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A Study On Nutritional Status Of Adolescent Girls In Bangladesh

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ABSTRACT

Adolescence is a significant period in human life during which individuals undergo physical, cognitive, and psychosocial growth ending with gaining the ability to legally be independent of parents or guardians. The UN defines adolescence as the years from 10 to 19 years of age, although the WHO extends it to include people up to 24 years of age. The adolescent girls are the most important and valuable assets of any countries of the world because in future the adolescent girls will become mother. For this reason their nutrition is very much important for their lives. However the present has conducted to assess dietary patterns of school going adolescent in rural areas in Bangladesh and to identify the nutritional status of school going adolescent in rural areas in Bangladesh. The study was documentary analysis type. Data and information were collected from secondary sources such as books, research reports, journal, and websites of different organizations. Data and information were also collected from website from the ministry of health and family welfare, peoples republic of Bangladesh. From the study it was found that in adolescent period, adolescents need a higher protein intake, adequate vitamins, minerals and micronutrients due to the rapid linear growth and bone accretion. Compared to younger children, adolescents generally prefer snack more, skip meals, eat outdoors, eat late, and eat fast food more frequently which is typically impacted by their body image, peers, and the media. It is also a common time for the initiation of other unhealthy habits, such as drinking, smoking, and lethargy. A diet containing diverse food items provides a wide range of macro and micronutrients and enhances the nutritional quality of the diet. In contrast, starchy staples based on monotonous diets are deficient in important nutrients and subsidize to the burden of malnutrition. Dietary diversity among the adolescents and women of Bangladesh is very low. Two-thirds (66%) of women (including adolescents) consumed inadequately diversified diet (highest inadequacy in Rangpur division, 72%). In addition, adolescent health is also influenced by community determinants, risk factors, health protective measures, genetic factors, and changing social roles. Household factors, such as sociodemographic and economic status, as well as community factors including land availability and customs also play a role. From the study it was found that the change of the behavior of adolescent girls in increasing dietary diversity through school-based nutrition education, instead it showed a pathway on how to increase dietary diversity at school setting. With a limited resource, school-based nutrition of Bangladesh education intervention in real settings of the schools has demonstrated its feasibility in improving dietary diversity of the adolescent girls. Adolescent girls in Bangladesh face significant nutritional challenges, with high rates of undernutrition, including stunting and anemia. This is further complicated by factors like poverty, lack of access to nutritious food, and early marriage, which can lead to early pregnancy and increased nutritional needs. Addressing these issues is crucial for improving their health and breaking the cycle of intergenerational poverty.

Key words: Nutritional Status, Nutritional element, Adolescent Girl, Deficiency, Dietary Diversity, Anthropometry, Anemia.

INTRODUCTION

In Bangladesh poverty is one of the major obstacles on the road towards sustained development. Here poverty makes a vicious cycle of malnutrition through prevailing food insecurity. The challenges of food security in Bangladesh are manifold. In spite of considerable socioeconomic progress over last couple of years, Bangladesh still has the third largest number of poor people after China and India, a segment of which is chronically malnourished, suffering from silent disaster. Such large-scale malnutrition results in preventable sufferings, diseases and losses of productive potential of the tolling mass. Food security is now the most threatening issue for the overall improvement of people; particularly of the vulnerable groups of people. As food security does not only consider the food availability to a family but also the food accessibility by all individual belonging in the family. But in our country an adolescent girl/boy often get deprived of special care and required food due to lack of social awareness. Moreover, girl adolescents are in much worse condition as they are subjected to gender discrimination. Their imbalance work load, contribution to household tasks and extra food requirement are often neglected.

