the remaining 19 % of matches were made with the USDA. The following nutrients of public health interest were selected for the present study: energy, fat, protein, Fe, Zn, and vitamin A. By convention, values of per capita daily energy consumption <2092 kJ (<500 kcal) and >20 920 kJ (>5000 kcal) are considered extreme values and were eliminated. The standard method was followed for cleaning the individual intake with lower and higher intake.

Nutrient calculation procedure

INFS survey collected the individual intake of the household member using the 24-hour recall survey. It used a conversion factor for converting the cooked food item to raw ingredients of the consumed food item. Household utensils and weighing scales for the kitchen were used to measure the raw food items consumed by the individual. For the BIHS survey, we used the modules on household food consumption (including quantitative data on raw ingredients used to prepare composite meals) and intra-household food consumption (including quantitative data on portions of cooked composite meals consumed by individuals within the household). Data for both household and intra-household food consumption were collected from the person primarily responsible for meal preparation, using a 24-hour recall method. The intra-household data set provided only the cooked weight of composite foods (menu items) consumed by the individual (e.g., fish and vegetable curry); therefore, calculation of the equivalent amount of raw ingredients consumed by each individual (to estimate nutrient intakes using food composition data) required the following calculation:

Weight of raw ingredient $_{(individual)}$ = weight of raw ingredient $_{(household)}$

$$Weightofrawingredient_{(individual)} = weightofrawingredient_{(household)} \times \frac{Cookedweightofcompositefood_{(individual)}}{Cookedweightofcompositefood_{(household)}}$$

Selection of dietary variables

We included dietary indicators that captured an individual's intake. Among the dietary factors, we included 15 food groups 7 macronutrients, 17 micronutrients, and total energy, considering public health significance. The 15 food groups include cereals and their products; pulses, legumes, and their products; vegetables and their products, non-leafy vegetables; leafy vegetables; starchy roots, tubers, and their products; nuts, seeds, and their products; spices, condiments, and herbs; fruits; fish, shellfish and their products; meat, poultry, and their products; eggs and their products; milk and its products; and fats and oils; beverages; and miscellaneous foods. The 7 macronutrients include protein, total fat, saturated fatty acids, monounsaturated fatty acids MUFA, PUFA, cholesterol, carbohydrate, total dietary fiber.

We have also calculated the usual intake adjusting with the inter and intra-variation of the household for the total energy, macro, and micronutrients.

Assessing nutrient adequacy

The percentages of energy consumption from protein, fat, and carbohydrate were calculated and compared with acceptable macronutrient distribution range (AMDR) (WHO, 2003). The probability of adequacy (PA) of the 12 micronutrients was calculated using estimated average requirements (EARs) recommended by the National Institute of Nutrition, India (NIN, 2000). We calculated the usual intake for measuring the adequacy of the individual person. Usual intake was calculated by adjusting the inter and intra-variation of the household for the INFS and BIHS survey, but HIES did not have the nonconsecutive repeated dietary measurement. Usual intake was calculated by transforming the data following its distribution and adjusting within and between variation with the ANOVA test (NRC, 1986). Standard deviation (SD) was calculated from RDA and EAR values (RDA-EAR/1.96).

The probability approach plots everyone's intake data from the study population and constructs a risk curve using the requirement (EAR and SD) distribution of the group [Z score = (Intake − EAR)/SD of the requirement]. The PA was computed using the "Probnorm" function in STATA software. The mean probability of adequacy (MPA) for 12 micronutrients was calculated by averaging the adequacy of the micronutrients. The 12 macronutrients are calcium, magnesium, iron, zinc, thiamine, riboflavin, niacin EQ, vitamin B_6, folate, vitamin B_{12}, L-ascorbic acid, vitamin A (as RAE). For pregnant and lactating women, nutrient adequacy was calculated separately. Nutrient requirement for pregnant and lactating women is relatively higher than for non-pregnant and non-lactating women (NPNL). EAR and RDA were assigned following the pregnant and lactating status of the women.

The mean adequacy ratio (MAR)was calculated as in addition to PA. NAR for a given nutrient is the ratio of an individual's intake to the age- and sex-specific EAR. The MAR is calculated by averaging all the NAR values together.

Statistical analysis

We have assigned the complex survey design provided by BIHS and HIES survey for calculating the weighted estimation. Lower and higher intake was identified following the Goldberg criteria for age and sex and counted as a missing value in this analysis. Average dietary consumption was estimated and compared by population strata, including by age, sex, and regions. Normality was checked off the nutrient intake. To calculate the usual intake, we have used log transformation for the non-normal data. After adjusting the inter and intra variation with log distribution, we did a back transformation to get the usual intake of an individual. We reported median with the mean as all the intakes are not normally distributed.

3.2 Nutrient Profiling

The assessment of the nutrient quality of different food items by nutrient profiling has been done based on their nutrient composition as reported in the food composition database. So, nutrient profiling helps to identify the nutrient-rich foods for consumers. Nowadays various nutrient profiling schemes are available to classify foods based on their nutrient composition. As a first attempt to utilize the nutrient-dense foods to fulfill the nutrient gaps identified among population level and dietary management for the prevention of NCDs foods of FCTB are categorized according to their nutrient density by using three different methods are Energy Density (ED), Naturally Nutrient Rich (NNR) foods and Nutrient Rich Food (NRF9.3) which are using in different countries.

Nutrient composition database

The 'Food Composition Database for Bangladesh' (FCDB) was used for assessing the nutrient profile of foods (Shaheen et al., 2013). The database provides comprehensive food descriptions for 381 foods and 15 food groups. The values of all foods including liquids and beverages are presented as per 100g edible portion based on fresh weight. The key description of foods is given in a unique 6-digit identification code. The first 2 digits represent the 15 food groups: 1) cereals and their products; 2) pulse, legumes, and their products; 3) vegetables and their products; 4) leafy vegetables; 5) starchy roots, tubers, and their products; 6) nuts, seeds, and their products; 7) spices, condiments, and herbs; 8) fruits; 9) fish, shellfish and their products; 10) meat, poultry and their products; 11) eggs and their products; 12) milk and its products; 13) fats and oils; 14) beverages; and 15) Miscellaneous. The rest of the digits indicate individual food numbers (example: 01_0001). The present study is limited to commonly consumed 389 foods. Infant formulas, mixed food items, baby foods, therapeutic foods, salt, water, and street foods are also included. A total of 389 foods (excluding water and salt) representing 15 groups were used for the final analysis of energy density, nutrient density score (NRF9.3), and naturally nutrient-rich score. Due to the lack of established serving size available in Bangladesh 100g and 100 kcal is used in this study. All calculations were done using the Food and Drug Administration's Daily Value (DV) (FAO, 2020) as the reference standard, based on a consumption of 2000 kcal diet (Table 2 and Table 3).

Energy Density (ED)

Energy density is the amount of energy (in kilocalories) per gram of food that is affected by components like water and macronutrient content of the food. Energy Density in this study was calculated by dividing the energy content of foods (in kilocalories) by the fresh weight (in gram) of the edible portion (100gm). For calculating dietary energy density and the following equation was used (Vermicelli et al., 2013).

$$\text{Energy Density} = \text{Total energy (kcal)} / \text{total weight (g)}$$

Naturally Nutrient Rich Score (NNR)

NNR in the present study was calculated for 16 nutrients shown in (Table 2), Food and Drug Administration's Daily Value (DV) for each nutrient used as the reference standard, based on the consumption of 2000 kcal energy. To prevent the excessive contribution of one or more nutrients in a food item to the total NNR score, the percentage daily value of any nutrient above 2,000% was trimmed to 2,000 (Drewnowski, 2005). The following formula was applied to calculate a naturally nutrient-rich score.

$$NNR = \Sigma\ \%DV_{2000\ kcal} / 16$$

Table 2. Sixteen key nutrients and their recommended daily values (DVs) based on the Dietary reference intakes that were used to calculate the naturally nutrient-rich scores (FDA 2020).

Nutrients	**Reference Daily Value**
Protein (g)	50
Vitamin A (mcg RAE)	900
Vitamin C (mg)	90
Vitamin D (mcg)	20
Vitamin E (mg)	15

Thiamine (mg)	1.2
Riboflavin (mg)	1.3
Folate (mcg of DFE)	400
Calcium (mg)	1300
Iron (mg)	18
Zinc (mg)	11
MUFA (mono-unsaturated fatty acid) (g)	20
Potassium (mg)	4700
Vitamin B_{12} (mcg)	2.4
Pantothenic acid (B_5) (mg)	5
Fiber (g)	28

Nutrient Rich Food Index (NRF9.3)

Nutrient density is usually described as the concentration of nutrients per 100 kcal of food, but sometimes it is stated per 100 g or serving size instead (Drewnowski, Maillot, & Darmon, 2009). Most designs have depended on nutrient-to-calorie ratios. While expressed per 100 kcal, it characterizes the proportion of nutrients to energy. Existing nutrient profiling approaches are mainly nutrient-based, and they do not take account of such issues as nutrient balance, nutrient interactions, or bioavailability. Some key points in developing nutrient density models have been recognized. Firstly, nutrients to encourage and nutrients to limit are chosen based on nutrients of public health concern and are acknowledged through studies of dietary patterns of the population.

The NRF index specifies a proven metric to calculate the nutrient density of individual foods (Drewnowski & Fulgoni, 2008; Fulgoni, Keast & Drewnowsk, 2009). The 'Food Composition Tables for Bangladesh' database was used for assessing the nutrient-rich food index in this study (Shaheen et al., 2013).

The variant that was used in this analysis is identified as NRF 9.3 model, where 9 nutrients to encourage are protein, fiber, vitamin A, vitamin E, vitamin C, calcium, magnesium, potassium, and iron and 3 nutrients to limit are saturated fat, added sugar and sodium. NRF 9.3 is based on the sum of the percentage of daily values for 9 nutrients to encourage minus the sum of the percentage of the maximum recommended values for 3 nutrients to limit. Where all daily values were calculated per 100 kcal and capped at 100%. The selection of 'nutrients to encourage' and ‘nutrients to limit’ are based on our dietary pattern and are the same as the nutrients used by Adam Drewnowski (Drewnowski, 2005). The NRF9.3 index was calculated per 100 kcal as there is no established serving size currently available in Bangladesh. Nutrient content of 100g edible portion of food on a fresh weight basis is altered to 100 kcal for this calculation. Daily Reference Values were used based on FDA standards (Table 3). Total sugar is considered where added sugar value was unavailable. All daily values were calculated per 100 kcal and were capped at 100% to foods having very large amounts of a single nutrient would not attain an unreasonably high index score. Nutrient-rich sub-score (nutrients to encourage) and limiting nutrients (LIM) was calculated by the following algorithms:

$NR9_{100\ kcal} = \Sigma_{1\text{-}9}\,(nutrient_i / DV_i)/S_i \times 100$

Where, $Nutrient_i$ = nutrient per serving (weight)
DV_i = daily value for the nutrient (weight)
Si = calories per serving

$LIM_{100\ kcal} == \Sigma_{1\text{-}3}\,(nutrient_i / MRV_i)/S_i \times 100$

Where, $Nutrient_i$ = nutrient per serving (weight)
MRVi = maximum recommended value for the nutrient (weight)
Si = calories per serving

For NRF composite model the following algorithm was followed:

$NRF9.3_{100\ kcal} = NR9_{100\ kcal} - LIM_{100\ kcal}$
NR9 subscore based on 9 nutrients to encourage
LIM3 subscore based on 3 nutrients to limit

Table 3. NRF9.3 algorithm

Model	Algorithm	Notes
NR9 subscore		
$NR9_{100\ kcal}$	$\Sigma_{1\text{-}9}\,(nutrient_i / DV_i)/S_i \times 100$	$Nutrient_i$ = nutrient per serving (weight) DV_i = daily value for the nutrient (weight) Si = calories per serving
LIM subscore		
$LIM_{100\ kcal}$	$\Sigma_{1\text{-}3}(nutrient_i / MRV_i)/S_i \times 100$	$Nutrient_i$ = nutrient per serving (weight) MRV_i = maximum recommended value for the nutrient (weight) S_i = calories per serving
$NR9.3_{\ 100\ kcal}$	$NRF9.3_{100\ kcal} = NR9_{100\ kcal} - LIM_{100\ kcal}$	---

Bioactive compounds for example polyphenols, flavonoids, and other antioxidants were not involved in nutrient profiling models mainly because of their lack of widespread nutrient data and Dietary Reference Intake values.

Table 4. Reference daily values and maximum recommended values for nutrients based on a 2000-kcal diet.

Nutrients to encourage	**RDV**	**MRV**
Protein (g)	50 g	
Fiber (gram)	28 g	
Vitamin A (mcg)	900 mcg RAE	
Vitamin C (mg)	90 mg	
Vitamin E (mg)	15 mg	
Calcium (mg)	1300 mg	
Iron (mg)	18 mg	
Potassium (mg)	4700 mg	
Magnesium (mg)	420 mg	
Nutrients to Limit		
Saturated fat (g)		20 g
Added sugar (g)		50 g
Sodium (mg)		2300 mg

3.3 Cost and affordability analysis of a nutritious/recommended diet

To understand the cost and affordability of healthy diets in Bangladesh we analyzed three reference diets to simulate incremental levels of diet quality, starting from a basic energy sufficient diet to a nutrient adequate diet and then to a healthy diet. The diets were defined as-

(i) Energy sufficient diet (ESD): This diet provides adequate calories for maintaining energy balance. This diet can be achieved through consuming only the basic least cost starchy staple for a given country (e.g., maize, wheat, or rice).

(ii) Nutrient adequate diet (NAD): This diet provides not only adequate calories but also adequate levels of all essential macro and micronutrients needed to maintain a healthy and active life. This diet maintains a balanced mix of carbohydrates, protein, fat, essential vitamins, and minerals within the upper and lower bounds needed to prevent deficiencies and avoid toxicity.

(iii) Healthy diet (HD): This diet in addition to adequate calorie and essential nutrients provides a diverse intake of foods from different food groups based on desirable dietary guidelines of a country. This diet is intended to meet all nutrient intake requirements and to help prevent malnutrition in all its forms, including diet-related non-communicable diseases.

3.3.1 Collecting price of the food items

From the website of the Department of Agricultural Marketing (DAM), a list of food markets around Bangladesh across eight divisions was prepared. Among all the food markets six locations from each division including three urban and three rural (n=48) were randomly chosen for price data collection (see Appendix-III-Table 1). Bangladesh Integrated Household Survey, 2015 (BIHS, 2015), Institute of Nutrition and Food Science survey, 2017-18 (INFS, 2017-18), and Household Income and Expenditure Survey, 2016 (HIES, 2016) were used to note most commonly consumed foods for preparing a comprehensive food list comprising of 124 food items under nine food groups (considering leafy and non-leafy vegetables separately). To consider the regional variation across eight divisions of Bangladesh, the data collectors were told to also note down the available food items in each market, and later the food items were incorporated into the regional food list while calculating the cost of three reference diets of that respective area. The data collectors were selected from each location who had previous experience of doing market surveys and were familiar with the local language of the assessment area. A two days training session was conducted to discuss the aims of the market survey, the method of collecting price data and answer the queries of the data collectors. Before starting the data collection process, we obtained formal permission from the market leaders and local traders to avoid unsolicited circumstances.

In each market, the prices of the food items were reported from four traders to reflect the actual price of the food items. The weight of three samples of a food item was recorded using a kitchen scale and the traders were asked the price of the food item which all were recorded in 100g weight of the food. We made sure we avoided rush hours and the prices were collected without causing any disturbance to the traders.

3.3.2 Method of calculating cost of three reference diets

3.3.2.1 Energy sufficient diet

This diet was simply calculated by multiplying the price per calorie of least cost staple food with the calorie requirement of our reference moderate active women of reproductive age which is 2130 kcal. The primary motivation behind choosing non-pregnant non-lactating reproductive women doing moderate physical activity as our reference is that the energy requirement of these reference women is the closest to the energy level used to calculate the poverty line of Bangladesh which is 2122 kcal. Also, the least cost to meet the requirements of this age group is at the median level of the least costs for all sex-age groups across the life cycle. Moreover, women of this age group are regarded as a nutritionally vulnerable group as they suffer from several energy and nutrient deficiencies as well as they are at higher risk of nutrient inadequacies due to social practices and customs.

3.3.2.2 Nutrient adequate diet

We calculated the cost of nutrient adequate diet through linear programming by putting constraints on energy, macronutrient, and micronutrient intake values. As we used moderate active reproductive women as our reference, the energy requirement was fixed at 2130 Kcal based on dietary reference values set by the National Institute of Nutrition, Indian Council of Medical Research (NIN/ICMR, 2020). We took the estimated average requirement (EAR) values for 12 micronutrients from the NIN-published reference values (NIN, 2020). We specified that the macronutrient intakes are within the Acceptable Macronutrient Distribution Range (AMDR) which is also set by the NIN. The nutrient values of foods were obtained from Bangladesh food composition databases (Shaheen et al., 2013).

3.3.2.3 Healthy diet

We calculated the cost of a healthy diet using the market food prices and food-based dietary guidelines of Bangladesh by following the Dizon and Herforth method (Dizon and Herforth, 2019).

The calculation of the cost of the healthy diet consisted of several steps.

Firstly, the foods were categorized into specific food groups according to the food-based dietary guidelines. In the case of multiple types of the same food, their average was taken such as we took the average of wheat flour red and wheat flour white. All items were standardized into grams. Items that are normally measured in non-standardized units were also converted into grams for example dozen eggs, dozen bananas.

In the second step, the price of the food items was converted into 100g edible by dividing the as purchased price with the edible coefficient. After that, the price of 100g edible food was multiplied by the serving size for each food group recommended by dietary guidelines of Bangladesh to estimate the price per edible serving.

In the third step, from each food group, we took the average price per serving of two lowest-cost items (see Appendix-III-Table 2) and multiplied it by the average of the upper and lower bound of the number of servings recommended for that group. We chose the lowest cost items as our objective is to calculate the minimum cost of meeting the recommended diet and more than one lowest cost item was chosen as food-based dietary guidelines promote diversity within food groups.

Finally, the costs for meeting the recommendations for each food group were summed to calculate the cost of the healthy diet.

Table 5. Serving size estimates based on the dietary guidelines of Bangladesh.

Food Groups		Serving size (g)	Recommended number of servings		Number of servings used (average of the number of servings)
			Min	Max	
Cereals		30	9	15	12
Pulses		30	1	2	1.5
Vegetables	Non-leafy vegetables	150	1	2	1.5
	Leafy vegetables	150	1	2	1.5
Fruits		100	1	2	1.5
Meat, fish, and egg		100	1.5	3.5	2.5
Milk and milk products		150	1	3	1.5
Fats and oils		15	2	3	2.5
Sugar		5	3	5	4

3.3.3 Measuring affordability

To estimate the affordability of each of the three diets, we compared the costs with poverty lines and household food expenditures as reported in the Household Income and Expenditure Survey, 2016. Using the data from the Household Income and Expenditure Survey we calculated the percent of households from the whole country as well as from each division that are unable to afford these reference diets.

1. **Poverty line:** The first measure of affordability compared the cost of each diet with 63 percent of the poverty line. The 63 percent accounts for a portion of the poverty line that can be credibly reserved for food, because it is the mean proportion of expenditures on food among the bottom consumer segment in low-income countries (World Bank Global Consumption Database;

FAO,2020). It is assumed that a minimum of 37 percent of expenditures must be reserved for non-food expenditures, such as housing, transport, education and health, and farm inputs.

2. **Household food expenditure:** The second measure of affordability compares the cost of each diet with daily household food expenditure from Household Income and Expenditure Survey (HIES), 2016. From the HIES, 2016 survey data we took the daily food expenditure and household size of every household. As we estimated the cost of three reference diets for an adult individual, we adjusted the reported household size with adult male equivalent (AME) values. We then determined the cost of healthy diets for a household by multiplying the cost of a healthy diet with AME-adjusted household size. Because we computed the cost of diets using current food prices of 2021 but used HIES 2016 data to estimate affordability, we multiplied the cost of three reference diets by a deflation factor and adjusted them according to the price of the year 2016. Then the deflation adjusted cost of diets for every household was divided by its daily food expenditure and the results were expressed in ratios. Ratios above 1 indicate that a diet is unaffordable as its cost exceeds the average food expenditures of a household.

3.5 Development of least-cost food baskets

Generation of Food list

The application of linear programming to develop least-cost food baskets required a list of the available foods with their nutrient composition. As the list of foods selected and analyzed to be included in the main table of the Food Composition Table for Bangladesh (FCTB) (Shaheen et al., 2013) was based on nutrient consumption approach as described in Haytowitz et al. (2002), we used that list as the starting point to generate the list of foods. Later, we modified that list based on the food items reported in the recent nutrition-related surveys namely Bangladesh Integrated Household Survey, 2015 (BIHS, 2015), Institute of Nutrition and Food Science survey, 2017-18 (INFS, 2017-18), and Household Income and Expenditure Survey, 2016 (HIES, 2016). On consensus, we finalized a list of foods containing 124 items which were categorized into the groups as described in the National Dietary Guidelines for Bangladesh (DGB) published jointly by the Ministry of Food and Ministry of Health and Family Welfare of the Government of Bangladesh in 2015 and updated 2020 (Ministry of Food and Ministry of Health and Family Welfare (MoF and MoHFW) 2015, 2020)

Food prices

As described in detail in section 3.4.1, a price survey was conducted in 48 retail markets (see Appendix-III-table 1) of Bangladesh. The price of each food item was collected from four retailers in each market subject to the availability of the food item and retailers in the markets. The average price of each food item was calculated from the collected price data points and was considered as the national-level price of that food item. However, this price was considered as the cost of per unit of food items "as purchased."

Food composition data

FCTB (Shaheen et al., 2013) was used to obtain the edible coefficients and energy and nutrients contents of the food items. Because the values for energy and nutrients contents of the foods in the FCTB were expressed per 100 grams of edible weight, edible coefficients were used to convert the cost per unit of food items "as purchased" into the cost per unit of food items "as edible."

Cultural acceptability data

The qualitative research approach was applied to understand the cultural acceptability of foods in Bangladesh. The study postulated that cross-cultural variation emanated from and embedded with the different agro-ecological conditions. Also, although the market principle was one of the leading influencing factors for the availability of specific foods, the availability of native food varieties was solely dependent on the local agro-ecological features. So, while selecting the study areas, the study considered agro-ecological features and administrative divisions- considering the growth of the urban market. In the study, the agro-ecological zones were broadly divided into seven groups based on the relative homogeneity principles.

Among the regions, all the eight administrative divisions of Bangladesh were selected to understand cross-cultural variation to food acceptability. These were Rajshahi, Rangpur, Dhaka, Mymensingh, Khulna, Barisal, Sylhet, and Chattogram. Moreover, addressing the extent of the influence of the market and agro-ecological condition, the study also considered rural and urban dimensions. Thus, the investigation finally selected the urban and rural population of all the administrative divisions in Bangladesh. A particular division in each broad agro-ecological category was chosen by following the principle except Barisal and Khulna divisions. Although Barisal and Khulna belonged to the same broad agro-ecological category in the study formulation, the study addressed both the divisions due to administration division.

For selecting study participants, the study also relied on the assumption that mothers would be the best source for the information because of their instrumental role in the household's food intake and preparation decision. Besides, in a patriarchal society, the household head or authority figure was usually a husband or father who was usually involved primarily in income and expenditure management. The other postulation was that one's religious affiliation also influences food choice decisions. So, the study selected mother and father/husband with an inclusion criterion for adding participants of the predominant religious background of Bangladesh i.e. Muslim and Hindu, as study participants.

Again, FGDs and KIIs were conducted for data collection. In each division, one FGD with mother, consisting of 7-10 participants, and a KII with father/husband was conducted equally in rural and urban areas separately. So, the study accomplished a total of 16 FGDs and 16 KIIs, which were equally distributed in rural and urban settings of a total of 08 administrative divisions. Noticeably, the attendance of at least two Hindu participants was ensured in each FGD session. For KIIs, participants of any religious background were allowed for the session. The KII sessions were mainly conducted with a Muslim background. Of the sampling strategy, the study was flexible enough to accommodate any participants complying with inclusion criteria, who were convenient to give time for the interview. Notably, settlers or migrants, below the length of one generation, to a particular region were avoided to be a potential respondent.

The interviews were recorded and transcribed details following a matrix by rural and urban settings for all the administrative divisions. All the matrix-based transcriptions were analyzed following content and thematic framework. By content analysis framework, the acceptable and unacceptable/less acceptable foods with ranking were identified in terms of the life cycle, seasons, and economic shocks by rural-urban continuum across administrative divisions. Also, the reasonings for edible and non-edible/less edible were coded with the semantic label. By homogeneity, codes were grouped into relatively larger code groups with thematic labeling in each group. The emerging themes were given the contextual understanding of the foods that were edible or non-edible/less edible. Figure 2 shows an overview of the methods and techniques adopted to explore cultural aspects of a typical Bangladeshi diet.

Nutritional constraints

Constraints are a predefined set of constraints (e.g., minimum requirements of key nutrients and maximum/minimum amount of a food item/group) were defined in the form of a system of inequalities or equations before entering them into the linear program. Our constraints included

(a) Estimated Energy Requirement (EER);
(b) Estimated Average Requirement (EAR) values for protein, four minerals (calcium, magnesium, iron, and zinc), and eight vitamins (thiamine, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, vitamin C, and Vitamin A);
(c) Acceptable Macronutrient Distribution Range (AMDR) values as a percent of EER (%EER) for carbohydrate, fat, and protein;
(d) Tolerable Upper Limit (TUL) for calcium, iron, zinc, niacin, vitamin $B_{6,}$ folate, vitamin C, and vitamin A;
(e) Maximum and minimum number of servings from different food groups;
(f) Minimum proportion of EER from rice; and

(g) Minimum amount of wheat flour, potato, and soy oil and maximum amount of wheat, potato, powdered milk, and condensed milk.

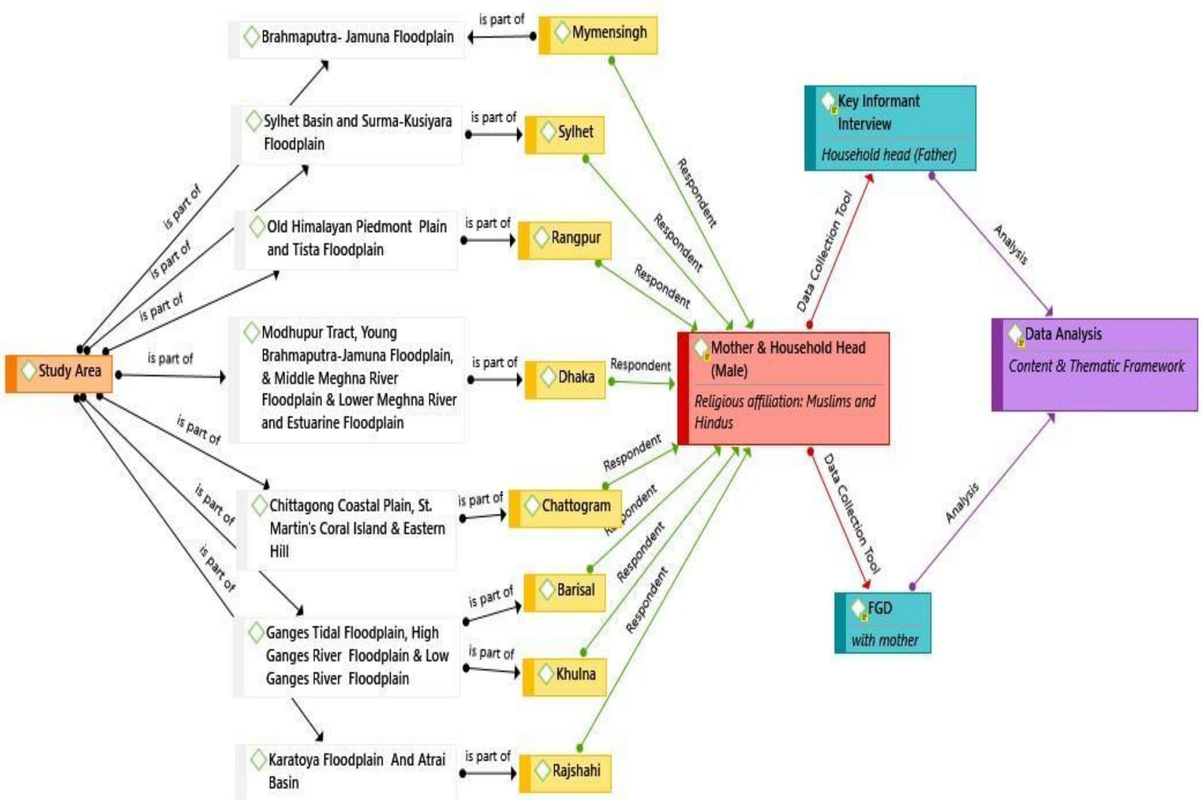


Figure 2. Methodological framework of the qualitative study

For values of the constraints relating to EER, EAR, AMDR, and TUL, we used the *Nutrient Requirements for Indians* published by the National Institute of Nutrition of the Indian Council of Medical Research (NIN/ICMR, 2020). We used the EAR and the lower end of the AMDR for minimum requirements of nutrients. For the upper bound, we applied the upper limits of the AMDR and TUL (when available for a nutrient and an individual). We set EER for an individual based on his/her age, body weight, sex, and level of physical activity. Given insufficient evidence to set an EAR for all nutrients, we included only those nutrients for which the EAR has been set. However, we excluded vitamin D and iodine as constraints despite having their EAR set. Vitamin D was excluded based on the insufficient evidence on the amount of vitamin D that can be produced in the body of the Bangladeshi population as they are potentially different from the Indian population in terms of sunlight exposure and variations in race/ethnicity. Iodine is fortified universally in salt in Bangladesh and not reported in the FCTB. The TUL values were not set for all nutrients and for all age groups/physiological stages. We only applied the TUL for specific nutrients when they were available for the specific population group for which we modeled the least-cost diet.

For setting the minimum and a maximum number of servings (including the amount/portion size of foods per serving) from different food groups that comprise a healthy diet, we adapted the recommendations as set in the Dietary Guidelines for Bangladesh (DGB) published jointly by the ministry of food and ministry of health and family welfare of the government of Bangladesh in 2015 and updated in 2020 (MoF and MoHFW, 2015, 2020). While this guideline recommends eight food groups for a healthy diet, we split the "vegetables" group into "leafy vegetables" and "non-leafy vegetables" to ensure that the least-cost diet contains at least one serving of leafy vegetables. As the DGB put the recommendations on a number of servings from each food group for adults only, we complemented the constraint on the maximum and the minimum number of servings from different food groups from Dietary Guidelines for Indians (NIN/ICMR, 2011) when designing the least-cost healthy diets for children.

We relied on the most recent nutrition-related surveys to get a quantitative estimate of the per capita consumption of major staples that are culturally integral to the Bangladeshi diet. We based our information about what food items must be in the least-cost diet on the results of a qualitative survey conducted to support the setting up of constraints to define a culturally acceptable diet. In general, Bangladeshi population consumes approximately half of their EER from rice and around 70% of their EER from carbohydrates. To keep things into perspective, we designed our least-cost diet so that it contains at least one-third of EER from rice. To promote a mixture of cereals while considering the palatability factor, we set the amount of wheat flour to range from 50-150 grams. We also kept potatoes in the range of 50-200 grams to promote variation in the sources of carbohydrates while we ensured that the amount of foods from "vegetables' 'remained within the recommended range. To depart minimally from the current oil consumption practices in Bangladesh, we set the oil constraint in such a way that linear programming selects "soya oil" to meet the minimum requirement of visible oil before it picks any other oil source for the additional quantity. Finally, we set the maximum amount of powdered milk and condensed milk at zero so that linear programming selects more healthier items like "whole milk" and/or "yoghurt" as sources of dairy and dairy products.

Least-costs diets and linear programming

For the least-cost food basket, we applied linear programming to identify unique combinations of food items in particular amounts that fulfill the nutritional recommendations of a particular person. The decision variables involved whether to select a food from the list of 124 foods and, if selected, at what amount. Each food that was entered into the linear program had its price and concentrations of nutrients. The goal function of the linear programming applied was to minimize the cost of the food combinations while meeting the nutritional recommendations set as constraints. We applied linear programming to model four different versions of least-cost diets each of which was characterized by a defined set of constraints as given below:

1. *Energy-adequate basket*: This least-cost basket contains the equal amount of energy required by an individual (i.e., EER). It has only one constraint:

- Estimated Energy Requirement (EER)

2. *Nutritionally adequate basket*: This least-cost basket meets the energy, protein, and micronutrient requirements of an individual while keeping the proportion of energy from macronutrients in acceptable ranges and amount of nutrients within the safe limit of consumption. It has the following four set of constraints:

- Estimated Energy Requirement (EER);
- Estimated Average Requirement (EAR) values for protein, four minerals (calcium, magnesium, iron, and zinc), and eight vitamins (thiamine, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, vitamin C, and Vitamin A);
- Acceptable Macronutrient Distribution Range (AMDR) values as a percent of EER (%EER) for carbohydrate, fat, and protein;
- Tolerable Upper Limit (TUL) for calcium, iron, zinc, niacin, vitamin $B_{6,}$ folate, vitamin C, and vitamin A.

3. *Nutritionally adequate and health-promoting basket:* This least-cost diet incorporates the principles and recommendations of a healthy diet as stipulated in the DGB in addition to preserving the characteristics of a *nutritionally adequate basket.* It has the following five set of constraints:

- Estimated Energy Requirement (EER);
- Estimated Average Requirement (EAR) values for protein, four minerals (calcium, magnesium, iron, and zinc), and eight vitamins (thiamine, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, vitamin C, and Vitamin A);
- Acceptable Macronutrient Distribution Range (AMDR) values as a percent of EER (%EER) for carbohydrate, fat, and protein;
- Tolerable Upper Limit (TUL) for calcium, iron, zinc, niacin, vitamin $B_{6,}$ folate, vitamin C, and vitamin A; and
- Maximum and minimum number of servings from different food groups.

4. *Nutritionally adequate, health-promoting, and culturally acceptable basket:* This least-cost basket incorporates the cultural aspects of a typical Bangladeshi diet while maintaining the features of the *nutritionally adequate and health-promoting basket.* It has the following seven set of constraints:

- Estimated Energy Requirement (EER);
- Estimated Average Requirement (EAR) values for protein, four minerals (calcium, magnesium, iron, and zinc), and eight vitamins (thiamine, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, vitamin C, and Vitamin A);
- Acceptable Macronutrient Distribution Range (AMDR) values as a percent of EER (%EER) for carbohydrate, fat, and protein;
- Tolerable Upper Limit (TUL) for calcium, iron, zinc, niacin, vitamin $B_{6,}$ folate, vitamin C, and vitamin A;
- Maximum and minimum number of servings from different food groups;
- Minimum proportion of EER from rice; and

- Minimum amount of wheat flour, potato, and soy oil and maximum amount of wheat, potato, powdered milk, and condensed milk.

Target population groups

Nutrient requirements vary by age, sex, reproductive status, and level of physical activity. Considering this we designed the least cost diets with values of constraints specific to an individual's age, sex, reproductive status, and physical activity level. We took a life-cycle approach to segregate the population into the following groups (Table 6) for each of which we calculated the least cost of a food basket that meet specific criteria.

Table 6. Segregation of population according to life-cycle stages

<table>
<tr><td colspan="2" rowspan="3">Children</td><td>1-3 years</td></tr>
<tr><td>4-6 years</td></tr>
<tr><td>7-9 years</td></tr>
<tr><td rowspan="6">Adolescents</td><td rowspan="3">Boys</td><td>10-12 years</td></tr>
<tr><td>13-15 years</td></tr>
<tr><td>16-18 years</td></tr>
<tr><td rowspan="3">Girls</td><td>10-12 years</td></tr>
<tr><td>13-15 years</td></tr>
<tr><td>16-18 years</td></tr>
<tr><td rowspan="6">Adults</td><td rowspan="3">Men</td><td>Sedentarily active</td></tr>
<tr><td>Moderately Active</td></tr>
<tr><td>Heavily Active</td></tr>
<tr><td rowspan="3">Women</td><td>Sedentarily active</td></tr>
<tr><td>Moderately Active</td></tr>
<tr><td>Heavily Active</td></tr>
<tr><td rowspan="4">Pregnant women</td><td rowspan="3">2nd trimester</td><td>Sedentarily active</td></tr>
<tr><td>Moderately Active</td></tr>
<tr><td>Heavily Active</td></tr>
<tr><td>3rd trimester</td><td>Sedentarily active</td></tr>
</table>

		Moderately Active
		Heavily Active
Lactating women	**0-6 months**	Sedentarily active
		Moderately Active
		Heavily Active
	6-12 months	Sedentarily active
		Moderately Active
		Heavily Active

Chapter 4: Food consumption of Bangladeshi population by life cycle stage and region

4.1 Food and nutrients intake: results from INFS-2017/2018 dataset

4.1.1 Demographic Characteristics of survey households

According to the INFS 2017/18 survey, the ratio of male and female respondents was approximately 1:1 both in urban and rural areas. The population was then further categorized into different age groups. Most of the people fell into the age group of 19-30 years (rural 26%, urban 33.7%). The second-largest age group in both regions was 31-50 years (rural-21.6%, urban-17%). In rural areas, the smallest age group was 0-5 months (1%) but in urban areas, the smallest group was over 60 years (0%) as there were no respondents over 60 years of age from urban regions (Table 7).

Table 7. Age and sex structure of sample population by residence in 2017/2018 (N=3541)

Age Category	**Rural**			**Urban**		
	Male N (%)	Female N (%)	Both N (%)	Male N (%)	Female N (%)	Both N (%)
0 to 5 months	15 (1.2)	10 (0.9)	25 (1.0)	14 (2.5)	16 (2.9)	30 (2.7)
6 to 12 months	17 (1.4)	24 (2.1)	41 (1.7)	14 (2.5)	15 (2.7)	29 (2.6)
1 to 3 years	101 (8.7)	97 (8.4)	207 (8.6)	104 (18.2)	97 (17.4)	201 (17.8)

4 to 6 years	84 (6.7)	89 (7.7)	173 (7.2)	47 (8.2)	50 (8.9)	97 (8.6)
7 to 9 years	74 (5.9)	73 (6.3)	147 (6.1)	28 (4.9)	40 (7.2)	68 (6.0)
10 to 12 years	65 (5.2)	64 (5.5)	129 (5.3)	38 (6.7)	25 (4.5)	63 (5.6)
13 to 15 years	69 (5.5)	58 (5.0)	127 (5.3)	17 (3.0)	13 (2.3)	30 (2.7)
16 to 18 years	70 (5.6)	60 (5.2)	130 (5.4)	10 (1.8)	22 (3.9)	32 (2.8)
19 to 30 years	295 (23.5)	334 (28.8)	629 (26.1)	149 (26.1)	232 (41.5)	381 (33.7)
31 to 50 years	306 (24.4)	214 (18.5)	520 (21.6)	145 (25.4)	47 (8.4)	192 (17.0)
51 to 60 years	71 (5.7)	88 (7.6)	159 (6.6)	4 (0.7)	2 (0.4)	6 (0.5)
Over 60 years	77 (6.1)	48 (4.1)	125 (5.1)	0	0	0
All age group	1253	1159	2412	570	559	1129

4.1.2 Per capita food intake by income categories and expenditure quintiles

The following section presents the findings on dietary intake and provides information about the types of food consumed and sources of nutrients. Foods were classified into fifteen categories (see Appendix-I-Table 1). They were then converted into nutrients using the updated Food Composition Table of Bangladesh (Shaheen et al., 2018).

Appendix-I-Table 1 provides information on the average quantity of major food items consumed per person per day among wealth quartiles which are represented by the letters A, B, C, and D (poor to rich). Among the food groups, cereal intake still dominates the diet of all income groups of people and it increased with higher income before decreasing in group D. Cereal intake was lowest in the highest wealth quartile D (389 gm) and was highest in the second-highest wealth group C (449 gm). In the cereals group, rice accounted for most of the cereal consumption as it is the staple food of the country. Rice consumption was highest in the 2nd wealth quartile.

Apart from rice, another popular cereal product is wheat, the average consumption of which was 48 grams per day. An analysis of 2010 HIES data revealed that rice still contributes most of the available energy (90%), zinc (85%), calcium (67%), and iron (55%) in the Bangladeshi diet. Domination of rice in diet limits improvement of nutrition and health status in Bangladeshi population (Fiedler, 2014).

The highest consumption of the majority of food items was observed in the 2nd and 3rd wealth quartile (mostly 3rd) and the lowest consumption was seen in the richest quartile for most food groups (e.g., cereal, pulses, non-leafy vegetables, starchy foods, meat). If we compare between the poorest and the wealthiest groups, intake of most foods was higher in group A (e.g., cereal, pulse, vegetables, starchy foods, meat, and poultry, etc.). Only the consumption of fruits, fish, eggs, milk, and fat was higher among group D compared to A (Table 8).

According to the 2016 HIES, consumption of edible oil, onion, beef, chicken/duck, eggs, and fish has increased but consumption of milk and milk products, fruits, and sugar has decreased in 2016 from 2010. A declining trend of energy consumption from cereals (such as rice and wheat) was observed. Two-third of the dietary energy is coming from cereals.

The target population was further classified into five expenditure groups or quintiles (1, 2, 3, 4, and 5) as seen in table 2. According to the expenditure quintile (Table 8), per capita, food intake was higher in the 5th quintile compared to the 1st quintile for most food groups. Intake of cereals, rice, pulses, non-leafy vegetables, eggs, and fats were highest in the 2nd quintile and highest intakes of wheat, starchy foods, nuts and seeds, fish, meat, and milk (or most animal protein) were seen in the richest quintile.

Per capita per day consumption of vegetable oil is 26.6 gm. NMS in 2013 reported that the average intake of oil was 24.4 gm (29.7, 25.9, and 22.9 grams respectively in the urban, slums and rural areas). The 2016 HIES reported a slightly higher intake of oil (26.75 gm) than NMS 2013, which contributes approximately 10% of the total energy based on the 2430 kcal diet (Quamrun et al., 2013). Three-quarter of the households in Bangladesh use open oil for consumption (NMS, 2013).

Table 8. Food Intake (grams/person/d) of the study population by expenditure quintile in 2017/2018

Food groups	**Per capita Expenditure quintile**					
	1 (lowest)	**2**	**3**	**4**	**5 (Highest)**	**All**
	(grams/person/day)					
Cereals and their products	421.6	448.3	446.3	437.3	443.5	421.6
Rice	355.8	404.2	404.1	389.9	390.1	390.0
Wheat	50.2	44.3	41.6	49.8	55.5	47.9
Pulses, legumes, and their products	37.3	41.8	35.8	36.1	41.6	37.3
Vegetables and their products	95.1	106.6	87.1	99.3	97.2	95.1

Leafy vegetables	116.9	112.5	123.8	101.0	107.9	116.9
Starchy roots, tubers, and their products	75.7	77.5	81.0	83.3	84.5	75.7
Nuts, seeds, and their products	10.9	4.6	13.8	13.4	21.8	10.9
Spices, condiments, and herbs	4.2	3.9	4.0	4.7	5.0	4.2
Fruits	24.9	30.8	32.5	30.7	31.1	24.9
Fish, shellfish, and their products	64.8	69.4	65.4	67.8	69.9	64.8
Meat, poultry, and their products	90.0	117.6	119.9	124.7	153.0	90.0
Chicken/duck	90.4	118.0	130.6	125.9	149.6	118.5
Eggs and their products	31.3	48.4	34.4	33.3	38.2	31.3
Milk and its products	5.9	6.7	6.6	6.2	18.4	5.9
Fat and oils	26.6	31.5	28.5	30.1	30.8	26.6
Beverages			56.0	133.2	58.9	
Miscellaneous	4.0	4.5	4.7	5.7	6.7	4.0

Note: Broiler chickens constitute the major share of meat and cultured pangash and tilapia constitute a major share of fish intake

4.1.3 Comparison of food group intakes between the rural and urban population in INFS 2017/18 survey

Figure 3 compares food intake by residency status which shows consumption of leafy vegetables, fish, meat, poultry, milk, and fat products are higher among the urban residents whereas consumption of starchy foods, pulses, and fruits are higher in the rural areas. The intake of other food groups is similar in both places.

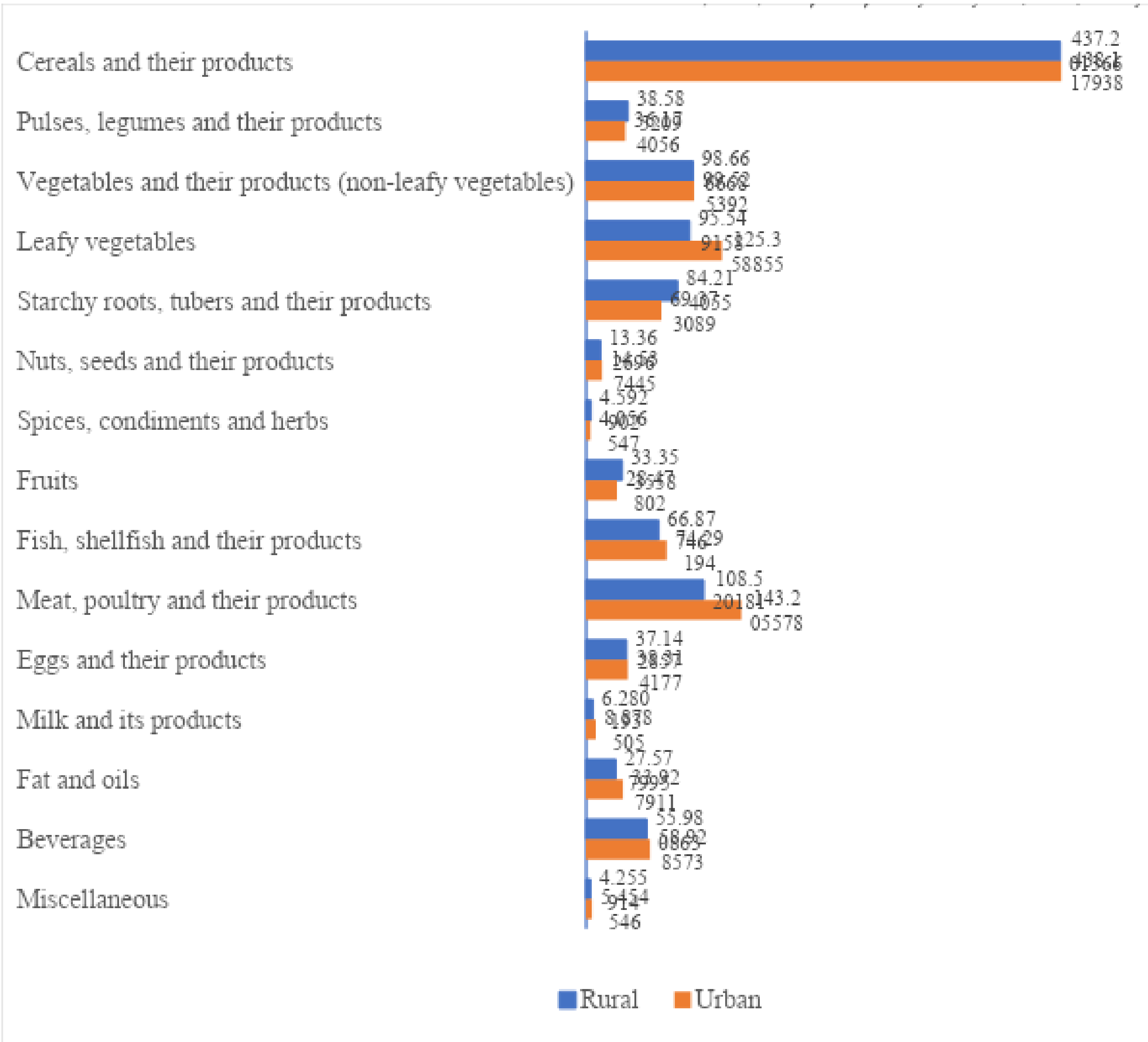


Figure 3. Food Intake (grams/person/d) of the study population by residency status in 2017/2018

4.1.4 Contribution food groups or nutrients to supply energy, macro, and micronutrient intakes

Our analysis found that people of Bangladesh meet 68.7% of their energy needs from carbohydrates, 10.9% from protein, and 18.1% from fat. The food group's supply to a daily intake of selected macronutrients in 2017/18 is presented in Figures 3 and 4.

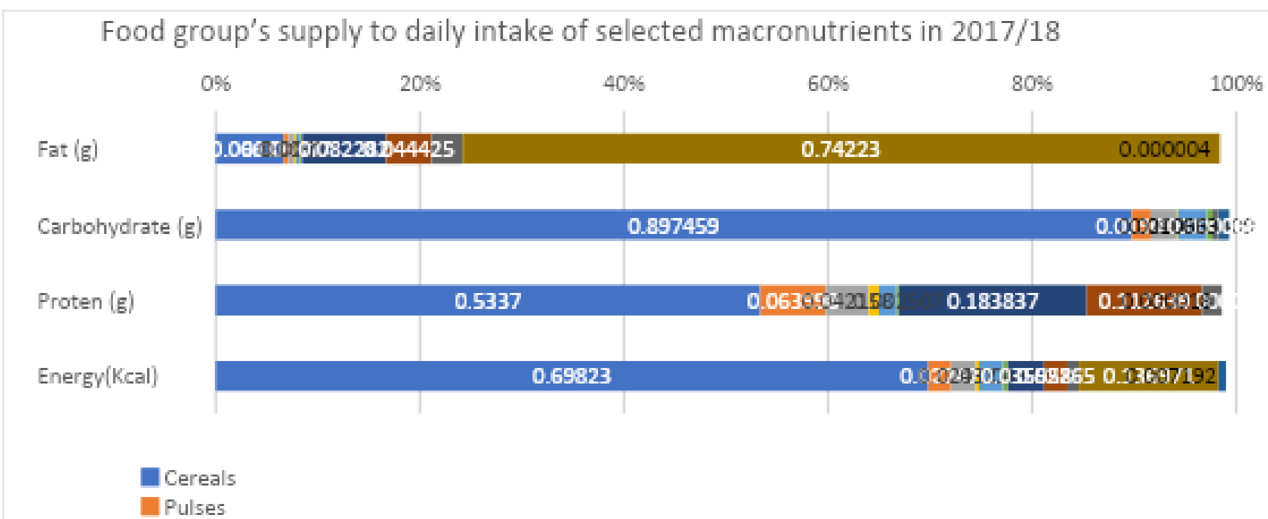
Further, table 9 provides details regarding the share of energy from the three macronutrients (carbohydrates, protein, and fat). 80% of the population receive 55-75% of their daily calorie needs from carbohydrates, 69% of people get 10-15% of energy from protein, and 65% of people get 15-30% of energy from fat. Seventeen percent of people meet their energy needs mostly from carbohydrates (>75%), and around 30% of people consume less than the recommended levels of protein and fat.

Table 9. Percent of the population sharing energy from macronutrients in 2017/18

Macronutrients	Ranges of intake	% Population
Carbohydrates	<55%	3%
	55-75%	80%
	>75%	17%
Protein	<10%	28%
	10-15%	69%
	>15%	3%
Fat	<15%	31%
	15-30%	65%
	>30%	4%

Figures 4 and 5 point out the contribution of the various food groups in providing selected macro and micronutrients in our daily diet. About 74% of our daily fat consumption comes from edible oils and the rest comes from cereals (7%), fish (8%), meat and eggs (4%), and milk products. 90% of carbohydrates are provided by cereals and a negligible amount comes from fruits and sugar. Surprisingly, 53% of our protein is also provided by cereals and only 18% comes from fish, 11% from meat and eggs, and 6% from pulses (figure 4).

Figure 4. Food group's supply to the daily intake of selected macronutrients in 2017/18



In figure 5 we can see the share of important micronutrients from different food groups. 32% of folate is provided by cereals. 24% from vegetables and 20% from fishes. We get 24% of vitamin A from meat and eggs, 16% from vegetables, 12% from leafy vegetables, and another 12% from fishes. In terms of iron, again 44% of iron is provided by cereals and around 17% from vegetables. Only a negligible amount of iron comes from animal sources. Major sources of calcium in our diet are cereals (22%), fish (21%), vegetables (15%), and milk (12%).

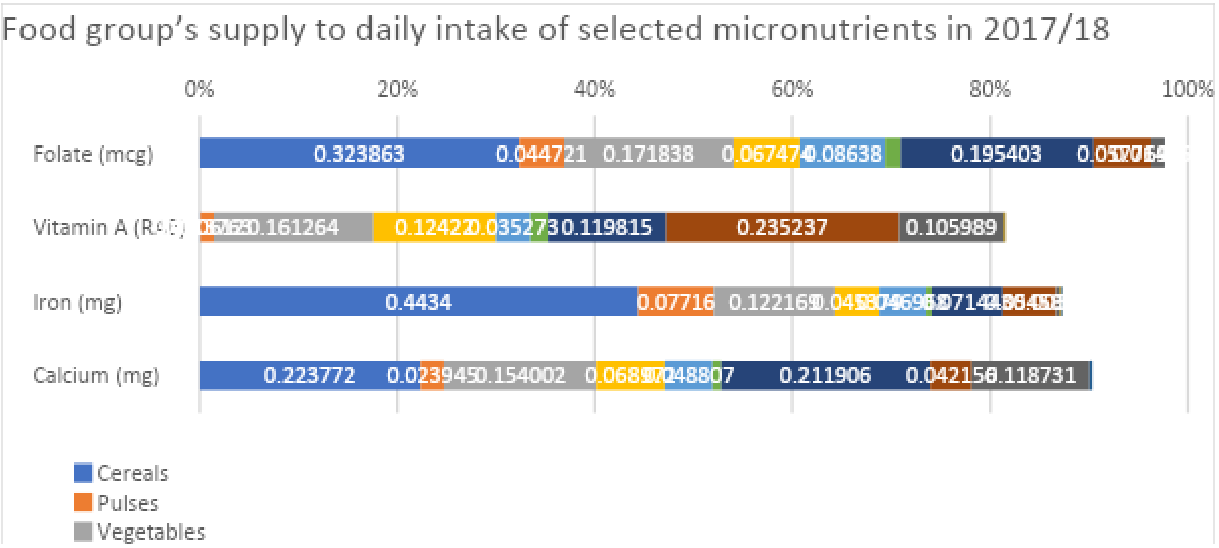


Figure 5. Food group's supply to the daily intake of selected micronutrients in 2017/18

Table 10 outlines the quality of the protein consumed by the people. In general, people consume higher levels of plant protein or non-heme protein as compared to animal protein or heme protein which is considered to be the better-quality protein in terms of indispensable amino acids as they have as compared to plant foods. Animal foods are absorbed better by our bodies.

Table 10. Heme, non-heme, animal, and plant protein intake in 2017/18

	Heme iron (mg)	Non-heme iron (mg)	Animal protein (g)	Plant protein (g)
Mean	1.17	8.10	19.70	38.24
Median	0.89	7.07	17.17	37.14
25th Percentiles	0.42	5.51	9.43	30.67
75th Percentiles	1.58	9.71	25.88	44.13

4.1.5 Per capita nutrient intake by income categories, expenditure quintiles, and residence

The following data represents the nutrient intake pattern of people of Bangladesh from different wealth quintile and residence status in 2017/18. According to tax categories, macronutrient intake increased with higher tax category (except for carbohydrates) in 2017/18 (see Appendix-I-Table 2) which resulted in maximum consumption of energy, protein, total fat, saturated fats, MUFA, and PUFA in group D and lowest consumption in group A. Similar pattern is seen for some micronutrients like vitamin D, E, and niacin. But for carbohydrate, cholesterol, dietary fiber, and all the other micronutrients, the highest levels of consumption were observed in group C except for vitamin B_6, thiamine, and riboflavin (See Appendix-I-Table 2). Table 11 shows the nutrient intake pattern in different expenditure quintiles which also shows higher levels to macro and micronutrient intakes with higher expenditure including energy, protein, total fat, calcium, sodium, zinc, potassium, and vitamin A. Intake of thiamine, riboflavin, vitamin B_6, vitamin D etc. was somewhat similar in all expenditure groups.

Table 12 shows nutrient intake in urban and rural areas. Macro and micronutrient intakes were slightly higher in the urban areas except for vitamin C, copper, vitamin B complex intake. Intakes of carbohydrates, dietary fiber, iron, zinc, copper, thiamine, riboflavin, vitamin B_6, and vitamin C were similar in both regions.

Table 11. Per capita nutrient intake by expenditure quintile in 2017/2018

Energy and Nutrients	**Per capita Expenditure quintile**					
	1 (Lowest)	**2**	**3**	**4**	**5 (Highest)**	**All**
Energy (Kcal)	2028.1	2236.4	2193.1	2115.2	2185.5	2155.0
Protein (g)	53.7	58.0	54.1	52.1	58.0	55.4
Total fat (g)	37.8	42.6	37.8	40.2	41.4	40.1
Saturated Fatty acids (g)	6.3	7.4	6.6	6.3	7.3	6.8
MUFA (g)	8.8	9.7	8.8	8.8	9.8	9.3
PUFA (g)	18.4	21.8	18.9	19.5	21.0	20.0
Cholesterol (mg)	50.7	82.6	68.9	41.7	73.9	62.3
Carbohydrate (g)	349.5	376.3	375.0	369.8	375.3	372.0
Total dietary fiber (g)	22.5	22.8	22.7	22.6	22.7	22.6
Calcium (mg)	190.2	195.9	165.5	243.8	234.0	203.0
Iron (mg)	8.2	8.4	7.8	8.2	8.7	8.2
Magnesium (mg	288.6	303.7	300.7	306.4	302.0	300.4
Phosphorus (mg)	885.0	957.4	922.8	909.4	978.7	933.3
Potassium(mg)	1561.3	1722.3	1679.4	1669.6	1763.5	1689.4

Sodium (mg)	124.1	151.9	140.8	134.8	160.6	141.7
Zinc (mg)	8.9	9.6	9.2	9.1	9.5	9.3
Copper (mg)	1.8	1.8	1.8	1.8	1.8	1.8
Vitamin A (mcg)	88.8	106.9	76.2	99.5	101.9	95.6
Vitamin D (mcg)	6.1	6.5	5.5	6.1	6.4	6.1
Vitamin E (mg)	6.3	7.1	6.3	6.5	7.0	6.7
Thiamine (mg)	1.3	1.3	1.3	1.3	1.3	1.3
Riboflavin (mg)	0.6	0.7	0.6	0.6	0.6	0.6
Niacin EQ (mg)	25.9	28.4	27.7	25.9	27.1	27.0
Vitamin B_6 (mg)	1.4	1.5	1.5	1.4	1.5	1.5
Folate (mcg)	145.3	174.8	140.7	147.8	133.9	150.3
L-ascorbic Acid (mg)	38.2	37.7	33.4	39.6	39.3	37.8

Table 12. Per capita nutrient intake by residence status in 2017/18

Energy and Nutrients	**Rural**	**Urban**
	(grams/person/day)	
Energy (Kcal)	2089.7	2222.0
Protein (g)	53.5	59.4
Total fat (g)	37.6	44.7
Saturated Fatty acids (g)	6.4	7.4
MUFA (g)	8.9	10.3
PUFA (g)	18.6	22.8
Cholesterol (mg)	56.9	66.9
Carbohydrate (g)	371.3	372.5
Total dietary fiber (g)	22.6	22.6
Calcium (mg)	198.4	220.0
Iron (mg)	8.1	8.6
Magnesium (mg	295.8	302.7

Phosphorus (mg)	915.1	969.8
Potassium(mg)	1663.8	1760.5
Sodium (mg)	135.7	161.4
Zinc (mg)	9.1	9.4
Copper (mg)	1.7	1.7
Vitamin A (mcg)	96.4	94.7
Vitamin D (mcg)	5.3	8.0
Vitamin E (mg)	6.3	7.1
Thiamine (mg)	1.3	1.3
Riboflavin (mg)	0.6	0.7
Niacin EQ (mg)	26.3	28.1
Niacin (mg)	26.3	28.1
Niacin TRP (mg)	7.3	8.9
Vitamin B_6 (mg)	1.5	1.5
Folate (mcg)	144.2	155.9
L-ascorbic Acid (mg)	38.2	36.5

4.1.6 Intrafamilial food distribution by age groups

Food consumption survey conceals information on the patterns of food allocation within the family. This requires that the food consumption survey be supplemented by an intrafamily food distribution survey. Efforts were accordingly made in this survey to find out the actual food intake of different members of the family according to age, sex, and physiologic status through the intrafamily food distribution survey. The intakes of the members covered by the survey were tabulated under two heads: food groups and nutrients.

Table 13 presents the average food intake by food groups according to different population subgroups. It appears from the table that cereal consumption still dominates the diets of all sub-groups of the population under study. The amount of cereal intake varies from 116 gm to 293gm for children aged 1-12 years, for adolescents (13-18 years) 337 gm to 484 gm, and for adults (19-50 years) 425 to 455 gm. For older adults (51 to over 70 years) the intake of cereals decreased with age. As with the average food intake, diets of the different sub-group of the population are observed to be diversified and varied. Food intake increased with age and was highest among 19–50-year-old for most food groups except for nuts and fruits intake. Fruit consumption was highest among the age group of 16-18 years and consumption of nuts and seeds was highest among people over 70 years. Food intake decreased again after 70 years of age. But consumption of pulses and leafy vegetables increased. Intake of animal source foods mirrored the same pattern and was highest among people aged 19-70 years. After 70 years, animal food intake decreased significantly.

Table 13 also shows the animal food consumption by different age groups in the families. In general, animal food consumption levels increased with age and they peaked in the age groups of 19-30 or 31-50 years.

Table 13. Intra-household food distribution by different age groups (grams/person/day)

Food groups	1- 3 years	4-6 years	7-9 years	10-12 years	13-15 years	16- 18 years	19- 30 years	31-50 years	51-70 years	70+ years
Cereals and their products	115.7	189.6	246.7	293.3	337.2	384.5	425.5	455.1	396.0	328.6
Pulses, legumes, and their products	12.8	16.9	21.8	25.4	35.1	33.3	42.1	44.3	41.3	44.7
Vegetables and their products	20.8	33.2	48.9	61.9	72.2	79.8	103	98.7	83.3	62.3
Leafy vegetables	36.9	45.3	57.8	68.3	87.2	90.7	131	113.9	82.2	108
Starchy roots, tubers, and their products	18.0	34.9	42.3	56.8	71.2	85.6	83.6	87.1	79.7	72.9
Nuts, seeds, and their products	4.2	2.8	11	16.5	12.2	11.4	13.6	15.1	8.3	51.8
Spices, condiments, and herbs	0.9	1.8	2.4	3.0	4.1	4.7	4.4	4.8	5.1	5.2

Fruits	65.0	73.0	89.9	76.0	73.0	106.0	77.8	80.0	96.0	49.0
Animal source food (ASF)										
Fish, shellfish, and their products	17.5	30.7	39.3	47.2	50.6	67.2	71.5	72.3	68.7	49.0
Meat, poultry, and their products	37.3	56.5	68.2	110	86.3	96.6	135.7	120.6	128.6	41.4
Eggs and their products	32.9	30	27.9	36.9	32.7	32.8	52.3	51.5	36.5	48.0
Milk and its products	1.0	43.4	12.2	10.4	29.1	31.1	14.8	13.1	61.8	43.5
Total ASF	36.3	46.5	56.5	69.3	70.8	92.3	102.1	96.6	84.5	48.0

4.1.7 Nutrient intake distribution by age and sex

The following tables (Tables 14-15) depict the intra-household distribution of macro and micronutrients among different age groups and genders. Among children under 6 years, macro and micronutrient intakes are higher among male children except for sodium intake among 4-6-year-old children. A similar pattern of nutrient intake was seen among the age groups of 7-18 years where most macro and micronutrient intakes were slightly higher among males. This difference between genders grew bigger in older age groups.

Table 14. Nutrient intake distribution by different age (1-15 years) years and sex groups (per person per day)

Nutrients	1 to 3 years		4 to 6 years		7 to 9 years		10 to 12 years		13 to 15 years	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Energy (Kcal)	619.7	566.8	926.2	896.9	1092.9	1126.4	1474.4	1242.1	1544.8	1455.4
Protein (g)	17.3	14.9	24.2	22.9	28.5	29.4	39.3	33.1	37.5	38.2
Total fat (g)	11.5	10.2	16	15.9	18.2	18	23.8	21.4	23.6	22.7
Carbohydrate (g)	101.6	89.7	163.6	154.7	193.3	202.8	242.1	214.2	278.7	255.9
Total dietary fiber (g)	6.1	5.4	10.5	9.3	12.4	12.9	16.6	14.1	17.3	17.1
Calcium (mg)	89.8	74	106.1	116.7	129	132.7	160.4	118.2	177.7	170.5
Iron (mg)	2.2	2	3.5	3.2	4.2	4.2	6.4	4.8	5.7	5.9
Magnesium (mg)	82.5	75	131.8	123.5	147.1	163.8	211.5	181	219.3	219.2
Potassium (mg)	517.5	467.9	779.9	760.8	895.4	975.8	1312.9	1081.7	1266.8	1315.6

Sodium (mg)	55.5	49.3	60.3	65.4	80.7	72.8	96.9	87.4	110.7	92.9
Zinc (mg)	2.7	2.4	3.9	3.6	4.6	4.7	6.4	5.2	6.2	6.5
Phosphorus (mg)	307.6	249.2	428.3	426	494.3	518.7	667.9	567.2	663.4	660.5
Copper (mg)	0.5	0.4	0.8	0.7	0.9	0.9	1.2	1	1.3	1.4
Vitamin A (mcg)	30.7	21	33.4	36.5	33.7	29.8	48.6	44.1	64.2	63.9
Vitamin D (mcg)	1.7	1.4	2.2	1.8	2	1.7	3.4	2.3	2.9	3.5
Thiamine (mg)	0.3	0.3	0.5	0.5	0.6	0.6	0.8	0.7	0.9	0.8
Vitamin E (mg)	1.7	1.4	2.8	2.6	3.2	3.2	4	3.6	4.5	3.9
Riboflavin (mg)	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.4
Niacin (mg)	5.1	4.2	8.7	8.3	10.6	10	13.3	11.7	14.6	12.8
Vitamin B_6 (mg)	0.4	0.3	0.6	0.6	0.7	0.7	0.9	0.8	1	0.9
Folate (mcg)	45.1	39.2	58.8	56.9	71.5	69.8	102.6	83.3	111.8	104
L-Ascorbic Acid (mg)	12.6	10.9	23.3	19.4	28.2	26.9	36.5	29.8	38.3	38.5

Table 15. Nutrient intake distribution by different age (16 to over 60 years) years and sex groups (per person per day)

Nutrients	**16 to 18 years**		**19 to 60 years**		**Over 60 years**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Energy (Kcal)	1765.0	1751.4	2253.4	1907.3	1936.6	1657.5
Protein (g)	45.2	46.8	58.2	50.4	48.4	41.2
Total Fat (g)	26.3	29.5	39.5	33.2	30.8	27.9
Carbohydrate (g)	320.8	305.6	384.0	334.1	330.7	305.0
Total dietary fiber (g)	20.4	20.5	25.8	22.3	22.1	19.6
Calcium (mg)	179.8	195.6	259.6	229.2	225.6	173.8
Iron (mg)	6.9	7.4	8.9	7.5	7.8	7.2
Magnesium (mg)	262.7	249.0	321.7	274.5	290.3	261.3
Potassium (mg)	1564.4	1610.6	1953.4	1685.2	1698.8	1548.4

Sodium (mg)	96.3	107.3	145.8	124.8	121.6	102.8
Zinc (mg)	7.4	7.3	9.2	8.0	7.7	7.0
Phosphorus (mg)	826.3	807.8	983.2	858.0	873.2	719.3
Copper (mg)	1.4	1.4	1.8	1.6	1.5	1.4
Vitamin A (mcg)	48.9	70.2	73.1	63.5	51.9	56.7
Vitamin D (mcg)	2.2	4.9	4.2	3.6	4.2	4.0
Thiamine (mg)	1.0	1.0	1.3	1.1	1.0	0.9
Vitamin E (mg)	4.4	5.9	6.9	5.9	5.3	5.3
Riboflavin (mg)	0.4	0.5	0.6	0.5	0.5	0.4
Niacin (mg)	16.6	15.5	20.5	17.8	16.9	15.3
Vitamin B_6 (mg)	1.1	1.2	1.5	1.3	1.2	1.1
Folate (mcg)	110.6	126.1	152.3	133.1	130.8	112.8
L-ascorbic Acid (mg)	36.5	50.1	58.1	52.0	44.6	46.2

4.2 Food and nutrients intake: results from BIHS-2015 dataset

4.2.1 Demographic characteristics of survey households

According to the BIHS-2015, the ratio of male and female respondents was also approximately 1:1 The population was then further categorized into different age groups. Most of the people fell into the age group of 19-30 and 31 to 50 years. In rural areas, the smallest age group was 0-1 year (1.02%) (Table 16).

Table 16. Age and sex structure of sample population by residence in BIHS 2015 (N=25832)

Age Category	**Male**	**Female**	**Both**
	n (%)	n (%)	n (%)
0 to 1 years	136 (1.11)	129 (0.95)	265 (1.02)
1 to 3 years	834 (6.78)	733 (5.39)	1567 (6.05)
4 to 6 years	851 (6.92)	855 (6.29)	1706 (6.59)
7 to 9 years	980 (7.97)	921 (6.78)	1901 (7.34)
10 to 12 years	926 (7.53)	996 (7.33)	1922 (7.43)
13 to 15 years	1026 (8.35)	944 (6.95)	1970 (7.61)
16 to 18 years	701 (5.7)	709 (5.22)	1410 (5.45)
19 to 30 years	1845 (15.01)	2691 (19.8)	4536 (17.53)

31 to 50 years	2839 (23.1)	3521 (25.91)	6360 (24.57)
51 to 60 years	989 (8.05)	1097 (8.07)	2086 (8.06)
Over 60 years	1165 (9.48)	994 (7.31)	2159 (8.34)
All	12,292 (100)	13,590 (100)	25,882 (100)

4.2.2 Per capita food intake by income categories and expenditure quintiles (BIHS-2015)

The following table lists the quantity of food consumed per person per day in rural Bangladesh by income group. Among different food items, rice is consumed in the largest amount as though other commodities i.e., leafy and non-leafy vegetables, starchy roots and tubers, dairy products are also consumed in relatively large amounts. Richer households consume lower amounts of rice and starchy roots and tuber and a greater amount of pulse and vegetables. As expected, in the richer quintile consumption of animal-based products like meat, fish, milk is higher. Consumption levels increased with higher expenditure and peaked in the 2nd or 3rd quintile and then decreased again but the consumption levels of the highest quintile were higher than the lowest one especially in terms of animal foods (Table 17).

Table 17. Food Intake (grams/person/d) of the study population by expenditure quintile

Food groups	Per capita Expenditure quintile					
	1 (lowest)	2	3	4	5 (Highest)	All
	(grams/person/day)					
Cereals and their products	497.5	528.3	509.2	505.9	494.2	506.9
Rice	465.7	486.3	467.8	465.7	425.9	463.9
Wheat	17.4	26.1	29.0	29.5	47.1	29.3
Pulses, legumes, and their products	35.9	38.9	38.7	38.8	42.6	38.9
Lentil	33.4	36.3	38.6	35.5	36.4	36.3
Grass pea	36.8	43.3	31.6	36.2	53.5	36.8
Vegetables and their products	99.8	132.5	132.0	153.2	159.0	135.6
Leafy vegetables	101.5	113.6	104.1	90.7	92.1	100.3
Starchy roots, tubers, and their products	118.3	122.0	117.7	107.8	99.2	113.2
Nuts, seeds, and their products	2.8	3.4	3.4	4.3	4.4	3.6
Spices, condiments, and herbs	2.9	4.1	4.6	5.4	6.0	4.6
Fruits	49.6	56.3	56.2	81.9	99.3	72.0
Fish, shellfish, and their products	32.7	39.5	41.5	44.0	50.3	42.5

Meat, poultry, and their products	66.1	62.9	73.0	87.3	115.6	87.5
Mutton		32.2	64.2	46.1	78.4	64.2
Beef	83.2	52.7	77.9	95.7	115.5	94.2
Chicken/duck	66.1	66.3	63.1	64.0	105.3	73.8
Eggs	26.6	28.0	33.5	34.4	36.1	33.4
Milk and its products	87.7	98.7	114.2	123.4	139.0	117.4
Fat and oils	15.0	20.2	23.0	27.2	33.4	23.1
Beverages	8.7	10.5	5.0	3.2	5.5	4.7
Miscellaneous	15.9	18.2	19.2	21.1	23.1	18.9

Table 18 presents the quantity of food consumed per person per day in accordance with HIES-2016 food group classification. According to BIHS -2015, rice is consumed in the largest amount while potato, vegetables, and milk consumption are also notable. Consumption of rice and potato is lower in richer households. On the other hand, the quantity consumed for pulse, milk, and meat increases dramatically in richer quintiles.

Table 18. Food Intake (grams/person/d) of the study population by expenditure quintile

Food groups	**Per capita Expenditure quintile**					
	1 (lowest)	**2**	**3**	**4**	**5 (Highest)**	**All**
	(grams/person/day)					
Cereals	497.5	528.3	509.2	505.9	494.2	506.9
Rice	465.7	486.3	467.8	465.7	425.9	463.9
Wheat	17.4	26.1	29.0	29.5	47.1	29.3
Potato	117.8	121.0	117.1	107.5	98.2	112.3
Vegetables	110.0	124.6	131.8	125.9	135.6	125.8
Non-leafy Vegetables	107.9	118.8	126.9	119.7	125.3	119.1
Leafy vegetables	101.5	113.6	104.1	90.7	92.1	100.3
Pulses, legumes, and their products	35.9	38.9	38.7	38.8	42.6	38.9
Lentil	33.4	36.3	38.6	35.5	36.4	36.3
Grass pea	36.8	43.3	31.6	36.2	53.5	36.8

Nuts, seeds, and their products	2.8	3.4	3.3	4.3	4.4	3.5
Milk and its products	87.7	98.7	114.2	123.4	139.0	117.4
Edible oils	14.9	20.1	23.0	27.1	33.3	23.0
Mustard	7.9	9.8	8.0	7.1	8.6	8.2
Soybean	14.4	19.7	21.8	26.5	32.3	22.9
Meat, poultry, eggs	16.3	35.8	45.7	57.8	76.5	46.1
Mutton		32.2	64.2	46.1	78.4	64.2
Beef	83.2	52.7	77.9	95.7	115.5	94.2
Chicken/duck	66.1	66.3	63.1	64.0	105.3	73.8
Eggs	26.6	28.0	33.5	34.4	36.1	33.4
Fish	32.7	39.5	41.5	44.0	50.3	42.5
Condiments and spices	31.6	41.8	44.5	52.6	59.6	45.3
Onion	17.0	22.7	25.4	31.2	35.8	25.5
Chilies	7.7	8.5	8.4	9.1	8.7	8.6
Fruits	49.6	56.3	56.2	81.9	99.3	72.0
Sugar	7.7	7.6	7.5	7.5	9.8	8.2

4.2.3 Contribution food groups or nutrients to supply energy, macro, and micronutrient intakes

The analysis of BIHS-2015 survey showed that carbohydrates contributed 72% of the total energy while protein 10.2% and fat 18.4% in rural Bangladesh. Eighty percent of the rural respondents' intakes of energy from carbohydrate ranges from 55-75%, while 69% of the respondents' intakes of energy from protein ranges from 10-15%, and 31% of the rural respondent's intake of energy from fat was less than 15% (Table 19).

Table 19. Percent of the population sharing energy from macronutrients from BIHS-2015 survey

Macronutrients	Ranges of intake	% Population
Carbohydrates	<55%	3%
	55-75%	80%
	>75%	17%
Protein	<10%	28%
	10-15%	69%

	>15%	3%
Fat	<15%	31%
	15-30%	65%
	>30%	4%

Figures 6 and 7 point out the contribution of the various food groups in providing selected macro and micronutrients in our daily diet. About 63% of our daily fat consumption comes from edible oils and the rest comes from cereals (14%), fish (5%), meat and eggs (5%), and milk products (2%). About 8% of carbohydrates are provided by cereals and a negligible amount comes from fruits and sugar. Surprisingly, 62% of our protein is also provided by cereals and only 11% comes from fish, 6% from meat and eggs, and 5% from pulses (Figure 6).

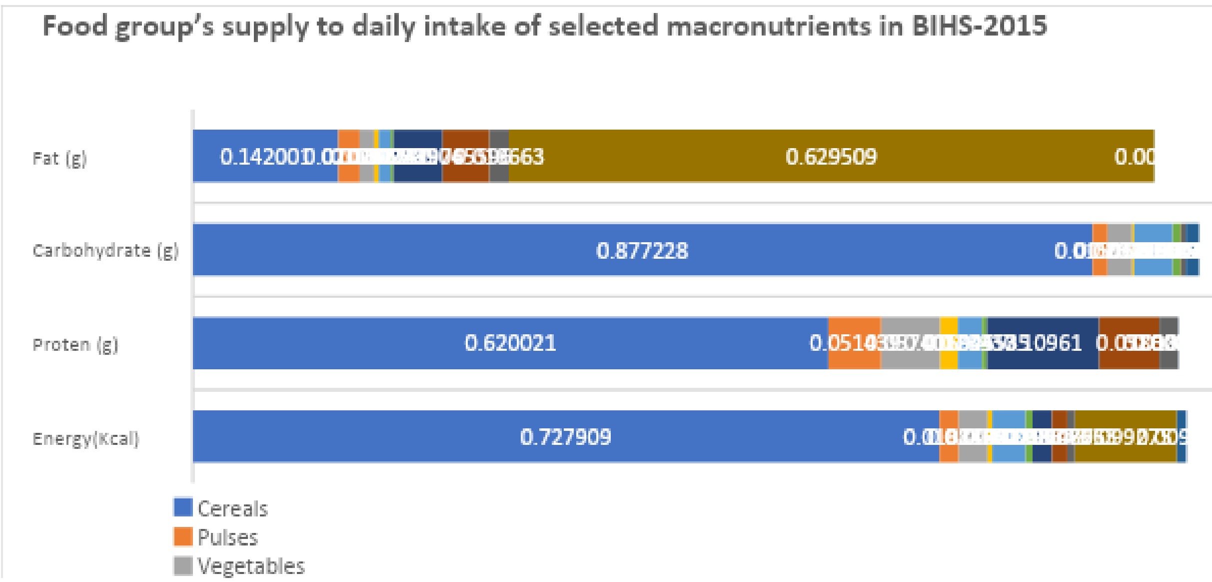


Figure 6. Food group's supply to the daily intake of selected macronutrients from BIHS-2015 survey

In figure 7 we can see the share of important micronutrients from different food groups. 35% of folate is provided by cereals, 20% from vegetables, and 14% from fishes. We get 17% of vitamin A from meat and eggs, 25% from vegetables, 16% from leafy vegetables, and another 10% from fishes. In terms of iron, again 44% of iron is provided by cereals and around 14% from vegetables. Only a negligible amount of iron comes from animal sources. Major sources of calcium in our diet are vegetables (19%), fish (23%), cereals (15%), and milk (8%) (Figure 6).

4.2.4 Nutrient intake distribution by expenditure quintile

Per capita nutrient intake per person by expenditure quintile is summarized in table 20. Energy and macronutrient consumption increase across income groups except for carbohydrates. The results across different income groups are an indication of a positive income-energy intake relationship. However, the average energy consumption is 2413 kcal/person/day which is above the nutritional threshold of 2122 kcal/person/day. A similar pattern is also observed in most of the micronutrients. Consumption of calcium, iron, zinc, magnesium, vitamin A and all other important micronutrients increases as income increases.

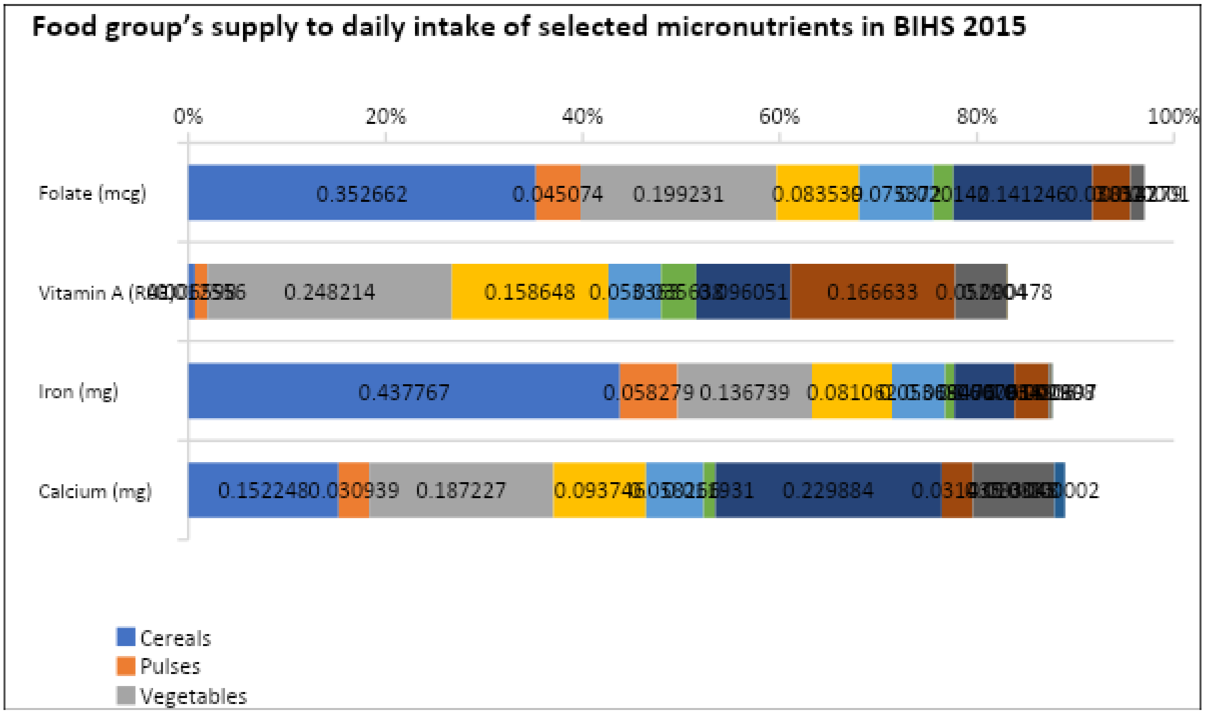


Figure 7. Food group's supply to the daily intake of selected micronutrients from BIHS-2015 survey

Table 20. Per capita nutrient intake by expenditure quintile

Energy and Nutrients	Per capita Expenditure quintile					
	1 (Lowest)	**2**	**3**	**4**	**5 (Highest)**	**All**
Energy (Kcal)	2186.4	2413.1	2413.0	2496.4	2563.6	2413.0
Protein (g)	52.0	58.7	60.4	63.1	68.7	60.2
Total fat (g)	24.9	33.1	36.0	41.5	51.3	36.4
Saturated Fatty acids (g)	5.3	7.6	8.1	9.8	11.7	8.4
MUFA (g)	8.2	10.6	11.0	12.3	14.4	11.2
PUFA (g)	9.8	13.5	14.9	18.0	22.1	15.3
Cholesterol (mg)	0.3	18.0	30.6	50.8	77.1	29.5
Carbohydrate (g)	418.3	446.8	434.6	437.8	431.9	432.9
Total dietary fiber (g)	27.1	29.3	28.9	29.0	29.8	28.8
Calcium (mg)	229.8	299.8	337.8	343.1	431.2	329.5

Iron (mg)	10.5	11.9	12.0	12.5	13.7	12.1
Magnesium (mg	328.8	359.3	363.8	363.0	377.8	358.5
Phosphorus (mg)	1004.9	1097.3	1096.1	1118.6	1178.9	1098.2
Potassium(mg)	1756.1	1955.7	1996.9	2054.5	2204.8	1983.6
Sodium (mg)	3657.4	3335.9	2320.6	746.6	552.5	2289.4
Zinc (mg)	9.8	10.5	10.8	10.7	11.2	10.6
Copper (mg)	2.1	2.3	2.3	2.3	2.3	2.3
Vitamin A (mcg)	72.6	105.2	136.5	156.6	188.2	131.7
Vitamin D (mcg)	4.0	5.9	7.0	7.6	10.0	6.8
Vitamin E (mg)	3.8	4.9	5.6	6.5	7.8	5.6
Thiamine (mg)	1.0	1.0	1.0	1.0	1.1	1.0
Riboflavin (mg)	0.6	0.7	0.8	0.8	0.9	0.8
Niacin EQ (mg)	17.4	19.1	19.7	20.1	21.3	19.5
Vitamin B6 (mg)	1.9	1.9	1.9	1.9	1.8	1.9
Folate (mcg)	189.1	201.3	215.7	212.7	236.9	209.7
L-Ascorbic Acid (mg)	62.2	71.5	69.8	77.2	77.4	71.9

4.2.5 Comparison of per capita energy and nutrient intake between INFS-2017 and BIHS-2015

Table 21 provides a comparison of energy and nutrient intake per person per day between two surveys (INFS-2017 and BIHS-2015). Per capita, energy intake is 15.41% higher in BIHS-2015 (2090 vs 2413 kcal/person/day). Protein and carbohydrate intake were consistently greater in the BIHS survey. In contrast to energy, protein, and carbohydrate, polyunsaturated fatty acid (PUFA) and cholesterol intake were higher in the INFS-2017 survey although the total fat intake was found to be quite similar in the two surveys. Per capita consumption of most of the micronutrients excluding vitamin E, thiamine, and niacin was higher in the BIHS-2015. Consumption of sodium and potassium was found to be somewhat in the two surveys.

Table 21. Comparison of per capita nutrient intake between two surveys

Energy and Nutrients	**INFS-2017**	**BIHS-2015**
	(grams/person/day)	
Energy (Kcal)	2090.9	2413.0
Protein (g)	53.8	60.2
Total fat (g)	36.3	36.4
Saturated Fatty acids (g)	5.9	8.4

MUFA (g)	7.7	11.2
PUFA (g)	18.1	15.3
Cholesterol (mg)	44.2	29.5
Carbohydrate (g)	367.3	432.9
Total dietary fiber (g)	24.1	28.8
Calcium (mg)	277.4	329.5
Iron (mg)	8.2	12.1
Magnesium (mg	297.3	358.5
Phosphorus (mg)	949.9	1098.2
Potassium(mg)	1836.6	1983.6
Sodium (mg)	2247.3	2289.4
Zinc (mg)	8.6	10.6
Copper (mg)	1.7	2.3
Vitamin A (mcg)	76.8	131.7
Vitamin D (mcg)	4.4	6.8
Vitamin E (mg)	6.3	5.6
Thiamine (mg)	1.2	1.0
Riboflavin (mg)	0.6	0.8
Niacin EQ (mg)	25.6	19.5
Vitamin B_6 (mg)	1.4	1.9
Folate (mcg)	145.5	209.7
L-ascorbic Acid (mg)	56.2	71.9

4.2.6 Nutrient intake distribution by age and sex

Table 22-23 summarize energy and nutrient intakes of Bangladeshi population by age and sex categories. Nutrient adequacy is calculated based on these intake values.

Table 22 presents per capita nutrient intake by children aged less than 10 years. Several uneven distributions of nutrient and energy intake are observed between male and female of different age groups. At all ages, average energy and macronutrient consumption is higher among male children. Quite similarities were observed in iron intake among male and female while calcium intake is little bit higher among male at all age groups except 1 to 3 years age group. Unlike other micronutrients, per capita consumption of vitamin A is greater among female children.

Per capita nutrient intake of adolescents (10 to 18 years) is summarized in table 23. Energy and macronutrient consumption are higher among males of all ages. Calcium, zinc, and iron are less consumed by female adolescents. Similar patterns are noticed in other nutrients.

Per capita energy and nutrient consumption of the adult population and older people are presented in table 23. Per capita energy intake is above the nutritional threshold (2122 kcal/person/day) for both male and female person beyond ages 50. Like other age groups, per capita consumption of macronutrients and most of the micronutrients are higher among male people. Women above 50 years of age are more efficient in most of the micronutrient intake while consumption is higher among males in the remaining age groups.

Table 22. Nutrient intake distribution by different age (1-18 years) years and sex groups (per person per day)

Nutrients	**1-3 years**		**4-6 years**		**7-9 years**		**10-12 years**		**13-15 years**		**16-18 years**	
	M	F	M	F	M	F	M	F	M	F	M	F
Energy (Kcal)	702.4	671.5	1222.9	1130.1	1489.8	1433.9	1750.7	1658.2	2122.1	1881.3	2316.1	2011.1
Protein (g)	18.5	17.1	29.5	29.2	37.1	35.6	43.2	41.0	52.1	46.5	59.8	49.6
Total Fat (g)	14.1	13.3	20.3	19.7	24.1	22.2	26.1	24.5	29.2	26.7	31.9	31.1
Carbohydrate (g)	120.8	113.8	215.4	191.8	266.1	255.0	317.3	302.2	385.5	343.4	426.4	365.5
Total dietary Fiber (g)	7.6	7.6	14.2	13.4	18.0	16.7	20.8	20.0	25.1	22.3	27.4	24.2
Calcium (mg)	117.1	119.9	160.2	159.0	215.9	195.6	245.0	198.8	268.3	234.7	302.6	268.5
Iron (mg)	3.3	3.2	5.7	5.7	7.5	7.0	8.7	8.1	10.3	9.1	11.4	10.1
Magnesium (mg)	95.5	90.5	166.8	155.4	218.2	206.2	258.7	241.7	305.2	273.7	332.6	295.9
Potassium (mg)	602.2	550.4	946.8	910.5	1226.9	1187.5	1400.6	1354.9	1673.4	1508.8	1832.7	1684.6
Sodium (mg)	413.8	373.8	992.0	891.4	1458.0	1614.1	2004.0	1955.9	2094.5	1997.5	1569.3	1461.9
Zinc (mg)	2.9	2.7	5.0	4.7	6.5	6.1	7.6	7.3	9.2	8.1	10.3	8.7
Phosphorus (mg)	331.9	309.7	530.2	504.6	674.5	650.3	788.1	746.2	951.5	836.5	1061.1	904.2
Copper (mg)	0.6	0.6	1.1	1.0	1.4	1.3	1.6	1.6	2.0	1.8	2.2	1.9
Vitamin A (mcg)	42.2	42.6	66.2	68.5	74.7	85.5	90.2	75.2	99.3	102.2	117.4	116.3
Vitamin D (mcg)	2.7	2.4	3.8	3.4	4.2	3.9	4.5	4.4	5.0	4.6	5.2	5.4
Thiamine (mg)	0.3	0.3	0.5	0.5	0.6	0.6	0.7	0.7	0.9	0.8	0.9	0.9
Vitamin E (mg)	1.6	1.5	2.8	2.6	3.5	3.1	3.9	3.7	4.6	4.2	5.1	4.7
Riboflavin (mg)	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.5	0.6	0.6	0.7	0.6
Niacin (mg)	3.6	3.3	6.4	6.2	8.3	7.7	9.8	9.4	11.6	10.4	13.3	11.5
Vitamin B_6 (mg)	0.5	0.4	0.8	0.8	1.1	1.1	1.3	1.3	1.6	1.4	1.8	1.6
Folate (mcg)	62.8	59.3	106.0	100.6	132.4	123.3	159.4	139.1	183.3	158.6	190.1	172.1
L-Ascorbic Acid (mg)	17.2	14.1	32.4	34.3	43.5	42.4	51.0	48.2	59.2	56.3	63.4	64.1

Table 23. Nutrient intake distribution by different age (19 to 60+ years) years and sex groups (per person per day)

Nutrients	**19 to 30 years**		**31 to 50 years**		**51 to 60 years**		**Over 60 years**	
	Male	**Female**	**Male**	**Male**	**Female**	**Female**	**Male**	**Female**
Energy (Kcal)	2509.8	2224.8	2525.7	2341.3	2003.4	2169.7	2133.9	1733.8
Protein (g)	63.0	55.4	62.7	60.6	50.2	53.6	53.8	44.2
Total Fat (g)	36.9	33.2	34.2	33.9	27.7	29.8	30.4	26.1
Carbohydrate (g)	452.7	398.1	462.4	427.1	363.3	393.6	385.3	306.4
Total dietary fiber(g)	29.2	26.4	30.1	28.5	25.1	26.3	25.9	21.2
Calcium (mg)	323.2	292.9	327.3	329.3	282.6	292.0	282.3	260.9
Iron (mg)	12.3	10.9	12.6	12.1	10.6	11.2	11.2	9.1
Magnesium (mg)	365.7	327.2	379.0	362.8	310.5	327.7	328.0	259.8
Potassium (mg)	2021.4	1803.7	2053.0	2024.2	1748.8	1800.8	1838.6	1482.1
Sodium (mg)	1267.6	1202.8	2706.7	2609.4	1833.0	2080.6	1910.2	1107.6
Zinc (mg)	11.0	9.7	11.1	10.5	9.1	9.5	9.5	7.6
Phosphorus (mg)	1128.2	999.6	1146.0	1103.3	920.9	986.0	991.7	783.2
Copper (mg)	2.3	2.1	2.4	2.3	2.0	2.1	2.1	1.7
Vitamin A (mcg)	133.5	120.8	132.1	128.3	95.5	101.1	91.3	90.2
Vitamin D (mcg)	5.5	5.3	5.8	6.4	6.3	5.9	6.1	5.0
Thiamine (mg)	1.0	0.9	1.0	1.0	0.9	0.9	0.9	0.7
Vitamin E (mg)	5.8	5.3	5.4	5.0	4.5	4.7	4.6	4.1
Riboflavin (mg)	0.8	0.7	0.8	0.8	0.6	0.7	0.7	0.5
Niacin (mg)	14.3	12.6	14.3	13.8	11.9	12.5	12.6	9.6
Vitamin B_6 (mg)	1.9	1.7	1.9	1.8	1.6	1.7	1.6	1.3
Folate (mcg)	203.8	198.3	214.8	200.4	175.1	185.0	183.2	149.4
L-Ascorbic Acid (mg)	68.8	66.1	67.8	67.0	61.2	63.8	60.7	52.2

Chapter 5: Adequacy of energy and nutrient intakes of Bangladeshi population

5.1 Dietary adequacy (nutrient intake gap) by life cycle stage and sex: results from INFS-2017/2018 dataset

5.1.1 Using Nutrient adequacy ratio (NAR)

In the 2017/2018 INFS survey, nutrient adequacy ratio (NAR) was assessed using the most recent Estimated Average Requirement (EAR) values recommended by ICMR-National Institute of Nutrition. When the nutrient consumption among different age and sex groups was compared to the EAR, few met the requirements (Table 24). The target population was classified into 10 age groups.

Among children aged 1-3 years, the percent adequacy of most macro and micronutrients was pretty low and it was even lower among female children. Protein adequacy was high among these children (male- 85%, female- 79%) and adequacy for carbohydrate was around 50% (male- 56%, female- 44.4%). Adequacy for most of the micronutrients was low. The percentage of children meeting their iron and vitamin D requirements was around only 5% and children who met their calcium, vitamin A, thiamine, riboflavin, vitamin B_6 were around 10% only. In terms of other micronutrients, percent adequacy was less than 50% and even lower among females.

Dietary adequacy for macronutrients got better with increased age but for micronutrients remained quite low. Protein adequacy increased to over 90% for 4-6 years old children and then decreased again in early adolescents reaching 85% in males and 78% in females, which is the same as the first age group. These rates further decreased among adolescents of 16-18 years then increased in adults of 19-51 years. After the age of 51, protein adequacy dropped again. Adequacy for carbohydrate consumption was low among 1-3 years children but it significantly increased (almost doubled) among older children and it remained over 95% in the later age groups for both genders.

For most of the micronutrients, percent adequacy remained under 50 in both males and females. Adequacy for iron consumption was under 5% in 1-3 years children (4.6% in male and 2.8% in female) and it remained low for other age groups as well. There were also significant discrepancies among male and female respondents in terms of adequacy. Male adequacy was twice as high as females among children (remained under 5%). In the early adolescence period (10-12 years), female adequacy slightly increased from 1.5% to 4.8% before plummeting to zero. Among 13-15-year-old male adolescents, adequacy increased to 7.6%. Iron adequacy increased 10 times among male adults (19-30 years) reaching 34% and peaked to 41% in 51-60-year-old people but in females, iron adequacy level remained alarmingly low (under 10%). Vitamin D adequacy was also extremely low among the study population especially children (below 5%) but it increased with age. Vitamin D adequacy was around 15% (15%, in male and 16.7% in female) in 13-15-year-old adolescents and it went over 20% in the following age groups. The highest levels of vitamin D adequacy were seen in the age group of 19-30 years, but the levels were lower in females in all age groups compared to their male counterparts.

Among 1-3 years old male children, calcium adequacy was also low (7.6%) but slightly higher in female children (10%). In males, adequacy fluctuated from 2%-8% and in females, it fluctuated from 0%-10%. The lowest rate of calcium adequacy was seen among 7-9 years old female children. Vitamin B complex adequacy was also low among the target population (under 20%) especially riboflavin (under 2% in adults). But niacin intake had one of the highest levels of adequacy in all micronutrients (over 50%, over 80% in 19-50-year-old people). Another micronutrient that showed high levels of adequacy was magnesium (around 50%). Higher levels of adequacy were seen among adult males compared to other age groups and females (Table 24).

5.1.2 Using Probability of Adequacy Approach (PA)

In the 2017/2018 INFS survey, the probability of inadequacy (PIA) of micronutrients was assessed using the most recent Estimated Average Requirement (EAR) values recommended by ICMR-National Institute of Nutrition (NIN, 2020). It is to be noted that when the risk of inadequacy is greater than 50%, one can consider how much additional nutrient intake would be required to reduce the prevalence of risk of inadequacy back to 50%. Table 25 presents the adequacy of selected micronutrient intakes by age and sex (see details in Appendix-I-Tables 3-12). The population was divided into 10 age groups which ranged from 1-60+ years. The risk of inadequacy of nutrient intake is measured using the probability approach which associates an individual's usual intake of nutrients to the distribution of requirements for a particular life stage and gender group using EAR (estimated average requirement). This study focused on 12 micronutrients of significant health impact including calcium, iron, magnesium, zinc, thiamine, riboflavin, vitamin B_6, folate, vitamin B_{12}, vitamin D, L-ascorbic acid, niacin, and vitamin. The inadequacy of micronutrient intake provides information on the proportion of a population which is at risk of inadequate intake for a specific micronutrient.

From the INFS survey data, we can see that inadequacy levels of most micronutrients were high among the study population. Inadequacy levels of calcium, iron, thiamine, riboflavin, vitamin B_6, vitamin B_{12}, vitamin A, vitamin D, and vitamin C were close to 100% almost in all age groups. It means that the prevalence of risk of inadequacy is 50% for these nutrients. The lowest levels of inadequacy were seen for niacin and magnesium intakes.

Prevalence of risk of inadequacy for calcium, vitamin D, and riboflavin inadequacy was 50% in all age groups for both genders, and vitamin A, vitamin B_{12} and vitamin C inadequacy was over 40% for all age groups and genders as well. Prevalence of risk of iron inadequacy levels were over 40% for most age groups except for 19-60-year-old males for whom the rates went below 20% but remained over 30% for female adults.

Table 24. Percent adequacy of nutrient intakes across different age (1-60+ years) and sex groups (per person per day) based on the EAR

Nutrients	**1-3 years**		**4-6 years**		**7-9 years**		**10-12 years**		**13-15 years**		**16-18 years**		**19-30 years**		**31-50 years**		**51-60 years**		**60+ years**	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Protein (g)	84.8	78.7	92.1	91.7	58.1	69.2	87.4	83.7	84.8	78.2	59.4	77.3	88.5	89.6	89.1	88.8	79.5	77.3	64	63.8
Carbohydrate (g)	55.8	44.4	90.5	91.7	97.3	98.5	96.8	97.1	98.9	100	98.4	100	100	100	99.8	99.6	100	100	97.3	95.7
Calcium (mg)	7.6	10.1	5.6	3.8	2.7	0	2.1	7.7	5.4	1.3	3.1	1.3	7	5.9	7.2	3.1	2.7	8	6.7	2.1
Iron (mg)	4.6	2.8	5.6	3.8	4.1	1.5	4.2	4.8	7.6	0	3.1	2.7	34.2	5.4	33.6	8.8	41.1	10.2	21.3	6.4
Magnesium (mg)	31.5	22.5	49.2	43.6	23	32.3	37.9	39.4	45.7	38.5	26.6	41.3	53.3	54.4	53.6	56.5	50.7	53.4	33.3	40.4
Zinc (mg)	62.9	54.5	66.7	54.9	4.1	9.2	51.6	59.6	50	24.4	1.6	6.7	12	16.3	13.1	16.9	15.1	13.6	6.7	8.5
Vitamin A (mcg)	12.7	11.8	8.7	8.3	5.4	13.8	10.5	8.7	9.8	9	10.9	9.3	14.4	12.8	8.9	10.4	9.6	14.8	16	14.9
Thiamine (mg)	16.8	12.4	19.8	21.8	5.4	18.5	18.9	12.5	10.9	5.1	10.9	25.3	42.3	27.6	43.7	31.5	45.2	23.9	22.7	19.1
Riboflavin (mg)	10.7	8.4	1.6	1.5	0	0	0	0	0	0	0	0	1.3	0.2	0.5	0	0	0	1.3	0
Niacin (mg)	37.1	31.5	61.1	54.1	31.1	58.5	58.9	56.7	67.4	51.3	48.4	72	87.2	92.6	89.1	91.9	75.3	83	61.3	63.8
Vitamin B_6 (mg)	10.7	7.3	16.7	11.3	5.4	12.3	11.6	11.5	9.8	5.1	6.3	9.3	21.1	31	21	28.5	13.7	25	12	14.9
Folate (mcg)	20.8	21.9	25.4	21.8	23	18.5	28.4	29.8	22.8	25.6	15.6	25.3	26.6	33.2	25.4	34.2	27.4	36.4	37.3	34
L-ascorbic Acid (mg)	16.8	12.9	21.4	19.5	20.3	24.6	23.2	19.2	16.3	21.8	25	28	29.8	30.4	26.9	28.5	30.1	29.5	25.3	38.3

Table 25. Risk of inadequate nutrient intakes (based on EAR) in 1 to 60+ years in INFS-17/18

Nutrients	1-3 years		4-6 years		7-9 years		10-12 years		13-15 years		16-18 years		19-30 years		31-50 years	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Calcium (mg)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Magnesium (mg	27.9	31.4	7.2	16.7	35.1	25.5	98.4	95.4	98.1	93.2	98.5	91.2	61.7	83.2	72.3	63.5
Iron (mg)	99.7	99.9	97.5	99.4	97.2	96.9	35.8	61.7	87.1	82.8	91.8	87.4	71.5	73	58.6	80.2
Zinc (mg)	42.4	44.4	19.5	30.5	46.7	39.8	55.9	84.9	99.8	98.2	99.9	98.8	95.3	92.1	93.2	85.2
Thiamine (mg)	99.2	98.4	90.6	95.1	97.9	97.1	97.9	99	99.2	91.1	99.2	83.6	47.6	75.1	51.4	70.7
Riboflavin (mg)	99	98.8	99.5	100	100	100	100	100	100	100	100	100	99.5	100	99.9	100
Niacin EQ (mg)	16.1	18	0.2	5.4	2.8	3.9	95.6	97.3	97.2	97.1	98.7	90.4	50.6	56.7	0.7	0
Vitamin B_6 (mg)	99.7	100	97	97.1	95.9	95	78.9	78.9	81.3	86.2	92.1	76.8	73.1	59.2	57.1	64.3
Folate (mcg)	79.5	78.8	71.6	76.7	62.7	56.6	99.8	100	99.7	100	95.7	95.6	98.5	99.6	64.7	48.3
Vitamin B_{12}	99.5	99.5	100	100	100	100	94.4	95.5	98.2	99.3	96.9	94.2	85.9	86.3	98	100
L-ascorbic Acid (mg)	99.8	99.9	96.6	96.9	93.8	99.7	20	22	14	2	8	0.1	0.3	0	91.8	90.2
Vitamin A (mcg)	91	90.9	92.3	92.1	92.1	92.6	91	92.3	92	92.4	92	90.9	89.8	90.6	90.1	90.6

Magnesium and niacin intakes had the lowest levels of inadequacy. Magnesium inadequacy was low among children and the lowest rate of percent inadequacy was seen among 4-6-year-old children (male- 7.2%, female- 16.7%) after which it started to increase and went over 40% in the age group of 16-18 years then it decreased slightly up until 60 years. Niacin inadequacy rates were lowest among all nutrients. The highest levels of niacin inadequacy were seen among the age groups of 1-3 years and 10-12 years (over 15%) but for other age groups, it was usually below 5%. Niacin is no longer a problem nutrient for the Bangladeshi population. Prevalence of zinc inadequacy levels was also comparatively low for children but increased significantly after adolescence (over 40%).

5.2 Evaluation of dietary adequacy (nutrient intake gap) by life cycle stage and sex: results from BIHS-2015 dataset

5.2.1 Using Nutrient Adequacy Ratio (NAR)

Table 26 describes the participant's estimated adequacy of macro and micronutrients among children aged 1 to 12 years. Inadequacy of protein intake is highest among children aged less than 1 years. After ages 1, protein inadequacy was the least, irrespective of sex. Carbohydrate intake is also satisfactory in most of the children. Unlike macronutrients, inadequacy in micronutrient intake is noticeable. In most of the age group, an intake above EAR is seen in a higher percentage of male children although male-female difference in terms of nutrient adequacy is almost identical.

Table 26. Percent adequacy of nutrient intakes across different age (1-60 years) and sex groups (per person per day) based on EAR

Nutrients	1 to 3 years		4 to 6 years		7 to 9 years		10 to 12 years	
	M	F	M	F	M	F	M	F
Protein (g)	84.9	83.0	97.0	97.0	96.5	94.6	94.3	89.9
Carbohydrate (g)	63.3	59.6	95.9	95.4	98.7	98.7	99.4	99.5
Calcium (mg)	12.1	8.6	11.9	12.7	14.7	13.3	11.0	10.1
Iron (mg)	16.9	15.3	24.6	24.6	24.9	20.5	23.6	6.3
Magnesium (mg)	41.3	36.3	69.7	68.8	70.0	66.2	66.1	61.7
Zinc (mg)	61.5	57.2	78.2	72.9	77.8	73.5	59.3	52.5
Vitamin A (mcg)	21.3	18.6	20.0	20.4	19.8	16.6	17.8	16.3
Vitamin D (mcg)	7.9	10.9	16.5	13.2	20.8	17.8	27.4	23.3
Thiamine (mg)	12.0	10.7	10.8	8.4	9.8	7.6	5.7	5.8
Riboflavin (mg)	12.3	7.8	5.0	3.9	3.7	3.1	1.6	0.9
Niacin (mg)	19.3	17.0	30.4	29.0	30.9	28.7	26.9	23.6
Vitamin B_6 (mg)	25.4	23.4	39.4	35.7	36.6	37.2	31.5	32.7
Folate (mcg)	32.9	33.4	47.2	44.1	45.3	41.3	40.8	32.2

L-Ascorbic Acid (mg)	41.5	38.3	58.9	60.5	60.1	58.7	55.5	54.8

Nutrient adequacy among older children and adult population is listed in table 27. Protein and carbohydrate intake are satisfactory in all age groups. However, among old age people (over 60 years) protein adequacy was low for both male and female. Like elder children, a higher proportion of older children and adult persons could not meet EAR value. Calcium intake was very low among the study population since the majority of participant's intake is below the recommended level. Moreover, a higher proportion of females with low iron, folate and zinc intake is noticeable. A remarkable proportion of participant's vitamin A intake was also below the recommended level.