The world's adolescent population (age of 10–19 years) is about 1200 million and more than three-quarters of them are living in developing countries. Bangladesh has a population of nearly 36 million adolescent people more than one-fifth of Bangladesh's total population is between the ages of 10 and 19. According to the World Health Organization, children aged between 10–19 years are considered as adolescents. The nutritional situation of youth, especially teenage girls in Bangladesh is in grievous state. Stunting among adolescents is 36% and low body mass index (BMI) 50% in Bangladesh. Previous studies revealed that nutritional disorders affect a substantial percentage of adolescent girls to varying degrees. There are some specific reasons for which pubescence are an intervention stage in the life cycle which is one of a kind. After the first year of life, adolescence (10–19 years) is the second most critical period for physical growth. During this period, adolescents gain up to 50% of their final adult weight, 20% or more than that of their adult height, and 50% of their adult skeletal mass; of this entire growth, most is achieved during the early adolescence. Study found that the peak velocity of linear growth of adolescent girls takes place approximately in six to twelve months prior to menarche. In Bangladesh, the mean age for menarche is 12.8 years. Therefore, any kind of health intervention will be very worthwhile if it is given during early adolescence (10–14 years). Furthermore, results from a multi-country study showed that maternal height is a key determinant of childhood nutritional status. Since maternal height cannot be increased, we must go down the life cycle and consider increasing the height of adolescent girls at the population level. It would be the last favorable circumstance to interfere and annihilate the inter-generational vicious cycle of malnutrition.

Data collected from multiple countries revealed that nutrient inadequacy and inadequate dietary diversity are the major causes of adolescent malnutrition. Adolescence is the transition period between childhood and adulthood, a window of opportunity for the improvement of nutritional status and correcting poor nutritional practices. This is about the same period puberty sets in, typically between the ages of 10 and 13 years in girls. Adolescence is characterized by the growth spurt, a period in which growth is very fast. During this time, physical changes affect the body's nutritional needs, while changes in one's lifestyle may affect eating habits and food choices. Adolescent nutrition is therefore important for supporting the physical growth of the body and for preventing future health problems. All parents should therefore pay particular attention to the nutritional needs of their teenagers.

Therefore, overall poor dietary patterns and inadequate intake of nutrients can attribute moderate and severe primary or secondary malnutrition which may adversely modulate the progression of development and adult height. A lack of micronutrients, a higher chance of increasing rates of overweight and obesity among adolescents and related diseases. Studies in low- and middle-income countries have shown that early childhood under nutrition can lead to stunting, elevated cortisol levels, and reduced mental ability in school-age offspring. Another study found that adolescents in South Asia are particularly vulnerable to under nutrition, with over 60% of school going adolescent consuming inadequate amounts of essential nutrients for proper body growth. The investigation of dietary pattern of adolescents is particularly significant in rural areas of developing countries like Bangladesh, where nutritional practices and access to diverse foods may be limited because of various reasons. For example, a study revealed that dietary patterns are frequently influenced by cultural practices, food availability, and economic constraints in Bangladesh. Another, research reported that adolescents in semi-urban regions are more likely to consume a diet lacking in essential nutrients, which can lead to deficiencies and associated health issues. Common dietary

inadequacies include insufficient intake of fruits, vegetables, and protein-rich foods, coupled with a higher consumption of carbohydrates and fats.

OBJECTIVES OF THE STUDY

The objective of the study is as follows:

1. To assess dietary patterns of school going adolescent in rural areas in Bangladesh.
2. To identify the nutritional status of school going adolescent in rural areas in Bangladesh.

METHODOLOGY OF THE STUDY

The study was documentary analysis type. Data and information were collected from secondary sources such as books, research reports, journal, and websites of different organizations. Data and information were also collected from website from the ministry of health and family welfare, People's Republic of Bangladesh.