Table 27. Percent adequacy of nutrient intakes across different age (13-60+ years) and sex groups (per person per day) based on EAR

Nutrients	13 to 15 years		16 to 18 years		19 to 30 years		31 to 51 years		51 to 60 years		Over 60 years	
	M	F	M	F	M	F	M	F	M	F	M	F
Protein (g)	85.8	80.6	78.2	81.2	88.2	89.3	88.0	87.5	85.1	82.6	73.2	68.5
Carbohydrate (g)	99.4	99.2	99.7	99.5	99.8	99.8	99.9	99.5	99.7	99.4	99.6	99.0
Calcium (mg)	7.9	7.4	9.3	8.7	13.4	10.2	11.9	10.7	14.6	9.1	10.7	6.8
Iron (mg)	18.5	9.5	11.8	11.6	61.2	22.9	62.6	24.8	59.9	24.9	52.0	15.0
Magnesium (mg)	55.4	52.1	47.7	55.2	64.2	73.5	69.4	71.6	64.1	66.1	51.8	45.5
Zinc (mg)	19.8	18.9	11.3	17.1	20.4	32.9	21.0	31.4	18.7	27.5	10.0	13.3
Vitamin A (mcg)	16.5	15.0	16.9	20.9	17.2	21.7	20.0	20.3	19.4	19.3	18.2	18.4
Vitamin D (mcg)	27.8	25.8	27.9	30.6	31.2	28.8	31.1	30.9	34.9	32.7	32.9	22.6
Thiamine (mg)	4.2	5.9	1.6	8.0	12.7	10.0	14.7	10.5	12.2	8.8	9.1	4.0
Riboflavin (mg)	0.7	1.6	0.5	1.7	1.2	1.2	1.8	1.0	2.1	1.0	1.8	0.5
Niacin (mg)	20.1	28.7	17.3	30.0	45.7	54.7	45.4	53.7	40.9	48.8	31.3	30.0
Vitamin B_6 (mg)	27.2	31.1	23.5	36.4	41.6	54.5	43.0	53.0	40.3	51.3	31.2	37.1
Folate (mcg)	34.0	33.7	28.1	35.6	38.7	55.9	41.4	51.9	34.0	49.0	31.9	39.6
L-Ascorbic Acid (mg)	48.4	51.1	45.5	57.0	53.5	58.7	52.2	57.0	51.2	56.1	45.6	47.2

5.2.2 Using Probability of Adequacy (PA)

The risk of inadequacy of nutrient intake is measured using the probability approach which associates an individual's usual intake of nutrients to the distribution of requirements for a particular life stage and gender group using EAR (estimated average requirement). This study focused on 12 micronutrients of significant health impact including: calcium, iron, magnesium, zinc, thiamine, riboflavin, vitamin B_6, folate, vitamin B_{12}, vitamin D, L-ascorbic acid, niacin, and vitamin A. The inadequacy of micronutrient intake provides information on the proportion of a population which is at risk of inadequate intake for a specific micronutrient.

In the 2015 BIHS data, we can see the similar patterns of inadequacy among Bangladeshi people. calcium (Table 28) (see details in Appendix-I-Tables 13-22). Prevalence of risk of thiamine and riboflavin inadequacy was 50% in all age groups and genders. For vitamin A and vitamin B_{12} intakes, inadequacies were above 90% and for niacin but for vitamin C inadequacy levels were lower than what was observed in the INFS survey. The lowest level of vitamin C inadequacy was seen among older children (below 40%) and in other age groups it fluctuated between 0%-30%. Risk of inadequacy of iron consumption was high among children and adolescents (over 30%) irrespective of their gender. It dropped among adult males, but the risk remained high for females (almost 20%). Zinc and magnesium inadequacy levels were observed to be low among children, but it gradually increased and spiked in later life (over 40%). Risk of niacin inadequacy was very low in all age groups and genders (below 30%) and even lower among females except for children under 3 years old. Among children of 1-3 years, niacin inadequacy risk was over 10%. In the 2017/18 INFS survey, niacin inadequacy levels among younger children were also observed to be comparatively higher than other age groups and the inadequacy levels were lower than the BIHS 2015.

A similar study conducted by Arsenault et al. (2016) among rural Bangladeshi women and children found that prevalence of adequacy for calcium, vitamin A, riboflavin, vitamin B_{12} intakes among women were less than 1% and it was less than 50% for all nutrients except for niacin and vitamin B_6. These adequacy levels were lower among lactating mothers compared to non-lactating mothers due to higher levels of requirements during lactation. Among children, iron, folate, calcium, riboflavin, folate, and vitamin B_{12} adequacy levels were below 50% and calcium adequacy level was zero. These findings coincide with the findings from the INFS 2017/18 and BIHS 2015. Another study conducted among rural Bangladeshi women found high levels of inadequacies in the consumptions of calcium, vitamin A, folate and vitamin B_{12} intakes and the inadequacy were significantly higher in adolescent girls compared to adult women but they were not compared to the male population (Akter et al., 2021). Similar findings were observed in our neighboring country India as well where high levels of iron, folate deficiency and inadequacy of vitamin A, E and calcium intake was found among Indian people especially in women (Shaini et al., 2018; Loukrakpam et al., 2020).

Table 28. Risk of inadequate nutrient intakes (based on EAR) in 1 to 60+ years in BIHS-2015

Nutrients	1-3 years		4-6 years		7-9 years		10-12 years		13-15 years		16-18 years		19-30 years		31-50 years	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Calcium (mg)	100.0	100.0	99.6	99.5	98.5	99.4	99.5	99.6	99.7	100.0	100.0	100.0	99.6	99.7	99.4	99.7
Magnesium (mg	25.0	26.1	4.6	5.6	4.2	7.1	13.0	26.3	36.7	54.5	65.9	62.6	55.0	39.4	48.6	38.8
Iron (mg)	97.7	97.6	83.8	84.9	79.9	82.0	85.5	88.1	83.6	86.4	92.0	83.6	38.1	68.6	34.7	67.7
Zinc (mg)	44.2	46.9	10.5	12.1	9.7	12.9	34.8	45.4	87.0	89.6	95.5	89.6	86.6	70.4	86.1	70.2
Thiamine (mg)	99.9	99.6	96.7	98.4	97.7	99.0	99.7	99.5	99.7	98.0	100.0	98.5	91.6	96.0	94.0	97.0
Riboflavin (mg)	97.9	98.3	99.9	100.0	99.9	100.0	99.9	100.0	99.8	100.0	99.7	100.0	99.8	100.0	99.7	99.9
Niacin EQ (mg)	60.8	65.0	19.5	24.2	14.4	19.7	24.5	31.4	32.3	19.0	42.8	20.4	14.4	3.2	16.9	6.6
Vitamin B_6 (mg)	86.6	87.8	57.3	57.6	57.1	56.1	64.7	63.0	71.2	61.1	78.3	53.1	47.6	33.2	55.9	38.7
Folate (mcg)	73.8	75.0	35.7	39.3	37.9	43.3	55.6	70.8	53.4	54.1	69.1	50.9	49.3	18.3	44.0	21.4
Vitamin B_{12}	85.5	89.2	98.8	99.0	98.1	98.8	95.7	97.9	91.0	96.2	86.5	92.8	80.7	89.0	81.6	91.0
L-ascorbic Acid (mg)	78.4	82.8	39.0	37.7	33.0	36.5	41.9	40.2	52.8	56.8	72.8	46.2	54.8	38.6	54.3	41.1
Vitamin A (mcg)	88.8	88.8	87.7	87.7	86.7	87.3	88.7	90.3	87.7	89.7	90.2	87.2	86.6	85.5	84.9	84.8

5.3 Evaluation of dietary adequacy by Vulnerable groups: results from BIHS-2015 dataset

The adequacy of micronutrients was assessed using two approaches: (1) the probability approach which relates an individual's usual intake of nutrients to the distribution of requirements for a particular life stage and gender group using EAR values and its standard deviation (SD) (NIN, 2020); (2) Nutrient adequacy ratio approach, NAR for a given nutrient is the ratio of an individual's intake to the age- and sex-specific EAR. Mean probability of adequacy (MPA) and the mean adequacy ratio was calculated by dividing the total number of nutrients.

Children under 2 years

Among children under 2 years, the PA is lowest for calcium, thiamine, riboflavin, iron (0-2%) followed by vitamin B_6 (7%), folate (8%), vitamin A (9%), vitamin B_{12} (10%), vitamin C (14%), zinc (28%). The MPA across the 12 micronutrients was 11% (Table 29). The reported MPA is lower than that of the overall mean prevalence of intake adequacy (for the 11 micronutrients) children, 43% as reported by Arsenault et al. (2013). However, NAR approach yielded increased percentage of adequacy as compared to probability approach. The MAR for 12 nutrients was 46%.

Adolescents

Among adolescents aged 10-19 years, the PA is lowest for calcium, thiamine, riboflavin, vitamin B_{12} (0-6%) followed by vitamin A (11%), iron (14%), zinc (25%), vitamin B_6 (34%), folate (34%), vitamin C (48%), magnesium (54%) and niacin EQ (65%). The MPA across the 12 micronutrients was 24% (Table 30). However, The MAR for 12 nutrients was 64%.

Table 29. Risk of inadequate nutrient intakes (based on EAR) in 10-19-year women

Nutrients	Average intake	Usual intake	PIA	PA	NAR
Calcium (mg)	333.19	261.03	1.00	0.00	0.40
Magnesium (mg	292.06	279.85	0.46	0.54	0.89
Iron (mg)	10.31	9.60	0.86	0.14	0.63
Zinc (mg)	8.75	8.46	0.75	0.25	0.80
Thiamine (mg)	0.85	0.81	0.99	0.01	0.59
Riboflavin (mg)	0.66	0.61	1.00	0.00	0.34
Niacin EQ (mg)	16.07	15.42	0.35	0.65	0.92
Vitamin B_6 (mg)	7.75	2.28	0.66	0.34	0.74
Folate (mcg)	273.49	206.35	0.66	0.34	0.76
Vitamin B_{12}	1.30	1.17	0.94	0.06	0.39
L-ascorbic Acid (mg)	69.31	56.01	0.52	0.48	0.79

Vitamin A (mcg)	228.15	104.54	0.89	0.11	0.38
MPIA/MPA (Mean ± SD)			0.73± 0.15	0.24 ± 0.15	0.64± 0.16

Note***:*** EAR=Estimated Average Requirement; PIA= Probability of Inadequacy for 12 micronutrients; PA= Probability of Adequacy for 12 micronutrients; NAR= Nutrient Adequacy Ratio for 12 micronutrients

Table 30. Adequacy of nutrient intakes (based on EAR) in under 2 years of children

Nutrients	Male						Female								
	Average intake	Usual intake	EAR	PIA	PA	NAR	Average intake	Usual intake	EAR	PIA	PA	NAR	Average intake	Usual intake	EAR
Calcium (mg)	165.59	100.23	400	1.00	0.00	0.35	139.89	95.00	400	1.00	0.00	0.33	153.58	97.78	400
Magnesium (mg	81.00	73.08	73	0.39	0.61	0.83	71.87	68.42	73	0.45	0.55	0.79	76.73	70.89	73
Iron (mg)	2.83	2.44	6	0.98	0.02	0.49	2.48	2.29	6	0.99	0.01	0.45	2.67	2.37	6
Zinc (mg)	2.43	2.23	2.8	0.70	0.30	0.73	2.25	2.12	2.8	0.74	0.26	0.69	2.34	2.18	2.8
Thiamine (mg)	0.26	0.23	0.6	1.00	0.00	0.44	0.24	0.22	0.6	1.00	0.00	0.41	0.25	0.22	0.6
Riboflavin (mg)	0.36	0.25	0.8	0.98	0.02	0.38	0.32	0.24	0.8	0.99	0.01	0.36	0.34	0.24	0.8
Niacin EQ (mg)	4.61	4.14	6	0.82	0.18	0.70	4.27	3.96	6	0.83	0.17	0.66	4.45	4.06	6
Vitamin B_6 (mg)	1.89	0.51	0.8	0.92	0.08	0.50	1.68	0.47	0.8	0.94	0.06	0.46	1.79	0.49	0.8
Folate (mcg)	76.49	54.66	97	0.92	0.08	0.55	67.67	51.55	97	0.93	0.07	0.51	72.37	53.19	97
Vitamin B_{12}	0.78	0.65	1	0.88	0.12	0.41	0.64	0.62	1	0.92	0.08	0.42	0.71	0.64	1
L-ascorbic Acid (mg)	19.69	14.04	24	0.84	0.16	0.57	16.36	12.75	24	0.88	0.12	0.51	18.14	13.44	24
Vitamin A (mcg)	91.02	34.87	460	0.91	0.09	0.35	68.23	31.77	460	0.91	0.09	0.30	80.37	33.43	460
MPIA/MPA (Mean ± SD)				0.75 ± 0.19	0.11 ± 0.12	0.48 ± 0.25				0.78 ± 0.18	0.1 ± 0.11	0.45 ± 0.24			

Note: EAR=Estimated Average Requirement; PIA= Probability of Inadequacy for 12 micronutrients; PA= Probability of Adequacy for 12 micronutrients; NAR= Nutrient Adequacy Ratio for 12 micronutrients

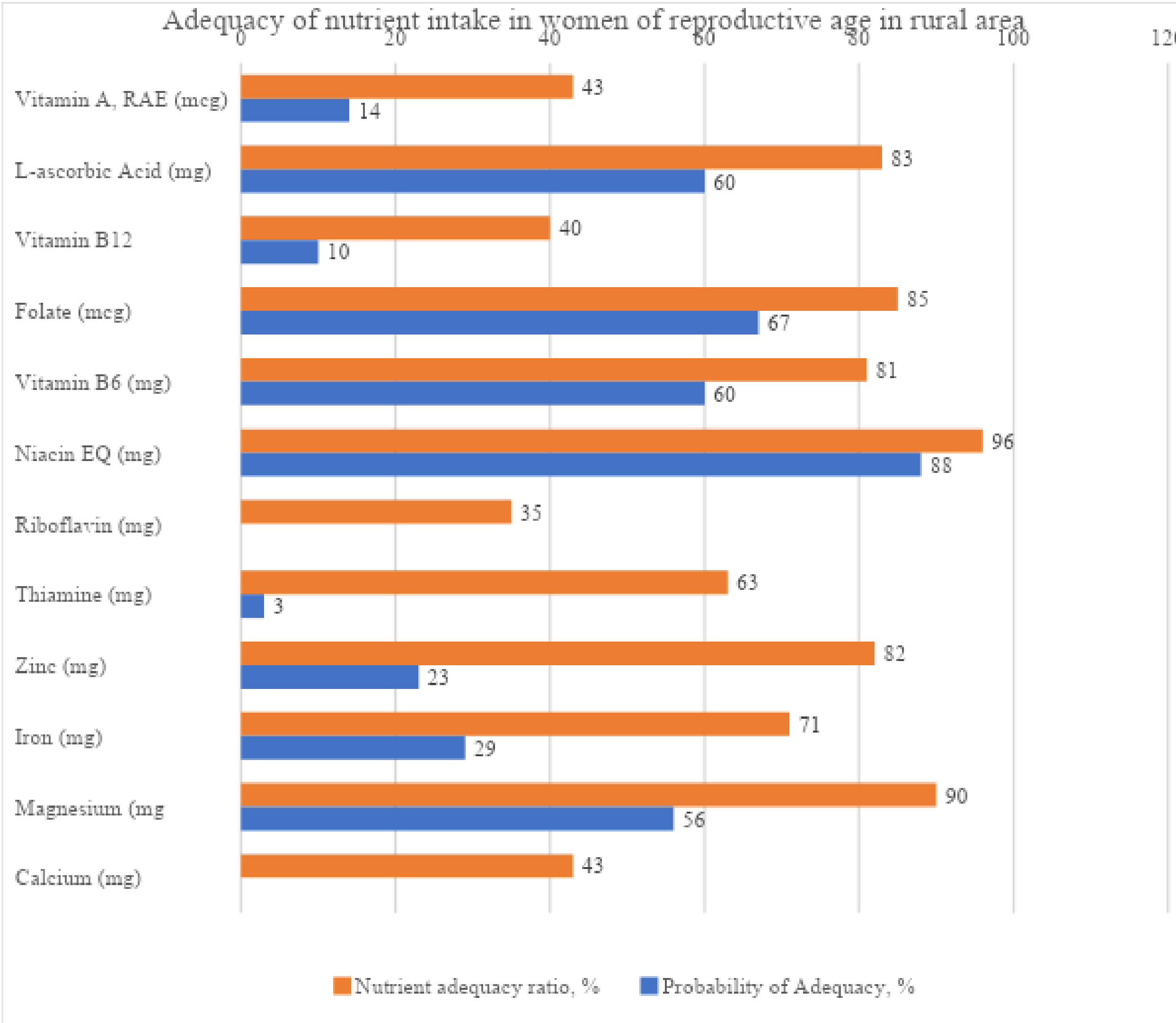


Figure 8. Adequacy of inadequate nutrient intakes (based on EAR) in women of reproductive age by Nutrient Adequacy Ratio (NAR) and Probability approach (PA)

Women of Reproductive Age

Among women of reproductive age, the PA is lowest for calcium, thiamine, riboflavin, vitamin B_{12} (0-10%) followed by zinc (23%), iron (29%), vitamin B_6 (60%), folate (67%), vitamin C (60%) (Figure 8). The MPA across the 12 micronutrients was 34%. Our findings are 4% higher than that of the report by Arsenault et al. (2013). The MAR for 12 nutrients was 68%.

Pregnant and Lactating Women

During pregnancy, energy and micronutrients requirements increase. However, this study reports that the PA for most of the nutrients below 50% except niacin. The critical nutrients like calcium, iron, zinc, and folate PA ranges from 0 to 5%, indicating that the diet quality of the rural pregnant women is very poor (Figure 9). The MPA across the 12 micronutrients was 20%, and the MAR value is 62%. During lactation, similar trends of diet quality is observed with MPA 20% and NAR 62% (Table 31).

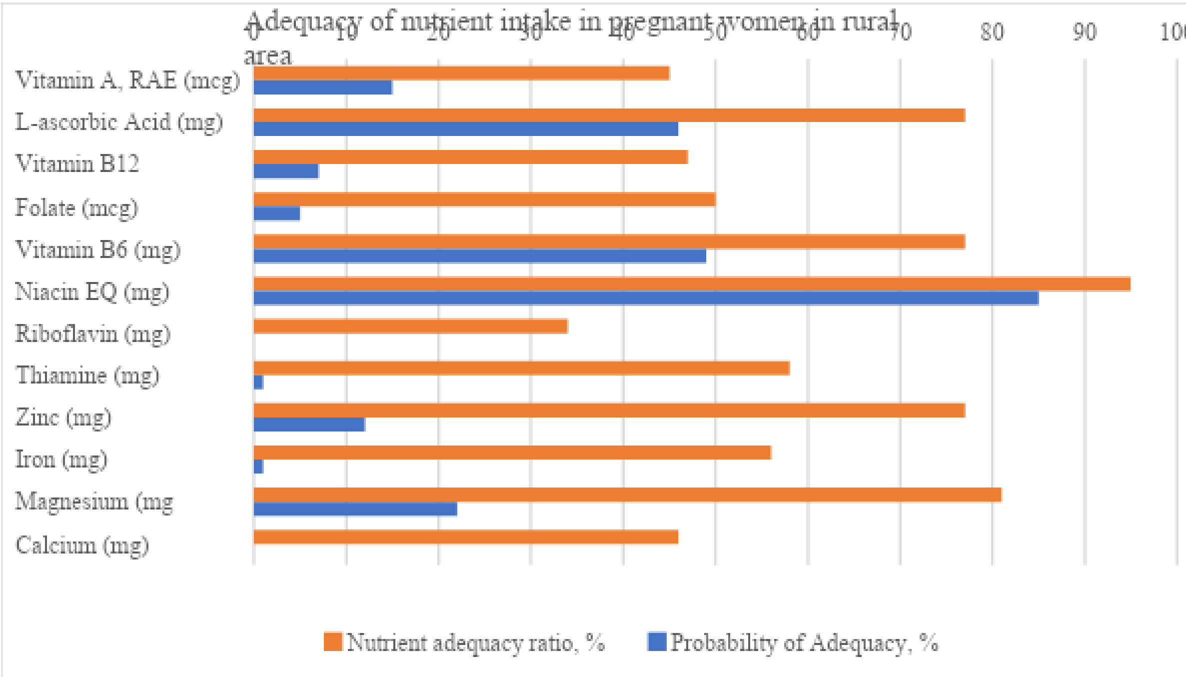


Figure 9. Adequacy of inadequate nutrient intakes (based on EAR) in pregnant women by Nutrient Adequacy Ratio (NAR) and Probability approach (PA)

Table 31. Risk of inadequate nutrient intakes (based on EAR) in lactating women

Nutrients	Average intake	Usual intake	EAR	PIA	PA	NAR
Calcium (mg)	391.21	308.23	1000.00	1.00	0.00	0.37
Magnesium (mg	354.34	334.46	335.00	0.51	0.49	0.90
Iron (mg)	12.39	11.43	16.00	0.86	0.14	0.71
Zinc (mg)	10.45	9.93	11.80	0.82	0.18	0.83
Thiamine (mg)	1.00	0.93	1.70	0.99	0.01	0.58
Riboflavin (mg)	0.77	0.71	2.40	1.00	0.00	0.31
Niacin EQ (mg)	19.03	18.01	13.00	0.28	0.72	0.94
Vitamin B_6 (mg)	9.25	2.64	1.88	0.37	0.63	0.82
Folate (mcg)	329.91	243.73	280.00	0.77	0.23	0.72
Vitamin B_{12}	1.53	1.33	2.80	0.98	0.02	0.34
L-ascorbic Acid (mg)	78.27	64.61	95.00	0.89	0.11	0.66

Vitamin A (mcg)	281.13	132.54	720.00	1.00	0.00	0.30
MPIA/MPA (Mean ± SD)				0.76 ± 0.12	0.20 ± 0.12	0.62 ± 0.14

Note: EAR=Estimated Average Requirement; PIA= Probability of Inadequacy for 12 micronutrients; PA= Probability of Adequacy for 12 Micronutrients; NAR= Nutrient Adequacy Ratio for 12 Micronutrients

5.4 Food and nutrient consumption at Division level

5.4.1 Demographic Characteristics of survey households

According to the HIES-2016, the proportion of male and female respondents, and the urban and rural area respondents were approximately balanced. The population was then further categorized into different age groups. Most of the people fell into the age group of 19-50 years (45.68%), and less proportion of individuals belonged to the 0 to 1-year age category (Table 32).

Table 32. Age and sex structure of sample population by residence in HIES 2016 (N=186019)

Age Category (years)	**Gender**			**Area**		
	Male	Female	Both	Rural	Urban	Both
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
0 to 1	1456 (1.57)	1396 (1.49)	2852 (1.53)	2040 (1.56)	812 (1.46)	2852 (1.53)
1 to 3	5446 (5.89)	5334 (5.7)	10780 (5.79)	7657 (5.87)	3122 (5.61)	10779 (5.79)
4 to 6	5956 (6.44)	5614 (6)	11570 (6.22)	8274 (6.35)	3295 (5.92)	11569 (6.22)
7 to 9	6253 (6.76)	6203 (6.63)	12456 (6.7)	9067 (6.95)	3389 (6.09)	12456 (6.7)
10 to 12	6987 (7.55)	6403 (6.85)	13390 (7.2)	9728 (7.46)	3661 (6.58)	13389 (7.2)
13 to 15	6241 (6.75)	5571 (5.96)	11812 (6.35)	8461 (6.49)	3351 (6.02)	11812 (6.35)
16 to 18	6096 (6.59)	5444 (5.82)	11540 (6.2)	7989 (6.13)	3551 (6.38)	11540 (6.2)
19 to 30	16807 (18.17)	21039 (22.5)	37846 (20.34)	25689 (19.7)	12152 (21.84)	37841 (20.34)
31 to 50	23388 (25.28)	23757 (25.4)	47145 (25.34)	32213 (24.71)	14928 (26.83)	47141 (25.34)
51 to 60	7109 (7.68)	6696 (7.16)	13805 (7.42)	9791 (7.51)	4012 (7.21)	13803 (7.42)
60+	6776 (7.32)	6061 (6.48)	12837 (6.9)	9475 (7.27)	3362 (6.04)	12837 (6.9)
All age group	92,515	93,518	186,033	130,384	55,635	186,019

5.4.2 Dietary energy and nutrient of intakes of <2-year children, early adolescent, and women of reproductive age by residence and division

HIES only measures 'apparent consumption' (based on acquisition data), not actual consumption; therefore, we analyzed HIES dietary based on AME, the proportion of food an individual is supposed to consume from a family pot. We did this analysis to report division level food and nutrient consumption (acquisition) among the target groups (children <2 years, preadolescent 10-14 years, and women of reproductive age 15-49 years). Tables 33 to 35 present the differences of respondents' dietary energy and nutrient intakes among different age groups, and in different divisions of Bangladesh.

Children <2 years

In Barisal division, among under 2 children, energy, carbohydrate, and protein intake was slightly higher in rural areas but fat intake was higher in the urban area (Appendix-I). In terms of micronutrients, the differences in the intake in rural and urban areas were insignificant. But intake of most of the micronutrients was higher in the rural areas. Only the intake of calcium, sodium, folate, and vitamin B_{12} was higher in the urban areas. A similar pattern is seen in the intakes of children of Khulna, Rajshahi, Rangpur, and Sylhet divisions where intakes of most nutrients were higher in rural region except for cholesterol, calcium and sodium in Khulna, saturated fat, calcium, folate, vitamin C in Rajshahi, saturated fats, cholesterol, calcium, sodium, vitamin A in Rangpur and total fats, cholesterol, sodium, folate in Sylhet (Appendix-I). In Chittagong division, consumption of all nutrients is higher in rural areas. On the other hand, in Mymensingh, consumption of most nutrients was higher in urban areas and the intake of other nutrients was somewhat similar in both regions. Similarly, in Dhaka division, consumption of most macro and micronutrients is higher in the urban region including protein, total fat, calcium, iron, sodium, zinc etc. (Table 33).

Early adolescents and women of reproductive age

Similar patterns of nutrient intake are noticed for early adolescents (10-14 years) and women of reproductive age in different divisions of Bangladesh. Dietary intake of most of the macro and micronutrients was higher in the rural areas of Bangladesh as compared to the urban regions (except for Dhaka and Mymensingh divisions) (Appendix-I). But consumption of fats (saturated, PUFA, MUFA, cholesterol), calcium, sodium, vitamin A, and folate were usually seen to be higher in urban localities. In case of Dhaka and Mymensingh divisions, intakes of most nutrients were higher in the urban regions for adolescents and adults. Carbohydrate intake was higher among rural residents for all divisions (Tables 34 and 35).

Table 33. Dietary energy and nutrient of intakes of <2-year children (grams/person/day) by Division

Energy and Nutrients	Barisal (n=852)	Chittagong (n=2074)	Dhaka (n=1893)	Khulna (n=1241)	Mymensingh (n=634)	Rajshahi (n=985)	Rangpur (n=1159)	Sylhet (n=884)
Energy (Kcal)	610.5	671.8	677.3	694.7	714	667.3	674.3	702
Protein (g)	16.3	18.4	17.7	17	18.1	16.3	15.8	18.4
Total fat (g)	13.1	14.1	15.1	13.6	9.9	11.1	10.1	11.8

Saturated fatty acids (g)	2.7	2.8	2.8	2.7	2.1	2	2.2	2.8
MUFA (g)	3.7	3.6	3.7	3.7	2.5	3.1	3.1	3.4
PUFA (g)	7.2	7.4	7.7	7.2	4.8	5.6	5.6	6.5
Cholesterol (mg)	15.1	17.1	16.2	12	10.7	10.6	7.2	10.6
Carbohydrate (g)	100.7	109.9	107.9	117.4	126.2	120.6	123.4	121.9
Total dietary fiber (g)	8.1	9.1	8.8	9.1	10	8.6	9.4	9
Calcium (mg)	116.2	145.9	134	117.1	131.1	104.2	114.4	142.5
Iron (mg)	3.9	4.2	3.9	3.8	3.8	3.7	3.9	3.9
Magnesium (mg)	100.9	115.1	111	113.6	121	107.4	115.1	112.6
Phosphorus (mg)	301.6	324.7	315.9	314.8	320.2	298.2	308.4	342.9
Potassium(mg)	623.3	713.3	652	652.3	663.6	587.6	654.4	686.2
Sodium (mg)	82.8	94.7	93	65.3	66.8	65.2	69.6	66.8
Zinc (mg)	2.7	3	3	3.1	3.2	3	3	3.1
Copper (mg)	0.6	0.7	0.7	0.7	0.7	0.6	0.7	0.7
Vitamin A (mcg)	111.9	119.6	121.5	113.7	113.8	93	137.3	101.1
Thiamine (mg)	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.4
Riboflavin (mg)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Niacin EQ (mg)	5.6	7.6	7	6.9	8.2	7.4	6.6	6.9
Vitamin B_6 (mg)	0.6	0.8	0.7	1.1	0.9	1.2	0.8	0.8
Folate (mcg)	142.5	125.9	127	100.5	110.1	81.2	85.1	102.2
L-ascorbic acid (mg)	20.9	26.7	28.6	29.5	22.8	21.1	28	19.7
Vitamin B_{12} (mcg)	0.5	0.7	0.5	0.4	0.4	0.3	0.2	0.5

Table 34. Dietary energy and nutrient of intakes of 10-14 years (grams/person/day) by Division

Energy and Nutrients	**Barisal (n=2118)**	**Chittagong (n=4305)**	**Dhaka (n=4280)**	**Khulna (n=2785)**	**Mymensingh (n=1245)**	**Rajshahi (n=2192)**	**Rangpur (n=2571)**	**Sylhet (n=1718)**
Energy (Kcal)	1510.5	1695.2	1681.1	1746.6	1708.9	1770.4	1758.6	1825.9
Protein (g)	39.7	45.4	43.6	42.1	42.3	41.8	41.2	46.4
Total fat (g)	30.1	32.5	34.1	31.3	22.6	28.1	23.2	26.8
Saturated fatty acids (g)	6.6	6.8	6.4	6.2	5.1	5	5.5	6.6
MUFA (g)	8.8	8.6	8.5	8.8	5.9	7.5	7.8	8.3
PUFA (g)	17.2	17.4	17.6	17.5	11.2	14.8	13.4	14.9

Cholesterol (mg)	34.6	37.8	37.8	27.2	24.8	24.8	16.5	24.7
Carbohydrate (g)	252.8	287.8	279.4	308.5	315.2	321.4	328	329.5
Total dietary fiber (g)	20.1	23	22.5	23.3	23.4	23.3	24.1	23.3
Calcium (mg)	268.8	341	322	275.1	299.2	251.8	279.1	347.5
Iron (mg)	9.4	10.3	9.7	9.7	9.1	9.3	9.9	9.8
Magnesium (mg)	251.3	288.1	279.3	287.5	282.9	285.4	298.4	295.6
Phosphorus (mg)	728.5	807.5	764.5	786.2	759.1	778.3	816.3	883.8
Potassium(mg)	1495.8	1723.8	1581.7	1600.9	1552.2	1514.6	1664	1747.8
Sodium (mg)	196.7	231.4	223.8	157.6	140.7	163.4	165.2	164.2
Zinc (mg)	6.8	7.6	7.5	7.7	7.6	7.8	7.9	8.1
Copper (mg)	1.4	1.7	1.6	1.7	1.6	1.6	1.7	1.7
Vitamin A (mcg)	276.9	290.8	287.8	291.7	264.7	242.4	341	248.3
Thiamine (mg)	0.7	0.9	0.9	0.9	1	1	0.9	0.9
Riboflavin (mg)	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Niacin EQ (mg)	14	18.2	18.4	17.1	20.7	20	16.5	18
Vitamin B_6 (mg)	1.5	1.8	1.8	2.8	2.4	3.2	2.1	1.9
Folate (mcg)	335.1	319.7	295.9	236.2	254.9	194.9	211.7	246.7
L-ascorbic acid (mg)	49.6	65.2	68.6	75	53.1	55	68.3	46.6
Vitamin B_{12} (mcg)	1.3	1.6		0.9	0.8	0.7	0.6	1.2

Table 35. Dietary energy and nutrient of intakes of WRA (15-49 years) (grams/person/day) by Division

Energy and Nutrients	**Barisal (n=4598)**	**Chittagong (n=9248)**	**Dhaka (n=10274)**	**Khulna (n=7647)**	**Mymensingh (n=2781)**	**Rajshahi (n=6013)**	**Rangpur (n=5909)**	**Sylhet (n=3649)**
Energy (Kcal)	1569.4	1776.6	1728.0	1790.4	1764.2	1831.0	1817.5	1891.0
Protein (g)	41.4	48.4	46.3	44.1	44.7	43.5	42.6	48.7
Total fat (g)	33.0	36.6	39.4	34.1	25.0	30.6	26.2	29.9

Saturated fatty acids (g)	7.2	7.3	7.3	6.6	5.6	5.4	5.9	7.3
MUFA (g)	9.5	9.4	9.4	9.4	6.4	8.1	8.4	9.0
PUFA (g)	18.7	19.4	20.2	18.9	12.5	16.2	14.8	16.4
Cholesterol (mg)	37.2	42.4	43.9	30.9	28.7	27.5	18.5	28.5
Carbohydrate (g)	257.8	295.0	280.9	313.6	322.3	328.7	334.6	336.1
Total dietary fiber (g)	20.9	24.3	23.3	24.3	24.7	23.8	25.0	24.4
Calcium (mg)	287.2	379.0	354.1	300.7	322.4	271.0	300.6	376.6
Iron (mg)	10.0	11.2	10.4	10.2	9.6	9.8	10.5	10.3
Magnesium (mg)	263.9	307.0	288.0	300.0	294.5	293.4	309.2	310.1
Phosphorus (mg)	757.1	858.6	792.5	817.8	793.4	804.9	839.6	928.8
Potassium (mg)	1577.9	1867.8	1682.6	1693.2	1652.4	1588.4	1742.8	1880.0
Sodium (mg)	211.5	254.0	261.1	169.3	154.5	177.3	177.9	184.2
Zinc (mg)	7.0	8.1	7.8	8.0	8.0	8.1	8.2	8.5
Copper (mg)	1.5	1.8	1.7	1.8	1.7	1.7	1.8	1.8
Vitamin A (mcg)	291.3	315.7	315.9	313.5	283.3	258.5	367.4	267.2
Thiamine (mg)	0.8	1.0	1.0	0.9	1.1	1.0	0.9	1.0
Riboflavin (mg)	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.5
Niacin EQ (mg)	14.6	19.3	19.2	18.1	21.6	20.3	17.1	18.8
Vitamin B_6 (mg)	1.6	1.9	1.8	2.9	2.8	3.4	2.1	2.0
Folate (mcg)	349.6	342.8	334.2	257.2	278.3	209.8	220.3	267.1
L-ascorbic acid (mg)	53.0	71.0	78.8	79.0	57.3	59.3	73.4	51.2
Vitamin B_{12} (mcg)	1.4	1.8	1.4	1.0	1.0	0.8	0.6	1.4

Chapter 6: Nutrient profiling of foods in Bangladesh

Diet quality can play an incredibly significant role in food-based programs and decreasing micronutrient deficiency. The low energy and less diversity in foods among the women and young child in rural Bangladesh reflects the magnitude of micronutrient inadequacy among this group (Arsenault et al., 2013). Inadequate micronutrient intake is largely responsible for many adverse health outcomes such as birth defects, cognition impairment, growth restriction, increased morbidity, and mortality; poor diet quality, repetitive diets, and lack of diversity in diets are credited to this situation. Assessing the amounts of foods and nutrients eaten by the population is significant for planning food-based programs (Black et al., 2006).

Developing nutrient profile models of commonly consumed foods to help consumers to identify affordable nutrient-rich foods across and within food groups has important implications for nutrition education, food policy, and public health. Therefore, the present study has calculated the Energy Density (ED), Nutrient Rich Foods (NRF9.3) Index, and Naturally Nutrient Rich (NNR) scores of foods consumed in Bangladesh by using the reported methods and Food composition database for Bangladesh (FCDB).

In the present study, locally available foods which has nutrient composition in FCDB are ranked according to Energy Density (ED), Naturally Nutrient Rich (NNR) and Nutrient Rich Food 9.3 and top scored foods has been described in result section according to food group wise and detail information for each food of FCDB have been presented as tables in Appendix-II.

The Foods in the Food Composition Table for Bangladesh (2013) and further updated database (2018) are arranged according to ED, NRF9.3, and NNR. Median values of each score with range are presented according to the food groups of FCT for Bangladesh in Table 36. Median value with minimum and maximum scores of ED, NRF9.3 and NNR of cereals and their products are 3.44 (1.05-3.98), 16.24 (2-126), 4.81 (1-34) respectively, and 43 different cereals and their products are scored according to their nutrient composition. In case of pulses, legumes, and their products median value with minimum and maximum scores of ED, NRF9.3, and NNR are 3.27 (1.42-4.24), 49.95 (33-79), 16.53 (5-29) respectively**.** Leafy and non-leafy vegetables and their products show lowest energy density (0.29) but higher NRF9.3 (375.97) and NNR (144.76) with wide range of values. Comparison among the food groups discovered that energy dense foods (e.g., fats (9.0), cereals (3.44)) are poor in nutrient density in terms of NRF9.3 (Table 36).

Table 36. Nutrient Density Scoring of foods by Energy Density (ED), Nutrient Rich Food 9.3 (NRF9.3), and Naturally Nutrient Rich (NNR) according to food groups of FCT

Food Groups	**Median Nutrient Density Scores with their minimum and maximum in parentheses**		
	Energy Density	**NRF 9.3**	**NNR**

Cereals and their products (n=43)	3.44 (1.05, 3.98)	16.24 (2, 126)	4.81 (1, 34)
Pulses, legumes, and their products (n=17)	3.27 (1.42, 4.24)	49.95 (33, 79)	16.53 (5, 29)
Vegetables and their products (n=51)	0.29 (0.10, 1.47)	144.76 (31, 386)	4.76 (2, 13)
Leafy vegetables (n=37)	0.45 (0.22, 0.88)	375.97 (45, 561)	11.94 (0.93, 36)
Starchy roots, tubers, and their products (n=21)	0.98 (0.66, 1.15)	62.35 (40, 139)	4.75 (3, 10)
Nuts, seeds, and their products (n=16)	5.58 (0.74, 7.12)	28.01 (-15, 69)	21.93 (3, 43)
Spices, condiments, and herbs (n=21)	3.02 (0.30, 5.23)	125.48 (35, 483)	20.28 (3, 40)
Fruits (n=43)	0.60 (0.09, 3.20)	87.11 (-13, 242)	5.58 (0.97, 34)
Fish, shellfish, and their products (n=76)	1.03 (0.60, 4.12)	67.37 (3, 214)	8.85 (3, 64)
Meat, poultry, and their products (n=16)	1.27 (0.68, 2.33)	54.72 (13, 196)	13.54 (6, 229)
Eggs and their products (n=7)	1.79 (1.39, 3.25)	41.03 (34, 50)	13.54 (10, 33)
Milk and its product (n=13)	0.94 (0.30, 4.97)	12.79 (-13, 65)	4.48 (3, 32)
Beverages (n=9)	0.41 (0.20, 3.55)	9.39 (-46, 95)	1.77 (0.13, 22)
Miscellaneous (n=7)	3.26 (0.42, 3.98)	8.95 (-50, 275)	2.00 (0.18, 10)

6.1 Nutrient Density of Cereals and their products

Cereals and their products group of FCDB consists of 33 raw and processed foods and median ED score of this group is 3.3. Rice bran ranked the top score in ED, NNR as well as in NRF 9.3 score. Popped rice, puffed rice, rice flakes, sorghum, brown rice has high energy density score. Concerning the rice varieties, brown rice, BRRI Dhan-40 (parboiled), BRRI Dhan-30 (parboiled) have high ED score. From the score of ED, NNR and NRF9.3 it is evident that wheat and millet are more nutrient dense as compared to rice and their product. Barley, wheat whole, millet (pearl), wheat flour, millet (proso), maize/corn also have higher NNR score. Apart from rice bran, barley and whole wheat other foods like wheat flour, sorghum, pearl millet, sweetcorn, maize/corn also have high nutrient density in terms of NRF9.3 and the median NRF9.3 score of this food group is 24.1 (Appendix-II-Table 1)

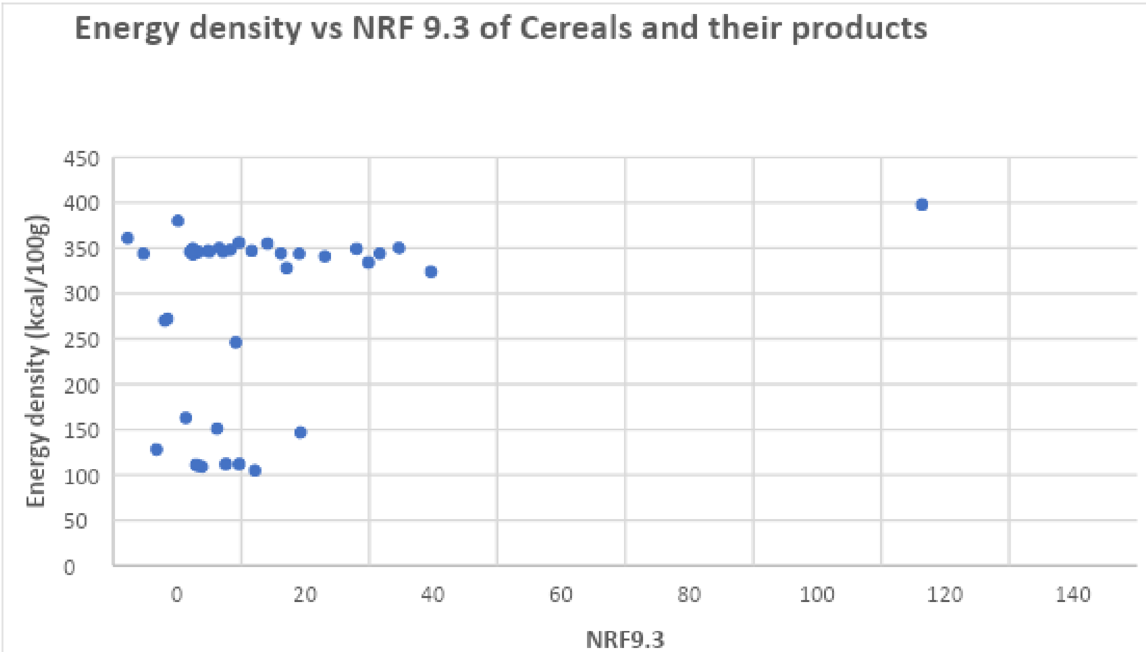


Figure 10. Energy density vs NRF9.3 of cereals and their products

6.2 Nutrient Density of Pulses, legumes, and their products

Median value of ED of this food group is 3.5. There are 12 different pulses and legumes available in this group. Soybean has the highest NNR score (29) in the pulse group followed by Bengal gram, grass pea, and red gram. Median NNR score of this group is 20.2. Green gram has the highest NRF9.3 score (79) followed by black gram, bengal gram, soybean, and cowpea. Median NRF9.3 scores of pulses, legumes and their products is 53.5. (Appendix-II-Table 2)

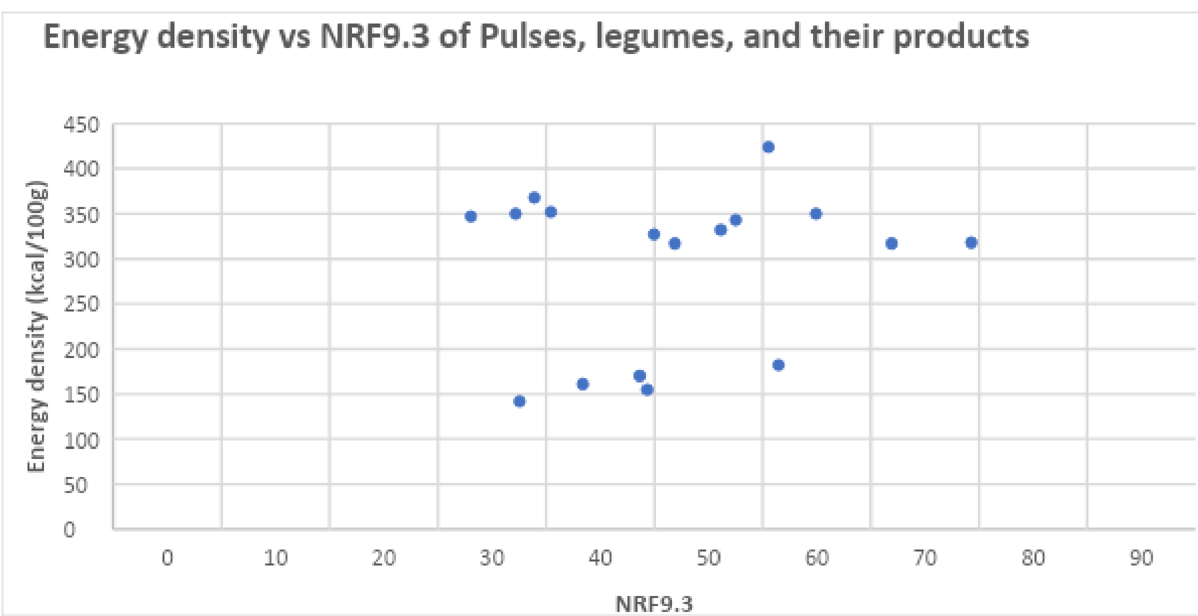


Figure 11. Energy density vs NRF9.3 of pulses, legumes, and their products

6.3 Nutrient Density of Non-leafy Vegetables

The group vegetable contains the nutrient composition of total 35 raw foods. Median ED score of this group is 0.4, median NNR score is 5.6 and median NRF9.3 score of the food group is 162.2. ED of this food group is comparatively low and NRF9.3 score is higher. Garlic (1.47), peas (1.17), plantain (0.77), teasle gourd (0.61) are showing the descending order of energy density score in this group. Teasle gourd has the highest NNR score (13) followed by chilli, bitter gourd, peas, cauliflower, garlic, drumstick, pumpkin, okra, carrot. Vegetable group is an exceptionally nutrient dense food group. Pumpkin is the topmost food of this group with highest NRF9.3 score (386). Followed by ash gourd, cauliflower, amaranth stem, taro, kohlrabi, radish, bitter gourd, and peas. (Appendix-II-Table 3)

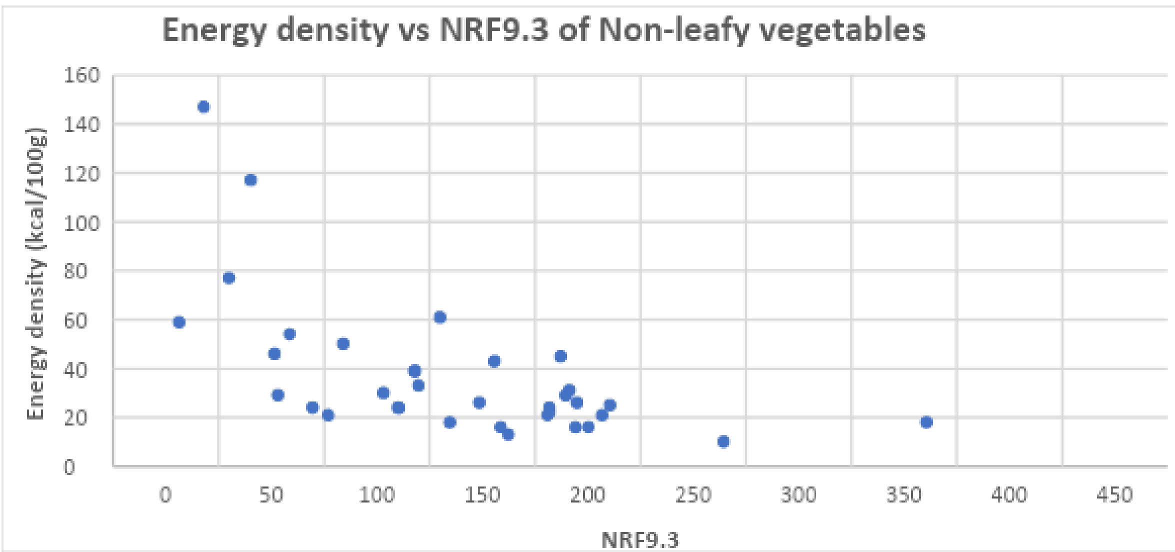


Figure 12. Energy density vs NRF9.3 of non-leafy vegetables

6.4 Nutrient Density of Leafy vegetables

Median ED of leafy vegetables food group is 0.4. Leafy vegetables have low energy density but nutrient dense as their nutrient density score is the highest among all of the food groups according to NRF9.3. However, agathi, drumstick leaves, farn leaves, colocasia leaves, amaranth leaves (spiney), alligator weed scored high ED comparing to other foods in this group. Agathi and drumstick leaves have the highest NNR score (36). Among the rest, high NNR leafy vegetables are slender amaranth leaves, amaranth leaves (spiney), colocasia leaves, jute leaves, amaranth leaves (green). Median NNR score of leafy vegetables is 13.8 and total 32 of LVs are available in this group. Amaranth leaves (spiney) have the highest NRF9.3 score (561) in the leafy vegetable group. Amaranth leaves (green), Bengal dayflower leaves, amaranth leaves (red), beet greens, jute leaves, spinach, bottle gourd leaves, agathi, cowpea leaves have the highest nutrient density compared to other foods of this group. Median NRF9.3 score of leafy vegetables food group is 340.2. (Appendix-II-Table 4)

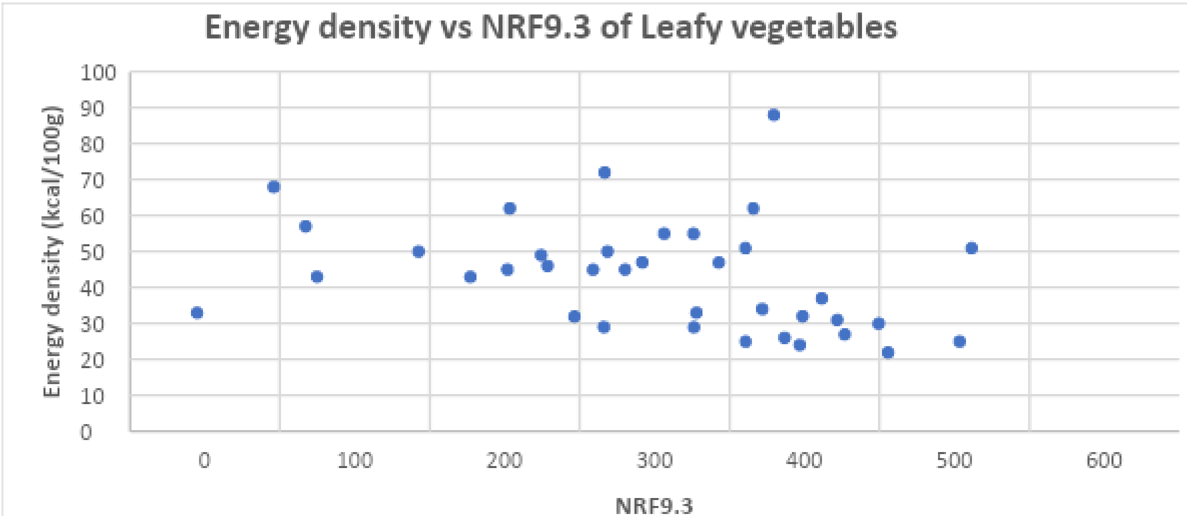


Figure 13. Energy density vs NRF9.3 of leafy vegetables

6.5 Nutrient Density of Starchy roots, tubers, and their products

Foods that ranked top in ED, NNR and NRF9.3 score are sweet potato, pale-yellow flesh, raw has the highest ED score (1.05). Orange fleshed sweet potato scored highest in NNR (10) and NRF9.3 Index (139). Other high scored foods in this group are colocasia, yam tuber, giant taro, elephant foot, potato. Median ED score of this group is 0.9. Sweet potato with purple skin and white skin, giant taro, yam tuber, colocasia/taro, elephant foot, potato are starchy foods with high NNR score. Median NNR of this group is 5.5 and median NRF9.3 is 70.5. Giant taro, elephant foot, colocasia/taro, potato, sweet potato, and yam are topmost NRF9.3 starchy foods (Appendix-II- Table 5).

6.6 Nutrient Density of Nuts, seeds, and their products

Nuts, seeds, and their products food group has nutrient composition of total 16 foods in FCDB and median ED (4.8), NNR (20) and NRF9.3 (32.2) indicates that foods of this group are energy dense as well as nutrient dense. So, this group is suitable for those age groups who need energy as well as nutrients or small quantities or desirable amounts of nuts/seeds can able to supply energy with required amount of nutrients. Energy density of the foods in this group are comparatively high. Chilgoza pine, coconut (desiccated), and walnuts have the highest ED score (7). Other energy dense foods of this group are groundnuts/peanuts, cashew nuts, pumpkin seeds, pistachio nuts, sesame seeds, sunflower seeds, mustard seeds. Sunflower seeds have the highest NNR score (44) followed by nuts, linseed, sesame seeds, mustard seeds, pumpkin seeds, pistachio nuts, chilgoza, cashew nuts, groundnuts/peanuts, walnuts. Sunflower seeds and linseed have the highest NRF9.3 score (69). Other topmost NRF9.3 scoring foods in this group are lotus seeds, mustard seeds, sesame seeds, pumpkin seeds, chilgoza pine, jackfruit seeds and pistachio nuts. So, incorporation of different seeds e.g., linseed, sesame, mustard, pumpkins, lotus in diets can enrich the diets with energy as well as nutrients. (Appendix-II-Table 6).