RESULTS AND DISCUSSION

A. ESSENTIALS OF NUTRITION FOR ADOLESCENT GIRLS

Any nutritional deficiency experienced during this critical period of life can have an effect on the future health of the individual and their offspring. For example, failure to consume an adequate diet at this time can result in delayed sexual maturation and delayed or retarded physical growth. The rapid physical changes of adolescence have a direct influence on a person's nutritional needs. The growth spurt that occurs in adolescence, second only to that in the first year of life, creates increased demands for energy and nutrients. Nutritional status and physical growth are dependent on one another such that optimal nutrition is a requisite for achieving full growth potential. Nutrition of the adolescent girl is particularly important but under-nutrition (too little food or food lacking required nutrients) in adolescents frequently goes unnoticed by their families or the young people themselves. Adolescence is a time to prepare for the nutritional demands of pregnancy and lactation that girls may experience in later life. Under-nutrition negatively affects adolescent girls by:

- Affecting their ability to learn and work at maximum productivity;
- Increasing the risk of poor obstetric outcomes for teen mothers;
- Arresting the healthy development of future children;
- Affecting sexual maturation and growth: and
- Preventing the attainment of normal bone strength and the development of healthy teeth if a youth doesn't get enough calcium.

It is also a well established fact that children born to short, thin women are more likely themselves to be stunted and underweight (low weight for age). What is more worrying therefore is that the negative effects of adolescent malnutrition persist throughout a woman's reproductive life. Dietary reference intakes (DRIs) developed by the National Health and Medical Research Council of Australia (NHMRC) provide current quantitative estimates of nutrient intakes to be used for planning and assessing diets for healthy people, including adolescents. The important nutrients that need to increase during adolescence include energy, protein, calcium, and iron.

1. Energy

Energy needs of adolescents are influenced by activity level, basal metabolic rate, and increased requirements to support pubertal growth and development. Adolescents need additional energy for growth and activity. Adolescent girls need approximately 2,200 calories each day. This is a significant increase from childhood requirements. To meet these calorie needs, adolescents should choose a variety of healthful foods, such as lean protein sources, low-fat dairy products, whole grains, fruits, and vegetables. In an attempt to meet their energy needs, adolescents can fall prey to unhealthy, coercive and aggressive advertisement. They must therefore be well informed in the choice of healthy foods both at home and in school. Caloric requirements may be estimated in kcal/cm of height, varying according to age and sex and adding extra expenditures with daily activities. The maximum consumption of calories for females should be estimated around 2,500 Kcal in the menarche period, on average between 12 and 12.6 years of age, decreasing progressively to 2,200 kcal after that. For males, the caloric intake requirements increase to up to 3,400 Kcal around 15 to 16 years of age, due to the pubertal spurt, and decrease to 2,800 Kcal until the end of the growth period. Energy requirements may also be calculated by using equations for the basal

metabolic rate, adding the growth factor and the activity factor for each age group, according to data from the Food and Agriculture Organization (Table 1).

Table 1: Calculation of energy requirements according to FAO/WHO, 1985

Female age (years)	Total Kcal/day	BMR/Kg (Kcal/day)	Recommendations (BMR x expenditures)
10-11	1160	34.3	1.65
11-12	1220	31.5	1.63
12-13	1280	29.1	1.60
13-14	1340	27.5	1.58
14-15	1375	26.7	1.57
15-16	1395	26.3	1.54
16-17	1405	26.0	1.53
17-18	1410	25.9	1.52

2. Carbohydrates

Carbohydrates are the main source of energy for adolescents, and usually contribute with 55% of the daily caloric intake. The monosaccharides glucose and fructose, which are present in fruit and vegetables, are agents of the "sweet" sugar. Their metabolic effects are different: although they release almost the same amount of energy, glucose releases more insulin and is metabolized in all tissues, while fructose is metabolized in the liver. The consumption of fructose, found in soft drink syrups, is responsible for the increased weight of many adolescents. Disaccharides, sucrose, lactose, and maltose are present in most balanced diets that include vegetables, cereals, and milk. The most common polysaccharide is the starch, which, along with fibers, forms complex carbohydrates. Carbohydrates act mainly in the center of hypothalamic satiety and affect the subsequent intake of other foods through its oxidation and transformation into calories; this process takes place in the liver.