6.7 Nutrient Density of Spices, condiments, and herbs

In updated FCDB, total 21 foods are available in the group of spices, condiments, and herbs. Median ED of this food group is 2.5, NNR is 21.9 and NRF9.3 is 165.5. Interestingly, Poppy seeds and nutmeg (dried) have the highest ED (5). Mace (ground), cumin seeds, bay leaf, coriander seed, turmeric (dried), fenugreek seeds, fennel seeds and red chilli (dried) are high energy dense spices in this group. Surprisingly, red chilli (dried) has the highest NNR score (40) followed by cumin seeds, bay leaf, poppy seeds, coriander seed, fennel seed, turmeric, fenugreek seeds, cinnamon (ground), mace (ground). In nutrient density, coriander leaves (indigenous) are found with highest NRF9.3 score (483). According to NNR and NRF9.3, nutrient density of spices is high as compared to different food groups. Spearmint leaves (fresh), Indian pennywort, lemon peel, red chilli (dried), bay leaf, cinnamon (ground), fennel seeds, cumin seeds are topmost nutrient dense spices according to nutrient composition of FCDB. (Appendix-II-Table 7)

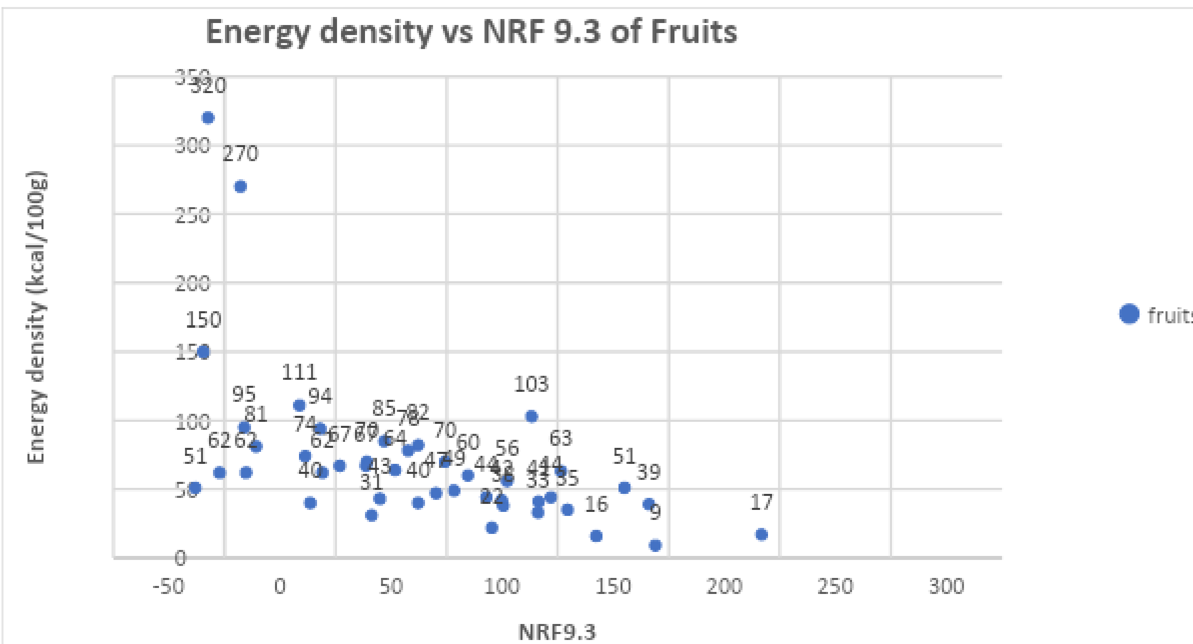


Figure 14. Energy density vs NRF9.3 of fruits

6.8 Nutrient Density of Fruits

Total 43 fruits are present in this group and median ED of this group is 0.7, NNR is 6.7 and NRF9.3 score is 88.3 which indicates fruits are nutrient dense with low ED. On the other hand, fruits with high ED are wood apple, monkey-jack, banana, grapes, custard apple, mango, and bullocks' heart. Emblic found to have the highest NNR score (34) followed by guava, mango (langra), monkey-jack, pomelo, hog plum, jambolan, dates, elephant apple, tamarind (pulp). Melon (futi) is the highest nutrient dense fruit in terms of NRF9.3 score (242). Followed by orange (juice), jambolan, hog plum, meshmelon, java apple, guava, Emblic, carambola and papaya. (Appendix-II-Table 8)

6.9 Nutrient Density of Fish, shellfish, and their products

Nutrient Composition of 74 fish varieties are available in the updated FCDB. Median ED score of this group is 1.2, NNR score is 14.3 and NRF9.3 is 75.3. Minnow finescale (dried) fish has the highest ED score (4). Pomfret (silver), Anchovy gangetic hairfin (dried), giant seaperch (whole, dried), hilsa (without bones, raw), barb olive (without bones, raw), Barb, pool barb (eyes included, raw), climbing perch (Thai, without bones, eyes included, raw) have high ED score. Hilsa (without bones) has the highest NNR score (64). Bombay duck, mola carplet (whole, eyes included), catla, stinging catfish, mackerel (narrow-barred Spanish), Mullet (goldspot), pangas (without bones), anchovy (gangetic hairfin, dried), minnow (finescale razorbelly, dried) are top ranked NNR fishes. Mola carplet (whole, eyes included) shows highest NRF9.3 (214). Fish, shellfish, and their products have high NRF9.3 score. Indian river shad, anchovy (goldspotted grenadier, raw), spotted snakehead (raw), anchovy (gangetic hairfin, dried), bronze featherback, minnow (finescale razorbelly, dried), chanda (Indian glassy fish, eyes included, raw), mrigal carp (eyes included, raw) are top ranked nutrient dense fishes. (Appendix-II-Table 9)

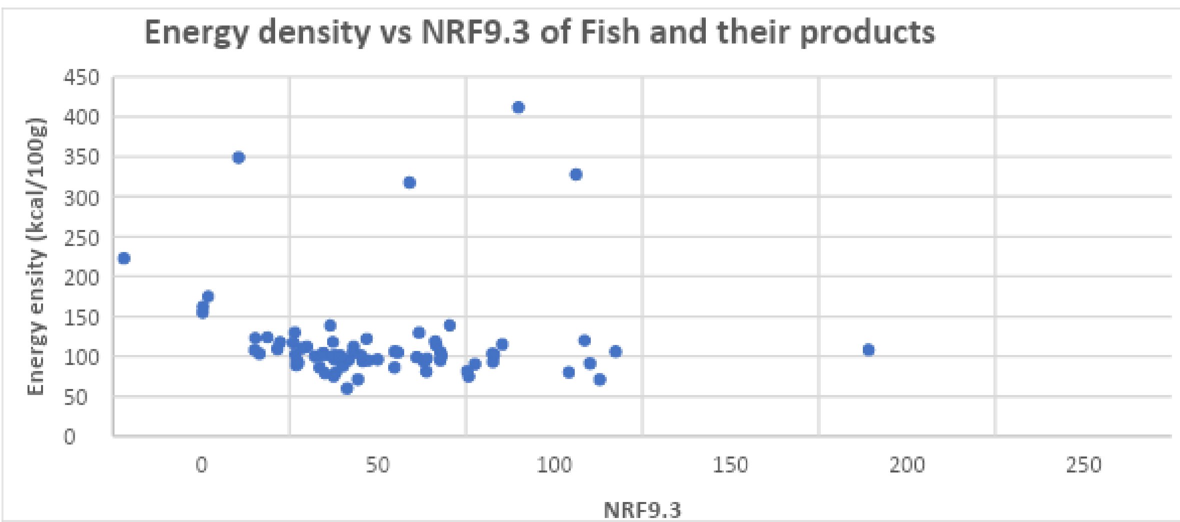


Figure 15. Energy density vs NRF9.3 of fish and their products

6.10 Nutrient Density of Meat, poultry, and their products

Total 15 foods available in this group and median ED is 1.4, NNR is 39.4, and NRF9.3 is 73.2. Beef (15-20% fat, boneless), lamb/mutton meat (moderately fat), lamb/mutton liver have the highest ED score (2). Pigeon meat, beef liver, duck meat, chicken leg, minced beef, goat meat, chicken liver are top ranked energy dense foods in this group. Lamb/mutton liver has the highest ranked NNR score (229). Other topmost NNR scored foods of this group are chicken liver, beef liver, beef meat, duck meat, lamb/mutton meat, minced beef, pork meat and pigeon meat. Chicken liver has the highest NRF9.3 (196). Other top ranked foods of this groups are lamb/mutton liver, beef liver, frog legs, buffalo meat, goat meat (lean), chicken (breast), beef meat (lean), pigeon meat and duck meat. (Appendix-II-Table 10)

6.11 Nutrient Density of Eggs and their products

Median ED score of this food group is 2, NNR is 23.2 and NRF9.3 is 37.2. Chicken egg yolk has the highest energy density score (3) and naturally nutrient rich score (33) while duck egg (whole) has the highest nutrient density score (41) (Appendix-II-Table 11)

6.12 Nutrient Density of Milk and its products

The median ED of this group is 1.7, NNR score is 9.5 and NRF9.3 score is 18.8. Milk powder (whole milk, cow) has the highest ED score (5) and other top ranked energy dense foods of this group are milk powder (skimmed, cow), cottage cheese (25% fat), cow milk (whole, condensed, sweetened), curd (sweetened), goat milk, cow milk whole (pasteurized, UHT). Topmost naturally nutrient rich food of this group is milk powder (cow, whole) (32). Milk powder (skimmed, cow) has the highest nutrient density score (65). Human milk (colostrum), cow milk (skimmed), buttermilk, milk powder (whole milk, cow), goat milk, milk whole (pasteurized, UHT), cottage cheese (25% fat), curd (sweetened, whole milk) are top ranked nutrient dense foods. (Appendix-II-Table 12)

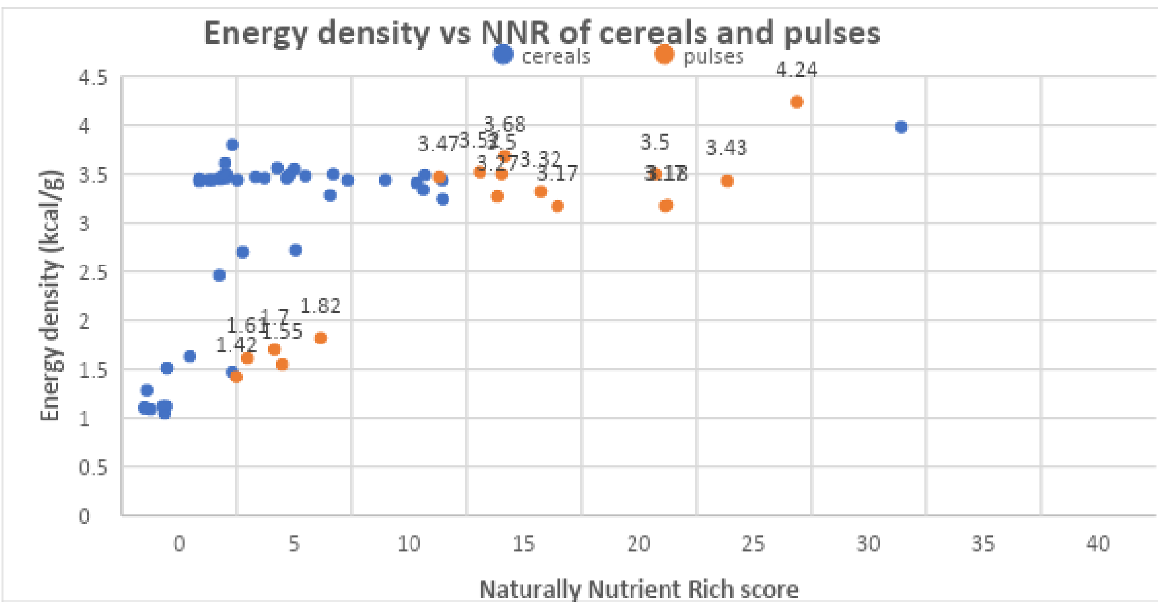


Figure 16. The relationship between NNR and Energy Density (ED) of cereals and pulses

6.13 Nutrient Density of Fat and oils

Fats and oils have the highest energy density compared with other food groups. Majority of the oils exhibit a similar ED score. Fish oil (cod liver) has the highest NNR score (108). Other high NNR ranked oils are palm oil, sesame oil, cottonseed oil, mayonnaise, peanut oil, mustard oil, margarine, and ghee (cow and vegetable). Fish oil (cod liver) also got the highest nutrient density score (53). Cottonseed oil, mayonnaise, and soya oil have high NRF9.3 scores. Mustard oil, margarine, sesame oil, and ghee (cow) scored negative NRF9.3 score as the amount of nutrients-to-limit of these oils are higher than the nutrients-to encourage. Median ED of this food group is 8.6 which is the highest of all group groups. Median NNR score is 37.1 and median NRF9.3 score is 0.8 which is the lowest of all food groups (Appendix-II-Table 13).

6.14 Comparison of NNR, ED and NRF 9.3 of different food groups

Figure 16 shows that cereals are more energy dense with low nutrient density in terms of NNR than pulses except Rice, bran. Soybean has high ED and NNR value as compared to other foods of the food group.

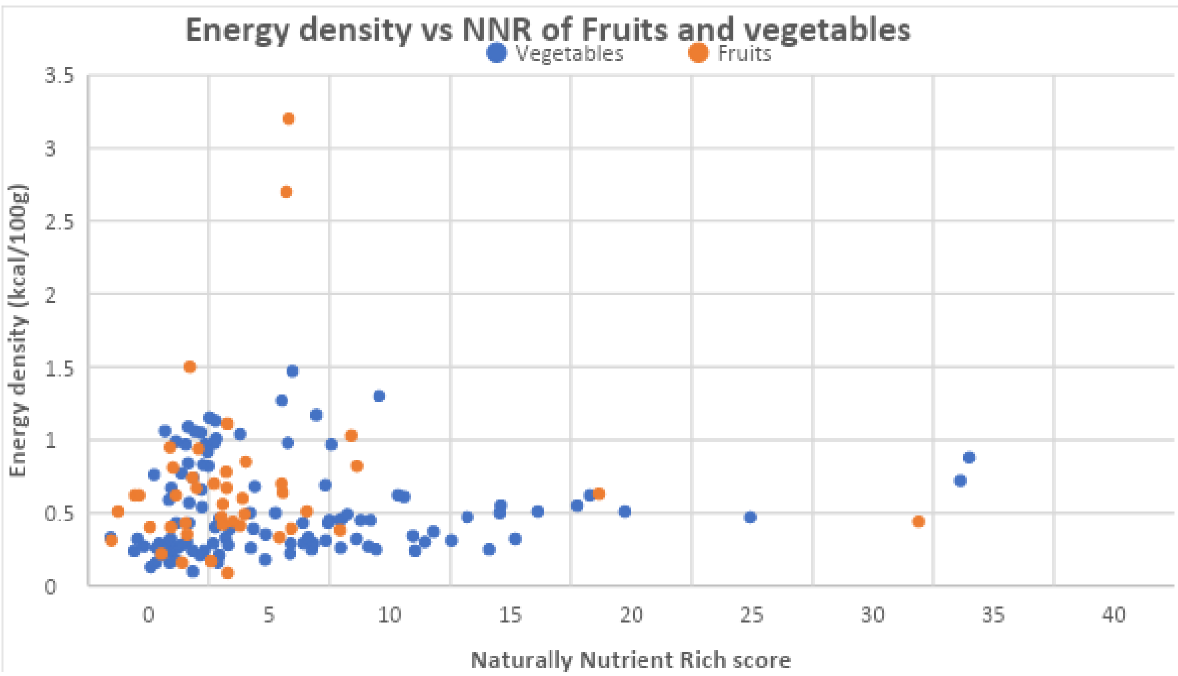


Figure 17. The relationship between NNR and Energy Density (ED) of fruits and vegetables.

Figure 17 shows that dried fruits are more energy dense than raw fruits due to moisture content Drumstick leaves and Agathi, raw are most nutrient dense vegetables in terms of NNR with low energy density. Among the fruits of FCDB, Emblic has the highest NNR score and lowest ED indicates nutrient rich fruits of Bangladesh.

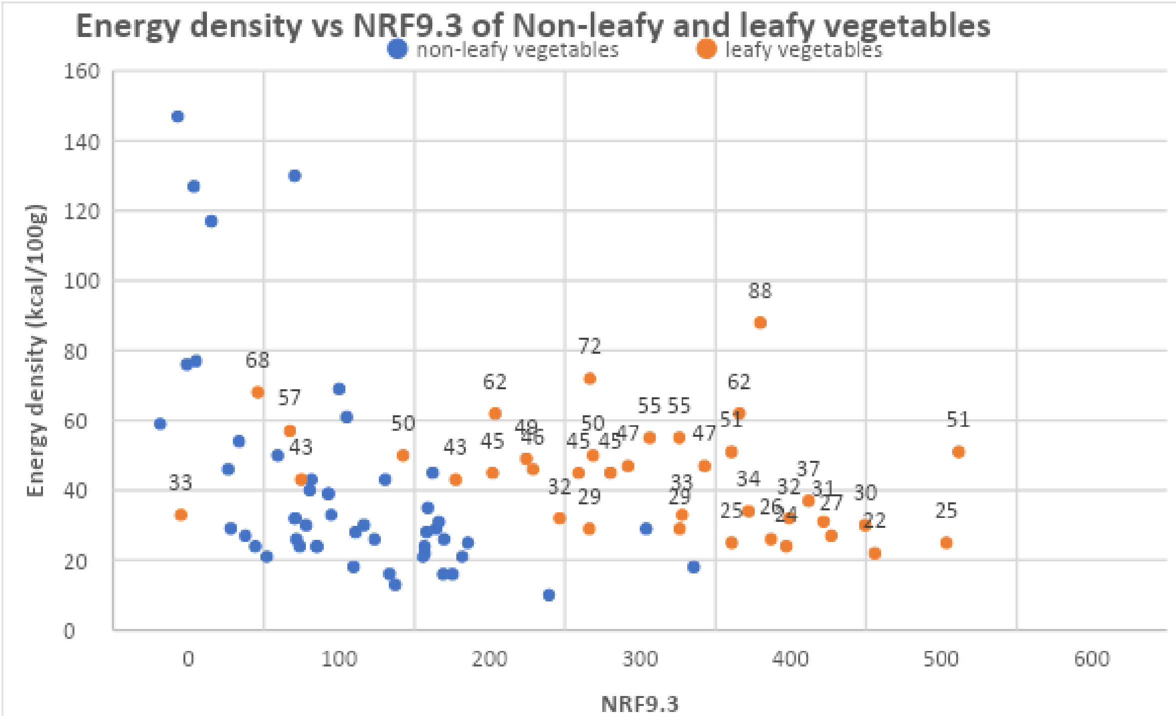


Figure 18. The relationship between NRF9.3 and Energy Density (ED) of non-leafy vegetables and leafy vegetables.

Comparison among leafy vegetables and non-leafy vegetables indicates that leafy vegetables are the most preferred food group for the prevention of NCDS as nutrient dense with lowest energy density to limit the calorie intake as well as Sodium, Sugar and Saturated fats. Vegetables are also low energy density food sources and slightly low nutrient density in terms of NRF9.3 as compared to leafy vegetables of Bangladesh.

Figure 19 shows the relationship between NRF9.3 with energy density (Kcal/100g) of foods of FCT for Bangladesh. The figure reflects that vegetables (leafy and non-leafy) are more nutrient dense as compared to other food groups. Especially, leafy vegetables have high NRF9.3 whereas lowest energy density, indicates as potential food source for the prevention of the risk of CVD, diabetes and all-cause mortality, since it is clear that eating nutrient dense foods was linked to a moderately decreased threat according to scientific literatures. As reported in different literatures that the relations between the NRF9.3 index and the occurrence of cardiovascular disease (CVD) events and all-cause mortality and observed that the NRF9.3 index score was inversely linked with all-cause mortality, high scored leafy and non-leafy vegetables, fruits, fishes might be potential candidates for food choices to address the double burden of malnutrition prevailing in Bangladesh

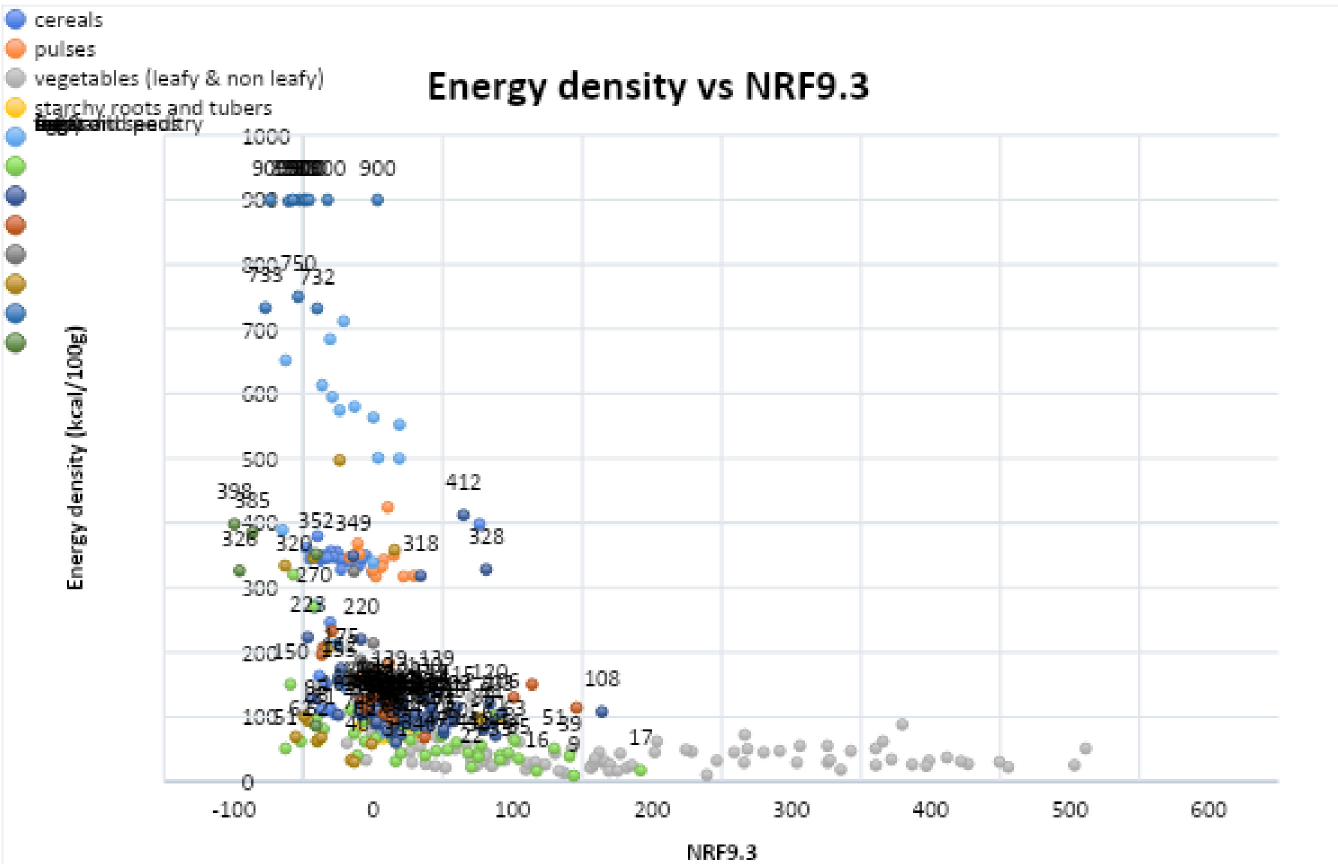


Figure 19. Energy density vs NRF9.3 of foods of FCT for Bangladesh.

On the other hand, fats and oils, and sugar are showing the highest ED with negative value of NRF9.3 indicating increased threats of NCDs and should maintain the level recommended by WHO for "Healthy Diet." By ensuring the healthy diet of the population of Bangladesh can achieve the SDGs and other targets of nutrition.

The relation between cost of foods expressed as BDT/100Kcal with nutrient density showed that leafy vegetables are giving highest nutrient return per taka e.g., amaranth leaves (slender, green, and red), jute leaves, bottle gourd leaves, Indian spinach with minimum level of energy. Comparatively local seasonal fruits are identified as least cost in terms of nutrient return per taka. Present study findings may be guiding the policy makers for the formulation of agriculture policy for the encouragement of increase production of nutrient dense foods to supply crucial nutrients to fulfill the nutrient intake gap to reduce the risk of inadequacy and could address the public health malnutrition and other diet related health problems e.g., NCDs among Bangladeshi population.

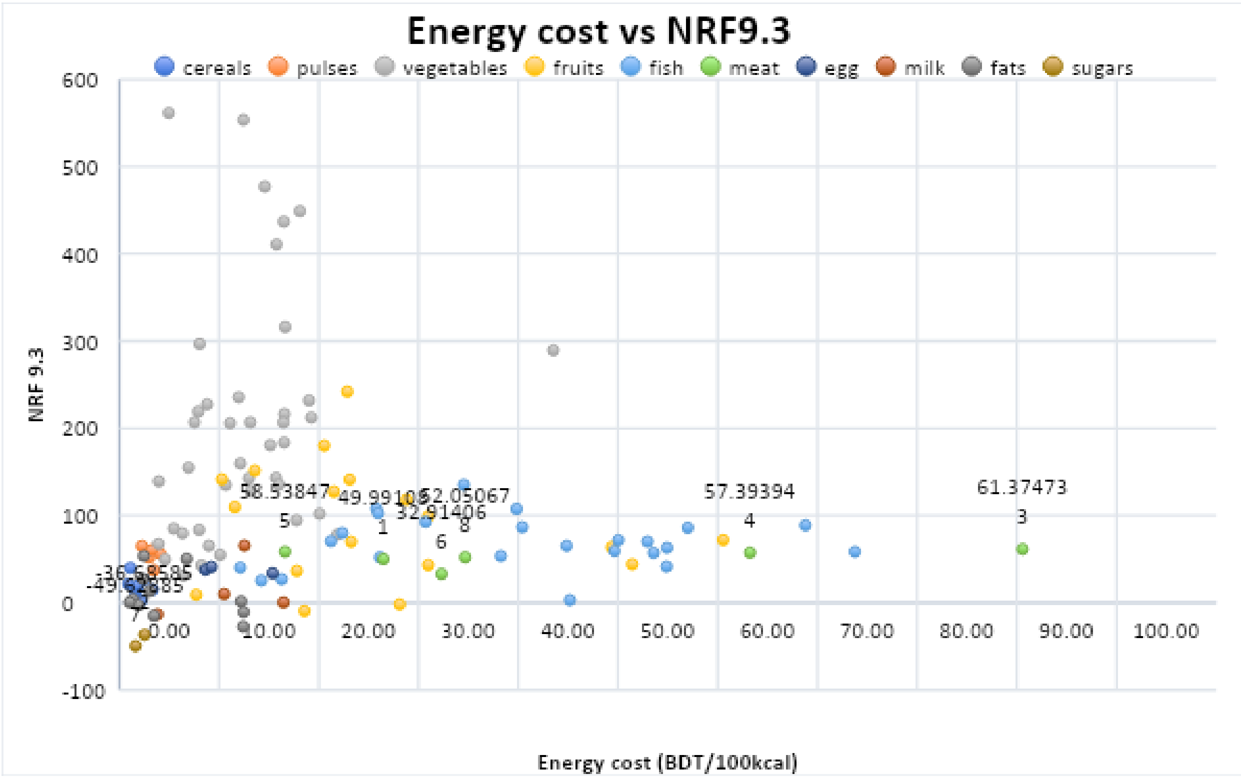


Figure 20. Energy cost vs NRF9.3

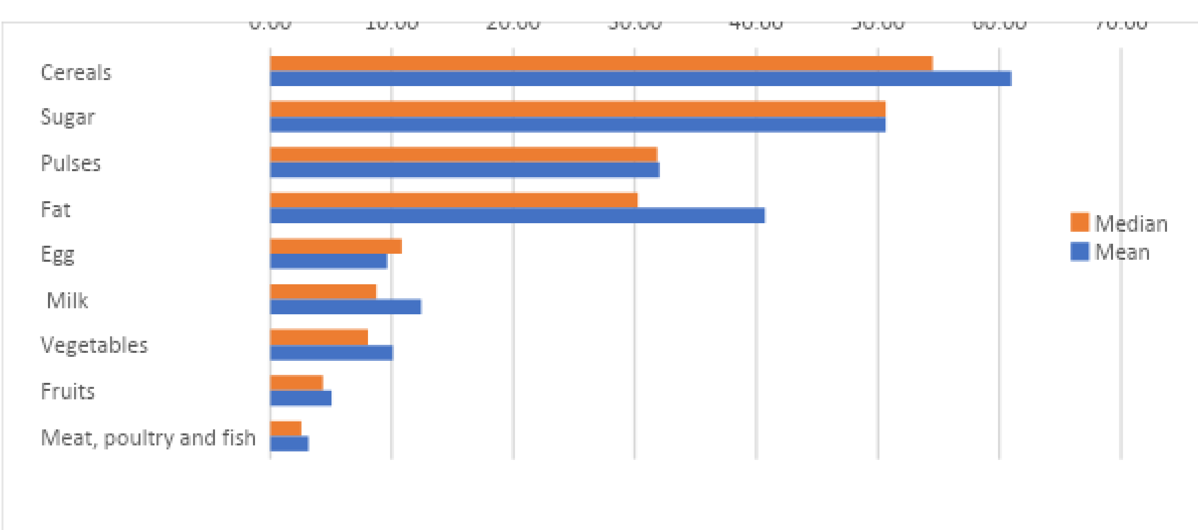


Figure 21. Mean and median calories per unit cost (kcal/BDT) for the nine different food groups

From the median values of calorie per unit cost (kcal/BDT) of different food groups it is evident that cereals give the highest energy return per taka followed by sugar, pulses, and fats & oils. On the other hand, meat, poultry, and fish are giving lowest energy per taka due to their high prices.

Food groups like fruits, vegetables, egg, and milk are nutrient dense but provide lower energy return.

Nutrient profiling of the individual foods of different food groups of FCDB according to ED, NNR and NRF9.3 are showing similarities with other studies of different developed countries (Jati et al., 2012; Connell et al., 2012). Therefore, nutrient density scores of the reported foods would be an important information resource for the consumers to make the appropriate food choices for preventing undernutrition and non-communicable diseases especially the vulnerable groups.

Chapter 7: Cost and affordability of recommended/nutritious diets in Bangladesh

7.1 Cost of the reference diets

The cost of diet increases incrementally as the diet quality increases from a basic energy sufficient diet to a nutrient adequate diet and then to a healthy diet across all divisions covering both urban and rural areas (Table 37).

Table 37. Cost of three reference diets in Bangladesh

Locations	Areas	Cost of energy sufficient diet (BDT)	Cost of nutrient adequate diet (BDT)	Cost of healthy diet (BDT)
Dhaka	Urban	19	30.9	88.4
	Rural	19	36.5	77
	Whole division	19	35.7	79
Chattagram	Urban	24.5	40.7	89.2
	Rural	18.4	31.5	70.6
	Whole division	21.4	35.7	84.5
Mymensingh	Urban	18.4	31.1	87.1
	Rural	18.4	41.2	76.3
	Whole division	18.4	30.5	80.5
Barisal	Urban	17.1	27.1	61
	Rural	21.4	36.2	74.5
	Whole division	19.3	39.8	70
Rajshahi	Urban	19.1	31.9	77
	Rural	17.4	29.1	69.1
	Whole division	18.5	32.6	75
Khulna	Urban	19.3	28.2	89
	Rural	18.4	33.1	88
	Whole division	18.1	30.1	80
Sylhet	Urban	17.1	41.1	92.5
	Rural	21.4	37.5	83

	Whole division	19.3	37.7	88
Rangpur	Urban	17.2	26.1	77
	Rural	21.5	33	64.1
	Whole division	19.3	29.5	75
National	Urban	19	37.1	85
	Rural	19.5	39.3	80
	Whole country	19.2	38.2	83

Energy Sufficient, Nutrient Adequate and Healthy diets cost 19.2 BDT, 38.2 BDT, and 83 BDT, respectively in Bangladesh (Table 37). Overall, a healthy diet costs 133 percent more than a diet that only meets the requirements for essential nutrients and more than 4 times as much as a diet that meets only the dietary energy needs through a starchy staple. The State of Food Security and Nutrition (SOFI), 2020 report using 2017 price data for 170 countries also reported same results where healthy diets cost 60 percent more than diets that only meet the requirements for essential nutrients and almost 5 times as much as diets that meet only the dietary energy needs through a starchy staple (FAO, 2020). Evidence of cost comparisons from existing studies indicates that the cost of nutritious foods, such as fruits, vegetables and animal source foods, is typically higher than the cost of more energy-dense foods high in fat, sugar and/or salt, and higher than the cost of starchy staples, oils, and sugars.

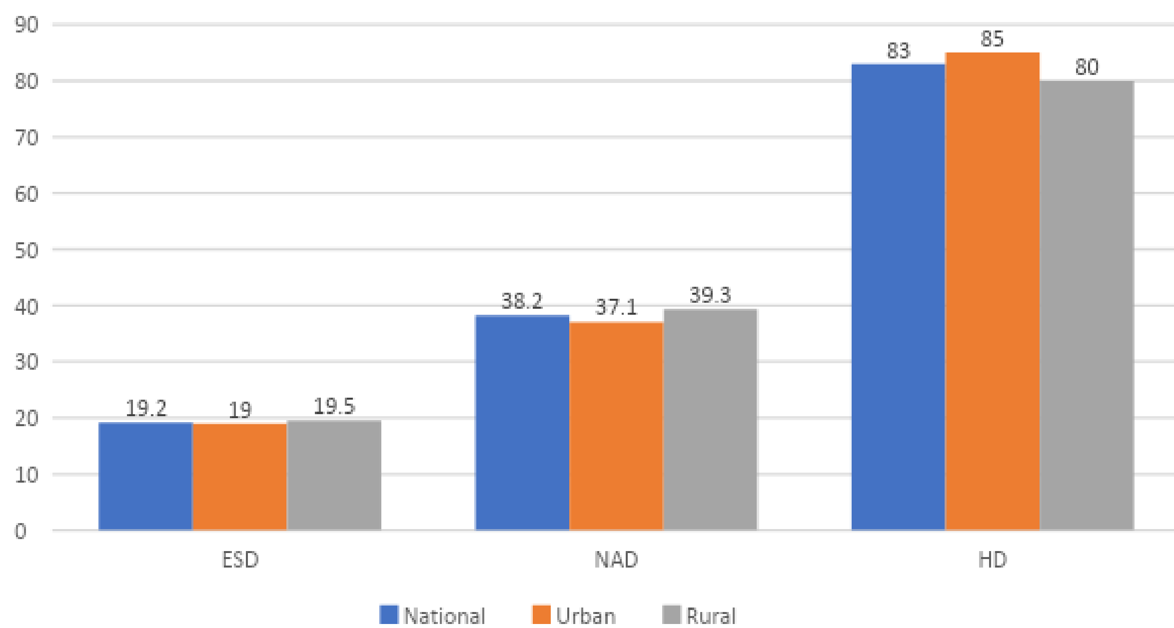


Figure 22. Comparison of the cost of three diets

While the cost of an energy sufficient diet and a nutrient adequate diet are relatively higher in rural areas than urban areas it is opposite for a healthy diet. Healthy diet costs 6.5 percent more in urban areas in comparison with rural areas whereas nutrient adequate diet and energy sufficient diet cost 5 percent and 2.5 percent more in rural areas respectively (Figure 22). This may happen because the prices of foods are typically higher in urban areas in comparison with rural ones. Foods like fruits, vegetables, and cereals are transported to the urban areas and thus transportation costs are likely to influence the food prices in the urban markets. As a healthy diet includes foods from all food groups according to FBDG of Bangladesh it tends to be more expensive in urban areas.

7.2 Regional variation in cost of the diets

In Bangladesh, the cost of diets differs greatly in eight divisions where a healthy diet is most expensive in Sylhet and least expensive in Barisal. However, the costs of nutrient adequate diet and energy sufficient diet are highest in Barisal and Chattagram divisions respectively (Figure 23).

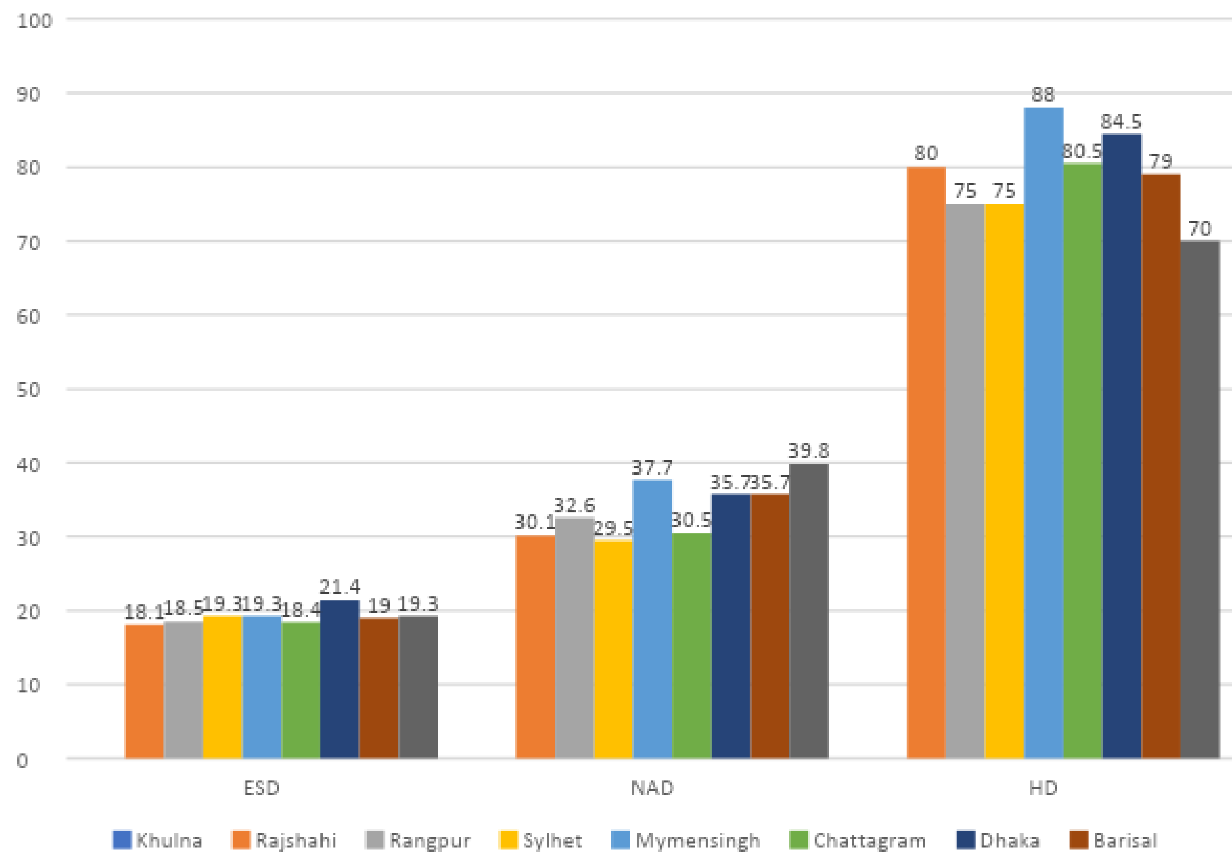


Figure 23. Cost of diets across eight divisions of Bangladesh

Healthy diet in Khulna costs 1.1 times more than Barisal and 1.1 times less than the cost of Sylhet division. The people of Rajshahi and Rangpur would have to spend the same amount of money for having a healthy diet whereas the people of Dhaka would have to spend 1.05 times more than them. The cost of energy sufficient diet is almost the same for all divisions which is in the range of 18.1-19.3 BDT except Rajshahi division where the diet costs around 21.4 BDT. Nutrient adequate diet costs least in Rangpur division and one must pay 34 percent more to get Nutrient adequate diet for Barisal division.

Cost of the diets fluctuates largely across regions as the prices of food items are very sensitive and may change in response with different factors (e.g., production, transportation system, and political stability). Nutritious foods are often highly perishable and less tradable, and thus their prices are determined by local productivity and value chain efficiency.

7.3 Diet quality of Bangladesh

Figure 24 compares the cost of a healthy diet against actual household expenditures for each of the seven food groups as reported in the latest HIES (HIES, 2016). According to the expenditure data of HIES, 2016 survey households spend the lion share of their food expenditure on starchy staples (38%) whereas it needs to spend only 21 percent to meet their daily requirements of cereals according to FBDG of Bangladesh. In contrast to staples, households underspend for protein foods and dairy products and on average overspends for fats and oils. They spend only 35 percent of their expenses on protein and 3 percent for dairy products. On the other hand, households spend 200 percent more for fats and oils compared to what is required for a healthy diet.

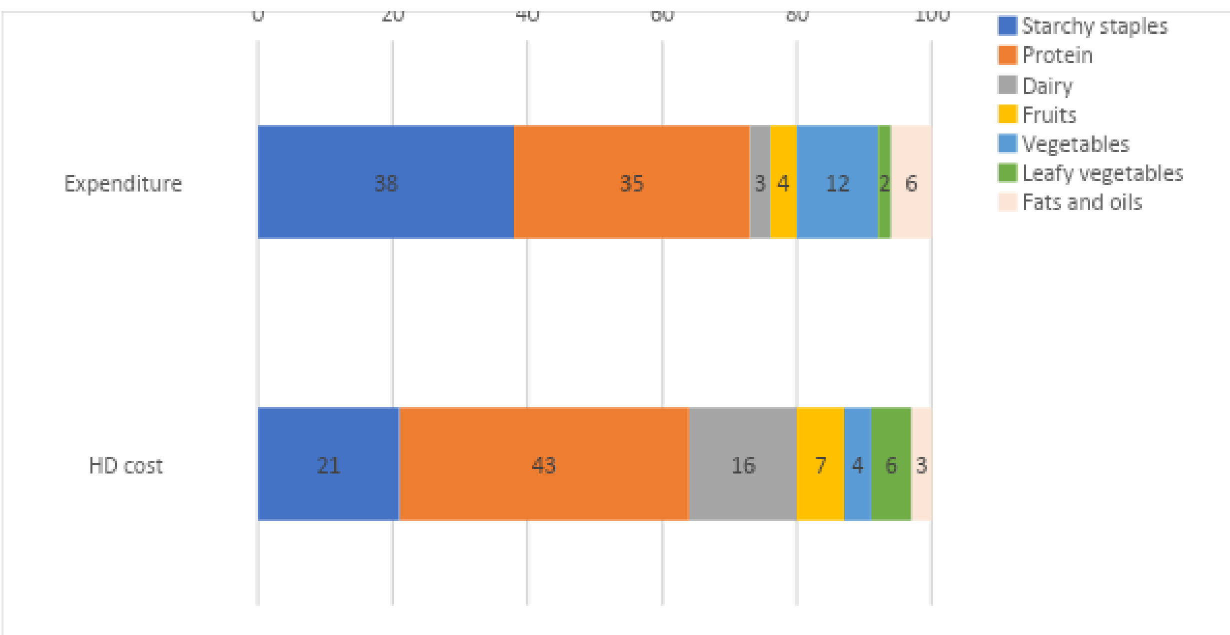


Figure 24. Cost of healthy diet and household food expenditure

The combined share of fruits and vegetables takes a large share of the healthy diet of Bangladesh. To meet required servings of fruits and leafy vegetables, households would have to spend 7 and 6 percent of their total food expenditure, respectively, but they spend only 4 percent on fruits and 2 percent on leafy vegetables. However, households spend more on vegetables than the cost of vegetables in healthy diets; so, it possibly indicates that they consume more expensive vegetables rather than cheaper ones. Among all food groups, staples possess the largest share of household expenditure, and spending more on cereals reduces their ability to pay for other micronutrient rich food groups.

7.4 Cost share of healthy diet for each food group

To the total cost of a healthy diet, the "meat, fish and egg" and "milk and milk products" food groups contribute the major share such as 32.6 BDT and 17.5 BDT, respectively (Figure 25). This means that for meeting the food based dietary guidelines of Bangladesh, an individual would need to spend more on meat, fish, and egg along with milk and milk products. The cost of meeting the recommended number of servings of all food groups except leafy vegetables and fruits is higher in urban areas than rural areas.

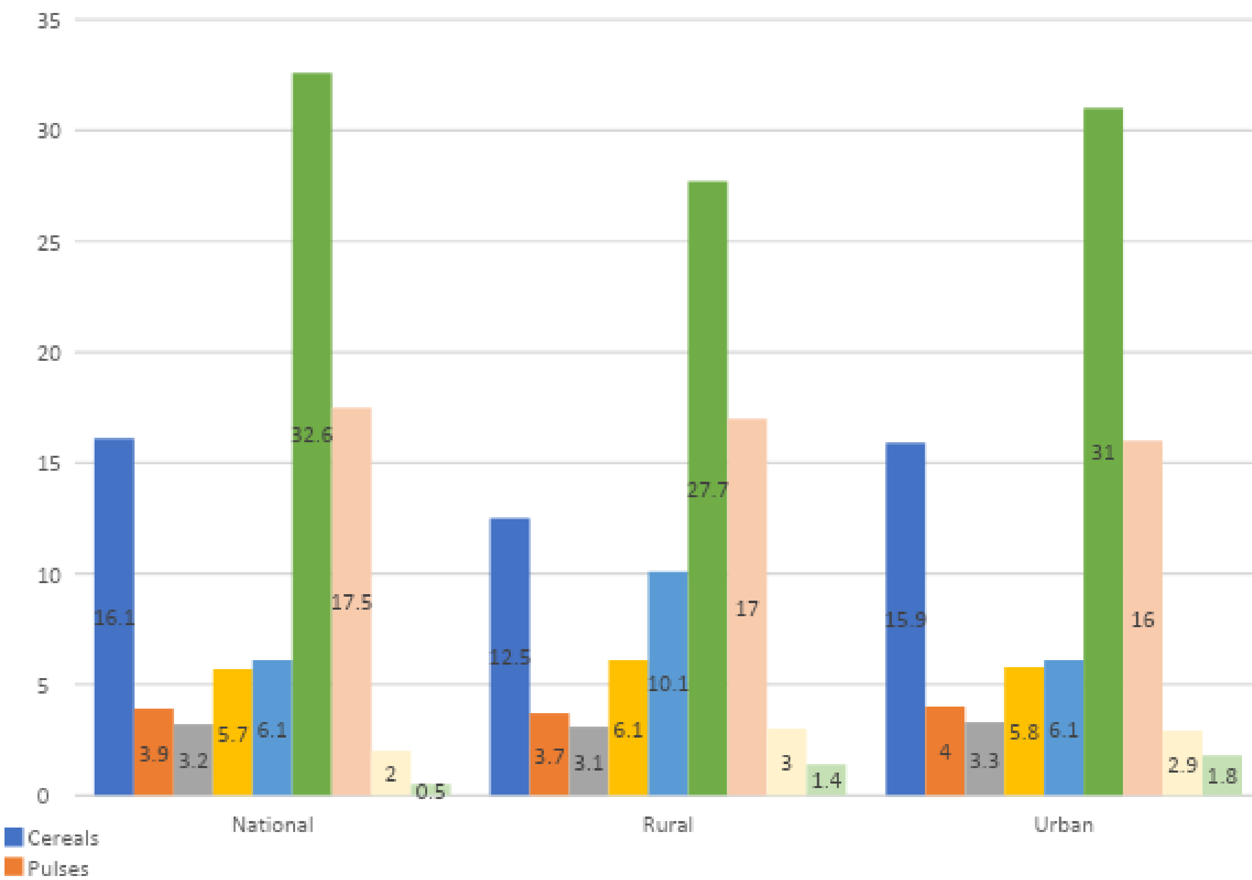


Figure 25. Cost contribution of each food group in a healthy diet

Figure 26 presents the cost contributions by the food groups across regions where meat, fish and eggs drive up the cost of a healthy diet in all divisions especially in Rangpur. The cost of each food group differs across divisions and, thus, is likely responsible for the regional differences in cost of the healthy diet. Followed by the meat, fish and egg food group, milk and milk products is the food group that costs more in Dhaka, Chattagram, Mymensingh and Sylhet division. The cost of meeting required amounts of cereals is the highest in Barisal and the lowest in Rangpur. To attain a healthy diet, one must pay relatively more for fruits and leafy vegetables in Dhaka whereas an individual from Rangpur would have to pay the least. The results indicate that not only the cost of the diets vary with geographical location but also the cost of each food group differs simultaneously.

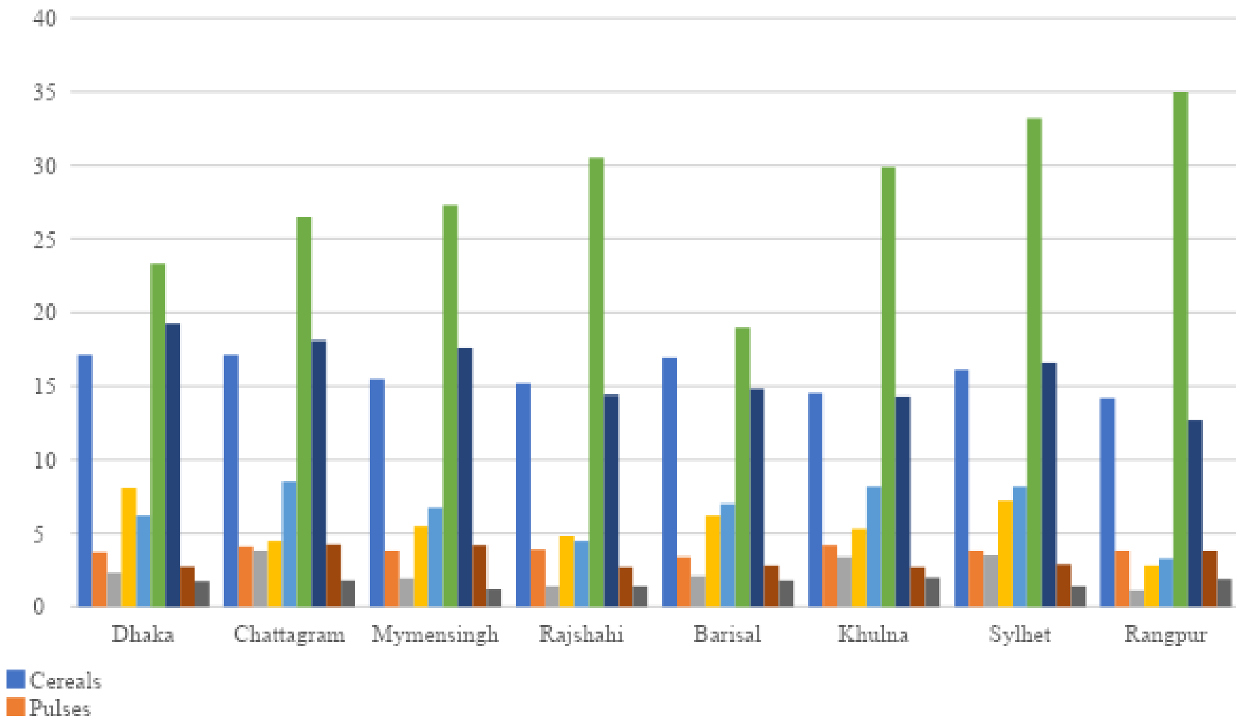


Figure 26. Cost contribution of food group in healthy diet across divisions

7.5 Affordability of diets

While nearly all of the households can afford energy sufficient diet and most of the households can afford nutrient adequate diet, cost of achieving a healthy diet is still beyond the purchasing power of approximately half of the households in all divisions (Table 38). As cost of the diets vary with region and residential area, affordability of these diets also differs with locations. Findings show that when we compare the cost of the diets with the poverty line the cost of a healthy diet remains much higher than the portion of the poverty lines that the poorest people spend on food. This puts healthy diet beyond the reach of those living in poverty or just above the poverty lines in all divisions.

As expected, an energy sufficient diet is most affordable in all divisions as well as nationally. Nationally about 41.3 percent households cannot afford healthy diet whereas only 0.09 percent households cannot afford energy sufficient diet. Energy sufficient diet is most affordable in Sylhet where almost all the households can pay for the diet and least affordable in Rangpur with the highest percent (0.28) of households unable to afford it. On the other hand, nutrient adequate diet is most unaffordable in Rangpur division (2.7%) followed by Barisal (2.5%) and

Mymensingh (2.4%). The affordability differs also with residential areas: only 0.3 percent households cannot afford in urban areas but 2.1 percent households living in rural areas are unable to afford it. If we compare the cost of the diets with the daily food expenditure of the households, it reveals that among all the divisions in Bangladesh, the highest proportion (0.66) of households who cannot afford healthy diets are from Khulna division and the fewest in Chattagram division (0.25). The burden of unaffordability of healthy diet is significantly greater in rural (42%) than urban (39%) areas.

Table 38. Percent of households unable to afford the reference diets

	ESD	**NAD**	**RHD**
	Households (%)	Households (%)	Households (%)
Rural	0.1	2.1	42.5
Urban	0.1	0.3	39.0
Barisal	0.20	2.5	35.6
Chattagram	0.04	1.9	25.5
Dhaka	0.05	0.7	30.4
Khulna	0.04	0.7	65.6
Mymensingh	0.07	2.4	47.3
Rajshahi	0.07	1.7	45.6
Rangpur	0.28	2.7	47.5
Sylhet	0.00	1.0	40.3
National	0.09	(1.6)	(41.3)

We also analyzed the district-wise proportion of households unable to afford a healthy diet (see Table 3 in Appendix-III-Table 3). It is evident from the analysis that the affordability of the diets is higher in urban areas in comparison with rural areas. This may happen because households of rural areas earn less than households of urban areas, and thus have less purchasing power.

Chapter 8: Optimized food baskets by life cycle stage

This chapter presents the results of the application of linear programming technique to obtain the least cost food baskets for an individual. Linear programming identified unique combinations of food items in particular amounts that fulfills the nutritional recommendations of a particular person.

8.1 Costs of the different versions of the least-cost baskets across the life cycle

As mentioned in the section 3.5, we applied linear programming to model four different versions ((i) energy-adequate; (ii) nutritionally adequate; (iii) nutritionally adequate, health-promoting; and (iv) nutritionally adequate, health-promoting and culturally acceptable) of least-cost diets each of which was characterized by a defined set of constraints.

The following section provides the costs of these four versions of food baskets designed for specific population groups.

Table 39. Costs of different-quality food baskets across the life-cycle stages

Life-cycle stages (yr: year; SA: Sedentary Active; MA: Moderate Active; HA: Heavily Active)			**Costs (in BDT) of different-quality food baskets**			
			Energy-adequate	Nutritionally adequate	Nutritionally adequate, health-promoting	Nutritionally adequate, health-promoting and culturally acceptable
Children		1-3 yr	10.0	18.2	25.9	32.6
		4-6 yr	12.3	25.1	31.8	38.8
		7-9 yr	15.4	29.3	39.1	47.6
Adolescents	**Boys**	10-12 yr	20.1	36.8	46.6	57.1
		13-15 yr	25.9	46.1	63.2	77.7
		16-18 yr	30.0	53.2	96.4	121.4
	Girls	10-12 yr	18.6	34.9	44.6	54.2
		13-15 yr	21.7	40.2	50.2	61.9
		16-18 yr	22.6	41.1	52.2	64.0
Adults	**Men**	SA	19.1	34.9	45.5	56.2
		MA	24.5	43.7	56.8	67.9
		HA	31.4	56.1	97.8	124.2
	Women	SA	15.0	31.7	42.1	54.7

		MA	19.3	38.3	48.4	58.4
		HA	24.6	47.8	61.2	77.2
Pregnant women	**2nd trimester**	SA	18.2	40.8	50.4	59.5
		MA	22.4	44.4	54.6	65.7
		HA	27.8	49.6	66.4	84.2
	3rd trimester	SA	18.2	40.8	50.4	59.5
		MA	22.4	44.4	54.6	65.7
		HA	27.8	49.6	66.4	84.2
Lactating women	**0-6 months**	SA	20.4	45.7	56.2	66.4
		MA	24.7	49.3	62.7	78.3
		HA	30.0	54.9	81.6	106.8
	6-12 months	SA	19.7	44.3	54.0	64.1
		MA	24.0	47.9	59.9	70.3
		HA	29.3	53.4	75.4	99.2

As evident in Table 39, the costs of least-cost food baskets rise as the complexity of the baskets increase with additional constraint. For any given individual at any stage of their life cycle, the cost of an energy-adequate *basket* is the lowest and that of a nutritionally *adequate, health-promoting and culturally acceptable basket* is the highest. It is also evident that the cost of food baskets for an individual rises with increasing levels of physical activity. For example, the cost of a food basket for an adult man doing heavy physical activity is highest across all the versions of baskets (31.4 BDT, 56.1 BDT, 97.8 BDT, 124.2 BDT). The costs of each version of the food baskets also vary depending on sex with baskets for females costing higher than their counterparts.

8.2 Composition of the nutritionally adequate, health-promoting and culturally acceptable baskets across the life cycle stages

While we identified the best combinations of food items for four different versions of baskets, the following section provides the composition (i.e., name and amount) of only the *nutritionally adequate, health-promoting and culturally acceptable basket* as it represents the highest quality. Application of linear programming identified 32 key nutrient-dense foods that comprised the nutritionally adequate, health-promoting, and culturally acceptable least cost food baskets designed for different population groups across the life cycle stages. The identified foods were locally available in the market areas, contained a majority of macro or micronutrients in the diets, and were the least expensive compared with alternative foods of similar nutrient composition. Food items that were almost universally included in the food baskets were rice, wheat flour, grass pea, egg (chicken), potato, melon (futi), slender amaranth leaves, water spinach, whole milk, soya oil, and sugar. Other food items comprising the food baskets included millet, soybean, bengal gram, radish, amaranth stem, cabbage, sweet potato, colocasia (taro), carambola, banana, red amaranth leaves, green amaranth leaves, radish leaves, jute leaves, Indian spinach, egg (duck), pool barb, palm oil, jackfruit seeds, and jaggery.

Table 40 presents the composition (i.e., name and amount) of the *nutritionally adequate, health-promoting and culturally acceptable basket* for children according to their age groups.

Table 40. Food Basket for children according to their age group

1-3 years (BDT 32.6)		4-6 years (BDT 38.8)		7-9 years (BDT 47.6)	
Food items	**Weight (g)**	**Food items**	**Weight (g)**	**Food items**	**Weight (g)**
Rice	106	Rice	130	Rice	163
Wheat flour	52	Wheat flour	84	Wheat flour	110
Potato	50	Potato	50	Potato	50
Grass pea	30	Grass pea	30	Grass pea	30
Radish	50	Cabbage	50	Radish	100
Slender amaranth leaves	40	Slender amaranth leaves	23	Slender amaranth leaves	33
Radish leaves	4	Water spinach	55	Water spinach	67
Water spinach	6	Melon (futi)	100	Melon (futi)	100
Melon (futi)	100	Egg (chicken)	28	Egg (chicken)	100
Egg (chicken)	50	Egg (duck)	22	Whole milk	100
Whole milk	100	Whole milk	100	Soya oil	30
Soya oil	15	Soya oil	25	Palm oil	1
Palm oil	6	Sugar	15	Sugar	15
Sugar	15				

Table 41 presents the composition (i.e., name and amount) of the *nutritionally adequate, health-promoting and culturally acceptable basket* for adolescents according to their age groups.

Table 41. Food baskets for adolescent boys according to their age group

10-12 years (BDT 57.1)		13-15 years (BDT 77.7)		16-18 years (BDT 121.4)	
Food items	**Weight (g)**	**Food items**	**Weight (g)**	**Food items**	**Weight (g)**
Rice	213	Rice	274	Rice	318
Wheat flour	150	Wheat flour	150	Wheat flour	77
Potato	50	Millet	26	Millet	55
Grass pea	52	Potato	50	Potato	150
Cabbage	150	Soybean	60	Soybean	60
Slender amaranth leaves	33	Cabbage	101	Colocasia/Taro	300
Water spinach	84	Sweet potato	49	Water spinach	150
Melon (futi)	100	Slender amaranth leaves	21	Banana (sagar)	100
Egg (chicken)	100	Water spinach	205	Pool barb	104
Whole milk	100	Carambola	100	Egg (duck)	63
Soya oil	30	Egg (chicken)	44	Whole milk	300
Palm oil	15	Egg (duck)	56	Soya oil	30
Sugar	15	Whole milk	100	Palm oil	15
		Soya oil	30	Jackfruit seeds	7
		Palm oil	15	Sugar	25
		Jackfruit seeds	52		
		Sugar	25		

Table 42 presents the composition (i.e., name and amount) of the *nutritionally adequate, health-promoting and culturally acceptable basket* for adolescents according to their age groups.

Table 42. Food baskets for adolescent girls according to their age group

10-12 years (BDT 54.2)		13-15 years (BDT 61.9)		16-18 years (BDT 64.0)	
Food items	**Weight (g)**	**Food items**	**Weight (g)**	**Food items**	**Weight (g)**
Rice	198	Rice	253	Rice	279
Wheat flour	150	Wheat flour	150	Wheat flour	150
Potato	50	Potato	50	Potato	50

Grass pea	30	Bengal gram	57	Bengal gram	41
Cabbage	150	Grass pea	3	Soybean	19
Slender amaranth leaves	38	Cabbage	150	Radish	40
Water spinach	72	Slender amaranth leaves	37	Cabbage	110
Melon (futi)	100	Water spinach	116	Slender amaranth leaves	46
Egg (chicken)	100	Melon (futi)	100	Water spinach	104
Whole milk	100	Egg (chicken)	100	Melon (futi)	100
Soya oil	30	Whole milk	100	Egg (chicken)	100
Palm oil	12	Soya oil	30	Whole milk	100
Sugar	15	Palm oil	15	Soya oil	30
		Sugar	15	Palm oil	15
				Sugar	15

Table 43 presents the composition (i.e., name and amount) of the *nutritionally adequate, health-promoting and culturally acceptable basket* for adult men according to their physical activity level.

Table 43. Food Basket for adult men according to their level of physical activity

Sedentarily active (BDT 56.2)		**Moderately active (BDT 67.9)**		**Heavily active (BDT 124.2)**	
Food items	**Weight (g)**	**Food items**	**Weight (g)**	**Food items**	**Weight (g)**
Rice	202	Rice	300	Rice	333
Wheat flour	150	Wheat flour	150	Wheat flour	39
Potato	50	Potato	50	Millet	78
Grass pea	60	Grass pea	60	Potato	50
Radish	150	Cabbage	150	Grass pea	60
Slender amaranth leaves	55	Slender amaranth leaves	40	Colocasia/Taro	300
Amaranth leaves, green	39	Water spinach	159	Water spinach	250

Water spinach	56	Melon (futi)	100	Banana (sagar)	102
Melon (futi)	44	Egg (chicken)	100	Pool barb	146
Carambola	56	Whole milk	100	Whole milk	300
Egg (chicken)	100	Soya oil	30	Soya oil	30
Whole milk	100	Palm oil	15	Palm oil	14
Soya oil	30	Jackfruit seeds	57	Jackfruit seeds	194
Palm oil	2	Sugar	25	Sugar	25
Sugar	15				

Table 44 presents the composition (i.e., name and amount) of the *nutritionally adequate, health-promoting and culturally acceptable basket* for adult women according to their physical activity level.

Table 44. Food Basket for adult women according to their level of physical activity

Sedentarily active (BDT 54.7)		**Moderately active (BDT 58.4)**		**Heavily active (BDT 77.2)**	
Food items	**Weight (g)**	**Food items**	**Weight (g)**	**Food items**	**Weight (g)**
Rice	159	Rice	204	Rice	300
Wheat flour	111	Wheat flour	150	Wheat flour	150
Potato	50	Potato	50	Potato	92
Bengal gram	30	Grass pea	30	Grass pea	60
Radish	118	Cabbage	150	Amaranth stem	270
Amaranth stem	32	Slender amaranth leaves	44	Jute leaves	59
Amaranth leaves, red	122	Water spinach	170	Water spinach	91
Indian spinach	28	Melon (futi)	100	Melon (futi)	100
Melon (futi)	100	Egg (chicken)	100	Egg (chicken)	100
Rohu	17	Whole milk	100	Whole milk	100
Egg (chicken)	83	Soya oil	30	Soya oil	30
Whole milk	100	Palm oil	12	Palm oil	15
Soya oil	30	Sugar	15	Jackfruit seeds	52

Jaggery	15		Sugar	25

Table 45. Food baskets for pregnant women according to their physical activity level

Sedentarily active (BDT 59.5)		**Moderately active (BDT 65.7)**		**Heavily active (BDT 84.2)**	
Food items	**Weight (g)**	**Food items**	**Weight (g)**	**Food items**	**Weight (g)**
Rice	193	Rice	263	Rice	295
Wheat flour	150	Wheat flour	150	Wheat flour	150
Potato	50	Potato	50	Millet	6
Grass pea	32	Grass pea	60	Potato	56
Cabbage	150	Cabbage	150	Soybean	31
Slender amaranth leaves	31	Slender amaranth leaves	32	Grass pea	29
Indian spinach	32	Water spinach	224	Colocasia/Taro	299
Water spinach	218	Melon, Futi	100	Slender amaranth leaves	8
Melon, Futi	100	Egg (chicken)	100	Water spinach	236
Egg (chicken)	100	Whole milk	100	Carambola	100
Whole milk	100	Soya oil	30	Pool barb	9
Soya oil	30	Palm oil	15	Egg (chicken)	91
Sugar	15	Sugar	15	Whole milk	100
				Soya oil	30
				Palm oil	15
				Jackfruit seeds	70
				Sugar	25

Table 45 presents the composition (i.e., name and amount) of the *nutritionally adequate, health-promoting and culturally acceptable basket* for pregnant women according to their stage of pregnancy and physical activity level. It is noteworthy that although women need extra protein during their third trimester of pregnancy, the same basket can meet the requirements both during the third and second trimesters of pregnancy.

Table 46. Food baskets for Lactating women (0-6 months) according to their physical activity level

Sedentarily active (BDT 66.4)		Moderately active (BDT 78.3)		Heavily active (BDT 106.8)	
Food items	**Weight (g)**	**Food items**	**Weight (g)**	**Food items**	**Weight (g)**
Rice	217	Rice	287	Rice	318
Wheat flour	150	Wheat flour	150	Wheat	132
Potato	50	Potato	50	Potato	97
Bengal gram	60	Grass pea	60	Soybean	25
Cabbage	150	Amaranth stem	300	Grass pea	35
Slender amaranth leaves	43	Slender amaranth leaves	26	Sweet potato	19
Jute leaves	48	Water spinach	124	Colocasia/Taro	281
Water spinach	209	Melon (futi)	100	Water spinach	203
Melon (futi)	100	Egg (chicken)	85	Carambola	100
Egg (chicken)	84	Egg (duck)	15	Pool barb	98
Egg (duck)	16	Whole milk	120	Egg (chicken)	2
Whole milk	100	Soya oil	30	Whole milk	300
Soya oil	30	Palm oil	15	Soya oil	30
Palm oil	6	Jackfruit seeds	85	Palm oil	14
Sugar	15	Sugar	25	Jackfruit seeds	151
				Sugar	25

Table 46 presents the composition (i.e., name and amount) of the *nutritionally adequate, health-promoting and culturally acceptable basket* for lactating women of 0-6 months according to their physical activity level.

Table 47. Food baskets for Lactating women (7-12 months) according to their physical activity level

Sedentarily active (BDT 64.1)		Moderately active (BDT 70.3)		Heavily active (BDT 99.2)	
Food items	**Weight (g)**	**Food items**	**Weight (g)**	**Food items**	**Weight (g)**
Rice	209	Rice	300	Rice	311

Wheat flour	150	Wheat flour	150	Wheat	139
Potato	50	Potato	50	Potato	150
Bengal gram	55	Bengal gram	12	Soybean	23
Cabbage	150	Grass pea	48	Grass pea	37
Slender amaranth leaves	46	Cabbage	150	Sweet potato	28
Water spinach	254	Slender amaranth leaves	55	Colocasia/Taro	272
Melon (futi)	100	Water spinach	245	Water spinach	150
Egg (chicken)	84	Melon (futi)	100	Carambola	100
Egg (duck)	16	Egg (chicken)	84	Pool barb	52
Whole milk	100	Egg (duck)	16	Eggs (chicken)	48
Soya oil	30	Whole milk	100	Whole milk	285
Palm oil	1	Soya oil	30	Soya oil	30
Sugar	15	Palm oil	15	Palm oil	15
		Sugar	19	Jackfruit seeds	96
				Sugar	25

Table 47 presents the composition (i.e., name and amount) of the *nutritionally adequate, health-promoting and culturally acceptable basket* for lactating women of 7-12 months according to their physical activity level.

8.3 Modification of diets to address socio-cultural acceptability, seasonality, and economic issues

Cultural acceptability of foods, whether edible or non/less edible, has regional, including rural-urban, and cross-cultural variations. Life cycle, seasonality, religion, and beliefs about the risk of morbidity can enhance the extent of that variation. At the time of economic shock, people often go with tradition rather than shifting food items by reducing meal items or skipping meals. The following sections provide information on different food groups which need to be considered when modifying the least-cost baskets designed through linear programming (section 5.2).

Cereals

Table 48 shows commonly eaten cereal and its variation by regions and contexts. People of all age groups, both Muslim and Hindu, commonly eat rice (especially boiled rice) and white-wheat flour (chapatti, paratha, bread, etc.) except children up to six months in rural and urban areas across the regions. In all the regions, rice is more popular than wheat flour, even in the low-income groups. Out of three meals, rice is taken at least two meals except for people with medication.

Interestingly, there is a variation to whether use boiled rice or un-boiled/raw rice. Unlike people of other divisions who typically use boiled paddy to make rice (cooked), the people of Khulna and Barisal moderately use raw rice (*atop chal*) to make rice (cooked).

The basis for the popularity of rice is local production, availability, habitual diet by generations and tradition, and religion (rice is a crucial component in rituals, including religion, among Hindus and, to some extent, social rituals of rural Muslim). A mother living in an urban area of Chattogram, stated in an FGD:

“From childhood, we have habituated to eat rice (boiled rice); any other foods cannot meet the hungriness for food; so, we eat rice.”

Similarly, a father residing in the urban setting of Barisal expressed in a KII:

"if I don't eat rice in a single meal, I feel I have not eaten anything".

Table 48. Commonly eaten cereal and its variation by regions and contexts

Aspects	**Commonly Eaten Cereals**	**Variation by Regions, and Contexts**
Economic crisis	-Rarely shift to other cereals, -Instead stick to rice, if necessary reduced amount rice taken in each meal or skip meal in nearly all the regions -Price fluctuation sometimes influences to adjustment of cereals for the meal in all the regions. *They often combined rice with other low-cost cereals in meals. Alternatively, those who use to eat rice in three meals a day may add wheat flour or others in one meal and rice is taken for the other two meals.*	In Dhaka, people prefer bread (chapatti) instead of rice during an economic crisis. *"When the price of rice gets high, the price of wheat is comparatively low; that time we eat bread," A father, inhabitant of Dhaka, told.* Similarly, price fluctuation impact on choosing what cereals to eat.

Social and Religious Rituals/Events	-Semolina, red-wheat, rice flakes and rice puff, and vermicelli, are also more or less prevalent in various divisions.	-Mymensingh division is the only place where millet is used to make *Polao*, Payesh and cake. -Hindu communities, especially Khulna, Barishal and Mymensingh, strictly maintain eating rice flakes at worship days. - Muslims of Khulna and Barishal mainly eat rice flakes at Iftar (break of fasting during Ramadan period), but in other areas, rice puff is much prevalent during the Iftar. -Puffed rice is eaten as snacks everywhere in Bangladesh.
Life Cycle	**Children aged (6 to 23 months):** - Parents feed them semolina and soft vegetable hotchpotch across the regions in Bangladesh because babies can quickly eat soft food and digest it quickly. **Aged (60 years and above):** - No variation to offer cereals for people with old age in Bangladesh. **Pregnant Women:** - Little or no variation for pregnant to offer cereals: usually, rice and wheat flour are given to them. **Lactating Mother:** -Lactating mother has usually avoided any kinds of bread made from wheat flour across the regions,	**Children aged (6 to 23 months):** -In Khulna and Barisal regions, mother offer *'jao vat'* (watery with a bit of thickness of boiled rice mixed with salt) with raw rice (locally known as Atop Chal) to their children. **Aged (60 years and above):** - The people of Rajshahi give a low amount of rice to them. *They think that if older people eat more rice, it might be harmful to them. Sometimes they may catch a cold.* - In Dhaka region, the pregnant women eat 'fena vat' (rice juice produced during boiling rice). It is widely believed that *'fena vat' give strength to the pregnant.* **Lactating Mother:** -Any dry preparation is strictly avoided in Mymensingh region. *A reputed belief is that any dry preparation, such as chapatti, bread etc., produced from wheat flour can cause a reduction of breast milk.*

Seasonal variation	-Not find any seasonal variation while choosing cereals.	-Similar in all regions
Non-Edible or Less edible	-No religious taboos in Muslim and Hindus in choosing any cereals.	-Less edible cereals in meals are the less available cereals, not produced locally and not popular, and its high price.

Pulses

Pulses are very popular to all ages of people in rural and urban areas in all the regions. Generally, people eat several kinds of pulses, namely, Lentil (dried), Grass pea, Green gram, Bengal gram, Black gram, Soybean (dried). Table 49 shows commonly eaten pulse and its variations by regions and contexts.

Table 49. Commonly eaten pulses and its variation by regions and contexts

Aspects	Commonly Eaten Pulse	Variation by Regions and Context
Economic Crisis and Affordability	- Lentils is the most preferred one except for people with stomach problems, such as ulcers and allergy, because of its taste, nutrients, and low cost (with small amounts of Lentil, many people could be served). -(with small amounts of Lentil, many people could be served). Its usage is also increased during the economic crisis. A father, inhabitant of Dhaka, said, *"Without pulses we can't imagine a meal, rich or poor everyone like it"*. - Again, economic shocks enhance pulses' eating, especially lentil, *anchor dal peas,* because its price is relatively low but tastes good. Other pulses, such as Green Gram, Black gram etc., which have a high price, are avoided or less preferred.	-In Mymensingh and Rajshahi division, people are fond of black gram because of its local production, nutritious value, quality to enhance appetite, and traditionally eaten by generation. Again, Bengal gram is most popular as snacks (especially at Iftar during Ramadan month). It is not usually eaten as a meal item. Dhaka urban and Mymensingh rural people use Grass pea to make fast food (*piaju*).

Social and religious rituals and events	--Though green gram tastes well, its price is comparatively high. So, it is taken in occasionally during rituals and festive period.	-In Khulna and Barishal division, Muslims intend to cook green gram at their marriage ceremony. Also, the Hindu community people of Sylhet division eat green gram at the time of worship.
Life Cycle	**Children (6-23 months)**: -Lentils and other pulses are often used in hotchpotch preparation in across the regions. **Aged (60 years and over):** -Pulses are provided more often due to their nutritious value in all the region. **Pregnant Women and Lactating Mother:** -Pregnant and lactating mother are encouraged to take any kinds pulses because of their nutrition value and other benefits.	**Children (6-23 months)**: -Similar to all regions. **Aged (60 years and over):** -Mostly like all areas. Older people avoid grass pea for gastric. **Pregnant and Lactating Mother:** - For pregnant and lactating mother, in Rangpur and Rajshahi division, lentils are offered more. There is a belief that *if breastfeeding mothers eat lentil, the baby gets more milk.*
Seasonal variation	-Seasonal variation has an impact on eating pulses. During the period, price falls a bit, so it also encourages to take more.	- During the production season, locals take specific pulse more after the yield.

Edible or Less Edible	All the pulses are edible,	-Some pulses are encouraged to avoid people with morbidity condition and during religious worship period. -Hindu communities usually avoid any kinds of pulses at the time of Puja. *They think that pulse is one kind of Protein.* -Lentil is avoided when people have ulcer, allergy, and kidney problems. -In Mymensingh division, people do not allow black grams to old persons with Asphyxia, Cold and Asthma. -In Rangpur, rural people do not feed black gram to their children because they believe it causes cold. -In Mymensingh urban people do not eat black gram because it is considered as one of the reasons for gastric/ulcer problem.

Non-leafy vegetables

A range of non-leafy vegetables is eaten across the regions (Table 50). However, potato is a commonly eaten root vegetable item eaten irrespective of economic condition, ages, season, residence, and region. Besides potato, also common in all the regions are brinjal, pointed gourd, and pumpkin. Those are eaten because of their availability and low cost.

Table 50. Commonly eaten non-leafy vegetables and its variation by regions and contexts

Factor	Commonly Eaten Non-Leafy Vegetables	Variation by Regions and Contexts
Economic Crisis	-If nothing is available and accessible to serve with rice in a meal, at least potato put on the menu. Applicable for all the regions	-No variations are observed

Seasons	-Does matter on the availability of non-leafy vegetables. -During the summer, nearly all consume bitter gourd, Okra, pointed gourd, plantain, drumstick, pumpkin, sweet potato, carrot, stem, and taro across the regions. -During winter, nearly all eat cauliflower, cabbage, tomato, cowpea, radish, beans, and gourd across the regions. -All the year round, onion, green chili, brinjal, potatoes are eaten across the regions	-Local production by seasons impacts on the scale and extent of the non-leafy vegetables eaten.
Life Cycle	**Children (6 to 23 months)**: -When cooking vegetable hotchpotch, the mothers/caregivers combine potato, pumpkin, cauliflower, and beans. **Aged (60 years and above):** -They are encouraged to eat various non-leafy vegetables. **Pregnant Women and Lactating Mother:** -The pregnant women and lactating mothers are also usually motivated to eat more vegetables except those believed to cause some problems. *A commonly held belief, when a breastfeeding mother eats vast amounts of gourd, the baby can get more milk.*	**Children (6-23 months)**: -Rural people make Halwa with carrots for their children in Khulna regions. **Aged (60 years and above):** -For aged people (60 years and above), no variation is observed. **Pregnant Women and Lactating Mother:** -Rural people of Sylhet do not give Taro to pregnant and breastfeeding mothers because it may cause allergies. -Rural breastfeeding mothers of Rangpur region avoid bitter gourd because it is believed to increase stomach pain.

Non-Edible or Less Edible	-The price does matter whether to and what to eat the non-leafy vegetable items. -There are hardly any religious taboos over any non-leafy vegetables.	-There is a belief that some may cause illness. In Dhaka division, like other areas, a mother in an FGD state, *"We never give papaya to a pregnant woman because papaya is one of the reasons for abortion. Similarly.* pregnant *also avoid cucumbers because it may cause cold to the children.* -Many Hindus eat onions, garlic, but vegetarian Hindus avoid them. - In Khulna region, availability (by local production) and traditions, many eat lily plants as one of their favorite foods. -In Khulna region, rural people normally eat Taro, but they never feed it to their children because taro is the cause of the cold. -Rural people of Khulna and Dhaka prefer fewer amounts of pumpkin, okra, brinjal and taro as those cause allergies. -Brinjal is responsible for allergy, so persons with allergy usually avoid brinjal.

Leafy vegetables

Generally, all kinds of leafy vegetables are eaten across the regions. However, there are several factors (see Table 51) that affect its scale and extent of eating leafy vegetables.

Table 51. Commonly eaten leafy vegetables and its variation by regions and contexts

Factors	**Commonly Eaten Leafy Vegetables**	**Variations by Regions and Context**

Seasons	In Winter, all the people of Bangladesh eat Amaranth leaves, gourd leaves, jute leaves, and Radish leaves as spinach. In summer, they eat pumpkin leaves, taro stems and Indian spinach.	-Regional variation in production local leafy vegetable items -People Mymensingh areas produce one kind of leafy vegetable called 'Kata Khuira.', which is popularly eaten. -Barishal has some local leafy vegetables such as maloncho, helencho, koloi shak, kapakanachi, surma, khata cira; these are edible fern. -Rangpur also has some local leafy vegetables such as Khurhiya, Pelka, potato leaves, Lapa shak etc. -In Dhaka, grass pea leaves and mustard leaves are eaten. -Rajshahi people, besides casual leafy vegetables, also eat their local 'katoya shak' and 'dhenga shak.' 'Nali shak' is Sylhet's local leafy vegetable.

Life Cycle	**Children (6-23 months):** -Children (6-23 months) are feed all kinds of vegetables across the regions. **Aged (60 years and above):** -Leafy vegetables are offered in general. **Pregnant women:** -Pregnant women also eat taro stems and green leaves in most of the regions. In Mymensingh, expectant mothers eat huge amounts of taro stems. They think it is very beneficial for the mother due to its nutrients needed for a pregnant and lactating mother. It gives energy, and its price is too low. **Lactating Mother:** -Leafy vegetables are generally consider very beneficial to their health.	**Children (6-23 months):** -In Dhaka, urban mothers cook jute leaves with grams for their children, -Urban people of Rangpur and Khulna and rural people of Sylhet give Amaranth leaves to their children because it has more nutrition and is very tasty. Children love to eat it. -Rajshahi urban people think that amaranth leaves and green leaves are the houses of energy for the children. **Aged (60 years and above):** -Rural and urban Rajshahi older people suffering from Asphyxia and cold avoid spinach, taro stem, and Indian spinach -Amaranth leaves are not given to older people in Mymensingh because it may cause stomach problems. **Pregnant:** -In Dhaka regions, pregnant are feed amaranth leaves and spinach, but Rajshahi mother avoid spinach as it may cause cold. -In Rangpur region, pregnant mothers avoid only lapa shak. -The pregnant rural Rajshahi are encouraged to consume taro stem because it contains iron. **Lactating Mother:** -Rural Rajshahi avoid some leafy vegetables, such as Indian spinach, taro stem, and spinach to the breastfeeding mother. They believe that those cause of cold for the children. -Rangpur's breastfeeding mothers avoid lapa shak and Indian spinach as they believe it causes cold.
Social and Religious Events/Rituals	-Mostly permitted to eat in any social and religious events in all the regions	-In Khulna region, urban Hindus do not eat kolmi shak in October (ashwin) and avoid Indian spinach when worshipping Ekadhoshi as they think it contains protein.

Non-Edible or Less Edible	-Mostly edible in all the regions.	-Rajshahi rural people avoid some leafy vegetables, but Rajshahi urban people avoid only spinach because it is the cause of cold. -Rangpur urban people often avoid lapa shak, Indian spinach, because it causes cold.

Fruits

Across the regions, people eat native and imported fruits. Due to locality in fruits production, there are regional variations too. All the people of Bangladesh prefer seasonal fruits. People try to take this fruit in the season when it is available. In many cases, when the price is high, they buy in a low amount but eat these fruits. Fruits like mango, blackberry, jackfruit, litchi, watermelon are eaten in summer, while plum and orange are eaten more in winter. Apple and grapes are also eaten at times. Pomegranate is mainly given to children and pregnant women as it increases blood and makes their body strength. The Hindus need different types of fruits, especially cucumbers, apples, and grapes. Again, Muslims must have dates during Iftar, and then they have cucumbers and apples. There is no other fruit they eat during the economic crisis if they do not have bananas.

All fruits are not equally popular in all areas of Bangladesh. Seasonal fruits produced in the country are more popular than imported fruits. Mango, blackberry, jackfruit, and litchi are some of the seasonal fruits which are eaten in summer. These fruits are eaten in every part of the country. In the Winter, the demand for external fruits such as oranges, malt, grapes, apples, pomegranate increases. Bananas are the only option when people face an economic crisis.

In the urban areas of Mymensingh, people generally eat mango, blackberry, jackfruit, guava, watermelon, litchi, kamranga etc. In Dhaka, Khulna, Barisal and Rajshahi regions, common eaten fruits are melon, mango, blackberry, jackfruit, guava, watermelon, litchi and kamranga etc. During Winter, olives, plum, oranges etc. are popularly eaten in Dhaka city.

Fruits like apple, malta, cucumber, banana etc., are taken mostly in urban areas in all parts of Khulna, Barisal and Dhaka, Muslims eat dates, cucumbers, bananas, apples, etc. during Ramadan. In all other regions, dates have been given more priority during the month of Ramadan. In rural Dhaka, children are fed apple and orange juice in feeders. In all parts of Sylhet, children are fed apples, grapes, oranges, and papayas. In the rural areas of Rajshahi, children and pregnant women are provided more pomegranates as it will cause more blood in the baby's body. In Khulna urban areas, children eat more mangoes, bananas, and papayas.

Although it is generally not forbidden to eat any fruit, it is better not to eat certain fruits at certain times, which is shown in table 52.

Table 52. Cultural aspects of fruits consumption

Aspects		Non-Edible or Less Edible
Life Cycle	**Children**	-In rural Dhaka, children are fed apple and orange juice in feeders. -In all parts of Sylhet, children are fed apples, grapes, oranges, and papayas. --In rural Rajshahi, children are not allowed to eat oranges because it is cold.
	Pregnant women	- In Rajshahi urban areas, expectant mothers are not allowed to eat papaya because they believe that the fruit is high in acid. Also, they are not allowed to eat jackfruit as it may cause jaundice in the baby. -In Dhaka and Barisal urban areas, pregnant are not allowed to eat pineapple. They think it will harm the fetus. - In Barisal rural areas, pregnant women are not allowed to eat tamarind. - In the Dhaka city area, pregnant women are not permitted to eat papaya, grapes, and lemon as it will harm the baby.
	Lactating mother	In Rajshahi, breastfeeding mothers are not permitted oranges as the baby may catch a cold. -In rural Rangpur, breastfeeding mothers are discouraged from eating bananas and watermelon as it can cause colds in the baby and mother. -In the rural areas of Rangpur, breastfeeding mothers are not allowed to eat tamarind and plum as it is thought that it may cause loose bowels in the baby.
Social and Religious Rituals/Events		-Hindus in Dhaka city, plums cannot be eaten before Saraswati Puja

Fish

Normally all kinds fishes are in eaten in all the regions, but there some occasions when those are non-edible or less edible (Table 53).

Table 53. Commonly eaten leafy vegetables and its variation by regions and contexts

Aspects	Commonly Eaten Fish	Variation by Regions and Contexts

All Seasons	Fishes, like Tilapia, silver carp, pangas, rui, katla, mrigal carp, kalibaus, stinging catfish, climbing perch, spotted snakehead, barb are eaten in all the areas of Bangladesh.	-In Barisal, people eat belegura, mola carplet, godkhirana, darodhi, surma, Surma, Gadkhirina and Tai dried fish etc. It is very easy for them to find such sea fish as it is located near the sea. -In the urban areas of Rangpur, dried jhatka hilsa and puti fish are eaten more often. -In the rural areas of Chittagong, coyote, barbel, Rohu, katla, Puti, Rupchanda, Hilsa, and shrimp are eaten. -Snakehead, taki, and horn fish are less thorny and more available in Khulna's rural areas.
Economic Crisis	-Silver carp, pangas, and telapia are among the most priced fish eaten in almost all parts of the country	-In rural Mymensingh, children are fed horns, walking catfish and Pangas.
Children	Less thorny fish, particularly Pangas and Rui fish, are preferred for feeding children in all the regions	-No variation is observed
Aged (60 years and above)	-All kinds of fishes are offered except some variation.	-People in the rural areas of Rangpur say that the old are not allowed to eat any fatty fish like hilsa and pangas.

Pregnant women	-Most of the fish types are offered except some variations in some areas.	-In Khulna, pregnant women are given stinging catfish and climbing fish. -In Mymensingh urban areas, pregnant are not allowed to eat mirca fish because they think that if they eat it, the baby will get epilepsy. They also think that gojar fish is a devil fish. -Prawn and hilsa fish are discouraged in Khulna as they increase allergies. -In Rajshahi and Sylhet urban areas, pregnant women are not allowed to eat Mrigal fish. They believe that eating mrigal fish will cause them to have seizures. -In rural Rajshahi, pregnant are advised to eat more zeol, chang and climbing perch as they are more nutritious and increases blood.
Lactating Mother	-Most of the fish types are offered except some variations in some areas.	-In Dhaka urban areas, breastfeeding mothers are fed sea fish oil because this improves mother's breast milk. -In the urban areas of Mymensingh, breastfeeding mothers give small fish like barb, tengra and boyal fish so that the baby gets more milk. -In rural Rajshahi, breastfeeding mothers are advised to eat more zeol, chang and climbing perch as they are more nutritious and increases blood. -In the rural areas of Sylhet, the breastfeeding mothers eat stinging catfish and mola fish so that the baby could get adequate milk from mother.
Non-edible or Less Edible	-Most of the fish types are offered except some variations in some areas.	-Hindus of the country, those who are vegetarians, do not eat any fish. -People in Rajshahi city say, they do not eat any kind of fish during Puja-Parvan --People in the Rangpur city area expressed that if someone has an allergy, he/she should avoid eating hilsa fish because it will aggravate the allergy. --It is forbidden to eat lewa fish in Barisal. .

Meat

Meat is more popular to Muslims than Hindus, and there are little or no regional variations in terms of eating meat. Farmed chicken is the most eaten meat in all areas of Bangladesh, and its price is less than any other meats. So, during the economic crisis if someone prefers to buy meat, they go for farmed chicken. Muslims eat more beef from a religious point of view. But in most areas, Muslims do not eat goat meat. Pork meat is forbidden for them. On the other hand, Hindus do not eat beef, but they eat more goat meat, mutton, and pork. Among the Hindus, those who are vegetarians do not eat any meat. All types of meat are forbidden for Hindus during Puja except Kali Puja. In contrary, Muslims usually eat meat in all religious festivals, especially at the time of Eid-ul-Azha.

In all regions, children eat more chicken, especially farmed ones. Pigeon meat is given more to the older people in the rural areas of Rajshahi. Attempts are made to feed chicken liver to the children in Sylhet region. They think that it makes the child's liver bigger. In almost all areas, pregnant and breastfeeding women are forbidden to eat duck meat. People in Rangpur urban area think that if pregnant and breastfeeding women eat duck meat, their body pain would increase, and wounds would not dry out. In Sylhet, urban people think that duck meat is too oily and that is harmful. In Dhaka urban areas, pregnant women are given chicken soup. People in rural areas of Rajshahi are encouraged to give more pigeon meat to pregnant and breastfeeding mothers as it is believed to increase blood flow in the body.

In the urban areas of Dhaka, when someone is sick, pigeon meat is fed because they think that it will increase energy in the body. In Mymensingh urban areas, eating beef is discouraged because beef is high in cholesterol. People in the urban areas of Rajshahi think that eating goat meat makes their stomachs hot. Among the urban people of Dhaka and Barisal, those who suffer from allergies and blood pressure eat less beef.

A household head in the urban area of Barisal said, *"Farm chickens are the only hope if the income goes down."* In all parts of Bangladesh, farmed chicken is eaten more because it is cheaper and softer and can easily be eaten by children and adults. In the case of eating domestic chicken and duck, it is consumed only when it is kept at home. Moreover, it is not eaten as much as it is bought from the market. Muslims usually do not eat much beef and mutton except on Eid and Shob-e- Barat or various occasions. Hindus eat mutton only for their puja-parvan or other occasions. One of the reasons for eating less duck meat is, it causes various diseases such as allergies, asthma etc.

Eggs

Eggs are the most popular protein food items consumed in all the regions. People all over Bangladesh eat farmed chicken eggs because it is always cheap and easy to get. When people earn less, they eat farmed chicken eggs. Children are fed *deshi* (native) chicken eggs, because it is thought that *deshi* (native) chicken eggs are nutritious, and children also like them.

Children like Koel Bird’s egg. In Dhaka cities, Koel bird’s egg is given to older people because it increases immunity against various diseases. If anyone suffers from low blood pressure, duck eggs are suggested to them. On the rural side of Mymensingh, pregnant women and breastfeeding mothers are fed duck eggs too. In some places, duck eggs are not suggested to eat because people of the urban area of Chattagram and rural area of Rangpur think that duck eggs increase pain and allergy. People in both rural and urban areas of Khulna and in the rural area of Sylhet think that duck eggs cause various diseases in old age. In Sylhet, duck eggs are prohibited for pregnant women suffering from blood pressure.

Vegetarians from Hindu religion do not ever eat eggs, and at the time of Puja eggs are strictly prohibited for all the Hindus as it is a source of protein. In Mymensingh, older people are given egg without yolk. In the villages of Rajshahi, when children suffer from stomach problems, eggs are not given to them.

Milk and milk products

Cow milk is primarily eaten in Bangladesh, and powder milk and condensed milk are after that. In Sylhet, when people cannot earn enough, they drink powdered milk instead of cow milk. But in Barisal village and Khulna town areas people do not eat any other dairy except cow milk. There is a patent belief in Rangpur cities that powder milk and condensed milk are contaminated, so they suggest not eating them. However, in Chattogram rural areas, powder milk is used more than cow milk. They use powder milk for making tea and sometimes drink cow milk. In Rajshahi villages, children who cannot digest cow milk properly are given powder milk suggested by doctors. Although in Barisal villages, older people are given less milk because milk causes gastric issues. But in Khulna villages, milk is not given to them. In Rangpur City, when people earn less, they only give milk to children and weak people, equally applicable to all the regions. Basically, in Mymensingh, milk for children is prepared with more water as they think children’s stomach will not digest thick milk.

Fats and oils

Nearly all the age groups consume different types of fats and oils, but old, including person with morbidity, are offered less fats and oils are consumed in all the regions. However, cultural preferences of fats and oils are varied across regions as shown in table 54.

Table 54. Cultural influence on consumption of fats and oils

Types of Fats and Oils	**Cultural Preference**	**Regions**
Soybean Oil	-Used for all curries and fried items	-All regions
	-Less used in preparing children foods	-Chattogram region -Mymensingh Urban -Dhaka Urban

Mustard oil	-Mash (*Vorta*) of some vegetables	-All regions
	-Avoids during Ekadashi rituals of Hindus	-Khulna and other regions
Ghee	-Used for special food items	-All regions
	-Offered to pregnant women	Rural Rajshai
	- Krishna Thakur's Mali rituals for Hindus	-Rajshai
Peanuts	-Suggested not to eat when someone has gastric/ulcer	-Rangpur region
	-Offered less to children	Rangpur region

Sugar

Mostly, sugar is eaten all over Bangladesh; besides, jaggery and honey are also eaten. Children are given Tal Mishri. In Dhaka cities, semolina for children is made with Tal Mishri. In Khulna, Rajshahi and Barisal villages, if a child catches a cold, he/she is given honey. Children in Rajshahi cities and Rangpur villages are given more jaggery. Pregnant women in Dhaka are advised to limit their intake of sugary foods. Diabetic patients can have honey but not sugar and jaggery all over Khulna Sylhet and Mymensingh as well as Chittagong village and Dhaka city. Sugar is less preferred for breastfeeding mothers in Dhaka city. In Winter, jaggery is primarily used in all the regions to make seasonal cakes.

Honey is provided to keep the body "warm" in Chittagong villages. Pregnant women and breastfeeding mothers are given more jaggery and honey than sugar in Sylhet village areas. Children are provided with less sugar in Rangpur village as people believe sugar is "cold food," and it will help catch a cold. Children are kept away from date molasses in Khulna village as it is believed to be a cause of abdominal pain. In the villages of Khulna, older people are kept away from date molasses because it supposedly causes abdominal pain.

Chapter 9: Summary

Food consumption and risk of nutrient adequacy

- Cereal consumption dominates the diets of all population sub-groups, rice being the most popular cereal in the country. Another popular cereal is wheat. wheat consumption levels were higher among richer households and urban regions. Across diets, 80% have 55-75% of energy coming from carbohydrate, 69% provide 10-15% of energy from protein, and 65% have 15-30% of energy from fat. About a third of the total protein (37.14 g) is from high biological value, animal source foods.
- The consumption of almost all food groups including cereals, pulses, vegetables, meat etc. were higher in the 2^{nd} or 3^{rd} expenditure quintiles and the consumption of fruits, oil and animal foods were higher in the richest group of people. Also, the intakes of these food groups were seen to be higher in the urban localities compared to the rural areas. This trend was observed in all the surveys included in this report. Food consumption levels for all the food groups were highest among adults ranging from 19-50 years.
- Macro and micronutrient intakes were higher among wealthier classes and male population. Nutrient adequacy levels were alarmingly low for calcium, riboflavin, thiamine, vitamin B_{12}, vitamin A except niacin and magnesium. Adequacy levels were lower in females than males. Nutrient adequacy level increases with increased age.
- Among children under 2, the probability of adequacy (PA) is lowest for calcium, thiamine, riboflavin, iron (0-2%) followed by vitamin B_6 (7%), folate (8%), vitamin A (9%), vitamin B_{12} (10%), vitamin C (14%), zinc (28%). The mean probability of adequacy (MPA) across the 12 micronutrients was 11% for children under 2 years, 24% for adolescent girls (10-14 years), 34% for women of reproductive age, and 20% for pregnant and lactating women. However, the mean adequacy ratio (MAR) approach yielded a higher level of nutrient adequacy than PA approach. Among the vulnerable groups with MAR across 12 micronutrients was found 46% for children, 64% for adolescent girls (10-14 years), 68% for women of reproductive age, and 62% for pregnant and lactating women.

Nutrient Density

In present study, locally available foods in the Food Composition Table for Bangladesh (2013) and further updated database (2018), categorized into 15 food groups, are ranked according to Energy Density, Nutrient Rich Food 9.3, and Naturally Nutrient Rich score.

- Among the 43 different cereals and their products are scored according to their nutrient composition and it's evident from the nutrient density score that wheat and millet are more nutrient dense as compared to rice and their product. Comparison among the food groups discover that energy dense foods e.g., fats (9.0), cereals (3.44) and pulses and legumes (3.27) are poor in nutrient density in terms of NRF9.3 except nuts and seeds.

Soybean has high ED and NNR value as compared to other members of the food group pulses, legumes and their products.

- Energy density scores of vegetables are comparatively low whereas NRF9.3 score is high. Drumstick leaves and Agathi raw are the most nutrient dense vegetables in terms of NNR with low energy density. Among the fruits of FCTB, Emblic has the highest NNR score and lowest ED indicates nutrient rich fruit of Bangladesh.
- Leafy vegetables are energy poor but nutrient rich as their nutrient density score is the highest among the all-food groups. Mean NNR score of leafy vegetables is 13.8, total 32 foods composition are available in this group. Amaranth leaves (spiney) showed the highest NRF9.3 score (561) in leafy vegetable group. Amaranth leaves (green), Bengal dayflower leaves, amaranth leaves (red), beet greens, jute leaves, spinach, bottle gourd leaves, agathi, cowpea leaves have the highest nutrient density compared with other foods of leafy vegetables. Leafy vegetables would be the most preferred food group for the prevention of NCDS as nutrient dense with lowest energy density to limit the calorie intake as well as Sodium, Sugar and Saturated fats. Vegetables are also energy poor sources but less nutrient density in terms of NRF9.3 as compared to leafy vegetables of Bangladesh.
- Nutrient density profiles of nuts, Seeds indicates that foods of this group are energy dense as well as nutrient dense. So, this group is suitable for those age groups of the population who need energy as well as nutrients. On the other hand, a small quantity or desirable amounts of nuts/seeds can be able to supply energy with nutrients. NRF9.3 of different locally produced oil and other seeds indicates that incorporation of different seeds e.g., linseed, sesame, mustard, pumpkins, lotus in diets can enrich the diets with energy as well as nutrients.
- In the present study, nutrient profiling of 74 fish varieties has been done as available in the FCTB and identified as energy poor nutrient dense food groups in terms of NNR and NRF9.3.
- Chicken egg yolk has the highest energy density score (3) and naturally nutrient rich score (33) while duck egg (whole) has the highest nutrient density score (41).
- The relationship between NRF9.3 per 100 Kcal with energy density (Kcal/100g) of commonly consumed foods reflects that vegetables (leafy and non-leafy) are more nutrient dense as compared to other food groups. Especially, leafy vegetables have high NRF9.3 whereas lowest energy density, indicates as potential food source for the prevention of the risk of CVD, diabetes and all-cause mortality, since it is clear that eating nutrient dense foods was linked to a moderately decreased threat according to scientific literatures.
- Fats and oils and sugar show the highest energy density with negative value of NRF9.3 indicates increased threats of NCDs and should maintain at the level recommended by

WHO for "Healthy Diet." By ensuring the healthy diet of the population Bangladesh can achieve the SDGs and other targets of nutrition.

- The relation between cost of foods expressed as taka/100Kcal with nutrient density showed that leafy vegetables are giving highest nutrient return per taka e.g., amaranth leaves (slender, green, and red), jute leaves, bottle gourd leaves, Indian spinach with minimum level of energy. Comparatively local seasonal fruits are identified as least cost in terms of nutrient return per taka.
- Cereals showed highest energy per taka followed by sugar, fats and oils, pulses whereas, meat, poultry and fish showed lowest energy per taka and then gradually fruits, vegetables, egg, and milk. In contrast, vegetables, fruits, meat, poultry and fish, egg and milk are nutrient dense with lower energy return per taka.

Cost and affordability of recommended/nutritious diets in Bangladesh

- "Energy Sufficient," "Nutrient Adequate," and "Recommended Healthy" diets would cost 19.2 BDT, 38.2 BDT, and 83 BDT, respectively, in Bangladesh. The cost of a diet increases incrementally as the diet quality rises across all divisions. Overall, "Recommended Healthy" diets cost 133 percent more than diets that only meet the requirements for essential nutrients and more than four times as much as diets that meet only the dietary energy needs through a starchy staple.
- The cost of a desirable dietary guidelines based "recommended healthy" diet is much higher than the portion of the poverty line (i.e., 63%) that the poorest people spend on food. This puts healthy diets beyond the reach of those living in poverty or just above the poverty lines in all divisions. However, households were found to heavily spend their money for cereals (38%) which could be used to increase their expenditure on more healthy nutritious food items (e.g., protein foods and dairy products). The highest proportion (0.66) of households who cannot afford healthy diets are from Khulna division, with the fewest in Chattagram division (0.25). The burden of unaffordability of "recommended healthy" diets was found to be significantly greater in rural (42%) than urban (39%) areas.
- Application of linear programming identified 32 key nutrient-dense foods that comprised the nutritionally adequate, health-promoting, and culturally acceptable least cost food baskets designed for different population groups across the life cycle stages. The identified foods were locally available in the market areas, contained a majority of macro or micronutrients in the diets, and were the least expensive compared with alternative foods of similar nutrient composition. Food items that were almost universally included in the food baskets were rice, wheat flour, grass pea, egg (chicken), potato, melon (futi), slender amaranth leaves, water spinach, whole milk, soya oil, and sugar. Other food items comprising the food baskets included millet, soybean, bengal gram, radish, amaranth stem, cabbage, sweet potato, colocasia (taro), carambola, banana, red amaranth leaves, green amaranth leaves, radish leaves, jute leaves, Indian spinach, egg (duck), pool barb, palm oil, jackfruit seeds, and jaggery.

Chapter 10: Recommendations/ policy implications

- To reduce the micronutrient gap, consumption of cereals should be decreased, and pulses, vegetables especially leafy vegetables, nuts and seeds, fruits, and milk and milk products would need to be increased.
- A robust nutrition education and behavior change communication program through various channels should be undertaken to bring about changes in rice-based food habits.
- Nutrient profiling of the foods of FCDB indicates the numerous indigenous and locally available foods (e.g., micronutrients-rich selective leafy vegetables) which are nutrient dense may serve as potential sources to fulfil the critical micronutrients intake gap in the Bangladeshi population.
- Nutrient density scores, as found in his study, may be used for food labelling, sensitizing consumer behavior, marketing channels, nutritional policy making, diet planning and food-based nutrition interventions. These findings may guide the policy makers for the formulation of agriculture policy that encourages increased production of nutrient dense foods to supply crucial nutrients lacking in the usual diets of Bangladeshi population.
- Enhance the availability of nutrient dense foods by increased production. Government subsidy for seeds, fertilizer and relevant agricultural inputs can promote farmers to produce nutrient dense crops/foods to increase accessibility for consumers.
- Disseminating and implementing dietary guidelines to assist consumers in selecting more nutrient-dense foods by introducing nutrient density profiling systems would be one of the guiding principles to follow for planning and consuming healthy diets.
- Bangladesh needs to raise the overall supply of food, reduce food prices in the markets and raise incomes and purchasing power, especially those who live below or just above the poverty line. Farmers should be encouraged to produce non-rice agricultural products, and there is need to ensure that their returns are stabilized.
- Different divisions of Bangladesh have different agro-ecological zones, and thus we need to plan and implement region-specific strategies to increase availability of diverse foods.
- Bangladesh must cut down cereal consumption and increase consumption of protein rich foods and dairy products. To change the dietary pattern of people, there is need to promote Behavior Change Communication (BCC) and make them aware of the importance of nutritious diets through appropriate messages on health and nutrition.
- In addition to staples, the cost of foods across a broader set of food groups that constitute healthy diets needs to be decreased and their availability improved. The government would need to pursue diversification policies and interventions around food production especially dairy, fruits, vegetables, and protein rich foods to reduce prices. In parallel, the

government would need to implement policies that support market access allowing the flow of diverse nutritious foods into markets.

- As healthy diets remain unaffordable even in their cheapest form to the poor population, nutrition education and behavior change communication (e.g., counselling on specific nutrient-rich foods identified in the least-cost food baskets) should be complemented with social protection and food systems policies and interventions (e.g., scaling up and intensifying home production of diverse foods through kitchen gardens) to improve access to and consumption of healthy diets. Poverty lines may need to be reconstructed so that they account for the cost of healthy diets beyond the current principle of meeting only the cost of energy sufficiency (i.e., 2122 Kcal).
- Urgent actions should also be taken to promote healthy purchasing behavior (i.e., reallocating expenditure share to a range of food groups). As households were found to spend on cereals more than they would require for a healthy diet, they need to be provided with information (i.e., composition and benefits) on healthy diets.
- Updating food-based dietary guidelines for Bangladesh to include age-, sex-, physiological stage-, and physical activity level-specific recommendations could be a fundamental starting point. This should be followed by provision of appropriate support to increase the use and dissemination of these recommendations among consumers, producers/marketers, and policy makers.

Chapter 11: Limitations of the research

This study had some limitations as follows:

- BIHS data set is based on rural low-income population, and therefore, their generalizability to urban or middle-income populations would be limited (Karageorgou et al., 2018).
- Use of AME to analyze per capita intake using HIES-2016 data set may not reveal dietary changes among population groups, including infants and young children or women of reproductive age (Waid et al., 2018). Rather it reflects the per capita food supply for consumption.
- Calculation of ED, NNR and NRF9.3 used the US Daily Values (DVs) for nutrients due to lack of country specific reference values.
- As we could not get access to the food prices data collected by BBS as part of monitoring the CPI and DAM as part of monitoring prices of important agricultural products, we conducted a market survey that did not account for seasonal variations in food prices and availability. We avoided retrospective recall of prices from previous seasons as it imposed a considerable cognitive burden on retail sellers.
- Due to the unknown reality of the dynamics of intrahousehold allocation of food, we implemented linear programming to generate food baskets for individuals specific to their age, sex, and activity level without consideration of shared meals. While this subpopulation level information about the cost and composition of healthy food baskets is useful for designing and evaluating targeted interventions, future research should focus on whole households incorporating the reality that households in Bangladesh procure food as a single unit and eat shared meals to make such information more salient for policy making and evaluation.
- We estimated the cost and affordability of healthy diet taking moderately active women of reproductive age as the reference individual as the energy requirement of this reference category most closely matches with the energy requirement used to define the poverty lines. Such estimates would vary if future research defines healthy diet for other individuals when age-, sex-, physiological stage-, and physical activity level-specific recommendations become available in food based dietary guidelines of Bangladesh.

References

Ahmed, F., Prendiville, N. and Narayan, A., 2016. Micronutrient deficiencies among children and women in Bangladesh: progress and challenges. *Journal of nutritional science*, *5*.

Akter, R., Sugino, H., Akhter, N., Brown, C.L., Thilsted, S.H. and Yagi, N., 2021. Micronutrient Adequacy in the Diet of Reproductive-Aged Adolescent Girls and Adult Women in Rural Bangladesh. *Nutrients*, *13*(2), p.337.

Arsenault, J.E., Hijmans, R.J. and Brown, K.H., 2015. Improving nutrition security through agriculture: an analytical framework based on national food balance sheets to estimate nutritional adequacy of food supplies. Food security, 7(3), pp.693-707.

Arsenault, J.E., Yakes, E.A., Islam, M.M., Hossain, M.B., Ahmed, T., Hotz, C., Lewis, B., Rahman, A.S., Jamil, K.M. and Brown, K.H., 2013. Very low adequacy of micronutrient intakes by young children and women in rural Bangladesh is primarily explained by low food intake and limited diversity. *The Journal of nutrition*, *143*(2), pp.197-203.

Baldi, G., Martini, E., Catharina, M., Muslimatun, S., Fahmida, U., Jahari, A.B., Hardinsyah, Frega, R., Geniez, P., Grede, N. and Minarto, 2013. Cost of the Diet (CoD) tool: first results from Indonesia and applications for policy discussion on food and nutrition security. *Food and Nutrition Bulletin*, *34*(2_suppl1), pp.S35-S42.

Bangladesh Second Country Investment Plan on Nutrition Sensitive Food Systems, 2016-2020, FPMU, Government of Bangladesh supported by USAID, EU and FAO

Basiotis, P., Brown, M., Johnson, S.R. and Morgan, K.J., 1983. Nutrient availability, food costs, and food stamps. *American Journal of Agricultural Economics*, 65(4), pp.685-693.

Black, R.E., Allen, L.H., Bhutta, Z.A., Caulfield, L.E., De Onis, M., Ezzati, M., Mathers, C., Rivera, J. and Maternal and Child Undernutrition Study Group, 2008. Maternal and child undernutrition: global and regional exposures and health consequences. *The lancet*, 371(9608), pp.243-260.

Bouis, H.E., 2017. The role of agriculture and biofortification in the UN Decade of Action on Nutrition. UNSCN News 42, 33–42.