3. Fats and oils

On a diet, fat serves as a concentrated source of energy (9 kcal/g), as well as a vehicle for fat-soluble vitamins and as a source for essential fatty acids, providing about 30% of the requirements. During the maximum growth rate, adolescents need so much energy that, without fats, the diet would become voluminous and unpalatable. On the other hand, exaggeration of "high-fat snacks", associated with sedentary life style, of the type "eat some snacks in front of the television", which is a common behavior among adolescents of wealthier social groups, is responsible for the "epidemics" of obesity and arteriosclerosis. It is always important to decrease the percentage of total fats and saturated fats, thus influencing their beneficial effects on the lipid profile and body composition. During adolescence, dietary fat continues to play important roles as an energy source, a significant cell structural component, a precursor to agents of metabolic function and a potent gene regulator. The Australian dietary guidelines for children and adolescents recommend 25% of total energy as fat, with less than 10% of energy from saturated fat for children aged over 15 years. The type of fat rather than its quantity is more important in determining the health consequences of dietary fat. This is because studies have shown that eating a low-fat diet for 8 years did not prevent heart disease, breast cancer, or colon cancer, and didn't do much for weight loss, either. Effective strategies for reducing fat intake in children include the use of skim milk and choosing only lean meat. A positive association between dietary saturated fats and total cholesterol level has demonstrated in an Australian adolescent population, although dietary factors may be more important in girls.

4. Protein

Protein needs of adolescents are determined by the amount of protein required for maintenance of existing lean body mass and the development of additional lean body mass during the adolescent growth spurt. In effect, protein is important for growth and maintenance of muscle. Adolescents need between 45 and 60 grams of protein each day. Most teens easily meet this requirement with their intake of beef, chicken, eggs, and dairy products. Protein is also available from certain vegetable sources, including tofu and other soy foods, beans, and nuts. These foods should be included in the diets of vegetarians especially. When protein intakes are consistently inadequate, reductions in linear growth, delays in sexual maturation and reduced

accumulation of lean body mass may occur. Protein requirements usually coincide with the maximum energy requirements during the pubertal spurt, and they may be estimated around 12 to 15% of the total calories for females and 15 to 20% for males (Table 1). It is important to consider an increase in this value for adolescents that work out or that live in "self-imposed restrictive diets", as in cases of anorexia nervosa.

Table 2: Calorie and protein requirements for adolescents and young adults

Female Age (Years)	Total daily calories (Kcal/cm height)	Total daily proteins (g/cm height)
11-14 Years	14.0	0.29
15-18 Years	12.9	0.28
19-24 Years	12.9	0.27

5. Calcium

It is estimated 45% of peak bone mass is attained during adolescence and so adequate calcium intake is important for the development of dense bone mass and the reduction of the lifetime risk of fractures and osteoporosis. Additionally, calcium needs during adolescence are greater than they are in either childhood or adulthood because of the increased demand for skeletal growth.

Adequate calcium intake is essential also for development of strong and dense bones during the adolescent growth spurt. Inadequate calcium intake during adolescence and young adulthood puts individuals at risk for developing osteoporosis later in life. In order to get the required 1,200 milligrams of calcium, teens are encouraged to consume three to four servings of calcium-rich foods each day. Milk provides the greatest amount of calcium in the diets of adolescents, followed by cheese, ice cream and frozen yogurt. Girls preoccupied with body shape might have a dilemma of including calcium-rich dairy foods, which they perceive as fattening. The National Nutrition Survey carried out in 1995 found 56 per cent of Australian girls aged 9 to 13 years did not meet the recommended dietary intake for calcium. The fear of getting fat through the consumption of dairy foods appears to be premature and may therefore not be a critical determinant of obesity since a recent study conducted in Canada found no difference in changes in per cent body fat over two years between girls eating varying amounts of calcium from food. Indeed, the type of fat consumed and not the quantity of fat per se must be watched. Empirical evidence indicates that bad fats, meaning saturated and trans fats, increase the risk for certain diseases while good fats (that is, monounsaturated and polyunsaturated fats), lower the risk. The basic idea regarding the prevention of diseases associated with fat consumption is to substitute good fats for bad fats. (Read more on how to reduce cholesterol in Nutrition for Lowering Cholesterol Levels)

There also appears to be varying degrees to which individuals respond to dietary fat intake. Calcium-fortified foods including orange juice, breakfast bars, bread and cereals are excellent sources of calcium. A study in the US showed that adolescents in the highest soft drink consumption category were found to consume less calcium and vitamin C than non-soft drink consumers. Therefore, excessive soft drink consumption by adolescents may displace the consumption of more nutrient-dense beverages, such as milk and juices. Good sources of calcium include milk, yogurt, cheese, calcium-fortified juices, and calcium-fortified cereals.