C. N. Ahsan KZ, Jamil K, Islam S, Al-Sabir A, “Bangladesh Demographic and Health Survey 2017-18: Key Indicators Report,” 2019, doi: https://dhsprogram.com/publications/publication-PR104-Preliminary-Reports-Key-Indicators-Reports.cfm.

Cabanac, M., 1995. Palatability vs. money: experimental study of a conflict of motivations. *Appetite*, *25*(1), pp.43-49

Charrondiere, U.R. and Burlingame, B., 2011. Report on the FAO/INFOODS Compilation Tool: A simple system to manage food composition data. Journal of Food Composition and Analysis, 24(4-5), pp.711-715.

Connell, C.L., Zoellner, J.M., Yadrick, M.K., Chekuri, S.C., Crook, L.B. and Bogle, M.L., 2012. Energy density, nutrient adequacy, and cost per serving can provide insight into food choices in the lower Mississippi Delta. Journal of nutrition education and behavior, 44(2), pp.148-153.

Chastre C, Duffield A, Kindness H, Le Jeune S, Taylor A. The minimum cost of a healthy diet. *Findings from piloting a new methodology in four study locations [Internet]*. London: Save the Children; 2007. [cited 2021 Apr 30]. Available from: https://motherchildnutrition.org/malnutrition/pdf/mcn-stc-minimum-cost-of-a-healthy-diet.pdf.

Chiuve, S.E., Sampson, L. and Willett, W.C., 2011. The association between a nutritional quality index and risk of chronic disease. *American journal of preventive medicine*, 40(5), pp.505-513

Cleveland, L.E., Escobar, A.J., Lutz, S.M. and Welsh, S.O., 1993. Method for identifying differences between existing food intake patterns and patterns that meet nutrition recommendations. *Journal of the American Dietetic Association*, *93*(5), pp.556-563.

Dantzig, G.B., 1990. The diet problem. *Interfaces*, *20*(4), pp.43-47.

Darmon, N., Darmon, M., Maillot, M. and Drewnowski, A., 2005. A nutrient density standard for vegetables and fruits: nutrients per calorie and nutrients per unit cost. *Journal of the American Dietetic Association*, 105(12), pp.1881-1887.

Darmon, N., Ferguson, E. and Briend, A., 2002. Linear and nonlinear programming to optimize the nutrient density of a population's diet: an example based on diets of preschool children in rural Malawi. *The American journal of clinical nutrition*, *75*(2), pp.245-253.

Darmon, N., Ferguson, E. and Briend, A., 2003. Do economic constraints encourage the selection of energy dense diets? *Appetite*, 41(3), pp.315-322.

Darmon, N., Ferguson, E.L. and Briend, A., 2002. A cost constraint alone has adverse effects on food selection and nutrient density: an analysis of human diets by linear programming. *The Journal of nutrition*, 132(12), pp.3764-3771.

Deptford, A., T. Allieri, R. Childs, C. Damu, E. Ferguson, J. Hilton, P. Parham, A. Perry, A. Rees, J. Seddon, and A. Hall. 2017. "Cost of the Diet: A Method and Software to Calculate the

Lowest Cost of Meeting Recommended Intakes of Energy and Nutrients from Local Foods." *BMC Nutrition* 3(26): 1–17.

Dizon, F., Herforth, A. and Wang, Z., 2019. The cost of a nutritious diet in Afghanistan, Bangladesh, Pakistan, and Sri Lanka. *Global Food Security*, *21*, pp.38-51.

Dizon, F., Herforth, A. and Wang, Z., 2021. The cost of a nutritious diet in Afghanistan, Bangladesh, Pakistan, and Sri Lanka. World Bank, Policy Research Working Paper.

Drewnowski A, Eichelsdoerfer P. Can low-income Americans afford a healthy diet? *Nutr Today* 2009; 44: 246–9.

Drewnowski, A. and Fulgoni III, V., 2008. Nutrient profiling of foods: creating a nutrient-rich food index. *Nutrition reviews*, 66(1), pp.23-39.

Drewnowski, A. and Fulgoni III, V.L., 2014. Nutrient density: principles and evaluation tools. *The American journal of clinical nutrition*, *99*(5), pp.1223S-1228S.

Drewnowski, A., 2005. Concept of a nutritious food: toward a nutrient density score. *The American journal of clinical nutrition*, *82*(4), pp.721-732.

Drewnowski, A., 2010. The Nutrient Rich Foods Index helps to identify healthy, affordable foods. *The American journal of clinical nutrition*, *91*(4), pp.1095S-1101S.

Drewnowski, A., 2017. Uses of nutrient profiling to address public health needs: from regulation to reformulation. *Proceedings of the Nutrition Society*, *76*(3), pp.220-229.

Drewnowski, A., Darmon, N., 2005. Food choices and diet costs: an economic analysis. *J Nutr*; 135:900–4.

Drewnowski, A., Fulgoni, V.L., Young, M.K. and Pitman, S., 2008. Nutrient-Rich Foods: Applying Nutrient Navigation Systems to Improve Public Health. *Journal of food science*, 73(9), pp.H222-H228.

Drewnowski, A., Fulgoni, V.L., Young, M.K. and Pitman, S., 2008. Nutrient-Rich Foods: Applying Nutrient Navigation Systems to Improve Public Health. *Journal of food science*, 73(9), pp.H222-H228

Drewnowski, A., Maillot, M. and Darmon, N., 2009. Should nutrient profiles be based on 100 g, 100 kcal or serving size? *European journal of clinical nutrition*, *63*(7), pp.898-904.

EAT Lancet Commission Report (2019), Healthy Diets from Sustainable Food Systems, Food, Planet, Health.

Eggersdorfer, M., Peter, S. and Weber, P., 2016. New Momentum in Healthy Nutrition: A Proposal for a Nutrient-Energy Density Score Concept. *Vitam Miner,* 5, p.e145.

FAO (2017) Guidelines for the compilation of Food Balance Sheets, publication prepared in the framework of the Global Strategy to improve Agricultural and Rural Statistics, FAO, Rome

FAO Regional Office for Asia and the Pacific (2018). Dynamic development, shifting demographics, changing diets. Bangkok. 172 p. License: CC BY-NC-SA 3.0 IGO.

Fulgoni VLIII, Keast DR, Drewnowski A. Development and validation of the Nutrient Rich Foods Index: a tool to measure nutrient density of foods. *J Nutr* 2009; 139:1549–54.

Gazan, R., Brouzes, C.M., Vieux, F., Maillot, M., Lluch, A. and Darmon, N., 2018. Mathematical optimization to explore tomorrow's sustainable diets: a narrative review. *Advances in Nutrition*, *9*(5), pp.602-616.

Gibson, R.S. and Ferguson, E.L., 1999. An interactive 24-hour recall for assessing the adequacy of iron and zinc intakes in developing countries (No. BOOK). Washington, DC: ILSI Press.

Global Purchasing Power Parities and Real Expenditures: 2011 International Comparison Program. http://siteresources.worldbank.org/ICPINT/Resources/icp-final.pdf.

Government of Bangladesh. National Food and Nutrition Policy [Internet]. Government of Bangladesh, Dhaka, Bangladesh; 1997.

Government of Bangladesh. National Nutrition Policy [Internet]. Government of Bangladesh, Dhaka, Bangladesh; 2015. Available from: http://extwprlegs1.fao.org/docs/pdf/bgd152517.pdf

Hatløy, A., Torheim, L.E. and Oshaug, A., 1998. Food variety—a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. European Journal of Clinical Nutrition, 52(12), pp.891-898

Haytowitz, D.B., Pehrsson, P.R. and Holden, J.M., 2002. The identification of key foods for food composition research. *Journal of Food Composition and Analysis*, *15*(2), pp.183-194.

Headey, Derek D., and Harold H. Alderman. "The Relative Caloric Prices of Healthy and

HKI and JPGSPH. (Helen Keller International and James P. Grant School of Public Health). (2015). State of Food Security and Nutrition in Bangladesh: 2014. BRAC University: Dhaka.

HREȚCANU, C.E. and HREȚCANU, C.I., 2017. A linear programming model for a diet problem. *Food and Environment Safety Journal*, *9*(1).

Indian Council CMR-NIN Expert Group on Nutrient Requirement for Indians, Recommended Dietary Allowances (RDA) and Estimated Average Requirements (EAR), 2020.

INFORMS (The Institute for Operations Research and the Management Sciences). *Operations research & analytics [Internet]*. 2021. [cited 2021 Apr 30]. Available from: https://www.informs.org/About-INFORMS/What-is-Operations-Research.

International Food Policy and Research Institute. Household Dietary Patterns and the Cost of a Nutritious Diet in Myanmar; Discussion Paper, 2019

Jati, I.R.A., Vadivel, V., Nöhr, D. and Biesalski, H.K., 2012. Nutrient density score of typical Indonesian foods and dietary formulation using linear programming. *Public health nutrition*, *15*(12), pp.2185-2192.

Lauk, J., Nurk, E., Robertson, A. and Parlesak, A., 2020. Culturally Optimised Nutritionally Adequate Food Baskets for Dietary Guidelines for Minimum Wage Estonian Families. *Nutrients*, *12*(9), p.2613.

Lele, U., Masters, W.A., Kinabo, J., Meenakshi, J.V., Ramaswami, B., Tagwireyi, J. and Goswami, S., 2016. Measuring food and nutrition security: An independent technical assessment and user's guide for existing indicators. Rome: Food Security Information Network, Measuring Food and Nutrition Security Technical Working Group, 177.

Lennernäs, M., Fjellström, C., Becker, W., Giachetti, I., Schmitt, A., De Winter, A.M. and Kearney, M., 1997. Influences on food choice perceived to be important by nationally representative samples of adults in the European Union. *European Journal of Clinical Nutrition*, *51*.

Maillot, M., Darmon, N. and Drewnowski, A., 2010. Are the lowest-cost healthful food plans culturally and socially acceptable? *Public health nutrition*, *13*(8), pp.1178-1185.

Maillot, M., Darmon, N., Darmon, M., Lafay, L. and Drewnowski, A., 2007. Nutrient-dense food groups have high energy costs: an econometric approach to nutrient profiling. *The Journal of nutrition*, *137*(7), pp.1815-1820.

Maillot, M., Ferguson, E.L., Drewnowski, A. and Darmon, N., 2008. Nutrient profiling can help identify foods of good nutritional quality for their price: a validation study with linear programming. *The Journal of nutrition*, *138*(6), pp.1107-1113.

Martin, A., 2002. Nutritional recommendations for the french population: the "Apports nutritionnels conseillés"(ANCs). Lavoisier.

Masters, W.A., Y. Bai, A. Herforth, D. Sarpong, F. Mishili, J. Kinabo, and J. Coates. 2018. "Measuring the Affordability of Nutritious Diets in Africa: Novel Price Indexes for Diet Diversity and Cost of Nutrient Adequacy." *American Journal of Agricultural Economics* 100(5): 1285–1301.

Miller, G.D., Drewnowski, A., Fulgoni, V., Heaney, R.P., King, J. and Kennedy, E., 2009. It is time for a positive approach to dietary guidance using nutrient density as a basic principle. *The Journal of nutrition*, 139(6), pp.1198-1202.

Ministry of Food and Ministry of Health and Family Welfare, 2015. Dietary guidelines for Bangladesh.

Mittal, S. and Sethi, D., 2009. Food security in South Asia: Issues and opportunities (No. 240). working paper.

National Institute of Nutrition, 2011. Dietary guidelines for Indians. *Indian Council of Medical research*.

National Institutes of Health Office of Dietary Supplements. Calcium Fact Sheet for Health Professionals. Available at: https://ods.od.nih.gov/factsheets/Calcium- HealthProfessional/. Accessed August 23, 2018b.

National Micronutrients Status Survey 2011–12: Final Report. Dhaka, Bangladesh: Centre for Nutrition and Food Security, icddr,b; 2013.

Osmani SR, Ahmed A, Ahmed T, Hossain N, Huq S, Shahan A. Strategic Review of FOOD SECURITY AND NUTRITION IN BANGLADESH [Internet]. 2016 Sep. Available from: http://www.wfp.org/sites/default/files/Bangladesh_Strategic_Review_full_report.pdf

Parlesak, A., Tetens, I., Dejgård Jensen, J., Smed, S., Gabrijelčič Blenkuš, M., Rayner, M., Darmon, N. and Robertson, A., 2016. Use of linear programming to develop cost-minimized nutritionally adequate health promoting food baskets. *PLoS One*, *11*(10), p.e0163411.

Perignon, M., Masset, G., Ferrari, G., Barré, T., Vieux, F., Maillot, M., Amiot, M.J. and Darmon, N., 2016. How low can dietary greenhouse gas emissions be reduced without impairing nutritional adequacy, affordability and acceptability of the diet? A modelling study to guide sustainable food choices. *Public health nutrition*, *19*(14), pp.2662-2674.

Putnam, J., Allshouse, J. and Kantor, L.S., 2002. US per capita food supply trends: more calories, refined carbohydrates, and fats. *Food Review*, *25*(3), pp.2-15.

Raghunathan, K., Headey, D. and Herforth, A., 2021. Affordability of nutritious diets in rural India. Food policy, 99, p.101982.

Ruel, M.T., 2003. Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs. Food and nutrition bulletin, 24(2), pp.231-232.

Second National Plan of Action for Nutrition (NPAN2); Government of Bangladesh, 2017.

Shaheen, N., A.T.M.A. Rahim, M. Mohiduzzaman, C.P.Banue, M.L. Bari, A.B. Tukun, M.A. Mannan, L. Bhattacharjee, and B. Stadlmayr. 2013. Food Composition Table for Bangladesh. Dhaka, Bangladesh: University of Dhaka, Institute of Nutrition and Food Science.

Smith, L.C., Dupriez, O. and Troubat, N., 2014. Assessment of the reliability and relevance of the food data collected in national household consumption and expenditure surveys. International Household Survey Network.

Stigler, G.J. 1945. “The Cost of Subsistence.” *American Journal of Agricultural Economics* 27(2): 303–14.

Streppel, M.T., Sluik, D., Van Yperen, J.F., Geelen, A., Hofman, A., Franco, O.H., Witteman, J.C.M. and Feskens, E.J.M., 2014. Nutrient-rich foods, cardiovascular diseases and all-cause mortality: the Rotterdam study. *European journal of clinical nutrition*, *68*(6), p.741.

Tetens, I., Oberdörfer, R., Madsen, C. and de Vries, J., 2007. Nutritional characterization of foods: Science-based approach to nutrient profiling. *European journal of nutrition*, 46(2), pp.4-14.

The Global BMI Mortality Collaboration. (2016). Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents. The Lancet, 388(10046), 776-786.

The Minimum Cost of a Healthy Diet: Findings from piloting a new methodology in four study locations; Save the Children ,2007

The state of food security and nutrition in the world 2020: transforming food systems for affordable healthy diets (Vol. 2020). Food & Agriculture Org.

Troesch, B., Biesalski, H., Bos, R., Buskens, E., Calder, P., Saris, W., Spieldenner, J., Verkade, H., Weber, P. and Eggersdorfer, M., 2015. Increased intake of foods with high nutrient density can help to break the intergenerational cycle of malnutrition and obesity. *Nutrients*, *7*(7), pp.6016-6037.

Unhealthy Foods Differ Systematically across Income Levels and Continents." *The Journal of* nutrition (2019).

UNICEF (United Nations Children's Fund). 1990. *Strategy for Improved Nutrition of Children and Women in Developing Countries*. New York.

UNICEF, B., 2013. National micronutrients status survey. *Institute of Public Health and Nutrition. Accessed August*, *16*, p.2018.

UNICEF, WHO & World Bank. 2020. UNICEF-WHO World Bank: Joint malnutrition expanded country dataset, May 2020. [online]. [Cited 27 May 2020]. data.unicef.org/ resources/jme, www.who.int/nutgrowthdb/estimates, www.data.worldbank.org/child-malnutrition

United Nations Children's Fund (UNICEF), World Health Organization, International Bank for Reconstruction and Development/The World Bank. *Levels and trends in child malnutrition: Key Findings of the 2020 Edition of the Joint Child Malnutrition Estimates*. Geneva: World Health Organization; 2020. Licence: CC BY-NC-SA 3.0 IGO.

US Department of Agriculture, US Department of Health and Human Services. *Dietary guidelines for Americans.* 6th ed. Washington, DC: US Government Printing Office, 2005. Available from: http://www.health.gov/dietaryguidelines/ (cited 7 February 2010

US Food and Drug Administration, 2003. Consumer Health Information for Better Nutrition Initiative Task Force Report. Available at: US Food and Drug Administration. Consumer health information for better nutrition initiative. Fed Regist 2004; 4(24):541. Accessed July 29, 2020.

US Food and Drug Administration, 2020. Daily Value on the New Nutrition and Supplement Facts Labels

WFP (World Food Programme), 2017b. Fill the nutrient gap tool. Available at: https:// www.wfp.org/content/2017-fill-nutrient

WHO Nutrient Profiling. Available at: http://www.who.int/nutrition/topics/profiling/ en/. Accessed May 29, 2020.

Williamson, G. and Holst, B., 2008. Dietary reference intake (DRI) value for dietary polyphenols: are we heading in the right direction? *British Journal of Nutrition*, *99*(S3), pp.S55-S58.

World Bank, 2019. Food for Improved Nutrition in Bangladesh

World Health Organization, 2010. Nutrient Profiling. Report of a WHO/IASO Technical Meeting, London, United Kingdom 4–6 October 2010. Geneva: WHO.

World Bank Global Consumption Database. http://datatopics.worldbank.org/consumption/sector/Food-and-Beverages

Appendices

Appendix-I: Food and nutrient consumption and nutrient adequacy by income, age, physiological status, and division

Table 1: Food Intake (grams/person/d) of the study population by expenditure quintile (based on income tax) in 2017/2018

Food groups	**Per capita food intake by income categories**				
	A (lowest)	**B**	**C**	**D (Highest)**	**All**
	(grams/person/day)				
Cereals and their products	417.8	439.7	449.3	389.2	437.3
Rice	350.9	396.9	366.5	367.6	390.0
Wheat	64.6	42.5	68.1	48.9	47.9
Pulses, legumes, and their products	25.0	40.0	32.7	23.5	37.9
Vegetables and their products	93.5	97.0	105.2	90.3	98.9
Leafy vegetables	116.3	116.9	104.6		114.4
Starchy roots, tubers, and their products	84.0	82.2	64.6	36.6	79.5
Nuts, seeds, and their products	11.2	13.4	21.0		13.8
Spices, condiments, and herbs	4.6	4.3	4.6	3.8	4.3
Fruits	33.2	30.5	31.2	55.8	30.7
Fish, shellfish and their products	79.7	69.4	51.6	83.1	67.9
Meat, poultry, and their products	147.4	122.5	98.9	80.5	118.0
Chicken/duck	125.9	124.7	86		118.5
Eggs and their products	42.8	39.9	27.1	43.5	38.1
Milk and its products	6.1	6.6	25.4	23.5	7.3
Fat and oils	25.1	29.7	32.5	41.8	29.9
Beverages					57.5
Miscellaneous	7.8	4.6	6.3	9.1	4.7

Note: The A-category Households are landless and do not pay any local tax, the B-category are marginal landholders and pay a token tax, the C-category Households are near- rich middle class owning a substantial amount of land and the D-category households are only a few in numbers in the village owning 80% of all lands and pay the highest slab of the local tax.

Table 2: Per capita nutrient intake by tax categories in 2017/18

Energy and Nutrients	Per capita Income Categories				All
	A (Lowest)	B	C	D (Highest)	
Energy (Kcal)	2039.1	2157.5	2193.1	2213.8	2155.0
Protein (g)	49.5	56.0	57.3	62.9	55.4
Total fat (g)	33.4	40.2	43.4	52.6	40.1
Saturated Fatty acids (g)	5.7	6.8	7.2	8.9	6.8
MUFA (g)	8.1	9.3	9.6	11.2	9.3
PUFA (g)	17.1	19.7	22.1	28.0	20.0
Cholesterol (mg)	44.6	62.8	71.4	57.6	62.3
Carbohydrate (g)	359.8	372.0	380.7	337.1	372.0
Total dietary fiber (g)	22.0	22.7	23.7	21.1	22.6
Calcium (mg)	182.4	205.0	205.5	153.8	203.0
Iron (mg)	8.0	8.3	8.5	8.2	8.2
Magnesium (mg	293.1	300.7	302.7	279.4	300.4
Phosphorus (mg)	867.7	941.8	966.0	956.0	933.3
Potassium(mg)	1634.2	1685.8	1722.6	1801.0	1689.4
Sodium (mg)	128.6	141.6	153.8	148.8	141.7
Zinc (mg)	8.8	9.3	9.9	9.3	9.3
Copper (mg)	1.7	1.8	1.9	1.7	1.8
Vitamin A (mcg)	75.6	93.2	122.7	81.2	95.6
Vitamin D (mcg)	6.3	6.0	7.3	8.9	6.1
Vitamin E (mg)	5.7	6.8	6.6	9.5	6.7
Thiamine (mg)	1.2	1.3	1.3	1.3	1.3
Riboflavin (mg)	0.6	0.6	0.6	0.6	0.6
Niacin EQ (mg)	24.7	27.1	27.7	27.2	27.0

Niacin (mg)	7.2	7.9	8.8	11.0	7.9
Niacin TRP (mg)	1.4	1.5	1.4	1.3	1.5
Vitamin B_6 (mg)	131.9	153.4	144.0	127.5	150.3
Folate (mcg)	28.8	38.2	38.3	35.3	37.8
L-Ascorbic Acid (mg)	75.6	93.2	122.7	81.2	95.6

Note: The A-category Households are landless and do not pay any local tax, the B-category are marginal landholders and pay a token tax, the C-category Households are near- rich middle class owning a substantial amount of land and the D-category households are only a few in numbers in the village owning 80% of all lands and pay the highest slab of the local tax.

Table 3: Risk of inadequate nutrient intakes (based on EAR) in 1-3 years

Nutrients	Male				Female			
	Average intake	Usual intake	EAR	% inadequacy	Average intake	Usual intake	EAR	% inadequacy
Calcium (mg)	143.1	83.9	400.0	100.0	140.4	85.8	400.0	100.0
Magnesium (mg	94.0	86.3	73.0	27.9	84.2	84.6	73.0	31.4
Iron (mg)	2.7	2.4	6.0	99.7	2.4	2.3	6.0	99.9
Zinc (mg)	3.1	2.9	2.8	42.4	2.8	2.9	2.8	44.4
Thiamine (mg)	0.4	0.4	0.6	99.2	0.4	0.4	0.6	98.4
Riboflavin (mg)	0.4	0.3	0.8	99.0	0.3	0.3	0.8	98.8
Niacin EQ (mg)	8.5	8.0	6.0	16.1	7.8	7.9	6.0	18.0
Vitamin B_6 (mg)	1.0	0.4	0.8	99.7	0.9	0.4	0.8	100.0
Folate (mcg)	115.9	71.5	97.0	79.5	127.6	76.3	97.0	78.8
Vitamin B_{12}	0.7	0.6	1.0	99.5	0.6	0.6	1.0	99.5
L-ascorbic Acid (mg)	13.4	8.3	24.0	99.8	11.3	8.2	24.0	99.9
Vitamin A (mcg)	85.9	35.1	180.0	91.0	67.7	36.0	180.0	90.9

Table 4: Risk of inadequate nutrient intakes (based on EAR) in 4-6 years

Nutrients	Male				Female			
	Average intake	Usual intake	EAR	% inadequacy	Average intake	Usual intake	EAR	% inadequacy
Calcium (mg)	148.1	97.5	450.0	100.0	145.0	97.1	450.0	100.0
Magnesium (mg	146.1	138.7	104.0	7.2	136.1	130.1	104.0	16.7
Iron (mg)	4.4	4.0	8.0	97.5	3.9	3.6	8.0	99.4
Zinc (mg)	4.6	4.5	3.7	19.5	4.2	4.1	3.7	30.5
Thiamine (mg)	0.6	0.6	0.8	90.6	0.6	0.6	0.8	95.1
Riboflavin (mg)	0.3	0.3	1.1	99.5	0.3	0.3	1.1	100.0
Niacin EQ (mg)	13.5	13.6	8.0	0.2	12.7	12.5	8.0	5.4
Vitamin B_6 (mg)	2.1	0.7	1.0	97.0	2.4	0.7	1.0	97.1
Folate (mcg)	197.5	109.0	111.0	71.6	147.8	99.5	111.0	76.7
Vitamin B_{12}	0.8	0.7	2.0	100.0	0.7	0.7	2.0	100.0

L-ascorbic Acid (mg)	21.8	13.1	27.0	96.6	19.2	13.9	27.0	96.9
Vitamin A (mcg)	92.4	41.9	240.0	92.3	88.1	43.8	240.0	92.1

Table 5: Risk of inadequate nutrient intakes (based on EAR) in 7-9 years

Nutrients	Male				Female			
	Average intake	Usual intake	EAR	% inadequacy	Average intake	Usual intake	EAR	% inadequacy
Calcium (mg)	146.7	119.5	500.0	100.0	178.6	123.4	500.0	100.0
Magnesium (mg	171.3	158.4	144.0	35.1	171.2	163.3	144.0	25.5
Iron (mg)	4.9	4.6	10.0	97.2	5.1	4.7	10.0	96.9
Zinc (mg)	5.2	5.0	4.9	46.7	5.2	5.1	4.9	39.8
Thiamine (mg)	0.8	0.7	1.0	97.9	0.7	0.7	1.0	97.1
Riboflavin (mg)	0.3	0.3	1.3	100.0	0.4	0.3	1.3	100.0
Niacin EQ (mg)	15.7	15.2	10.0	2.8	15.4	15.6	10.0	3.9
Vitamin B_6 (mg)	3.5	1.0	1.3	95.9	4.7	1.0	1.3	95.0
Folate (mcg)	286.8	166.2	142.0	62.7	329.5	177.0	142.0	56.6
Vitamin B_{12}	0.8	0.7	2.0	100.0	0.7	0.7	2.0	100.0
L-ascorbic Acid (mg)	30.6	18.2	36.0	93.8	24.1	17.7	36.0	99.7
Vitamin A (mcg)	86.3	44.0	290.0	92.1	88.1	38.7	290.0	92.6

Table 6: Risk of inadequate nutrient intakes (based on EAR) in 10-12 years

Nutrients	**Male**				**Female**			
	Average intake	**Usual intake**	**EAR**	**% inadequacy**	**Average intake**	**Usual intake**	**EAR**	**% inadequacy**
Calcium (mg)	228.3	163.7	650.0	100.0	170.6	136.3	650.0	100.0
Iron (mg)	7.0	6.5	12.0	98.4	5.8	5.5	16.0	95.4
Magnesium (mg)	224.5	214.8	199.0	35.8	201.3	196.4	207.0	61.7
Zinc (mg)	7.1	6.8	7.0	55.9	6.1	5.9	7.1	84.9
Thiamine (mg)	1.0	0.9	1.3	97.9	0.8	0.8	1.2	99.0
Riboflavin (mg)	0.5	0.4	1.7	100.0	0.4	0.4	1.6	100.0
Vitamin B_6 (mg)	3.4	1.2	1.7	95.6	2.2	1.0	1.6	97.3
Folate (mcg)	329.3	163.8	180.0	78.9	313.1	152.0	186.0	78.9
Vitamin B_{12}	1.3	1.2	2.0	99.8	1.1	1.0	2.0	100.0

L-ascorbic Acid (mg)	34.0	24.7	45.0	94.4	32.1	23.6	44.0	95.5
Niacin EQ (mg)	20.6	19.0	12.0	20.0	18.1	17.0	12.0	22.0
Vitamin A (mcg)	171.6	75.0	360.0	91.0	147.5	61.0	370.0	92.3

Table 7: Risk of inadequate nutrient intakes (based on EAR) in 13-15 years

Nutrients	Male				Female			
	Average intake	Usual intake	EAR	% inadequacy	Average intake	Usual intake	EAR	% inadequacy
Calcium (mg)	264.6	197.0	800.0	100.0	191.1	156.5	800.0	100.0
Iron (mg)	7.2	6.7	15.0	98.1	7.3	6.8	17.0	93.2
Magnesium (mg	241.2	228.1	287.0	87.1	239.2	229.8	282.0	82.8
Zinc (mg)	7.2	7.0	11.9	99.8	7.3	7.0	10.7	98.2
Thiamine (mg)	1.0	1.0	1.6	99.2	1.0	0.9	1.3	91.1
Riboflavin (mg)	0.5	0.5	2.2	100.0	0.5	0.5	1.9	100.0
Vitamin B_6 (mg)	4.6	1.3	2.2	97.2	2.9	1.2	1.8	97.1
Folate (mcg)	351.2	184.8	238.0	81.3	293.5	150.4	204.0	86.2
Vitamin B_{12}	1.4	1.2	2.0	99.7	1.1	0.9	2.0	100.0
L-ascorbic Acid (mg)	39.5	28.4	60.0	98.2	36.7	27.5	55.0	99.3
Niacin EQ (mg)	20.6	19.4	16.0	14.0	21.3	20.1	13.0	2.0
Vitamin A (mcg)	124.7	70.0	430.0	92.0	160.8	72.7	420.0	92.4

Table 8: Risk of inadequate nutrient intakes (based on EAR) in 16-18 years

Nutrients	Male				Female			
	Average intake	Usual intake	EAR	% inadequacy	Average intake	Usual intake	EAR	% inadequacy
Calcium (mg)	274.3	216.7	850.0	100.0	245.8	190.8	850.0	100.0
Iron (mg)	8.6	8.0	18.0	98.5	8.6	7.9	18.0	91.2
Magnesium (mg)	292.1	281.5	367.0	91.8	266.5	260.1	317.0	87.4

Zinc (mg)	8.7	8.4	14.7	99.9	8.0	7.8	11.8	98.8
Thiamine (mg)	1.3	1.2	1.9	99.2	1.2	1.2	1.4	83.6
Riboflavin (mg)	0.6	0.5	2.5	100.0	0.5	0.5	1.9	100.0
Vitamin B_6 (mg)	3.4	1.4	2.5	98.7	8.2	1.6	1.9	90.4
Folate (mcg)	268.7	166.1	286.0	92.1	407.2	208.4	223.0	76.8
Vitamin B_{12}	1.4	1.4	2.0	95.7	1.4	1.4	2.0	95.6
L-ascorbic Acid (mg)	48.9	33.5	70.0	96.9	45.8	36.6	57.0	94.2
Niacin EQ (mg)	25.8	24.7	19.0	8.0	23.9	23.2	14.0	0.1
Vitamin A (mcg)	245.2	100.2	480.0	92.0	159.5	83.8	400.0	90.9

Table 9: Risk of inadequate nutrient intakes (based on EAR) in 19-30 years

Nutrients	**Male**				**Female**			
	Average intake	**Usual intake**	**EAR**	**% inadequacy**	**Average intake**	**Usual intake**	**EAR**	**% inadequacy**
Calcium (mg)	343.6	263.3	800.0	100.0	285.3	213.6	800.0	100.0
Iron (mg)	10.3	9.7	11.0	61.7	8.4	7.9	15.0	83.2
Magnesium (mg	359.1	343.0	370.0	71.5	293.7	284.8	310.0	73.0
Zinc (mg)	10.5	10.2	14.1	95.3	8.8	8.6	11.0	92.1
Thiamine (mg)	1.5	1.5	1.5	47.6	1.3	1.2	1.4	75.1
Riboflavin (mg)	0.7	0.7	2.1	99.5	0.6	0.6	2.0	100.0
Vitamin B_6 (mg)	6.6	1.9	2.1	50.6	5.7	1.6	1.6	56.7
Folate (mcg)	449.6	251.1	250.0	73.1	416.9	213.3	180.0	59.2
Vitamin B_{12}	1.5	1.3	2.0	98.5	1.4	1.2	2.0	99.6
Vitamin D (mcg)	1.4	1.2	400.0	100.0	1.2	1.1	400.0	100.0
L-ascorbic Acid (mg)	62.0	46.0	65.0	85.9	50.2	37.8	55.0	86.3
Niacin EQ (mg)	31.5	30.4	15.0	0.3	26.8	25.9	12.0	0.0

Vitamin A (mcg)	254.2	104.9	460.0	89.8	178.4	84.6	390.0	90.6

Table 10: Risk of inadequate nutrient intakes (based on EAR) in 31-50 years

Nutrients	**Male**				**Female**			
	Average intake	Usual intake	EAR	% inadequacy	Average intake	Usual intake	EAR	% inadequacy
Calcium (mg)	328.7	250.6	800.0	100.0	245.4	189.3	800.0	100.0
Magnesium (mg	344.1	337.5	370.0	72.3	303.3	297.5	310.0	63.5
Iron (mg)	10.5	10.1	11.0	58.6	9.1	8.7	15.0	80.2
Zinc (mg)	10.7	10.8	14.1	93.2	9.2	9.2	11.0	85.2
Thiamine (mg)	1.5	1.5	1.5	51.4	1.3	1.3	1.4	70.7
Riboflavin (mg)	0.7	0.7	2.1	99.9	0.6	0.6	2.0	100.0
Niacin EQ (mg)	31.4	31.6	15.0	0.7	26.4	26.4	12.0	0.0
Vitamin B_6 (mg)	6.3	1.9	2.1	57.1	4.7	1.6	1.6	64.3
Folate (mcg)	483.6	289.4	250.0	64.7	385.2	249.4	180.0	48.3
Vitamin B_{12}	1.6	1.4	2.0	98.0	1.2	1.1	2.0	100.0
L-ascorbic Acid (mg)	56.4	39.3	65.0	91.8	47.6	34.9	55.0	90.2
Vitamin A (mcg)	187.4	102.2	460.0	90.1	174.8	84.5	390.0	90.6

Table 11: Risk of inadequate nutrient intakes (based on EAR) in 51-60 years

Nutrients	Male				Female			
	Average intake	Usual intake	EAR	% inadequacy	Average intake	Usual intake	EAR	% inadequacy
Calcium (mg)	281.1	225.4	800.0	100.0	316.0	219.0	800.0	100.0
Magnesium (mg	338.3	331.7	370.0	73.7	290.4	274.6	310.0	74.8
Iron (mg)	11.2	10.3	11.0	58.4	9.1	7.9	15.0	83.3
Zinc (mg)	10.2	10.0	14.1	97.0	8.2	8.2	11.0	94.3
Thiamine (mg)	1.5	1.4	1.5	67.3	1.2	1.2	1.4	81.1
Riboflavin (mg)	0.7	0.7	2.1	100.0	0.6	0.5	2.0	100.0
Niacin EQ (mg)	29.8	29.4	15.0	0.1	23.3	23.6	12.0	0.0
Vitamin B_6 (mg)	4.2	1.6	2.1	83.9	4.7	1.4	1.6	88.3
Folate (mcg)	415.5	286.1	250.0	60.7	348.9	246.0	180.0	47.9
Vitamin B_{12}	1.3	1.2	2.0	97.7	1.1	1.1	2.0	100.0
L-ascorbic Acid (mg)	60.0	46.0	65.0	82.4	52.3	33.0	55.0	91.2
Vitamin A (mcg)	176.4	97.5	460.0	90.5	227.9	97.8	390.0	89.5

Table 12: Risk of inadequate nutrient intakes (based on EAR) in 60+ years

Nutrients	Male				Female			
	Average intake	Usual intake	EAR	% inadequacy	Average intake	Usual intake	EAR	% inadequacy
Calcium (mg)	274.8	192.9	800.0	100.0	210.0	159.5	800.0	100.0
Magnesium (mg	325.1	290.5	370.0	90.2	270.5	234.5	310.0	89.8
Iron (mg)	10.2	8.4	11.0	72.0	8.3	7.4	15.0	84.3
Zinc (mg)	8.5	8.2	14.1	99.8	7.6	7.2	11.0	95.9
Thiamine (mg)	1.2	1.1	1.5	81.7	1.1	0.9	1.4	87.7
Riboflavin (mg)	0.6	0.5	2.1	100.0	0.6	0.5	2.0	100.0
Niacin EQ (mg)	25.2	24.7	15.0	1.6	22.1	20.9	12.0	4.6
Vitamin B_6 (mg)	3.2	1.3	2.1	98.5	1.2	1.1	1.6	99.9
Folate (mcg)	576.1	372.5	250.0	36.2	320.6	217.6	180.0	53.7
Vitamin B_{12}	1.0	1.1	2.0	100.0	0.8	0.9	2.0	100.0

L-ascorbic Acid (mg)	60.3	31.4	65.0	94.1	53.5	30.9	55.0	86.7
Vitamin A (mcg)	238.0	82.1	460.0	91.3	175.6	77.9	390.0	91.2

Table 13: Risk of inadequate nutrient intakes (based on EAR) in 1 to 3 years (BIHS- 2015)

Nutrients	Male				Female			
	Average intake	Usual intake	EAR	% Inadequacy	Average intake	Usual intake	EAR	% Inadequacy
Calcium (mg)	171.3	117.0	400.0	100.0	155.2	114.1	400.0	100.0
Magnesium (mg	105.4	93.2	73.0	25.0	98.3	90.8	73.0	26.1
Iron (mg)	3.7	3.2	6.0	97.7	3.6	3.1	6.0	97.6
Zinc (mg)	3.1	2.9	2.8	44.2	2.9	2.9	2.8	46.9
Thiamine (mg)	0.3	0.3	0.6	99.9	0.3	0.3	0.6	99.6
Riboflavin (mg)	0.4	0.3	0.8	97.9	0.4	0.3	0.8	98.3
Niacin EQ (mg)	5.9	5.7	6.0	60.8	5.7	5.5	6.0	65.0
Vitamin B_6 (mg)	2.9	0.7	0.8	86.6	3.1	0.7	0.8	87.8
Folate (mcg)	103.1	81.1	97.0	73.8	103.9	80.9	97.0	75.0
Vitamin B_{12}	0.8	0.7	1.0	85.5	0.7	0.7	1.0	89.2
L-ascorbic Acid (mg)	26.7	17.4	24.0	78.4	25.8	16.3	24.0	82.8
Vitamin A (mcg)	108.2	47.0	180.0	88.8	110.6	46.8	180.0	88.8

Table 14: Risk of inadequate nutrient intakes (based on EAR) in 4 to 6 years (BIHS- 2015)

Nutrients	Male				Female			
	Average intake	Usual intake	EAR	% Inadequacy	Average intake	Usual intake	EAR	% Inadequacy
Calcium (mg)	221.6	174.3	450.0	99.6	225.6	173.8	450.0	99.5
Magnesium (mg	179.7	165.7	104.0	4.6	173.8	165.0	104.0	5.6
Iron (mg)	6.6	5.9	8.0	83.8	6.4	5.9	8.0	84.9
Zinc (mg)	5.3	5.1	3.7	10.5	5.1	5.1	3.7	12.1
Thiamine (mg)	0.5	0.5	0.8	96.7	0.5	0.5	0.8	98.4
Riboflavin (mg)	0.5	0.4	1.1	99.9	0.5	0.4	1.1	100.0
Niacin EQ (mg)	10.0	9.9	8.0	19.5	9.8	9.9	8.0	24.2
Vitamin B_6 (mg)	4.9	1.3	1.0	57.3	4.9	1.2	1.0	57.6
Folate (mcg)	181.7	148.2	111.0	35.7	171.5	144.4	111.0	39.3

Vitamin B_{12}	1.0	0.9	2.0	98.8	1.0	0.9	2.0	99.0
L-ascorbic Acid (mg)	48.4	33.8	27.0	39.0	47.0	34.4	27.0	37.7
Vitamin A (mcg)	151.6	75.1	240.0	87.7	149.6	75.2	240.0	87.7

Table 15: Risk of inadequate nutrient intakes (based on EAR) in 7 to 9 years (BIHS- 2015)

Nutrients	Male				Female			
	Average intake	Usual intake	EAR	% Inadequacy	Average intake	Usual intake	EAR	% Inadequacy
Calcium (mg)	284.8	214.6	500.0	98.5	266.4	204.0	500.0	99.4
Magnesium (mg	229.5	218.7	144.0	4.2	215.6	208.6	144.0	7.1
Iron (mg)	8.2	7.5	10.0	79.9	7.9	7.3	10.0	82.0
Zinc (mg)	6.7	6.6	4.9	9.7	6.4	6.4	4.9	12.9
Thiamine (mg)	0.7	0.6	1.0	97.7	0.6	0.6	1.0	99.0
Riboflavin (mg)	0.6	0.5	1.3	99.9	0.5	0.5	1.3	100.0
Niacin EQ (mg)	12.6	12.5	10.0	14.4	12.1	12.2	10.0	19.7
Vitamin B_6 (mg)	5.2	1.6	1.3	57.1	5.9	1.7	1.3	56.1
Folate (mcg)	220.6	185.8	142.0	37.9	204.9	175.4	142.0	43.3
Vitamin B_{12}	1.1	1.0	2.0	98.1	1.0	1.0	2.0	98.8
L-ascorbic Acid (mg)	58.5	44.4	36.0	33.0	58.9	43.6	36.0	36.5
Vitamin A (mcg)	195.4	91.0	290.0	86.7	172.8	88.1	290.0	87.3

Table 16: Risk of inadequate nutrient intakes (based on EAR) in 10 to 12 years (BIHS- 2015)

Nutrients	**Male**				**Female**			
	Average intake	**Usual intake**	**EAR**	**% Inadequacy**	**Average intake**	**Usual intake**	**EAR**	**% Inadequacy**
Calcium (mg)	315.65	246.87	650.00	99.54	289.51	227.22	650.00	99.60

Magnesium (mg	271.06	259.06	199.00	13.01	253.37	241.79	207.00	26.26
Iron (mg)	9.73	8.91	12.00	85.51	9.08	8.40	16.00	88.11
Zinc (mg)	8.01	7.70	7.00	34.81	7.54	7.29	7.10	45.44
Thiamine (mg)	0.78	0.74	1.30	99.73	0.73	0.70	1.20	99.51
Riboflavin (mg)	0.64	0.58	1.70	99.91	0.59	0.55	1.60	100.00
Niacin EQ (mg)	14.81	14.10	12.00	24.50	13.90	13.33	12.00	31.42
Vitamin B_6 (mg)	7.30	2.09	1.70	64.68	7.21	1.99	1.60	63.01
Folate (mcg)	257.45	192.19	180.00	55.57	217.83	171.19	186.00	70.84
Vitamin B_{12}	1.30	1.15	2.00	95.74	1.08	0.97	2.00	97.90
L-ascorbic Acid (mg)	67.08	51.71	45.00	41.90	65.09	51.53	44.00	40.15
Vitamin A (mcg)	219.74	97.96	360.00	88.74	189.13	85.71	370.00	90.25

Table 17: Risk of inadequate nutrient intakes (based on EAR) in 13 to 15 years (BIHS- 2015)

Nutrients	Male				Female			
	Average intake	**Usual intake**	**EAR**	**% Inadequacy**	**Average intake**	**Usual intake**	**EAR**	**% Inadequacy**
Calcium (mg)	365.63	291.29	800.00	99.73	319.92	247.16	800.00	99.97
Magnesium (mg	321.97	309.90	287.00	36.67	290.09	277.42	282.00	54.46
Iron (mg)	11.44	10.85	15.00	83.59	10.17	9.35	17.00	86.40
Zinc (mg)	9.61	9.49	11.90	86.97	8.47	8.36	10.70	89.59
Thiamine (mg)	0.92	0.90	1.60	99.66	0.82	0.79	1.30	97.95
Riboflavin (mg)	0.71	0.70	2.20	99.80	0.66	0.64	1.90	100.00
Niacin EQ (mg)	17.57	17.72	16.00	32.27	15.65	15.77	13.00	19.04
Vitamin B_6 (mg)	8.68	2.65	2.20	71.15	7.54	2.33	1.80	61.09
Folate (mcg)	309.69	268.25	238.00	53.40	254.44	222.65	204.00	54.07

Vitamin B_{12}	1.42	1.29	2.00	90.95	1.21	1.09	2.00	96.19
L-ascorbic Acid (mg)	75.52	60.89	60.00	52.83	74.15	56.07	55.00	56.76
Vitamin A (mcg)	242.61	126.30	430.00	87.69	228.11	110.33	420.00	89.74

Table 18: Risk of inadequate nutrient intakes (based on EAR) in 16 to 18 years (BIHS- 2015)

Nutrients	Male				Female			
	Average intake	**Usual intake**	**EAR**	**% Inadequacy**	**Average intake**	**Usual intake**	**EAR**	**% Inadequacy**
Calcium (mg)	384.02	312.99	850.00	99.98	346.06	279.34	850.00	99.99
Magnesium (mg	349.10	336.98	367.00	65.90	306.94	294.98	317.00	62.62
Iron (mg)	11.98	11.45	18.00	91.95	11.27	10.58	18.00	83.64
Zinc (mg)	10.55	10.57	14.70	95.45	9.15	9.08	11.80	89.56
Thiamine (mg)	1.01	0.98	1.90	99.99	0.90	0.86	1.40	98.51
Riboflavin (mg)	0.79	0.78	2.50	99.70	0.71	0.69	1.90	99.99
Niacin EQ (mg)	19.64	19.93	19.00	42.77	17.26	17.28	14.00	20.41
Vitamin B_6 (mg)	8.76	2.61	2.50	78.29	9.04	2.70	1.90	53.08
Folate (mcg)	297.07	266.62	286.00	69.08	294.82	251.99	223.00	50.92
Vitamin B_{12}	1.55	1.40	2.00	86.54	1.42	1.21	2.00	92.76
L-ascorbic Acid (mg)	73.95	59.36	70.00	72.83	78.72	62.32	57.00	46.18
Vitamin A (mcg)	267.37	127.86	480.00	90.18	257.79	124.91	400.00	87.20

Table 19: Risk of inadequate nutrient intakes (based on EAR) 19 to 30 years (BIHS- 2015)

Nutrients	**Male**				**Female**			
	Average intake	**Usual intake**	**EAR**	**% Inadequacy**	**Average intake**	**Usual intake**	**EAR**	**% Inadequacy**
Calcium (mg)	417.25	325.23	800.00	99.64	382.87	303.78	800.00	99.72
Magnesium (mg	378.44	362.41	370.00	54.97	343.30	330.09	310.00	39.40
Iron (mg)	13.29	12.52	11.00	38.14	12.20	11.38	15.00	68.62
Zinc (mg)	11.44	11.28	14.10	86.59	10.08	10.02	11.00	70.39
Thiamine (mg)	1.07	1.03	1.50	91.62	0.96	0.93	1.40	95.97
Riboflavin (mg)	0.84	0.81	2.10	99.79	0.77	0.74	2.00	99.99
Niacin EQ (mg)	21.28	21.18	15.00	14.35	18.72	18.93	12.00	3.24
Vitamin B_6 (mg)	10.25	2.98	2.10	47.60	10.12	2.69	1.60	33.15
Folate (mcg)	351.09	295.18	250.00	49.30	330.10	282.94	180.00	18.27
Vitamin B_{12}	1.74	1.53	2.00	80.67	1.52	1.34	2.00	88.97
L-ascorbic Acid (mg)	80.38	63.99	65.00	54.79	82.14	64.22	55.00	38.62
Vitamin A (mcg)	278.29	146.28	460.00	86.63	273.89	138.66	390.00	85.46

Table 20: Risk of inadequate nutrient intakes (based on EAR) 31 to 50 years (BIHS- 2015)

Nutrients	**Male**				**Female**			
	Average intake	Usual intake	EAR	% Inadequacy	Average intake	Usual intake	EAR	% Inadequacy
Calcium (mg)	419.4	333.9	800.0	99.4	385.9	304.1	800.0	99.7
Magnesium (mg	393.8	376.0	370.0	48.6	342.8	331.9	310.0	38.8
Iron (mg)	13.9	13.0	11.0	34.7	12.3	11.6	15.0	67.7
Zinc (mg)	11.5	11.4	14.1	86.1	9.9	9.9	11.0	70.2
Thiamine (mg)	1.1	1.1	1.5	94.0	1.0	0.9	1.4	97.0
Riboflavin (mg)	0.9	0.8	2.1	99.7	0.7	0.7	2.0	99.9
Niacin EQ (mg)	21.3	21.4	15.0	16.9	18.4	18.7	12.0	6.6

Vitamin B_6 (mg)	10.0	3.0	2.1	55.9	8.3	2.6	1.6	38.7
Folate (mcg)	347.8	302.4	250.0	44.0	298.0	265.5	180.0	21.4
Vitamin B_{12}	1.8	1.5	2.0	81.6	1.4	1.3	2.0	91.0
L-ascorbic Acid (mg)	82.6	65.1	65.0	54.3	80.9	63.1	55.0	41.1
Vitamin A (mcg)	315.2	164.9	460.0	84.9	278.1	144.9	390.0	84.8

Table 21: Risk of inadequate nutrient intakes (based on EAR) 51 to 60 years (BIHS- 2015)

Nutrients	Male				Female			
	Average intake	**Usual intake**	**EAR**	**% Inadequacy**	**Average intake**	**Usual intake**	**EAR**	**% Inadequacy**
Calcium (mg)	426.5	337.0	800.0	99.7	388.7	313.9	800.0	99.6
Magnesium (mg	381.5	364.0	370.0	55.2	330.4	313.7	310.0	49.0
Iron (mg)	13.4	12.5	11.0	38.2	12.2	11.3	15.0	68.8
Zinc (mg)	11.1	10.9	14.1	89.5	9.4	9.3	11.0	80.7
Thiamine (mg)	1.1	1.0	1.5	95.2	0.9	0.9	1.4	97.7
Riboflavin (mg)	0.9	0.8	2.1	99.5	0.7	0.7	2.0	100.0
Niacin EQ (mg)	20.6	20.7	15.0	24.1	17.3	17.5	12.0	10.1
Vitamin B_6 (mg)	9.8	3.1	2.1	56.1	8.9	2.6	1.6	46.3
Folate (mcg)	340.8	296.1	250.0	50.0	280.7	252.3	180.0	27.2
Vitamin B_{12}	1.8	1.5	2.0	80.1	1.3	1.3	2.0	92.4
L-ascorbic Acid (mg)	79.6	61.3	65.0	61.5	77.7	61.2	55.0	42.9
Vitamin A (mcg)	302.9	155.7	460.0	85.8	283.1	157.6	390.0	83.5

Table 22: Risk of inadequate nutrient intakes (based on EAR) 60+ years (BIHS- 2015)

Nutrients	Male				Female			
	Average intake	Usual intake	EAR	% inadequacy	Average intake	Usual intake	EAR	% inadequacy
Calcium (mg)	412.2	332.6	800.0	99.5	341.5	271.8	800.0	100.0
Magnesium (mg	343.3	332.9	370.0	69.3	277.8	270.0	310.0	73.3
Iron (mg)	12.5	11.8	11.0	43.9	10.3	9.7	15.0	76.4
Zinc (mg)	10.0	9.9	14.1	95.3	8.1	8.0	11.0	93.4
Thiamine (mg)	1.0	1.0	1.5	94.9	0.8	0.8	1.4	97.6
Riboflavin (mg)	0.8	0.8	2.1	99.7	0.6	0.6	2.0	100.0
Niacin EQ (mg)	18.6	18.9	15.0	29.1	14.7	15.1	12.0	12.1
Vitamin B_6 (mg)	8.2	2.6	2.1	63.7	7.5	2.3	1.6	54.3
Folate (mcg)	305.1	271.8	250.0	54.5	268.4	236.3	180.0	39.8
Vitamin B_{12}	1.5	1.3	2.0	89.8	1.2	1.2	2.0	95.5

L-ascorbic Acid (mg)	73.5	59.8	65.0	63.2	63.2	49.7	55.0	64.6
Vitamin A (mcg)	280.1	146.4	460.0	86.6	227.6	134.1	390.0	86.1

Table 23: Risk of inadequate nutrient intakes (based on EAR) in WRA women (15-49 years)

Nutrients	**Average intake**	**Usual intake**	**PIA**	**PA**	**NAR**
Calcium (mg)	379.52	299.54	1.00	0.00	0.43
Magnesium (mg	334.57	320.57	0.44	0.56	0.90
Iron (mg)	11.94	11.11	0.71	0.29	0.71
Zinc (mg)	9.85	9.51	0.77	0.23	0.82
Thiamine (mg)	0.95	0.90	0.97	0.03	0.63
Riboflavin (mg)	0.73	0.68	1.00	0.00	0.35
Niacin EQ (mg)	18.15	17.36	0.12	0.88	0.96
Vitamin B_6 (mg)	8.74	2.55	0.40	0.60	0.81
Folate (mcg)	311.80	233.24	0.33	0.67	0.85
Vitamin B_{12}	1.44	1.29	0.90	0.10	0.40
L-ascorbic Acid (mg)	78.09	63.60	0.40	0.60	0.83
Vitamin A (mcg)	264.60	129.72	0.86	0.14	0.43
MPIA/MPA (Mean ± SD)			0.63± 0.15	0.34 ± 0.12	0.68 ± 0.15

Note*:* EAR=Estimated Average Requirement; PIA= Probability of Inadequacy for 12 micronutrients; PA= Probability of Adequacy for 12 Micronutrients; NAR= Nutrient Adequacy Ratio for 12 micronutrients

Table 24: Risk of inadequate nutrient intakes (based on EAR) in pregnant women

Nutrients	**Average intake**	**Usual intake**	**EAR**	**PIA**	**PA**	**NAR**
Calcium (mg)	407.78	311.29	800.00	1.00	0.00	0.46
Magnesium (mg	326.73	316.19	370.00	0.78	0.22	0.81
Iron (mg)	12.21	11.20	21.00	0.99	0.01	0.56
Zinc (mg)	9.70	9.43	12.00	0.88	0.12	0.77
Thiamine (mg)	0.93	0.89	1.60	0.99	0.01	0.58
Riboflavin (mg)	0.78	0.71	2.30	1.00	0.00	0.34
Niacin EQ (mg)	17.97	17.32	11.00	0.15	0.85	0.95

Vitamin B_6 (mg)	7.50	2.43	1.90	0.51	0.49	0.77
Folate (mcg)	331.23	240.89	480.00	0.95	0.05	0.50
Vitamin B_{12}	1.73	1.41	2.20	0.93	0.07	0.47
L-ascorbic Acid (mg)	87.02	66.19	65.00	0.54	0.46	0.77
Vitamin A (mcg)	264.22	133.18	406.00	0.85	0.15	0.45
MPIA/MPA (Mean ± SD)				0.77 ± 0.11	0.20 ± 0.11	0.62 ± 0.16

Note: EAR=Estimated Average Requirement; PIA= Probability of Inadequacy for 12 micronutrients; PA= Probability of Adequacy for 12 Micronutrients; NAR= Nutrient Adequacy Ratio for 12 micronutrients

Table 25: Dietary energy and nutrient of intakes of <2-year children (grams/person/day) by rural and urban in Barisal Division (N=852)

Energy and Nutrients	Rural		Urban		All	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	639.0	622.1	646.6	594.5	640.5	610.5
Protein (g)	17.1	16.3	17.8	15.7	17.3	16.3
Total fat (g)	14.0	12.6	18.3	16.3	14.9	13.1
Saturated fatty acids (g)	3.0	2.7	3.8	3.1	3.2	2.7
MUFA (g)	4.0	3.6	4.9	4.2	4.2	3.7
PUFA (g)	7.9	7.0	9.7	8.0	8.3	7.2
Cholesterol (mg)	17.7	14.2	22.0	17.1	18.6	15.1
Carbohydrate (g)	106.4	103.2	98.1	89.0	104.7	100.7
Total dietary fiber (g)	8.6	8.2	8.3	7.7	8.5	8.1
Calcium (mg)	123.1	114.1	139.3	122.1	126.4	116.2
Iron (mg)	4.2	3.9	4.2	3.7	4.2	3.9
Magnesium (mg)	107.6	102.1	104.8	95.4	107.0	100.9
Phosphorus (mg)	314.7	305.1	309.9	285.3	313.8	301.6
Potassium(mg)	658.2	626.0	661.1	610.0	658.8	623.3
Sodium (mg)	94.2	80.9	118.5	96.1	99.1	82.8
Zinc (mg)	2.9	2.8	2.9	2.6	2.9	2.7
Copper (mg)	0.6	0.6	0.6	0.6	0.6	0.6
Vitamin A (mcg)	125.7	114.4	118.2	105.9	124.2	111.9
Thiamine (mg)	0.3	0.3	0.3	0.3	0.3	0.3
Riboflavin (mg)	0.2	0.2	0.2	0.2	0.2	0.2

Niacin EQ (mg)	6.1	5.7	6.4	5.5	6.2	5.6
Vitamin B_6 (mg)	1.0	0.6	0.7	0.5	0.9	0.6
Folate (mcg)	198.0	136.3	208.3	152.7	200.1	142.5
L-ascorbic acid (mg)	24.8	20.9	25.0	20.7	24.8	20.9
Vitamin B_{12} (mcg)	0.6	0.5	0.8	0.7	0.7	0.5

Table 26: Dietary energy and nutrient of intakes of <2-year children (grams/person/day) by rural and urban in Chittagong Division (N=2074)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	721.3	692.9	663.7	627.6	707.3	671.8
Protein (g)	19.8	19.1	18.3	17.0	19.4	18.4
Total fat (g)	15.5	14.1	15.3	14.3	15.4	14.1
Saturated fatty acids (g)	3.2	2.8	3.0	2.7	3.2	2.8
MUFA (g)	4.0	3.6	3.9	3.4	4.0	3.6
PUFA (g)	8.2	7.4	8.2	7.5	8.2	7.4
Cholesterol (mg)	19.1	17.2	19.2	16.8	19.1	17.1
Carbohydrate (g)	120.3	113.8	108.3	101.0	117.4	109.9
Total dietary fiber (g)	9.9	9.4	9.0	8.5	9.7	9.1
Calcium (mg)	163.8	151.3	148.1	132.6	160.0	145.9
Iron (mg)	4.6	4.3	4.2	3.9	4.5	4.2
Magnesium (mg)	123.3	118.0	111.2	104.7	120.3	115.1
Phosphorus (mg)	348.3	332.4	314.1	295.1	340.0	324.7
Potassium(mg)	759.8	734.6	697.8	655.8	744.7	713.3
Sodium (mg)	111.2	95.6	105.9	92.0	109.9	94.7
Zinc (mg)	3.3	3.1	3.0	2.8	3.2	3.0
Copper (mg)	0.7	0.7	0.7	0.6	0.7	0.7
Vitamin A (mcg)	134.5	122.0	122.2	110.8	131.6	119.6
Thiamine (mg)	0.4	0.4	0.4	0.3	0.4	0.4
Riboflavin (mg)	0.3	0.2	0.2	0.2	0.2	0.2

Niacin EQ (mg)	8.1	7.8	7.6	6.9	8.0	7.6
Vitamin B_6 (mg)	1.4	0.8	1.2	0.6	1.4	0.8
Folate (mcg)	149.7	128.8	143.9	120.8	148.3	125.9
L-ascorbic acid (mg)	31.8	26.8	28.4	25.0	30.9	26.7
Vitamin B_{12} (mcg)	0.8	0.7	0.8	0.7	0.8	0.7

Table 27: Dietary energy and nutrient of intakes of WRA <2-year children (grams/person/day) by rural and urban in Dhaka Division (N=1893)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	714.1	678.2	670.0	677.3	691.7	677.3
Protein (g)	18.3	17.2	18.7	18.2	18.5	17.7
Total fat (g)	16.1	14.2	16.8	15.3	16.4	15.1
Saturated fatty acids (g)	3.2	2.8	3.1	2.8	3.1	2.8
MUFA (g)	4.2	3.6	4.0	3.8	4.1	3.7
PUFA (g)	8.2	7.2	8.6	7.9	8.4	7.7
Cholesterol (mg)	17.1	13.6	21.2	18.8	19.2	16.2
Carbohydrate (g)	119.0	112.1	106.3	104.2	112.6	107.9
Total dietary fiber (g)	9.4	8.9	9.1	8.7	9.3	8.8
Calcium (mg)	151.8	133.7	155.4	135.9	153.6	134.0
Iron (mg)	4.2	3.8	4.3	4.0	4.2	3.9
Magnesium (mg)	117.1	110.2	114.2	111.0	115.6	111.0
Phosphorus (mg)	324.1	308.6	315.4	320.4	319.7	315.9
Potassium(mg)	680.8	638.4	699.1	660.5	690.0	652.0
Sodium (mg)	114.2	84.7	129.4	99.9	121.9	93.0
Zinc (mg)	3.1	3.0	3.1	3.1	3.1	3.0
Copper (mg)	0.7	0.7	0.7	0.7	0.7	0.7
Vitamin A (mcg)	132.4	113.9	144.5	128.3	138.6	121.5

Thiamine (mg)	0.4	0.4	0.4	0.4	0.4	0.4
Riboflavin (mg)	0.2	0.2	0.2	0.2	0.2	0.2
Niacin EQ (mg)	7.7	7.0	7.5	7.0	7.6	7.0
Vitamin B_6 (mg)	1.3	0.8	1.1	0.6	1.2	0.7
Folate (mcg)	146.2	117.5	160.4	135.8	153.4	127.0
L-ascorbic acid (mg)	31.9	26.7	38.1	32.1	35.1	28.6
Vitamin B_{12} (mcg)	0.6	0.5	0.7	0.6	0.6	0.5

Table 28: Dietary energy and nutrient of intakes of <2-year children (grams/person/day) by rural and urban in Khulna Division (N=1241)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	726.6	713.6	628.0	600.9	705.2	694.7
Protein (g)	17.8	17.4	16.2	15.2	17.4	17.0
Total fat (g)	14.0	13.5	15.1	13.6	14.3	13.6
Saturated fatty acids (g)	2.9	2.7	2.9	2.6	2.9	2.7
MUFA (g)	4.2	3.7	3.9	3.3	4.1	3.7
PUFA (g)	7.7	7.3	8.1	7.0	7.8	7.2
Cholesterol (mg)	13.6	11.6	16.9	14.4	14.3	12.0
Carbohydrate (g)	127.2	123.4	102.2	97.6	121.8	117.4
Total dietary fiber (g)	9.7	9.5	8.5	8.2	9.4	9.1
Calcium (mg)	123.2	117.1	130.1	118.1	124.7	117.1
Iron (mg)	4.0	3.9	3.8	3.5	4.0	3.8
Magnesium (mg)	119.2	116.7	106.3	100.7	116.4	113.6
Phosphorus (mg)	330.8	324.8	288.0	278.1	321.5	314.8
Potassium(mg)	676.0	666.5	635.7	581.0	667.3	652.3

Sodium (mg)	76.0	62.9	93.4	71.5	79.8	65.3
Zinc (mg)	3.2	3.2	2.8	2.7	3.1	3.1
Copper (mg)	0.7	0.7	0.6	0.6	0.7	0.7
Vitamin A (mcg)	126.1	113.2	128.9	114.9	126.7	113.7
Thiamine (mg)	0.4	0.4	0.3	0.3	0.4	0.4
Riboflavin (mg)	0.2	0.2	0.2	0.2	0.2	0.2
Niacin EQ (mg)	7.5	7.0	6.8	6.4	7.4	6.9
Vitamin B_6 (mg)	1.8	1.1	1.4	0.9	1.7	1.1
Folate (mcg)	112.8	100.5	125.8	99.8	115.6	100.5
L-ascorbic acid (mg)	33.7	29.4	36.9	29.9	34.4	29.5
Vitamin B_{12} (mcg)	0.5	0.4	0.5	0.4	0.5	0.4

Table 29: Dietary energy and nutrient of intakes of <2-year children (grams/person/day) by rural and urban in Mymensingh Division (N=634)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	732.8	714.0	721.3	719.2	731.2	714.0
Protein (g)	18.4	18.1	18.7	18.1	18.5	18.1
Total fat (g)	11.1	9.8	12.8	11.2	11.4	9.9
Saturated fatty acids (g)	2.4	2.1	2.7	2.3	2.5	2.1
MUFA (g)	3.0	2.5	3.1	2.5	3.0	2.5
PUFA (g)	5.6	4.8	6.4	5.4	5.7	4.8
Cholesterol (mg)	12.8	10.6	15.4	12.2	13.2	10.7
Carbohydrate (g)	134.1	126.2	127.3	125.3	133.2	126.2
Total dietary fiber (g)	10.1	10.0	10.0	9.7	10.1	10.0
Calcium (mg)	142.9	128.8	155.1	143.2	144.6	131.1
Iron (mg)	4.1	3.8	4.2	3.9	4.1	3.8
Magnesium (mg)	121.8	121.1	121.1	120.1	121.7	121.0

Phosphorus (mg)	331.6	324.9	325.2	313.5	330.7	320.2
Potassium(mg)	698.2	659.6	699.5	677.2	698.3	663.6
Sodium (mg)	86.2	64.0	109.2	74.7	89.4	66.8
Zinc (mg)	3.3	3.2	3.2	3.2	3.2	3.2
Copper (mg)	0.7	0.7	0.7	0.7	0.7	0.7
Vitamin A (mcg)	126.6	112.2	135.2	123.5	127.8	113.8
Thiamine (mg)	0.4	0.4	0.4	0.4	0.4	0.4
Riboflavin (mg)	0.2	0.2	0.3	0.2	0.2	0.2
Niacin EQ (mg)	8.6	8.1	8.7	8.7	8.6	8.2
Vitamin B_6 (mg)	1.4	0.9	1.3	0.8	1.4	0.9
Folate (mcg)	131.7	111.3	134.4	109.2	132.0	110.1
L-ascorbic acid (mg)	25.4	22.5	28.3	24.5	25.8	22.8
Vitamin B_{12} (mcg)	0.4	0.4	0.5	0.4	0.4	0.4

Table 30: Dietary energy and nutrient of intakes of <2-year children (grams/person/day) by rural and urban in Rajshahi Division (N=985)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	716.8	682.4	654.9	616.0	706.1	667.3
Protein (g)	17.4	16.5	16.4	14.6	17.2	16.3
Total fat (g)	11.9	11.0	13.7	12.5	12.2	11.1
Saturated fatty acids (g)	2.1	2.0	2.6	2.3	2.2	2.0
MUFA (g)	3.5	3.1	3.5	3.1	3.5	3.1
PUFA (g)	5.9	5.5	7.0	6.4	6.1	5.6
Cholesterol (mg)	12.6	9.9	15.9	12.9	13.2	10.6
Carbohydrate (g)	130.2	123.8	112.1	104.8	127.1	120.6
Total dietary fiber (g)	9.3	8.8	8.4	7.7	9.2	8.6
Calcium (mg)	113.6	103.5	123.8	107.1	115.3	104.2

Iron (mg)	3.9	3.7	3.6	3.6	3.9	3.7
Magnesium (mg)	115.8	108.6	106.2	99.7	114.2	107.4
Phosphorus (mg)	321.4	302.3	296.3	271.9	317.0	298.2
Potassium(mg)	623.3	590.9	605.1	569.4	620.1	587.6
Sodium (mg)	80.3	65.2	81.0	64.7	80.4	65.2
Zinc (mg)	3.2	3.1	2.9	2.7	3.1	3.0
Copper (mg)	0.7	0.6	0.6	0.6	0.7	0.6
Vitamin A (mcg)	107.7	92.7	111.1	95.2	108.3	93.0
Thiamine (mg)	0.4	0.4	0.4	0.3	0.4	0.4
Riboflavin (mg)	0.2	0.2	0.2	0.2	0.2	0.2
Niacin EQ (mg)	8.0	7.6	7.5	6.6	7.9	7.4
Vitamin B_6 (mg)	1.8	1.2	1.7	1.0	1.8	1.2
Folate (mcg)	90.0	80.5	106.1	89.7	92.7	81.2
L-ascorbic acid (mg)	24.2	20.5	27.9	23.6	24.8	21.1
Vitamin B_{12} (mcg)	0.4	0.3	0.5	0.4	0.4	0.3

Table 31: Dietary energy and nutrient of intakes of <2-year children (grams/person/day) by rural and urban in Rangpur Division (N=1159)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	715.3	686.7	656.3	631.2	704.8	674.3
Protein (g)	16.8	16.3	15.8	14.9	16.6	15.8
Total fat (g)	10.8	9.9	12.9	12.0	11.2	10.1
Saturated fatty acids (g)	2.9	2.1	3.0	2.4	2.9	2.2
MUFA (g)	3.5	3.1	3.5	3.2	3.5	3.1
PUFA (g)	5.9	5.4	7.1	6.3	6.1	5.6
Cholesterol (mg)	8.9	7.0	11.3	8.8	9.3	7.2
Carbohydrate (g)	131.8	126.4	114.0	111.3	128.6	123.4

Total dietary fiber (g)	9.9	9.6	9.0	8.8	9.8	9.4
Calcium (mg)	125.1	113.5	125.2	116.7	125.2	114.4
Iron (mg)	4.2	3.9	4.1	3.8	4.2	3.9
Magnesium (mg)	121.5	116.2	112.6	109.0	119.9	115.1
Phosphorus (mg)	329.9	317.6	295.0	280.9	323.7	308.4
Potassium(mg)	688.0	657.4	649.4	621.6	681.1	654.4
Sodium (mg)	83.6	68.3	98.2	80.3	86.2	69.6
Zinc (mg)	3.2	3.1	2.9	2.8	3.1	3.0
Copper (mg)	0.7	0.7	0.7	0.6	0.7	0.7
Vitamin A (mcg)	155.1	137.0	147.2	140.1	153.7	137.3
Thiamine (mg)	0.4	0.4	0.3	0.3	0.4	0.3
Riboflavin (mg)	0.2	0.2	0.2	0.2	0.2	0.2
Niacin EQ (mg)	7.1	6.6	6.7	6.3	7.1	6.6
Vitamin B_6 (mg)	1.3	0.8	1.3	0.9	1.3	0.8
Folate (mcg)	92.8	85.1	92.5	84.9	92.7	85.1
L-ascorbic acid (mg)	31.2	27.9	31.2	28.5	31.2	28.0
Vitamin B_{12} (mcg)	0.3	0.2	0.3	0.3	0.3	0.2

Table 32: Dietary energy and nutrient of intakes of <2-year children (grams/person/day) by rural and urban in Sylhet Division (N=884)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	740.9	704.2	706.0	691.4	735.3	702.0
Protein (g)	19.2	18.4	18.9	18.5	19.2	18.4
Total fat (g)	12.8	11.7	14.1	12.4	13.0	11.8
Saturated fatty acids (g)	3.0	2.8	3.0	2.8	3.0	2.8
MUFA (g)	3.7	3.4	3.8	3.4	3.7	3.4
PUFA (g)	7.0	6.4	7.5	6.6	7.1	6.5

Cholesterol (mg)	13.2	10.4	16.3	13.2	13.7	10.6
Carbohydrate (g)	131.5	123.0	120.6	116.7	129.8	121.9
Total dietary fiber (g)	9.6	9.0	9.2	8.9	9.5	9.0
Calcium (mg)	155.5	142.5	158.6	142.6	156.0	142.5
Iron (mg)	4.1	3.9	4.1	3.7	4.1	3.9
Magnesium (mg)	120.3	113.1	115.8	108.9	119.6	112.6
Phosphorus (mg)	361.7	344.5	344.2	327.5	358.9	342.9
Potassium(mg)	732.5	686.2	735.0	683.0	732.9	686.2
Sodium (mg)	78.8	66.0	84.2	72.8	79.6	66.8
Zinc (mg)	3.3	3.2	3.2	3.1	3.3	3.1
Copper (mg)	0.7	0.7	0.7	0.7	0.7	0.7
Vitamin A (mcg)	115.2	101.1	118.3	97.0	115.7	101.1
Thiamine (mg)	0.4	0.4	0.4	0.4	0.4	0.4
Riboflavin (mg)	0.2	0.2	0.2	0.2	0.2	0.2
Niacin EQ (mg)	7.7	6.9	7.6	7.2	7.7	6.9
Vitamin B_6 (mg)	1.5	0.8	1.6	0.8	1.5	0.8
Folate (mcg)	117.8	101.2	138.4	112.5	121.1	102.2
L-ascorbic acid (mg)	21.9	19.7	25.6	19.9	22.5	19.7
Vitamin B_{12} (mcg)	0.6	0.5	0.7	0.6	0.6	0.5

Table 33: Dietary energy and nutrient of intakes of 10-14 years) (grams/person/day) by rural and urban in Barisal Division (N=2118)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1568.7	1514.7	1525.3	1459.8	1561.9	1510.5
Protein (g)	41.5	39.9	41.5	38.5	41.5	39.7
Total fat (g)	33.4	29.8	37.2	32.5	34.0	30.1
Saturated fatty acids (g)	7.3	6.6	7.9	7.1	7.4	6.6
MUFA (g)	9.6	8.9	10.0	8.7	9.6	8.8

PUFA (g)	19.0	17.0	20.1	17.6	19.2	17.2
Cholesterol (mg)	40.6	34.2	44.6	37.6	41.2	34.6
Carbohydrate (g)	263.9	254.1	244.7	237.9	260.9	252.8
Total dietary fiber (g)	20.9	20.1	20.2	19.3	20.8	20.1
Calcium (mg)	287.1	264.7	316.1	288.8	291.7	268.8
Iron (mg)	10.0	9.5	10.0	9.4	10.0	9.4
Magnesium (mg)	262.4	252.6	252.8	243.4	260.9	251.3
Phosphorus (mg)	762.8	732.0	730.3	696.9	757.7	728.5
Potassium(mg)	1576.8	1498.5	1538.3	1460.1	1570.8	1495.8
Sodium (mg)	222.5	194.0	270.2	218.2	230.0	196.7
Zinc (mg)	7.0	6.8	6.8	6.3	7.0	6.8
Copper (mg)	1.5	1.5	1.4	1.4	1.5	1.4
Vitamin A (mcg)	301.4	278.9	287.0	270.3	299.1	276.9
Thiamine (mg)	0.8	0.7	0.8	0.7	0.8	0.7
Riboflavin (mg)	0.5	0.4	0.5	0.4	0.5	0.4
Niacin EQ (mg)	15.0	14.0	15.3	13.9	15.1	14.0
Vitamin B_6 (mg)	2.2	1.5	1.8	1.4	2.2	1.5
Folate (mcg)	469.1	333.6	437.7	346.7	464.2	335.1
L-ascorbic acid (mg)	61.7	49.6	57.9	49.8	61.1	49.6
Vitamin B_{12} (mcg)	1.5	1.3	1.8	1.5	1.5	1.3

Table 34: Dietary energy and nutrient of intakes of 10-14 years) (grams/person/day) by rural and urban in Chittagong Division (N=4305)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1783.6	1735.0	1621.3	1578.3	1744.8	1695.2
Protein (g)	47.8	46.4	44.7	42.8	47.1	45.4
Total fat (g)	35.2	32.4	35.9	34.1	35.4	32.5
Saturated fatty acids (g)	7.7	6.8	7.2	6.5	7.6	6.8

MUFA (g)	9.8	8.6	9.2	8.5	9.6	8.6
PUFA (g)	18.7	17.2	19.1	18.1	18.8	17.4
Cholesterol (mg)	42.6	37.2	45.1	39.4	43.2	37.8
Carbohydrate (g)	305.5	295.4	268.1	257.5	296.6	287.8
Total dietary fiber (g)	24.3	23.6	21.8	21.3	23.7	23.0
Calcium (mg)	374.8	349.4	348.1	324.9	368.4	341.0
Iron (mg)	11.1	10.6	10.1	9.8	10.9	10.3
Magnesium (mg)	303.5	297.3	273.4	268.3	296.3	288.1
Phosphorus (mg)	851.4	823.2	772.7	751.4	832.6	807.5
Potassium(mg)	1827.4	1761.7	1680.6	1612.7	1792.3	1723.8
Sodium (mg)	254.7	232.0	265.5	227.6	257.3	231.4
Zinc (mg)	8.1	7.8	7.3	7.0	7.9	7.6
Copper (mg)	1.8	1.7	1.6	1.6	1.7	1.7
Vitamin A (mcg)	314.6	293.8	292.4	280.1	309.3	290.8
Thiamine (mg)	1.0	1.0	0.9	0.9	1.0	0.9
Riboflavin (mg)	0.6	0.6	0.5	0.5	0.6	0.5
Niacin EQ (mg)	20.0	18.7	18.1	16.9	19.6	18.2
Vitamin B_6 (mg)	3.3	1.9	3.0	1.6	3.2	1.8
Folate (mcg)	373.1	327.4	335.3	298.6	364.0	319.7
L-ascorbic acid (mg)	76.3	66.5	66.2	60.8	73.9	65.2
Vitamin B_{12} (mcg)	1.8	1.6	1.9	1.7	1.8	1.6

Table 35: Dietary energy and nutrient of intakes of 10-14 years) (grams/person/day) by rural and urban in Dhaka Division (N=4280)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1784.1	1732.2	1641.9	1635.7	1722.5	1681.1
Protein (g)	45.5	43.7	45.5	43.3	45.5	43.6

Total fat (g)	36.0	33.2	38.1	35.2	36.9	34.1
Saturated fatty acids (g)	7.1	6.4	7.1	6.6	7.1	6.4
MUFA (g)	9.5	8.5	9.2	8.4	9.4	8.5
PUFA (g)	18.7	17.1	19.3	18.1	18.9	17.6
Cholesterol (mg)	38.9	33.4	49.1	44.2	43.3	37.8
Carbohydrate (g)	306.8	295.9	267.5	257.2	289.8	279.4
Total dietary fiber (g)	23.7	22.9	22.8	22.1	23.3	22.5
Calcium (mg)	342.8	317.8	363.6	331.9	351.8	322.0
Iron (mg)	10.3	9.7	10.5	9.9	10.4	9.7
Magnesium (mg)	292.9	282.0	283.8	277.1	288.9	279.3
Phosphorus (mg)	810.8	783.3	761.1	737.6	789.3	764.5
Potassium(mg)	1654.0	1585.1	1676.6	1581.4	1663.8	1581.7
Sodium (mg)	262.5	195.1	322.2	275.4	288.4	223.8
Zinc (mg)	7.9	7.6	7.5	7.4	7.8	7.5
Copper (mg)	1.7	1.6	1.7	1.6	1.7	1.6
Vitamin A (mcg)	306.6	270.4	342.6	308.4	322.2	287.8
Thiamine (mg)	1.0	0.9	0.9	0.9	1.0	0.9
Riboflavin (mg)	0.6	0.5	0.6	0.5	0.6	0.5
Niacin EQ (mg)	19.7	18.5	18.9	18.2	19.3	18.4
Vitamin B_6 (mg)	3.3	1.9	2.9	1.6	3.1	1.8
Folate (mcg)	332.8	280.1	395.1	326.2	359.8	295.9
L-ascorbic acid (mg)	74.7	63.6	92.1	77.5	82.2	68.6
Vitamin B_{12} (mcg)	1.3	1.1	1.5	1.3	1.4	1.2

Table 36: Dietary energy and nutrient of intakes of 10-14 years) (grams/person/day) by rural and urban in Khulna Division (N=2785)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median

Energy (Kcal)	1821.3	1785.6	1647.8	1610.3	1784.2	1746.6
Protein (g)	44.0	42.7	42.3	40.4	43.6	42.1
Total fat (g)	32.8	31.1	36.2	32.8	33.5	31.3
Saturated fatty acids (g)	6.6	6.1	6.9	6.3	6.7	6.2
MUFA (g)	9.9	8.9	9.3	8.6	9.7	8.8
PUFA (g)	18.1	17.3	19.5	18.2	18.4	17.5
Cholesterol (mg)	29.8	26.2	39.1	31.5	31.8	27.2
Carbohydrate (g)	324.6	317.8	276.4	273.7	314.3	308.5
Total dietary fiber (g)	24.5	23.8	22.3	21.8	24.0	23.3
Calcium (mg)	297.2	273.9	316.1	282.3	301.2	275.1
Iron (mg)	10.2	9.8	9.8	9.4	10.1	9.7
Magnesium (mg)	302.4	291.3	278.6	272.2	297.3	287.5
Phosphorus (mg)	826.3	807.2	746.9	724.2	809.4	786.2
Potassium(mg)	1684.4	1622.9	1607.4	1556.0	1668.0	1600.9
Sodium (mg)	186.1	154.2	231.9	172.7	195.9	157.6
Zinc (mg)	8.1	7.9	7.3	7.2	7.9	7.7
Copper (mg)	1.8	1.7	1.6	1.6	1.8	1.7
Vitamin A (mcg)	317.6	289.8	327.4	299.2	319.7	291.7
Thiamine (mg)	1.0	0.9	0.9	0.9	1.0	0.9
Riboflavin (mg)	0.5	0.5	0.5	0.5	0.5	0.5
Niacin EQ (mg)	18.9	17.2	18.1	16.9	18.7	17.1
Vitamin B_6 (mg)	4.1	3.1	3.1	1.8	3.9	2.8
Folate (mcg)	264.1	232.4	300.9	249.4	271.9	236.2
L-ascorbic acid (mg)	83.3	74.3	87.8	78.7	84.3	75.0
Vitamin B_{12} (mcg)	1.0	0.8	1.3	1.1	1.1	0.9

Table 37: Dietary energy and nutrient of intakes of 10-14 years) (grams/person/day) by rural and urban in Mymensingh Division (N=1254)

Energy and Nutrients	Rural		Urban		All	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1729.9	1708.9	1718.4	1705.6	1728.2	1708.9
Protein (g)	43.0	42.3	44.7	43.2	43.3	42.3
Total fat (g)	23.4	21.7	29.2	27.0	24.3	22.6
Saturated fatty acids (g)	5.5	5.0	6.4	6.0	5.6	5.1
MUFA (g)	6.4	5.8	7.0	6.6	6.5	5.9
PUFA (g)	11.9	10.8	15.2	13.8	12.4	11.2
Cholesterol (mg)	27.5	23.8	36.4	31.7	28.8	24.8
Carbohydrate (g)	323.5	317.3	306.0	302.8	320.9	315.2
Total dietary fiber (g)	23.8	23.4	23.8	23.3	23.8	23.4
Calcium (mg)	307.8	294.5	339.7	323.0	312.6	299.2
Iron (mg)	9.3	9.0	9.8	9.4	9.4	9.1
Magnesium (mg)	286.0	282.7	287.6	285.6	286.2	282.9
Phosphorus (mg)	774.8	759.9	773.0	751.0	774.5	759.1
Potassium(mg)	1590.8	1547.2	1655.8	1617.0	1600.6	1552.2
Sodium (mg)	185.3	135.9	229.7	171.0	192.0	140.7
Zinc (mg)	7.7	7.7	7.7	7.6	7.7	7.6
Copper (mg)	1.6	1.6	1.7	1.6	1.6	1.6
Vitamin A (mcg)	285.1	262.8	303.0	277.4	287.8	264.7
Thiamine (mg)	1.0	1.0	1.0	1.0	1.0	1.0
Riboflavin (mg)	0.5	0.5	0.6	0.5	0.5	0.5
Niacin EQ (mg)	20.7	20.6	20.9	21.2	20.8	20.7
Vitamin B_6 (mg)	3.4	2.4	3.7	2.9	3.4	2.4
Folate (mcg)	284.6	251.8	326.9	284.6	291.0	254.9
L-ascorbic acid (mg)	59.2	52.4	60.8	57.1	59.4	53.1
Vitamin B_{12} (mcg)	0.9	0.8	1.2	1.0	0.9	0.8

Table 38: Dietary energy and nutrient of intakes of 10-14 years) (grams/person/day) by rural and urban in Rajshahi Division (N=2192)

Energy and Nutrients	Rural		Urban		All	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1847.5	1788.6	1712.6	1670.0	1821.5	1770.4
Protein (g)	43.9	42.0	42.3	40.3	43.6	41.8
Total fat (g)	29.3	27.5	32.7	30.8	29.9	28.1
Saturated fatty acids (g)	5.4	4.9	5.8	5.2	5.4	5.0
MUFA (g)	8.5	7.5	8.4	7.3	8.5	7.5
PUFA (g)	15.2	14.6	16.9	16.1	15.5	14.8
Cholesterol (mg)	29.0	23.3	36.3	31.1	30.4	24.8
Carbohydrate (g)	339.4	329.8	300.7	288.1	331.9	321.4
Total dietary fiber (g)	24.2	23.7	22.3	21.7	23.8	23.3
Calcium (mg)	268.9	247.3	288.1	266.6	272.6	251.8
Iron (mg)	9.8	9.3	9.6	9.2	9.8	9.3
Magnesium (mg)	297.2	289.0	279.2	272.6	293.7	285.4
Phosphorus (mg)	816.2	792.8	755.0	730.5	804.4	778.3
Potassium(mg)	1571.0	1520.3	1543.5	1479.6	1565.7	1514.6
Sodium (mg)	201.5	161.7	213.9	174.0	203.9	163.4
Zinc (mg)	8.2	7.9	7.6	7.3	8.1	7.8
Copper (mg)	1.7	1.6	1.6	1.5	1.7	1.6
Vitamin A (mcg)	268.5	239.3	283.9	250.9	271.4	242.4
Thiamine (mg)	1.0	1.0	1.0	0.9	1.0	1.0
Riboflavin (mg)	0.5	0.5	0.5	0.5	0.5	0.5
Niacin EQ (mg)	20.7	20.1	20.0	19.3	20.5	20.0
Vitamin B_6 (mg)	4.7	3.4	3.8	2.7	4.5	3.2
Folate (mcg)	228.5	193.3	243.3	210.4	231.4	194.9
L-ascorbic acid (mg)	60.8	53.7	73.2	63.9	63.2	55.0

Vitamin B_{12} (mcg)	0.9	0.7	1.0	0.9	0.9	0.7

Table 39: Dietary energy and nutrient of intakes of 10-14 years) (grams/person/day) by rural and urban in Rangpur Division (N=2571)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1814.7	1769.7	1702.4	1666.9	1799.2	1758.6
Protein (g)	42.2	41.5	40.9	38.9	42.1	41.2
Total fat (g)	24.6	22.7	29.5	27.6	25.2	23.2
Saturated fatty acids (g)	7.1	5.4	6.9	5.9	7.1	5.5
MUFA (g)	8.2	7.8	8.0	7.6	8.2	7.8
PUFA (g)	13.8	13.1	16.2	15.4	14.1	13.4
Cholesterol (mg)	20.8	15.8	26.8	20.0	21.6	16.5
Carbohydrate (g)	340.8	335.4	304.8	291.9	335.9	328.0
Total dietary fiber (g)	25.2	24.4	23.5	22.7	24.9	24.1
Calcium (mg)	297.9	277.7	315.6	289.5	300.4	279.1
Iron (mg)	10.3	9.9	10.5	9.9	10.3	9.9
Magnesium (mg)	306.9	300.6	294.5	284.0	305.2	298.4
Phosphorus (mg)	837.1	825.2	765.6	745.8	827.3	816.3
Potassium(mg)	1721.1	1676.3	1655.9	1603.3	1712.1	1664.0
Sodium (mg)	200.2	160.9	238.8	194.4	205.5	165.2
Zinc (mg)	8.1	8.0	7.6	7.4	8.0	7.9
Copper (mg)	1.8	1.8	1.7	1.6	1.8	1.7
Vitamin A (mcg)	378.2	342.7	380.6	335.7	378.6	341.0
Thiamine (mg)	0.9	0.9	0.9	0.9	0.9	0.9
Riboflavin (mg)	0.5	0.5	0.6	0.5	0.5	0.5
Niacin EQ (mg)	18.0	16.4	18.1	17.2	18.0	16.5
Vitamin B_6 (mg)	3.2	2.0	3.3	2.2	3.2	2.1

Folate (mcg)	230.9	214.0	234.7	204.4	231.4	211.7
L-ascorbic acid (mg)	75.7	68.2	77.5	69.5	75.9	68.3
Vitamin B_{12} (mcg)	0.7	0.6	0.8	0.6	0.7	0.6

Table 40: Dietary energy and nutrient of intakes of 10-14 years) (grams/person/day) by rural and urban in Sylhet Division (N=1718)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1888.7	1837.9	1792.8	1763.5	1874.7	1825.9
Protein (g)	48.0	46.3	47.8	46.7	48.0	46.4
Total fat (g)	28.9	26.5	31.9	29.7	29.4	26.8
Saturated fatty acids (g)	7.1	6.5	7.4	6.7	7.2	6.6
MUFA (g)	8.7	8.2	8.8	8.5	8.8	8.3
PUFA (g)	15.8	14.7	16.9	16.2	16.0	14.9
Cholesterol (mg)	29.2	24.0	38.2	31.6	30.5	24.7
Carbohydrate (g)	344.9	333.8	315.2	302.6	340.6	329.5
Total dietary fiber (g)	24.2	23.4	23.2	22.3	24.0	23.3
Calcium (mg)	372.6	345.7	382.8	350.1	374.1	347.5
Iron (mg)	10.3	9.8	10.1	9.7	10.2	9.8
Magnesium (mg)	306.5	297.7	292.6	282.4	304.5	295.6
Phosphorus (mg)	913.6	892.4	877.6	850.0	908.3	883.8
Potassium(mg)	1824.3	1760.1	1779.9	1690.0	1817.8	1747.8
Sodium (mg)	183.0	161.8	201.7	184.5	185.7	164.2
Zinc (mg)	8.4	8.2	8.1	7.8	8.4	8.1
Copper (mg)	1.8	1.7	1.8	1.7	1.8	1.7
Vitamin A (mcg)	277.3	248.1	272.4	250.0	276.5	248.3
Thiamine (mg)	1.0	0.9	1.0	0.9	1.0	0.9
Riboflavin (mg)	0.5	0.5	0.6	0.5	0.5	0.5

Niacin EQ (mg)	19.7	18.0	19.6	18.4	19.7	18.0
Vitamin B_6 (mg)	3.5	1.9	3.7	1.9	3.5	1.9
Folate (mcg)	268.9	244.1	314.0	277.6	275.5	246.7
L-ascorbic acid (mg)	51.8	46.2	56.5	50.3	52.5	46.6
Vitamin B_{12} (mcg)	1.4	1.2	1.7	1.4	1.5	1.2

Table 41: Dietary energy and nutrient of intakes of WRA (15-49 years) (grams/person/day) by rural and urban in Barisal Division (N=4598)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1622.3	1581.6	1557.0	1493.1	1610.31	1569.41
Protein (g)	43.2	41.7	42.3	39.3	43.03	41.41
Total fat (g)	36.3	32.2	42.0	37.3	37.33	33.04
Saturated fatty acids (g)	7.8	7.1	8.5	7.8	7.94	7.23
MUFA (g)	10.2	9.5	10.7	9.7	10.29	9.53
PUFA (g)	20.6	18.4	22.6	20.2	20.94	18.68
Cholesterol (mg)	44.2	36.4	48.4	40.8	44.95	37.16
Carbohydrate (g)	268.5	262.8	241.2	229.9	263.53	257.75
Total dietary fiber (g)	21.7	21.2	20.5	19.7	21.50	20.89
Calcium (mg)	308.9	285.1	335.9	298.7	313.86	287.21
Iron (mg)	10.5	10.1	10.2	9.5	10.46	9.95
Magnesium (mg)	273.2	267.3	257.2	244.3	270.23	263.93
Phosphorus (mg)	788.0	767.2	737.2	696.5	778.75	757.07
Potassium(mg)	1657.5	1590.2	1586.6	1478.3	1644.56	1577.86
Sodium (mg)	241.3	208.3	285.0	236.9	249.27	211.47
Zinc (mg)	7.2	7.1	6.8	6.4	7.16	6.99
Copper (mg)	1.6	1.5	1.5	1.4	1.55	1.50
Vitamin A (mcg)	325.7	297.2	305.1	270.3	321.96	291.32
Thiamine (mg)	0.8	0.8	0.8	0.7	0.82	0.77

Riboflavin (mg)	0.5	0.5	0.5	0.5	0.50	0.46
Niacin EQ (mg)	15.7	14.6	15.6	14.2	15.65	14.55
Vitamin B_6 (mg)	2.3	1.6	2.0	1.4	2.24	1.55
Folate (mcg)	504.3	347.7	454.1	359.8	495.12	349.61
L-ascorbic acid (mg)	65.9	53.4	63.3	52.1	65.41	53.03
Vitamin B_{12} (mcg)	1.6	1.4	1.9	1.6	1.67	1.43

Table 42: Dietary energy and nutrient of intakes of WRA (15-49 years) (grams/person/day) by rural and urban in Chittagong Division (N=9248)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1873.9	1843.1	1699.6	1642.8	1822.4	1776.6
Protein (g)	51.3	49.8	47.3	45.5	50.1	48.4
Total fat (g)	39.2	35.8	40.2	38.3	39.5	36.6
Saturated fatty acids (g)	8.5	7.5	7.8	7.1	8.3	7.3
MUFA (g)	10.6	9.5	9.9	9.2	10.4	9.4
PUFA (g)	20.7	19.1	21.4	20.1	20.9	19.4
Cholesterol (mg)	48.5	42.5	49.2	42.3	48.7	42.4
Carbohydrate (g)	314.8	309.9	274.8	265.7	303.0	295.0
Total dietary fiber (g)	25.9	25.4	23.1	22.5	25.0	24.3
Calcium (mg)	417.4	389.7	387.7	363.4	408.6	379.0
Iron (mg)	12.1	11.7	10.9	10.5	11.8	11.2
Magnesium (mg)	323.0	319.1	288.6	280.9	312.8	307.0
Phosphorus (mg)	905.2	897.3	807.5	786.5	876.3	858.6
Potassium(mg)	1979.6	1921.1	1819.8	1733.9	1932.3	1867.8
Sodium (mg)	281.1	256.0	296.0	249.0	285.5	254.0
Zinc (mg)	8.6	8.4	7.6	7.3	8.3	8.1
Copper (mg)	1.9	1.9	1.7	1.6	1.8	1.8
Vitamin A (mcg)	349.9	325.0	320.8	301.8	341.3	315.7

Thiamine (mg)	1.1	1.0	0.9	0.9	1.0	1.0
Riboflavin (mg)	0.7	0.6	0.6	0.6	0.6	0.6
Niacin EQ (mg)	21.1	19.9	19.1	18.0	20.5	19.3
Vitamin B_6 (mg)	3.6	2.0	3.0	1.7	3.4	1.9
Folate (mcg)	396.4	353.0	370.2	317.1	388.7	342.8
L-ascorbic acid (mg)	83.3	72.5	74.1	68.0	80.6	71.0
Vitamin B_{12} (mcg)	2.0	1.8	2.1	1.9	2.0	1.8

Table 43: Dietary energy and nutrient of intakes of WRA (15-49 years) (grams/person/day) by rural and urban in Dhaka Division (N=10274)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1846.0	1795.7	1712.1	1678.0	1777.1	1728.0
Protein (g)	47.5	45.7	48.0	46.8	47.8	46.3
Total fat (g)	40.6	37.3	42.9	41.6	41.8	39.4
Saturated fatty acids (g)	8.0	7.2	7.8	7.3	7.9	7.3
MUFA (g)	10.5	9.4	10.1	9.4	10.3	9.4
PUFA (g)	21.0	19.3	21.9	21.0	21.5	20.2
Cholesterol (mg)	43.4	37.5	55.0	49.0	49.4	43.9
Carbohydrate (g)	309.5	300.5	271.2	264.9	289.8	280.9
Total dietary fiber (g)	24.7	23.8	23.8	22.9	24.2	23.3
Calcium (mg)	377.8	344.3	393.2	361.8	385.7	354.1
Iron (mg)	10.9	10.3	11.2	10.6	11.1	10.4
Magnesium (mg)	304.9	293.5	295.3	284.0	300.0	288.0
Phosphorus (mg)	840.3	815.7	792.8	773.5	815.9	792.5
Potassium(mg)	1764.8	1672.8	1793.2	1686.9	1779.4	1682.6
Sodium (mg)	290.0	221.1	348.4	309.1	320.0	261.1
Zinc (mg)	8.2	7.9	7.9	7.7	8.1	7.8

Copper (mg)	1.8	1.7	1.7	1.7	1.8	1.7
Vitamin A (mcg)	336.3	294.6	373.0	335.4	355.2	315.9
Thiamine (mg)	1.0	1.0	1.0	0.9	1.0	1.0
Riboflavin (mg)	0.6	0.6	0.6	0.6	0.6	0.6
Niacin EQ (mg)	20.2	19.2	19.7	19.2	19.9	19.2
Vitamin B_6 (mg)	3.5	2.0	3.0	1.6	3.3	1.8
Folate (mcg)	366.9	303.7	421.8	360.0	395.1	334.2
L-ascorbic acid (mg)	81.8	68.6	101.2	89.7	91.8	78.8
Vitamin B_{12} (mcg)	1.4	1.2	1.7	1.5	1.6	1.4

Table 44: Dietary energy and nutrient of intakes of WRA (15-49 years) (grams/person/day) by rural and urban in Khulna Division (N=7647)

Energy and Nutrients	Rural		Urban		All	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1885.0	1830.7	1681.9	1651.5	1838.1	1790.4
Protein (g)	46.0	44.9	43.5	42.0	45.4	44.1
Total fat (g)	35.8	33.6	39.5	36.6	36.6	34.1
Saturated fatty acids (g)	7.2	6.6	7.5	6.9	7.3	6.6
MUFA (g)	10.5	9.5	10.1	9.2	10.4	9.4
PUFA (g)	19.6	18.6	21.2	19.6	20.0	18.9
Cholesterol (mg)	34.1	29.6	42.7	36.8	36.1	30.9
Carbohydrate (g)	331.3	325.5	275.9	271.5	318.6	313.6
Total dietary fiber (g)	25.4	24.7	23.0	22.4	24.9	24.3
Calcium (mg)	322.9	298.9	339.9	307.5	326.8	300.7
Iron (mg)	10.7	10.3	10.3	9.9	10.6	10.2
Magnesium (mg)	313.5	305.4	287.6	281.1	307.5	300.0
Phosphorus (mg)	854.2	837.3	765.7	747.4	833.8	817.8
Potassium(mg)	1769.9	1706.9	1691.1	1628.8	1751.7	1693.2

Sodium (mg)	200.5	164.2	250.2	194.2	211.9	169.3
Zinc (mg)	8.3	8.2	7.5	7.4	8.2	8.0
Copper (mg)	1.9	1.8	1.7	1.6	1.8	1.8
Vitamin A (mcg)	337.7	312.2	346.9	317.7	339.8	313.5
Thiamine (mg)	1.0	1.0	0.9	0.9	1.0	0.9
Riboflavin (mg)	0.6	0.5	0.6	0.5	0.6	0.5
Niacin EQ (mg)	19.8	18.4	18.4	17.6	19.5	18.1
Vitamin B_6 (mg)	4.3	3.2	3.3	1.9	4.1	2.9
Folate (mcg)	287.8	252.1	322.3	273.1	295.8	257.2
L-ascorbic acid (mg)	89.3	78.1	93.5	82.7	90.3	79.0
Vitamin B_{12} (mcg)	1.2	1.0	1.4	1.2	1.2	1.0

Table 45: Dietary energy and nutrient of intakes of WRA (15-49 years) grams/person/day) by rural and urban in Mymensingh Division (N=2781)

Energy and Nutrients	Rural		Urban		All	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1799.4	1760.5	1792.9	1782.9	1798.3	1764.2
Protein (g)	45.8	44.3	46.8	45.8	45.9	44.7
Total fat (g)	26.6	24.4	31.8	29.2	27.4	25.0
Saturated fatty acids (g)	6.1	5.5	6.9	6.3	6.2	5.6
MUFA (g)	7.1	6.2	7.8	7.1	7.2	6.4
PUFA (g)	13.5	12.2	16.4	14.7	14.0	12.5
Cholesterol (mg)	32.7	27.6	39.3	34.0	33.8	28.7
Carbohydrate (g)	330.3	324.4	316.0	311.0	327.9	322.3
Total dietary fiber (g)	25.0	24.7	25.0	24.6	25.0	24.7
Calcium (mg)	346.0	317.3	369.7	346.8	350.0	322.4
Iron (mg)	10.0	9.5	10.5	9.9	10.1	9.6
Magnesium (mg)	300.2	293.5	301.6	300.7	300.4	294.5
Phosphorus (mg)	813.3	792.4	809.6	797.2	812.6	793.4

Potassium(mg)	1711.4	1647.7	1756.8	1701.6	1719.0	1652.4
Sodium (mg)	204.2	149.8	244.3	185.4	211.0	154.5
Zinc (mg)	8.1	8.0	8.1	8.0	8.1	8.0
Copper (mg)	1.7	1.7	1.8	1.7	1.7	1.7
Vitamin A (mcg)	314.4	281.0	325.1	299.5	316.2	283.3
Thiamine (mg)	1.1	1.1	1.1	1.1	1.1	1.1
Riboflavin (mg)	0.6	0.5	0.6	0.6	0.6	0.5
Niacin EQ (mg)	21.8	21.5	21.8	22.2	21.8	21.6
Vitamin B_6 (mg)	3.8	2.8	3.8	2.9	3.8	2.8
Folate (mcg)	319.1	275.1	333.6	294.6	321.6	278.3
L-ascorbic acid (mg)	63.1	56.7	66.4	62.8	63.7	57.3
Vitamin B_{12} (mcg)	1.1	0.9	1.3	1.1	1.1	1.0

Table 46: Dietary energy and nutrient of intakes of WRA (15-49 years) (grams/person/day) by rural and urban in Rajshahi Division (N=6013)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1897.3	1872.9	1722.8	1686.3	1857.1	1831.0
Protein (g)	45.6	44.2	43.5	41.3	45.1	43.5
Total fat (g)	31.7	29.9	35.1	33.2	32.5	30.6
Saturated fatty acids (g)	5.8	5.3	6.3	5.7	5.9	5.4
MUFA (g)	9.2	8.2	8.9	7.9	9.1	8.1
PUFA (g)	16.2	15.7	18.3	17.5	16.7	16.2
Cholesterol (mg)	32.6	26.2	40.1	33.2	34.3	27.5
Carbohydrate (g)	344.4	340.5	296.5	284.3	333.4	328.7
Total dietary fiber (g)	24.8	24.4	22.5	22.1	24.3	23.8
Calcium (mg)	290.5	269.2	302.8	277.8	293.3	271.0
Iron (mg)	10.3	9.8	10.0	9.8	10.2	9.8
Magnesium (mg)	306.4	300.0	283.1	272.0	301.1	293.4

Phosphorus (mg)	842.6	825.6	767.4	737.7	825.3	804.9
Potassium(mg)	1647.0	1603.2	1584.4	1523.1	1632.6	1588.4
Sodium (mg)	216.1	174.9	223.7	183.8	217.9	177.3
Zinc (mg)	8.4	8.2	7.8	7.4	8.2	8.1
Copper (mg)	1.8	1.7	1.6	1.6	1.7	1.7
Vitamin A (mcg)	290.4	257.2	285.0	260.4	289.2	258.5
Thiamine (mg)	1.1	1.0	1.0	0.9	1.0	1.0
Riboflavin (mg)	0.6	0.5	0.6	0.5	0.6	0.5
Niacin EQ (mg)	21.2	20.6	20.2	19.2	21.0	20.3
Vitamin B_6 (mg)	5.0	3.6	4.0	2.7	4.8	3.4
Folate (mcg)	241.8	206.7	255.8	220.2	245.0	209.8
L-ascorbic acid (mg)	66.2	57.6	74.6	66.2	68.1	59.3
Vitamin B_{12} (mcg)	1.0	0.8	1.2	1.0	1.0	0.8

Table 47: Dietary energy and nutrient of intakes of WRA (15-49 years) (grams/person/day) by rural and urban in Rangpur Division (N=5909)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1867.4	1843.0	1700.6	1677.6	1841.4	1817.5
Protein (g)	43.7	43.1	41.4	39.7	43.4	42.6
Total fat (g)	27.5	25.5	32.7	30.1	28.3	26.2
Saturated fatty acids (g)	7.6	5.8	7.8	6.4	7.6	5.9
MUFA (g)	9.0	8.5	8.8	8.4	8.9	8.4
PUFA (g)	15.4	14.6	17.9	16.8	15.8	14.8
Cholesterol (mg)	23.1	17.7	31.2	23.5	24.3	18.5
Carbohydrate (g)	345.5	342.7	296.3	294.6	337.8	334.6
Total dietary fiber (g)	26.0	25.5	23.4	23.0	25.6	25.0
Calcium (mg)	321.8	299.5	333.0	305.8	323.5	300.6
Iron (mg)	10.9	10.5	10.7	10.3	10.9	10.5

Magnesium (mg)	318.0	312.5	294.0	289.6	314.3	309.2
Phosphorus (mg)	861.8	855.0	769.7	751.1	847.4	839.6
Potassium(mg)	1804.1	1759.1	1698.2	1665.9	1787.6	1742.8
Sodium (mg)	217.5	174.6	243.8	196.5	221.6	177.9
Zinc (mg)	8.4	8.3	7.6	7.4	8.2	8.2
Copper (mg)	1.9	1.9	1.7	1.6	1.9	1.8
Vitamin A (mcg)	409.4	371.1	382.4	349.3	405.2	367.4
Thiamine (mg)	1.0	0.9	0.9	0.9	1.0	0.9
Riboflavin (mg)	0.6	0.5	0.6	0.5	0.6	0.5
Niacin EQ (mg)	18.5	17.1	18.0	17.2	18.4	17.1
Vitamin B_6 (mg)	3.4	2.1	3.3	2.0	3.4	2.1
Folate (mcg)	244.0	222.6	243.0	213.9	243.8	220.3
L-ascorbic acid (mg)	81.9	73.7	80.7	72.3	81.7	73.4
Vitamin B_{12} (mcg)	0.8	0.6	1.0	0.7	0.8	0.6

Table 48: Dietary energy and nutrient of intakes of WRA (15-49 years) (grams/person/day) by rural and urban in Sylhet Division (N=3649)

Energy and Nutrients	**Rural**		**Urban**		**All**	
	Mean	Median	Mean	Median	Mean	Median
Energy (Kcal)	1955.5	1904.3	1883.5	1852.0	1943.6	1891.0
Protein (g)	50.4	48.7	50.2	48.7	50.3	48.7
Total fat (g)	32.3	29.5	36.1	33.5	33.0	29.9
Saturated fatty acids (g)	7.9	7.2	8.2	7.5	7.9	7.3
MUFA (g)	9.5	9.0	9.6	9.0	9.5	9.0
PUFA (g)	17.5	16.2	19.2	17.9	17.8	16.4
Cholesterol (mg)	33.5	27.4	41.4	34.8	34.8	28.5
Carbohydrate (g)	350.9	340.9	325.1	314.9	346.7	336.1
Total dietary fiber (g)	25.2	24.4	24.3	23.7	25.0	24.4
Calcium (mg)	405.5	373.8	421.4	390.6	408.1	376.6

Iron (mg)	10.8	10.4	10.6	10.2	10.8	10.3
Magnesium (mg)	320.0	312.0	308.0	301.4	318.0	310.1
Phosphorus (mg)	953.6	936.1	914.8	899.3	947.2	928.8
Potassium(mg)	1950.9	1888.0	1924.5	1847.9	1946.5	1880.0
Sodium (mg)	203.4	181.9	219.7	200.1	206.1	184.2
Zinc (mg)	8.7	8.6	8.4	8.3	8.7	8.5
Copper (mg)	1.9	1.8	1.9	1.8	1.9	1.8
Vitamin A (mcg)	297.8	266.9	297.9	268.4	297.8	267.2
Thiamine (mg)	1.0	1.0	1.0	1.0	1.0	1.0
Riboflavin (mg)	0.6	0.5	0.6	0.6	0.6	0.5
Niacin EQ (mg)	20.4	18.6	20.8	19.7	20.5	18.8
Vitamin B_6 (mg)	4.0	2.1	3.9	1.9	3.9	2.0
Folate (mcg)	295.5	263.9	339.7	293.4	302.8	267.1
L-ascorbic acid (mg)	56.6	50.7	61.9	54.6	57.5	51.2
Vitamin B_{12} (mcg)	1.6	1.4	1.8	1.5	1.6	1.4

Appendix-II: Nutrient Profiling

1. Cereals and their products

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	01_0019	01_0019	Chaler kura	Rice, bran, raw	3.98	126	34
2	01_0001	01_0001	Jaab, gota	Barley, whole-grain, raw	3.24	50	14
3	01_0033	01_0033	Gom	Wheat, whole, raw	3.44	42	14
4	01_0008	01_0008	Bajra, gota-dana	Pearl millet, whole-grain, raw	3.49	38	13
5	01_0030	01_0030	Ata, lal	Wheat flour, brown, whole grain, raw	3.34	40	13
6	01_0007	01_0007	Cheena, gota-dana	Millet, Proso, whole-grain, raw	3.41	33	13
7	01_0006	01_0006	Kaon	Millet, Foxtail, raw	3.44	26	11
8	01_0005	01_0005	Bhutta, shukna	Maize/corn, yellow, dried, raw	3.44	29	10
9	01_0027	01_0027	Jowar	Sorghum, raw	3.50	45	9
10	01_0009	01_0009	Popcorn, Bhutta	Popcorn, maize (salt added)	3.28	27	9
11	01_0020	01_0020	Chal, siddha, dhekichata	Rice, brown, parboiled, home-pounded, raw	3.48	18	8
12	01_0003	01_0003	Pawruti	Bread, white, for toasting	2.72	8	8
13	01_0004	01_0004	Bhutta, atta	Maize/corn flour, whole, white	3.55	24	8
14	01_0021	01_0021	Chal, lal, siddha, kolechata	Rice, brown, parboiled, milled, raw	3.50	17	7
15	01_0031	01_0031	Ata, sada, paket	Wheat, flour, white	3.47	22	7

16	01_0026	01_0026	Sooji, gom	Semolina, wheat, raw	3.46	15	7
17	01_0010	01_0010	Chira	Rice flakes	3.56	20	7
18	01_0032	01_0032	Maida	Wheat flour, white, refined	3.46	17	6
19	01_0029	01_0029	Semai	Vermicelli, wheat, raw	3.47	15	6
20	01_0002	01_0002	Bonruti, bun/roll	Bread, bun/roll	2.70	8	5
21	01_0012	01_0012	Chal, BR-28, majhari dana, siddha, kolechata	Rice, BR-28, parboiled, milled, raw	3.44	13	5
22	01_0022	01_0022	Khoi	Rice, popped	3.80	10	5
23	01_0028	01_0028	Bhutta, kancha	Sweetcorn, yellow, on-the cob, raw	1.47	29	5
24	01_0017	01_0017	Chal, BRRI Dhan-30, siddha, kole chata	Rice, BRRI Dhan-30, parboiled, milled, raw	3.49	12	5
25	01_0015	01_0015	Chal, BR-26, siddha, kole chata	Rice, BR-26, parboiled, milled, raw	3.46	13	5
26	01_0023	01_0023	Muri	Rice, puffed, salted	3.61	2	4
27	01_0018	01_0018	Chal, BRRI Dhan-40, siddha, kole chata	Rice, BRRI Dhan-40, parboiled, milled, raw	3.49	12	4
28	01_0013	01_0013	Chal, BR-11, siddha, kole chata	Rice, BR-11, parboiled, milled, raw	3.45	13	4
29	01_0014	01_0014	Chal, BR-16, siddha, kole chata	Rice, BR-16, parboiled, milled, raw	3.46	12	4
30	01_0042	01_0042	Ruti	Ruti*	2.46	19	4
31	01_0034	01_0034	Misti biscuit	Biscuit, sweet*	3.44	5	4

32	01_0016	01_0016	Chal, BR-3, siddha, kole chata	Rice, BR-3, parboiled, milled, raw	3.44	13	4
33	01_0025	01_0025	Chal, atop, HYV, kolechata, raw	Rice, white, sunned, polished, milled, raw	3.45	12	3
34	01_0024	01_0024	Chal, atop, sugondhi, chikon dana, dhekichata	Rice, white, sunned, aromatic, raw	3.43	12	3
35	01_0035	01_0035	Khichuri	Plain Khichuri*	1.63	11	3
36	01_0043	01_0043	Semai siddha	Vermicelli, boiled* (without salt)	1.51	16	2
37	01_0038	01_0038	Bhat, siddha, dhekichata	Rice, brown, home-pounded, boiled* (without salt)	1.12	20	2
38	01_0011	01_0011	Chira, veja	Rice flakes, white grain, water-soaked	1.05	22	2
39	01_0039	01_0039	Bhat, lal, siddha, kolechata	Rice, brown, parboiled, milled, boiled*(without salt)	1.12	18	2
40	01_0037	01_0037	Bhat, BR-28, bosa bhat	Rice, BR-28, boiled* (without salt)	1.09	14	1
41	01_0036	01_0036	Plain pulao	Plain pulao*	1.28	7	1
42	01_0040	01_0040	Bhat, Sugondhi, bosa bhat	Rice, white, sunned, aromatic, boiled* (without salt)	1.10	13	1
43	01_0041	01_0041	Bhat, Atop, bosa bhat	Rice, white, sunned, polished, milled, boiled* (without salt)	1.11	13	1

2.