6. Minerals

The requirements for most minerals duplicate during adolescence, mainly calcium, iron, and zinc. Restrictive diets and sports competitions influence bone mineralization, causing osteopenia, osteoporosis, amenorrhea, and pubertal delay. Out of the total body calcium, 97% are located in the bone mass, and this proportion also increases dramatically during the pubertal spurt, when the daily deposit of calcium is almost twice as high as the average amount during the whole growth period (also higher for boys). Calcium content depends on height; so, a tall adolescent that is on the 95th percentile may need 36% more calcium than a short adolescent on the 5th percentile. Among females, this difference is about 20% between tall and short women. About 20 to 30% of ingested calcium is absorbed; thus an average daily intake of 1,200 mg of calcium is recommended, depending on the needs of each adolescent. In the same way, iron requirement increases with the growth of the muscle mass, blood volume, and respiratory capacity, besides menstrual losses and increase in exercises. The iron content in the foods also ranges from 4 to 6 mg/ 1,000 kcal. So, adolescents that menstruate, athletes, or adolescents that have deficient dietary habits will not receive the

total amount of iron required, which is calculated to be about 15 to 18 mg per day during the pubertal spurt. Zinc has been associated with delayed growth, hypogonadism, decreased taste sensation, and hair loss in adolescents with anorexia and also in athletes and pregnant women. The need for mineral supplementation will depend on the variety and quality of the diet, mainly during the pubertal spurt.

7. Iron

Iron is vital for transporting oxygen in the bloodstream. A deficiency of iron causes anaemia, which leads to fatigue, confusion, and weakness. With the onset of adolescence, the need for iron increases as direct consequence of rapid growth and the expansion of blood volume and muscle mass. As adolescents gain muscle mass, more iron is needed to help their new muscle cells obtain oxygen for energy. The onset of menstruation imposes additional iron needs for girls. The Recommended Dietary Allowance (RDA) for iron is 12-15 milligrams (mg) per day. Good sources of iron include beef, chicken, legumes (including beans and peanuts), enriched or whole grains, and leafy green vegetables such as spinach.

8. Zinc

Zinc is important in adolescence because of its role in growth and sexual maturation. It is known that serum zinc levels decline in response to the rapid growth and hormonal changes that occur during adolescence. Serum zinc levels indicative of mild zinc deficiency ($<10.71 \times 10^{-6}$ mol/L) have been found in 18% to 33% of female adolescents. The RDA for zinc for males and females ages 9-13 is 8 mg/day. For females ages 14-18, the RDA 9 mg/day. Zinc is naturally abundant in red meats, shellfish, and whole grains. Additionally, many breakfast cereals are fortified with zinc. Zinc and iron compete for absorption, so elevated intakes of one can reduce the absorption of the other. Adolescents who take iron supplements may be at increased risk of developing mild zinc deficiency if iron intake is over twice as high as that of zinc.

9. Folate

Folate plays an integral role in DNA, RNA and protein synthesis. Thus, adolescents have increased requirements for folate during puberty. Rich sources of dietary folate consumed by adolescents include ready-to-eat cereal, orange juice, bread, milk, and dried beans or lentils. Adolescents who have formed the habit of skipping breakfast or do not include orange juice and ready-to-eat cereals in their meals may be at an increased risk of low folate consumption.