2. Pulse, legumes, and their products

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	02_0012	02_0011	Gari kalai/Soyabean	Soybean, dried, raw	4	61	29
2	02_0005		Borbotir bij	Cowpea, seed, dried, raw	3	58	26
3	02_0008	02_0006	Mungkalai	Green gram, whole, dried, raw	3	79	24
4	02_0003	02_0003	Mashkalai dal, asto	Black gram, dehulled, dried raw	3	72	24
5	02_0002	02_0002	Chola, shukna	Bengal gram, whole dried, raw	4	65	23
6	02_0009	02_0008	Mosur dal	Lentil, dried, raw	3	52	19
7	02_0007	02_0005	Mung dal, vanga	Green gram, split dried, raw	3	56	18
8	02_0001	02_0001	Cholar dal, vanga	Bengal gram, dehulled, split dried, raw	4	39	17
9	02_0004	02_0004	Maskalai dal, vanga	Black gram, split dried, raw	4	37	17
10	02_0010	02_0009	Motor	Pea, dried, raw	3	50	16
11	02_0006	02_0007	Khesari dal, vanga	Grass pea, split dried, raw	4	40	16
12	02_0011	02_0010	Arhar dal	Red gram, split, dried, raw	3	33	14

13	02_0013	02_0012	Chola siddha, lobon chara	Bengal gram, whole, boiled* (without salt)	2	61	9
14	02_0016	02_0015	Mosur dal siddha, lobon chara	Lentis, boiled* (without salt)	2	49	7
15	02_0017	02_0016	Motor siddha, lobon chara	Pea, boiled* (without salt)	2	49	7
16	02_0014	02_0013	Mung dal siddha, lobon chara	Green gram, split, boiled* (without salt)	2	43	5
17	02_0015	02_0014	Khesari dal siddha, lobon chara	Grass pea, split, boiled* (without salt)	1	38	5

3.

3. Vegetables and their products

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	03_0023	03_0022	Kakrol	Gourd, teasle, raw	0.61	155	13
2	03_0051	03_0048	Korola vaji	Gourd, bitter, fry*	1.30	121	12
3	03_0010	03_0010	Kancha morich	Chilli, green, with seeds, raw	0.45	212	12
4	03_0017	03_0016	Korola	Gourd, bitter, raw	0.31	216	10
5	03_0042	03_0039	Kakrol siddha, lobon chara	Gourd, teasle, boiled* (without salt)	0.69	150	10
6	03_0028	03_0026	Motorshuti	Peas, raw	1.17	65	9
7	03_0046	03_0043	Mistikumra siddha, lobon chara	Pumpkin, boiled* (without salt)	0.29	354	9

8	03_0009	03_0009	Fulkopi	Cauliflower, raw	0.25	236	9
9	03_0014	03_0013	Sajna data	Drumstick, pods, raw	0.43	181	9
10	03_0015	03_0014	Rosun	Garlic, raw	1.47	43	8
11	03_0049	03_0046	Dheros-tomato bhuna	Lady's finger-tomato bhuna*	1.27	53	8
12	03_0050	03_0047	Korola siddha, lobon chara	Gourd, bitter, boiled* (without salt)	0.35	209	7
13	03_0030	03_0028	Mistikumra	Pumpkin, raw	0.18	386	7
14	03_0011	03_0011	Borboti	Cowpea, pods and seeds, raw	0.39	143	7
15	03_0024		Olekopi	Kohlrabi, green, raw	0.26	220	7
16	03_0006	03_0006	Makhon shim	Broad beans, raw	0.50	109	7
17	03_0025	03_0023	Dheros	Okra/ladies finger, raw	0.39	143	6
18	03_0039	03_0036	Fulkopi siddha, lobon chara	Cauliflower, boiled* (without salt)	0.28	208	6
19	03_0008	03_0008	Gajor	Carrot, raw	0.33	145	6
20	03_0004	03_0004	Beet	Beet root, red, raw	0.46	76	5
21	03_0001	03_0001	Data	Amaranth, stem, raw	0.21	232	5
22	03_0031	03_0029	Mula	Radish, raw	0.16	219	5
23	03_0040	03_0037	Borboti siddha, lobon chara	Cowpea, boiled* (without salt)	0.40	131	5
24	03_0003	03_0003	Shim	Bean, seeds and pods, raw	0.29	214	5
25	03_0019	03_0018	Potol	Gourd, pointed, raw	0.24	207	5

26	03_0007	03_0007	Badhakopi	Cabbage, raw	0.22	207	5
27	03_0002	03_0002	Shim	Bean, scarlet runner, raw	0.54	84	5
28	03_0033	03_0030	Tomato, kancha	Tomato, green, raw	0.21	206	5
29	03_0016	03_0015	Chalkumra	Gourd, ash, raw	0.10	289	4
30	03_0047	03_0044	Mula siddha, lobon chara	Radish, boiled* (without salt)	0.24	124	4
31	03_0038	03_0035	Gajor siddha, lobon chara	Carrot, boiled* (without salt)	0.43	132	4
32	03_0048	03_0045	Tomato paka siddha, lobon chara	Tomato, red, ripe, boiled* (without salt)	0.30	166	4
33	03_0041	03_0038	Potol siddha, lobon chara	Gourd, pointed, boiled* (without salt)	0.28	161	4
34	03_0029	03_0027	Kancha kola	Plantain, raw	0.77	55	4
35	03_0035	03_0032	Shalgom	Turnip, raw	0.26	174	4
36	03_0018	03_0017	Lau	Gourd, bottle, raw	0.18	160	4
37	03_0005	03_0005	Begun, kalo lomba	Brinjal, purple, long, raw	0.24	135	3
38	03_0043	03_0040	Dheros siddha, lobon chara	Okra/ladies finger, boiled* (without salt)	0.32	121	3
39	03_0032		Kochu, sobuj kando	Taro, stem, green, raw	0.16	225	3
40	03_0026	03_0024	Piaj	Onion, raw	0.59	31	3
41	03_0027	03_0025	Kancha pepe	Papaya, unripe, raw	0.30	128	3
42	03_0021	03_0020	Chichinga	Gourd, snake, raw	0.24	135	3
43	03_0012	03_0012	Shosa	Cucumber, Elongate, peeled, raw	0.21	102	3

44	03_0020	03_0019	Jhinga	Gourd, ridge, raw	0.29	78	3
45	03_0036	03_0033	Begun siddha, lobon chara	Brinjal, purple, long, boiled* (without salt)	0.26	122	3
46	03_0034	03_0031	Tomato, paka	Tomato, red, ripe, raw	0.16	184	3
47	03_0045	03_0042	Kancha kola siddha, lobon chara	Plantain, boiled* (without salt)	0.76	49	3
48	03_0013		Kheera	Cucumber, Short, peeled, raw	0.13	187	3
49	03_0037	03_0034	Badhakopi siddha, lobon chara	Cabbage, boiled* (without salt)	0.27	88	2
50	03_0044	03_0041	Kacha pepe siddha, lobon chara	Papaya, unripe, boiled* (without salt)	0.32	121	2
51	03_0022	03_0021	Dhundul	Gourd, sponge, raw	0.24	94	2

4.

4. Leafy vegetables

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	04_0001	04_0001	Bok ful shak	Agathi, raw	0.88	430	36
2	04_0017	04_0017	Sajna pata	Drumstick, leaves, raw	0.72	317	36
3	04_0025	04_0024	Notay shak	Slender amaranth leaves, raw	0.47	393	27
4	04_0004	04_0003	Kanta notay shak	Amaranth leaves, spiney, raw	0.51	561	22
5	04_0012	04_0013	Kalo kochu shak	Colocasia leaves, black, raw	0.62	416	21

6	04_0035	04_0034	Notay shak siddha, lobon chara	Slender amaranth leaves, boiled* (without salt)	0.55	356	20
7	04_0013	04_0014	Shobuj kochu shak	Colocasia leaves, green, raw	0.51	411	19
8	04_0022	04_0021	Pat shak	Jute leaves, raw	0.32	449	18
9	04_0008	04_0009	Korola shak	Bitter gourd leaves, green, raw	0.55	376	17
10	04_0019	04_0019	Methi shak	Fenugreek, leaves, raw	0.50	319	17
11	04_0005	04_0005	Data shak	Amaranth, leaves, green, raw	0.25	553	17
12	04_0036	04_0035	Palong shak siddha	Spinach, boiled*(without salt)	0.47	342	16
13	04_0006	04_0007	Beet shak	Beet greens leaves	0.31	472	15
14	04_0033	04_0032	Lal shak, siddha, lobon chara	Amaranth leaves, red, boiled* (without salt)	0.37	462	14
15	04_0034	04_0033	Data shak, sobuj, siddha, lobon chara	Amaranth leaves, green, boiled* (without salt)	0.30	500	14
16	04_0026	04_0025	Palong shak	Spinach, raw	0.24	447	14
17	04_0014	04_0015	Borboti pata	Cowpea, leaves, raw	0.34	422	13
18	04_0011	04_0012	Simei alu shak	Cassava, leaves, raw	0.62	254	13
19	04_0021	04_0020	Pui shak	Indian spinach, raw	0.25	411	12
20	04_0003	04_0004	Lal shak	Amaranth leaves, red, raw	0.27	477	12
21	04_0027	04_0026	Misti alu shak	Sweet potato leaves, raw	0.45	330	11

22	04_0024	04_0023	Mula shak	Radish leaves, raw	0.32	297	11
23	04_0032	04_0031	Helencha shak	Watercress, raw	0.49	274	11
24	04_0016	04_0006	Chukai shak, bivinno projati	Dock leaves, raw	0.46	279	11
25	04_009	04_0010	Lau shak	Bottle gourd leaves, raw	0.26	437	10
26	04_0028	04_0027	Misti alu shak (SP4)	Sweet potato leaves, SP4, dark green, mature, raw	0.45	309	10
27	04_0029	04_0028	Misti alu shak (SP7)	Sweet potato leaves, SP7, dark green, mature, raw	0.45	252	10
28	04_0031	04_0030	Kolmee shak	Water spinach, raw	0.43	227	10
29	04_0037	04_0036	Pui shak siddha	Indian spinach, boiled*(without salt)	0.33	378	9
30	04_0023	04_0022	Misti kumra shak	Pumpkin leaves, raw	0.29	316	9
31	04_0020		Bon palong	Golden dock, raw	0.29	376	8
32	04_0007	04_0008	Bat baitta shak	Bengal dayflower, leaves, raw	0.22	506	8
33	04_0030	04_0029	Misti alu shak (SP8)	Sweet potato leaves, SP8, light green, mature, raw	0.50	192	8
34	04_0018	04_0018	Dheki shak	Farn, leaves, raw	0.68	96	7
35	04_0002	04_0002	Malancha shak	Alligator weed, raw	0.57	117	4
36	04_0010	04_0011	Sabarang	Bugleweed, raw	0.43	125	4
37	04_0015	04_0016	Dima shak	Dima leaves, raw	0.33	45	1

5.

5. Starchy roots, tubers, and their products

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	05_0006	05_0006	Misti alu, Komola Sundori	Sweet potato, Komola Sundori, orange flesh, raw	0.97	139	10
2	05_0016	05_0016	Misti alu, Komola Sundori, siddha, lobon chara	Sweet potato, Komola Sundori, orange flesh, boiled* (without salt)	0.98	127	8
3	05_0008	05_0008	Misti alu, Lal khosa	Sweet potato, skin purple, flesh pale-yellow, raw (without skin)	1.04	63	6
4	05_0002	05_0002	Dudh kochu	Colocasia/Taro/Tannia, cormel, raw	1.01	69	5
5	05_0017	05_0017	Dudh kochu siddha, lobon chara	Colocasia/Taro/Tannia cormel, boiled* (without salt)	1.13	65	5
6	05_0009	05_0009	Misti Alu, Sada	Sweet potato, white flesh, raw	0.98	50	5
7	05_0011	05_0011	Kochur Mukhi siddha, lobon chara	Colocasia/Taro, boiled* (without salt)	1.15	62	5
8	05_0004	05_0004	Mankochu	Giant taro, corm, raw	0.82	85	5
9	05_0019	05_0019	Mankochu siddha, lobon chara	Giant taro, corm, boiled* (without salt)	0.92	79	5

10	05_0010	05_0010	Bon Alu, bivinno projati	Yam, tuber, raw	0.97	50	5
11	05_0018	05_0018	Ole kochu siddha, lobon chara	Elephant foot, corm, boiled* (without salt)	0.83	82	5
12	05_0005	05_0005	Gol alu, Diamond jat, khosa chara	Potato, Diamond, raw	0.66	67	5
13	05_0007	05_0007	Misti alu, holdey	Sweet potato, pale-yellow flesh, raw	1.05	52	5
14	05_0015	05_0015	Misti alu, lal khosa, siddha, lobon chara	Sweet potato, skin purple, flesh pale-yellow, boiled* (without salt)	1.06	58	4
15	05_0003	05_0003	Ole Kochu	Elephant foot, corm, raw	0.74	79	4
16	05_0021	05_0021	Alu siddha, lobon soho	Potato Mash*	0.84	40	4
17	05_0020	05_0020	Bon alu siddha, lobon chara	Yam, tuber, boiled* (without salt)	1.09	48	4
18	05_0001	05_0001	Kochur Mukhi	Colocasia/Taro, corm, raw	0.97	50	4
19	05_0014	05_0014	Misti alu, sada, siddha, lobon chara	Sweet potato, white flesh, boiled* (without salt)	0.99	50	4
20	05_0012	05_0012	Gol alu siddha, lobon chara	Potato, Diamond, boiled* (without salt)	0.67	57	3

21	05_0013	05_0013	Misti alu, holdey, siddha, lobon chara	Sweet potato, pale-yellow flesh, boiled* (without salt)	1.06	45	3

6.

6. Nuts, seeds, and their products

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	06_0001	06_0001	Surjomukhi bij	Sunflower seeds, dried	6	69	43
2	06_0009	06_0009	Tisi	Linseed, Tisi, raw	5	69	33
3	06_0015	06_0015	Til	Sesame seeds, whole, dried	6	50	32
4	06_0012	06_0012	Sarisha	Mustard seeds, dried	5	54	29
5	06_0003	06_0003	Chilgoza	Chilgoza pine, dried	7	29	27
6	06_0013	06_0013	Pesta	Pistachio nuts, dried	6	26	26
7	06_0014	06_0014	Mistikumrar bichi	Pumpkin seeds, dried	6	37	25
8	06_0002	06_0002	Hizlee badam	Cashew nuts, raw	6	21	25
9	06_0007	06_0007	China badam	Groundnuts/ Peanut, raw	6	13	19
10	06_0016	06_0016	Akhrot	Walnuts	7	19	19
11	06_0010	06_0010	Poddo gota, shukna	Lotus seeds, dried	3	50	14
12	06_0005	06_0005	Narikel, shukna	Coconut, desiccated	7	-13	10
13	06_0006	06_0006	Narikel	Coconut, mature kernel	4	-15	7
14	06_0008	06_0008	Kathal er bichi	Jackfruit seeds, raw	2	27	6

15	06_0011	06_0011	Poddo gota, kancha	Lotus seeds, green	1	56	3
16	06_0004	06_0004	Narikel dudh	Coconut Milk	2	24	3

7.

7. Spices, condiments, and herbs

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	07_0003	07_0003	Shukna morich	Chilli, red, dry	3	153	40
2	07_0009	07_0008	Jira	Cumin seeds	4	137	39
3	07_0001	07_0001	Tejpata	Bay leaf, dried	4	152	39
4	07_0019	07_0018	Posto dana	Poppy seeds	5	71	32
5	07_0008	07_0007	Dhonia	Coriander seed, dry	3	125	32
6	07_0010	07_0009	Mauri	Fennel seeds	3	147	31
7	07_0021	07_0020	Holud	Turmeric, dried	3	117	28
8	07_0011	07_0010	Methi	Fenugreek seeds	3	98	26
9	07_0004	07_0004	Darchini gura	Cinnamon, ground	2	150	23
10	07_0016	07_0015	Jayitri, gura	Mace, ground	4	49	21
11	07_0018	07_0017	Golmorich	Pepper, black	3	104	20
12	07_0005	07_0005	Labongo	Cloves, dried	3	103	19
13	07_0020	07_0019	Pudina pata	Spearmint leaves, fresh	0	441	17
14	07_0007		Dhone pata, deshi, raw	Coriander leaves, idigenous, raw	0	483	17
15	07_0006	07_0006	Dhone pata	Coriander leaves, raw	0	408	15
16	07_0015	07_0014	Lebur khosa	Lemon peel, raw	1	220	15

17	07_0002	07_0002	Elach	Cardamom	3	76	14
18	07_0017	07_0016	Jayfol	Nutmeg, dried	5	35	13
19	07_0013	07_0012	Thankuni pata	Indian pennywort, raw	0	316	9
20	07_0014	07_0013	Lemon ghas	Lemon grass, raw	1	37	4
21	07_0012	07_0011	Ada	Ginger root, raw	1	53	3

8.

8. Fruits

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	08_0012	08_0012	Amloki	Emblic, raw	0.44	147	34
2	08_0015	08_0015	Peyara, bivinno variety, kancha	Guava, green, raw	0.63	152	21
3	08_0026	08_0026	Aam, Langra, paka	Mango, Langra, yellow flesh, ripe, raw	0.82	87	11
4	08_0028	08_0028	Dewa	Monkey-jack, yellowish-orange flesh, raw	1.03	138	11
5	08_0040	08_0040	Zambura	Pomelo, raw	0.38	126	10
6	08_0016	08_0016	Amra	Hog plum, raw	0.51	180	9
7	08_0018	08_0018	Kalojam	Jambolan, raw	0.39	191	8
8	08_0009	08_0009	Khorma	Dates, combined species, dried	3.20	-7	8
9	08_0041	08_0041	Tetul, paka, misti	Tamarind, pulp, sweet, ripe, raw	2.70	7	8
10	08_0011	08_0011	Kodbel	Elephant apple, ripe, raw	0.64	77	8

11	08_0025	08_0025	Aam, Fazli, paka	Mango, Fazli, orange flesh, ripe, raw	0.70	99	8
12	08_0035	08_0035	Pepe, paka	Papaya, ripe, raw	0.33	141	8
13	08_0008	08_0008	Atafol	Custard apple, raw	0.85	72	7
14	08_0032	08_0032	Malta, paka	Orange, Sweet, ripe, raw	0.49	103	6
15	08_0021	08_0021	Boroi	Jujube, raw	0.60	110	6
16	08_0007	08_0007	Kamranga	Carambola, raw	0.41	141	6
17	08_0031	08_0031	Komola	Orange, raw	0.44	118	6
18	08_0030	08_0030	Komolar ross	Orange juice, raw (unsweetened)	0.09	194	6
19	08_0043	08_0043	Bel, paka	Woodapple, ripe, raw	1.11	34	6
20	08_0039	08_0039	Bedana, paka, bichi soho	Pomegranate, ripe, with seed, raw	0.67	64	6
21	08_0034	08_0034	Taal, paka	Palmyra palm, pulp, orange flesh, ripe, raw	0.78	83	6
22	08_0022	08_0022	Lebu, Kagoji	Lemon, Kagoji, raw	0.56	127	6
23	08_0023	08_0023	Mushambee	Lime, Sweet, raw	0.42	125	6
24	08_0038	08_0038	Anaros, paka	Pineapple, ripe, raw	0.47	95	6
25	08_0005	08_0005	Madar	Breadfruit, raw	0.70	64	5
26	08_0027	08_0027	Futi, paka	Melon, Futi, orange flesh, ripe, raw	0.17	242	5
27	08_0014	08_0014	Angur, halka sobuj	Grapes, green, raw	0.94	43	5
28	08_0036	08_0036	Gab, Bilati, paka	Persimmon, ripe, raw	0.67	52	4

29	08_0017	08_0017	Kathal, paka	Jackfruit, ripe, raw	0.74	36	4
30	08_0010	08_0010	Khejur, paka, taza	Dates, raw	1.50	-9	4
31	08_0020	08_0020	Golapjam	Java apple, raw	0.35	154	4
32	08_0037	08_0037	Anaros, Joldugee, paka	Pineapple, Joldugee, ripe, raw	0.43	70	4
33	08_0029	08_0029	Bangee, paka	Muskmelon, Bangee, light orange flesh, ripe, raw	0.16	167	4
34	08_0024	08_0024	Lichu	Lychee, raw	0.62	44	4
35	08_0006	08_0006	Nona ata	Bullocks Heart, ripe, raw	0.81	14	4
36	08_0013	08_0013	Dumur, paka	Fig, ripe, raw	0.40	39	3
37	08_0004	08_0004	Kola, Sagar, paka	Banana, Sagar, ripe, raw	0.95	9	3
38	08_0042	08_0042	Tarmuz, lal, paka	Watermelon, ripe, raw	0.22	121	3
39	08_0019	08_0019	Jamrul	Jambos, raw	0.40	87	3
40	08_0003	08_0003	Nashpati	Asian pears, raw	0.62	10	2
41	08_0002	08_0002	Apel, khosa soho	Apple, with skin, raw	0.62	-2	2
42	08_0001	08_0001	Apel, khosa chara	Apple, without skin, raw	0.51	-13	1
43	08_0033	08_0033	Kochi taal er shas	Palmyra palm, cotyledon, raw	0.31	66	1

9.

9. Fish, shellfish, and their products

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR

1	09_0036	09_0033	Ilish, kata chara	Hilsa, without bones, raw	2.23	3	64
2	09_0012		Loitta	Bombay Duck, raw	0.71	69	50
3	09_0046	09_0043	Mola, chokh soho	Mola carplet, whole, eyes included, raw	1.08	214	49
4	09_0017	09_0015	Katla	Catla, raw	1.03	107	43
5	09_0068	09_0065	Shing mach, kata chara	Stinging catfish, raw	1.01	70	40
6	09_0042	09_0039	Chompa	Mackerel, Narrow-barred Spanish, raw	1.12	68	38
7	09_0048	09_0045	Parshe	Mullet, Goldspot, raw	1.20	134	33
8	09_0050	09_0047	Pangas, kata chara	Pangas, without bones, raw	1.62	25	31
9	09_0001	09_0001	Fesha, shutki	Anchovy, Gangetic hairfin, dried	3.28	131	30
10	09_0043	09_0041	Chela, Fulchela, shukna	Minnow, Finescale razorbelly, dried	4.12	115	30
11	09_0063	09_0060	Rui, kata chara	Rohu, without bones, raw	1.05	68	29
12	09_0037	09_0034	Chapila	Indian river shad, raw	1.06	142	28
13	09_0058	09_0055	Chingri, Bagda	Prawn, Giant tiger prawn, raw	0.92	52	24
14	09_0045	09_0042	Chela, Narkeli	Minnow, Large Scale razorbelly, raw	1.19	91	24
15	09_0044	09_0040	Chela, Fulchela	Minnow, Finescale razorbelly, raw	0.95	93	22
16	09_0062	09_0059	Rui, nodir	Rohu, river, raw	0.90	103	22

17	09_0035	09_0032	Khailsa, kata chara, chokh soho	Gourami, Banded gourami, eyes included, raw	1.05	81	21
18	09_0008	09_0007	Punti, Vadi punti, chokh soho	Barb, Pool barb, eyes included, raw	1.39	95	21
19	09_0028	09_0025	Kachki, bivinno projati	Ganges river sprat, combined species, raw	0.93	108	18
20	09_0032	09_0029	Vetkee, shutki	Giant seaperch, whole, dried	3.18	84	18
21	09_0074	09_0070	Magur, kata chara	Walking catfish, without bones, raw	1.03	25	18
22	09_0024	09_0022	Tengra, bivinno projati, chokh soho	Day's mystus, combined species, eyes included, raw	1.14	92	17
23	09_0029	09_0026	Kajuli	Gangetic ailia, raw	1.17	51	14
24	09_0019	09_0017	Koi, deshi, chokh soho	Climbing perch, indigenous, eyes included, raw	1.30	87	14
25	09_0066	09_0063	Kakila, chokh soho	Silver needle fish, eyes included, raw	0.94	88	13
26	09_0013	09_0011	Foli	Bronze featherback, raw	0.80	129	13
27	09_0067	09_0064	Taki, kata chara	Spotted snakehead, raw	0.91	135	13
28	09_0071	09_0068	Tilapia, kata chara	Tilapia, without bones, raw	1.10	53	12
29	09_0020	09_0018	Koi, Thai, chokh soho	Climbing perch, Thai, without bones, eyes included, raw	1.39	62	11

30	09_0023	09_0021	Poa, kata chara	Croaker, Blackspotted, without bones, raw	1.00	57	11
31	09_0034	09_0031	Bele	Goby, Tank goby, raw	0.81	89	11
32	09_0021	09_0019	Chital, kata chara	Clown knifefish, without bones, raw	0.96	63	11
33	09_0015	09_0013	Bacha	Catfish, Bacha, raw	1.22	72	10
34	09_0018	09_0016	Chanda, Ranga, chokh soho	Chanda, Indian glassy fish, eyes included, raw	1.15	110	9
35	09_0064	09_0061	Chingri, Horina	Shrimp, Speckled, raw	0.81	100	9
36	09_0060	09_0057	Chingri sada, nodir	Prawn, Indian white prawn, raw	0.95	72	9
37	09_0002	09_0002	Fesha	Anchovy, Gangetic hairfin, raw	1.05	93	9
38	09_0076	09_0072	Macher kopta	Fish ball*	2.20	41	9
39	09_0033	09_0030	Vetkee, kata chara	Giant seaperch, without bones, raw	0.96	75	9
40	09_0051	09_0048	Meni	Perch, Mud, raw	0.99	86	9
41	09_0005	09_0005	Sorpunti	Barb, Olive, raw	1.55	25	8
42	09_0073	09_0069	Tuna, kata chara	Tuna, without bones, raw	1.18	62	8
43	09_0027		Tailla, kata chara	Fourfinger Threadfin, without bones, raw	1.01	63	8
44	09_0004	09_0004	Fesha, Teli	Anchovy, Scaly hairfin, raw	1.01	93	8

45	09_0054	09_0051	Rupchanda, sada, shutki	Pomfret, Silver, dried	3.49	36	8
46	09_0047	09_0044	Mrigal, chokh soho	Mrigal carp eyes included, raw	1.02	108	8
47	09_0052	09_0049	Rupchanda, kalo, bivinno projati	Pomfret, Black, raw	1.12	55	8
48	09_0070	09_0067	Shol, kata chara	Striped snake-head, raw	1.01	59	8
49	09_0007		Sorpunti, Thai, kata chara	Barb, Silver, fillet, raw	1.18	47	7
50	09_0003	09_0003	Olua	Anchovy, Goldspotted grenadier, raw	0.71	138	7
51	09_0022	09_0020	Common carp, kata chara	Common carp, without bones, raw	0.88	65	7
52	09_0026	09_0024	Macher peti (Katla, Mrigal,Rui)	Fish (Catla, Mrigal, Rohu), ventral with skin, raw	1.30	51	7
53	09_0061	09_0058	Chingri, nodir	Prawn, Monsoon river prawn, raw	0.79	60	7
54	09_0057	09_0054	Chingri, Golda	Prawn, Giant river prawn, raw	1.02	52	6
55	09_0010	09_0009	Bata	Bata, raw	1.06	80	6
56	09_0030	09_0027	Gulsha	Gangetic mystus, raw	0.86	80	6
57	09_0053	09_0050	Rupchanda, China sada	Pomfret, Chinese Silver, raw	1.03	41	6
58	09_0069	09_0066	Tatkini	Stone roller, raw	0.97	89	6
59	09_0016	09_0014	Pabda	Catfish, Pabdah, raw	0.95	67	6

60	09_0009	09_0008	Punti, Vadi punti, chokh soho, kata chara	Barb, Pool barb, without bones, eyes included, raw	0.94	71	6
61	09_0025	09_0023	Macher gada (Katla,Mrigal, Rui)	Fish (Catla, Mrigal, Rohu), dorsal with skin, raw	1.04	60	6
62	09_0031	09_0028	Guizza	Giant river-catfish, raw	0.75	101	5
63	09_0075	09_0071	Kachki mach vaja	Small fish fry*	1.07	47	5
64	09_0038	09_0035	Lakkha, kata chara	Indian threadfin, without bones, raw	1.00	62	5
65	09_0065	09_0062	Silver carp, kata chara	Silver carp, without bones, raw	1.23	40	5
66	09_0072		Kauwa, kata chara	Torpedo scad, fillet, raw	1.24	44	4
67	09_0039	09_0036	Surma/ Bijoram, kata chara	Indo-pacific king mackerel, without bones, raw	1.01	64	4
68	09_0041	09_0038	Ayre, kata chara	Long-whiskered catfish, without bones, raw	0.89	52	4
69	09_0049	09_0046	Jhinuk	Mussel/Clam, mixed species, raw	0.60	66	4
70	09_0014	09_0012	Kalbaush, kata chara	Calbasu, without bones, raw	0.95	52	4
71	09_0056	09_0053	Chingri, Birma nodir	Prawn, Birma river prawn, raw	0.86	58	4
72	09_0011	09_0010	Boal, kata chara	Boal, without bones, raw	0.80	63	4

73	09_0006	09_0006	Sorpunti, kata chara	Barb, Olive, without bones, raw	1.75	27	4
74	09_0055	09_0052	Rupchanda, Sada	Pomfret, Silver, without bones, raw	1.08	40	3
75	09_0059	09_0056	Chingri	Prawn, Hairy river prawn, raw	0.75	63	3
76	09_0040	09_0037	Gonia, kata chara	Kuria labeo, without bones, raw	1.09	47	3

10.

10. Meat, poultry, and their products

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	10_0013	10_0013	Verhar koliza	Lamb/Mutton, liver,raw	1.50	164	229
2	10_0008	10_0008	Murgeer koliza	Chicken liver, raw	1.14	196	151
3	10_0001	10_0001	Gorur koliza	Beef liver, raw	1.30	151	72
4	10_0003	10_0003	Gorur mangsaw, harh chara	Beef, meat, 15-20% fat, boneless, raw	2.07	14	17
5	10_0002	10_0002	Gorur mangsaw, harh o chorbi chara	Beef, meat, lean, boneless, raw	1.06	57	17
6	10_0009	10_0009	Hasher mangsaw	Duck, meat, raw	1.30	50	14
7	10_0012	10_0012	Verhar mangsaw	Lamb/mutton, meat. moderate fat, raw	1.96	13	14

8	10_0004	10_0004	Gorur mangaw, kima	Beef, mince, lean, raw	1.26	44	14
9	10_0015	10_0015	Shukorer mangsaw	Pork, meat < 5 % fat, raw	1.14	44	13
10	10_0014	10_0014	Kobutorer mangsaw	Pigeon meat, raw	1.37	52	11
11	10_0016	10_0016	Haaree kabab (goru)	Beef handi kabab*	2.33	21	11
12	10_0011	10_0011	Khaseer mangsaw	Goat meat, lean, raw	1.19	61	9
13	10_0006	10_0006	Murgi, buker mangsaw, chamra charano	Chicken breast, without skin, raw	1.06	59	8
14	10_0007	10_0007	Murgi, ranner mangsaw, chamra charano	Chicken leg, without skin, raw	1.28	41	8
15	10_0010	10_0010	Bang	Frog, legs, raw	0.68	87	8
16	10_0005	10_0005	Mohisher mangsaw	Buffalo meat, raw	0.95	64	6

11.

11. Eggs and their products

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	11_0003	11_0003	Murgir dim r kusum, deshi	Egg, chicken, yolk, raw	3.25	36	33
2	11_0004	11_0004	Hasher dim	Egg, duck, whole, raw	1.88	41	28
3	11_0001	11_0001	Murgir dim, farm er	Eggs, chicken, farmed, raw	1.39	38	18
4	11_0002	11_0002	Murgir dim, deshi	Egg, chicken, native, raw	1.58	34	14

5	11_0007	11_0007	Hasher dim siddha, lobon chara	Egg, duck, whole, boiled* (without salt)	2.14	50	11
6	11_0006	11_0006	Deshi Murgir dim siddha, lobon chara	Egg, chicken, native, boiled* (without salt)	1.79	44	11
7	11_0005	11_0005	Murgir Dim siddha, lobon chara	Eggs, chicken, farmned boiled* (without salt)	1.58	47	10

12.

12. Milk and its products

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	12_0006	12_0006	Gura dudh, Goru, noni soho	Milk, cow, powder, whole	4.97	26	32
2	12_0005	12_0005	Gura dudh, Goru, makhon tola/noniheen	Milk, cow, powder, skimmed	3.58	65	27
3	12_0002	12_0002	Poneer	Cheese, cottage, 25 % fat	3.46	7	17
4	12_0009	12_0009	Kondense milk, Goru, chini soho	Milk, cow, whole, condensed, sweetened	3.34	-13	7
5	12_0004	12_0004	Mohiser dudh	Milk, buffalo, whole fat	1.01	0	5
6	12_0008	12_0008	Gorur dudh, purno noni soho	Milk, cow, whole fat (pasteurised, UTH)	0.63	10	5
7	12_0007	12_0007	Gorur dudh, makhon tola/noniheen	Milk, cow, skimmed	0.30	37	4
8	12_0013	12_0013	Payesh	Payesh*	2.05	17	4

9	12_0011	12_0011	Shaldudh	Milk, human, colostrum, raw	0.58	49	4
10	12_0001	12_0001	Ghol	Buttermilk, fluid, low fat	0.33	34	3
11	12_0003	12_0003	Doi, misti	Curd, sweetened, whole milk	0.94	3	3
12	12_0010	12_0010	Chagoler dudh	Milk, goat, combined breeds	0.68	13	3
13	12_0012	12_0012	Mayer dudh	Milk, human, mature, raw	0.69	-6	3

13.

13. Fats and oils

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	13_0003	13_0003	Kod liver tel	Fish oil, cod liver	9.00	53	108
2	13_0009	13_0009	Palm tel	Palm oil	9.00	0	40
3	13_0011	13_0011	Tiler tel	Sesame oil	9.00	-8	26
4	13_0002	13_0002	Tular bij er tel	Cottonseed oil	9.00	17	23
5	13_0007	13_0007	Mayonnaise, nonta	Mayonnaise, salted	7.32	10	22
6	13_0010	13_0010	China badam er tel	Peanut oil	9.00	2	21
7	13_0008	13_0008	Sorishar tel	Mustard oil	9.00	-3	20
8	13_0006	13_0006	Margarine	Margarine	7.50	-4	18
9	13_0004	13_0004	Ghee, gorur	Ghee, cow	8.98	-11	18
10	13_0005	13_0005	Dalda/Bonoshpati	Ghee	9.00	-24	16
11	13_0012	13_0012	Soyabean tel	Soya oil	9.00	4	13
12	13_0001	13_0001	Makhon, nonta	Butter, salted	7.33	-27	12

14.

14. Beverages

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	14_0009	14_0009	Cha pata	Tea, powder	3	95	22
2	14_0003	14_0003	Coffee	Coffee, powder	4	60	9
3	14_0006	14_0006	Akher Ross	Sugar cane Juice	0	9	2
4	14_0001	14_0001	Daber pani	Coconut Water	0	77	2
5	14_0005	14_0005	Soyabean dudh	Soya milk (not sweetened)	1	31	2
6	14_0007	14_0007	Dudh cha	Tea infusion (with sugar and milk powder, whole fat)	0	-6	1
7	14_0002	14_0002	Coffee, dudh o chini soho	Coffee infusion (instant with sugar and milk powder, whole fat)	0	-8	1
8	14_0008	14_0008	Likar cha	Tea, infusion (with sugar)	0	-29	0
9	14_0004	14_0004	Komol paniyo	Soft drinks, carbonated	0	-46	0

15.

15. Miscellaneous

Serial	New Code	Old Code	Food name (Bengali)	Food name (English)	Energy Density (kcal/g)	NRF9.3	NNR
1	15_0002	15_0002	Pan pata	Betel leaves, raw	0	275	10
2	15_0001	15_0001	Baking powder	Baking powder	2	21	8
3	15_0004	15_0004	Gur, Akh	Jaggery, sugarcane, solid	4	-37	2

4	15_0005	15_0005	Gur, Khejur	Jaggery/Panela, date palm	4	9	2
5	15_0003	15_0003	Modhu	Honey	3	-46	1
6	15_0006	15_0006	Nolen gur	Jagggery liquid, date palm	1	9	0
7	15_0008	15_0008	Chini, sada	Sugar, white	4	-50	0

16.

Appendix-III: Information used to determine cost and affordability of diets

Table 1: List of markets (n=48) across eight divisions of Bangladesh

Division	Area	Name of Bazar	Name of Location
Chattagram	Urban	Kazi dewri bazar	Chittagong
		Paduar bazar	Comilla
		Borail bazar	Brahmanbaria
	Rural	Shebarhat bazar	Noakhali
		Mojurhat bazar	Laxmipur
		Hazari road bazar	Feni
Dhaka	Urban	Polashi bazar	Dhaka
		Kaikartek bazar	Narayanganj
		Bhairab bazar	Kishoreganj
	Rural	Ulpur bazar	Gopalganj
		Jalchatra bazar	Tangail
		Katakhali bazar	Munshiganj
Mymensingh	Urban	Mechua bazar	Mymensingh
		Rajbari bazar	Muktagacha
		Choto bazar	Netrokona
	Rural	Hazipur bazar	Jamalpur
		Bou bazar	Sherpur
		Panashail Bazar	Bhaluka

Rangpur	Urban	Salondar bazar	Thakurgaon
		Bahadur bazar	Dinajpur
		Pirganj bazar	Rangpur
	Rural	Lahiri bazar	Nilphamari
		Sabujpara bazar	Kurigram
		Kaliganj bazar	Lalmonirhat
Sylhet	Urban	Noyabazar	Sylhet
		Shahaji bazar	Habiganj
		Sripur bazr	Tahirpur
	Rural	Lamagaon bazar	Shunamganj
		Kalighat bazar	Maulvibazar
		Joynagar bazar	Fenchuganj
Khulna	Urban	New market bazar	Khulna
		Bhalki bazar	Jhenaidah
		Gilatola bazar	Bagerhat
	Rural	Rajarhat bazar	Kushtia
		Boro bazar	Jessore
		Jamjami bazar	Chuadanga
Rajshahi	Urban	Mollapara bazar	Rajshahi
		Shibganj bazar	Bogra

		Chinakhara bazar	Pabna
	Rural	Nimgachi bazar	Shirajganj
		Kazipara bazar	Jaypurhat
		Tebaria bazar	Natore
Barisal	Urban	Notulla bazar	Barisal
		Fulijhuri bazar	Barguna
		Mollarhat bazar	Jhalokathi
	Rural	Masjidpara bazar	Patuakhali
		Notun bazar	Bhola
		Ekri bazar	Pirojpur

Table 2: List of two least cost items under each food group

Food group	Name of divisions	Two least expensive food items appearing under each food group in calculating cost of healthy diet
Cereals	Dhaka	Wheat, Rice flakes
	Chittagong	Wheat, Rice
	Mymensingh	Wheat, Rice flakes
	Barisal	Wheat, Rice
	Rajshahi	Wheat, Rice
	Rangpur	Wheat, Rice

	Sylhet	Wheat, Rice
	Khulna	Wheat, Rice
Pulses	Dhaka	Bengal gram, Lentil
	Chittagong	Bengal gram, Lentil
	Mymensingh	Bengal gram, Black gram
	Barisal	Bengal gram, Lentil
	Rajshahi	Bengal gram, Lentil
	Rangpur	Bengal gram, Lentil
	Sylhet	Bengal gram, Lentil
	Khulna	Bengal gram, Lentil
Non-leafy vegetables	Dhaka	Potato, Radish
	Chittagong	Potato, Radish
	Mymensingh	Bottle Gourd, Radish
	Barisal	Potato, Radish
	Rajshahi	Bottle Gourd, Cabbage
	Rangpur	Radish, Cabbage
	Sylhet	Potato, Cabbage
	Khulna	Brinjal, Radish
Leafy vegetables	Dhaka	Radish leaves, Green Amaranth leaves

	Chittagong	Jute leaves, Radish leaves
	Mymensingh	Jute leaves, Pumpkin leaves
	Barisal	Radish leaves, Red Amaranth leaves
	Rajshahi	Bottle Gourd leaves, Red Amaranth leaves
	Rangpur	Water Spinach, Radish leaves
	Sylhet	Green Amaranth leaves, Indian Spinach
	Khulna	Radish leaves, Spiny Amaranth leaves
Fruits	Dhaka	Melon, Carambola
	Chittagong	Banana, Hog plum
	Mymensingh	Carambola, Jujube
	Barisal	Carambola, Melon
	Rajshahi	Carambola, Papaya
	Rangpur	Carambola, Banana
	Sylhet	Carambola, Guava
	Khulna	Carambola, Hog plum
Meat, fish and egg	Dhaka	Pool Barb, Egg
	Chittagong	Catfish, Egg
	Mymensingh	Pool Barb, Egg
	Barisal	Pool Barb, Egg

	Rajshahi	Egg, Silver Carp
	Rangpur	Silver Carp, Egg
	Sylhet	Pool Barb, Egg
	Khulna	Egg, Chicken meat
Milk and milk products	Dhaka	Cow's milk, Condensed milk
	Chittagong	Cow's milk, Condensed milk
	Mymensingh	Cow's milk, Condensed milk
	Barisal	Condensed milk, Cow's milk
	Rajshahi	Powdered milk, Condensed milk
	Rangpur	Cow's milk, Condensed milk
	Sylhet	Cow's milk, Condensed milk
	Khulna	Condensed milk, Powdered milk
Fats and oils	Dhaka	Soya oil, Palm oil
	Chittagong	Palm oil, Soya oil
	Mymensingh	Palm oil, Soya oil
	Barisal	Soya oil, Palm oil
	Rajshahi	Palm oil, Coconut
	Rangpur	Palm oil, Soya oil
	Sylhet	Soya oil, Palm oil

	Khulna	Soya oil, Palm oil
Sugar	Dhaka	Sugar, Jaggery
	Chittagong	Sugar, Jaggery
	Mymensingh	Sugar, Jaggery
	Barisal	Sugar, Jaggery
	Rajshahi	Sugar, Jaggery
	Rangpur	Sugar, Jaggery
	Sylhet	Sugar, Jaggery
	Khulna	Sugar, Jaggery

Table 3: District-wise estimates of proportion of households unable to afford healthy diet

District	**Proportion (95% CI)**
Bagerhat	57.5 (53.9 – 61.1)
Bandarban	64.3 (60.8 – 67.9)
Barguna	29.8 (26.4 – 33.1)
Barisal	40.4 (36.8 – 44.0)
Bhola	16.7 (14.0 – 19.5)
Bogra	46.8 (43.1 – 50.5)
Brahmanbaria	11.6 (9.2 – 13.9)

Chandpur	25.8 (22.6 – 29.0)
Chapainawabganj	70.1 (66.8 – 73.5)
Chattagram	28.5 (25.2 – 31.8)
Chuadanga	67.1 (63.6 – 70.6)
Cumilla	14.3 (11.7 – 16.8)
Cox's Bazar	9.3 (7.2 – 11.4)
Dhaka	16.7 (14.0 – 19.4)
Dinajpur	67.5 (64.1 – 70.9)
Faridpur	18.6 (15.8 – 21.5)
Feni	21.5 (18.4 – 24.5)
Gaibandha	53.6 (49.9 – 57.2)
Gazipur	18.4 (15.5 – 21.2)
Gopalganj	44.6 (40.9 – 48.2)
Habiganj	44.8 (41.1 – 48.4)
Jamalpur	66.3 (62.8 – 69.7)
Jashore	64.8 (61.3 – 68.3)
Jhalakathi	33.4 (30.0 – 36.9)
Jhenaidah	68.1 (64.6 – 71.5)
Joypurhat	48.0 (44.3 – 51.6)

Khagrachhari	45.3 (41.7 – 49.0)
Khulna	68.4 (65.0 – 71.8)
Kishoreganj	59.7 (56.1 – 63.3)
Kurigram	75.4 (72.2 – 78.6)
Kushtia	57.2 (53.6 – 60.8)
Lakshmipur	25.0 (21.8 – 28.2)
Lalmonirhat	35.6 (32.1 – 39.1)
Madaripur	11.4 (9.1 – 13.7)
Magura	71.4 (68.1 – 74.7)
Manikganj	56.3 (52.6 – 59.9)
Moulvibazar	31.2 (27.8 – 34.6)
Meherpur	75.5 (72.3 – 78.6)
Munsiganj	22.1 (19.1 – 25.2)
Mymensingh	41.7 (38.1 – 45.3)
Naogaon	49.3 (45.6 – 53.0)
Narail	61.6 (58.1 – 65.2)
Narayanganj	10.1 (7.9 – 12.4)
Narsingdi	16.9 (14.1 – 19.7)
Natore	36.0 (32.5 – 39.5)

Netrakona	47.2 (43.6 – 50.9)
Nilphamari	34.5 (31.0 – 38.0)
Noakhali	21.8 (18.8 – 24.9)
Pabna	37.9 (34.4 – 41.5)
Panchagar	30.7 (27.3 – 34.1)
Patuakhali	37.8 (34.2 – 41.4)
Pirojpur	54.9 (51.2 – 58.5)
Rajbari	57.4 (53.8 – 61.1)
Rajshahi	39.5 (35.9 – 43.2)
Rangamati	13.4 (10.9 – 15.8)
Rangpur	49.7 (46.1 – 53.4)
Satkhira	64.6 (61.1 – 68.1)
Shariatpur	27.5 (24.2 – 30.8)
Sherpur	34.2 (30.7 – 37.6)
Sirajganj	37.2 (33.7 – 40.8)
Sunamganj	60.0 (54.6 – 63.6)
Sylhet	25.1 (21.9 – 28.3)
Tangail	36.2 (32.7 – 39.7)
Thakurgaon	33.4 (29.8 – 36.7)

Appendix-IV: Research team

Principal investigator

Dr. Nazma Shaheen, Professor, Institute of Nutrition and Food Science (INFS), University of Dhaka
Email: nazmashaheen@du.ac.bd
Cell: +8801747799562

Co-investigators

1. Dr. Md. Ruhul Amin, Associate Professor, INFS, University of Dhaka
   Email: ruhul.infs@du.ac.bd

   Cell: +8801819504434

2. Dr. Shafiun Nahin Shimul, Associate Professor, IHE, University of Dhaka
   Email: nazmashaheen@du.ac.bd

   Cell: +8801747799562

3. Saiful Islam, Assistant Professor, INFS, University of Dhaka
   Email: nazmashaheen@du.ac.bd

   Cell: +8801747799562

4. Dr. Syed Abdul Hamid, Professor, Institute of Health Economics (IHE), University of Dhaka
   Email: nazmashaheen@du.ac.bd

   Cell: +8801747799562

Research Associates

1. Fariha Ferdaus Chowdhury, Research Support Staff, INFS, University of Dhaka

   E-mail: c2fariha@gmail.com

   Cell: +8801571796187

2. Abira Nowar, Research Support Staff, INFS, University of Dhaka

   Email: abira.nowar0695@gmail.com

   Cell: +8801986968481

Data Wrangling and Statistical Support Team

1. Dr. Syed Shahadat Hossain, Professor, Institute of Statistical Research and Training (ISRT), University of Dhaka

   Email: shahadat@isrt.ac.bd

Cell: +8801747816856

2. Oumma Halima, Department of Food Technology and Nutrition Science, Noakhali Science and Technology University

   Email: oummahalimaeva@gmail.com

   Cell: +8801765564234

3. Md. Mynul Islam, Lecturer, ISRT, University of Dhaka

   Email: mislam2@isrt.ac.bd

   Cell: +8801756882581

4. Masum Ali, Consultant, Charité – Universitätsmedizin Berlin

   Email: masum.nf@gmail.com

   Cell: +8801723406635

Anthropological Researcher

Md. Kamal Pasa, Associate Professor, Department of Anthropology, University of Rajshahi
Email: kamalpasa@ru.ac.bd
Cell: +8801711075067

Qualitative Data Collection Team

1. Md. Shamiur Rahman

   Department of Anthropology, University of Rajshahi

2. Md. Sumon Hossain

   Department of Anthropology, University of Rajshahi

3. Shaheda Azbela Purna

   Department of Anthropology, University of Rajshahi

4. Shahana Akter Iren

   Department of Anthropology, University of Rajshahi

5. Jhilam Biswas

   Department of Anthropology, University of Rajshahi

6. Sayed Muntasir Mamun

   Department of Anthropology, University of Rajshahi

7. Priyanka Pervin Pinky

Department of Anthropology, University of Rajshahi

8. Farzana Akter Lima

   Department of Anthropology, University of Rajshahi

9. Abu Yousuf Sajid

   Department of Anthropology, University of Rajshahi

10. Sadia Afrose

    Department of Anthropology, University of Chittagong

11. Nahidul Islam Khan

    Department of Anthropology, Shahjalal University of Science and Technology

12. Nuzhat Munawara Lokman

    Department of Anthropology, Shahjalal University of Science and Technology

Market Survey (Price Data Collection) Team

1. Nobonita Shaha
   Institute of Nutrition and Food Science, University of Dhaka
2. Joynab Sultana Ushma
   Institute of Nutrition and Food Science, University of Dhaka
3. Jarif Mahbub Srabon
   Institute of Nutrition and Food Science, University of Dhaka
4. Mousumi Anny
   Institute of Nutrition and Food Science, University of Dhaka
5. Liton Sarker
   Institute of Nutrition and Food Science, University of Dhaka
6. Kahirul Khabir Shohag
   Institute of Nutrition and Food Science, University of Dhaka
7. Md. Aytullah Hasan
   Institute of Nutrition and Food Science, University of Dhaka
8. Shanto Das
   Institute of Nutrition and Food Science, University of Dhaka
9. Shuvo Biswas
   Institute of Nutrition and Food Science, University of Dhaka
10. Suman Mahato
    Institute of Nutrition and Food Science, University of Dhaka
11. Tushar Paul
    Institute of Nutrition and Food Science, University of Dhaka
12. Sumaya Shila

Institute of Nutrition and Food Science, University of Dhaka
13. Sheikh Muhammad Maruf
Institute of Nutrition and Food Science, University of Dhaka
14. Jahidul Islam Saikat
Institute of Nutrition and Food Science, University of Dhaka
16. Abira Nowar
Institute of Nutrition and Food Science, University of Dhaka
17. Peal Mahmud
Institute of Nutrition and Food Science, University of Dhaka