10. Vitamins

Vitamin requirements are all increased in puberty due to increased anabolism and energetic expenditure. Other factors also contribute to this increase, such as physical activities, pregnancy, oral contraception, and chronic diseases. Requirements for vitamins A, B, C, and D are progressively higher during the pubertal spurt, with cellular differentiation and bone mineralization. Folic acid supplementation, at 400 mcg/day, should be routinely prescribed for sexually active or pregnant adolescents, as well as to those of low socioeconomic level. Adolescents with vitamin deficiencies are more frequent when they do not have the habit of daily intake of fruit, vegetables, milk, and cereals. Nutritional recommendations for adolescents according to the age group are found in the article “Bases of nutritional support in pediatrics”, also published in this issue.

11. Eating and snacking patterns

Adolescents tend to eat differently than they did as children. Preoccupied with after-school activities and engagement in active social endeavours, adolescents are not always able to sit down for three meals a day. These apparent busy schedules may lead to meal skipping, snacking throughout the day, and more eating away from home. Many teens skip breakfast, for example, but this meal is particularly important for getting enough energy to make it through the day, and it may even lead to better academic performance. When teens skipping meals at home is prevalent, the likelihood of purchasing fast food from a restaurant, vending machine, or convenience store will be high. These foods tend to be high in fat and sugar and they provide little nutritional value. More importantly, eating too many fast foods can lead to weight gain and which may predispose one to diseases such as diabetes and heart disease.

B. NUTRITION-RELATED PROBLEMS FOR ADOLESCENT CHILDREN

Poor eating habits during the critical adolescent years may lead to both short and long term health consequences including obesity, osteoporosis and sexual maturation delays. Adolescents are at risk of obesity, obesity-related chronic diseases, and eating disorders.

1. Obesity

All over the world, adolescent obesity is on the rise. In Australia, the prevalence of overweight and obesity is reported to be on the increase among children and adolescents, suggesting a problem with energy imbalance. Obesity is associated with an increased risk of obesity-related diseases like diabetes and heart disease. Experts have linked this rise in obesity to lack of physical activity and an increase in the amount of fast food and "junk food" available to adolescents. Staying active and avoiding sugary drinks and fatty snacks foods will promote a healthy weight for adolescents.

2. Eating disorders

Over-eating, under-eating and eating disorders can have serious health impacts. Adolescents tend to be very conscious of appearances and may feel pressured to be thin or to look a certain way (that is self image). Fear of becoming obese may lead to overly restrictive eating habits. Some adolescents even go to the extent of resorting to self-induced vomiting in an attempt to control their weight.

3. High-risk adolescent groups

Though adolescents in general are nutritionally vulnerable, certain groups of adolescents may be at greater risk for nutritional inadequacies. This category of adolescents includes the following:

4. Pregnant adolescents

When a teenager becomes pregnant, she needs more nutrients than her non-pregnant colleague to support both her baby and her own continued growth and physical development. If her nutritional needs are not met, her baby may be born with impaired foetal growth and the subsequent low birth weight or other health problems. For the best outcome, pregnant adolescents need to seek prenatal care and nutrition advice early in their pregnancy (see Nutrition during Pregnancy for more information).

5. Athletes

Adolescents involved in athletics may feel pressure to be at a particular weight or to perform at a certain level. Some young athletes may be tempted to adopt unhealthy behaviours such as crash dieting, taking supplements to improve performance, or eating unhealthy foods to fulfill their hearty appetites. A balanced nutritional outlook is important for good health and athletic performance.

6. Vegetarians

A vegetarian diet can be a very healthy option. However, adolescents who follow a vegetarian diet, whether for religious or personal reasons, need to carefully plan their intake to get the protein and minerals they need. Strict vegetarians (those who do not eat eggs or dairy products), also known as vegans, may need nutritional supplements to meet their needs for calcium, vitamin B_{12}, and iron.

7. Healthy eating tips for adolescents

Consume low-fat foods especially include sources of polyunsaturated and monounsaturated fatty acids (oils, lean meat, poultry and nuts) but limit intake of "hidden" saturated fatty acids (for example, biscuits and fast foods).

C. NUTRITIONAL STATUS OF ADOLESCENT GIRLS IN BANGLADESH

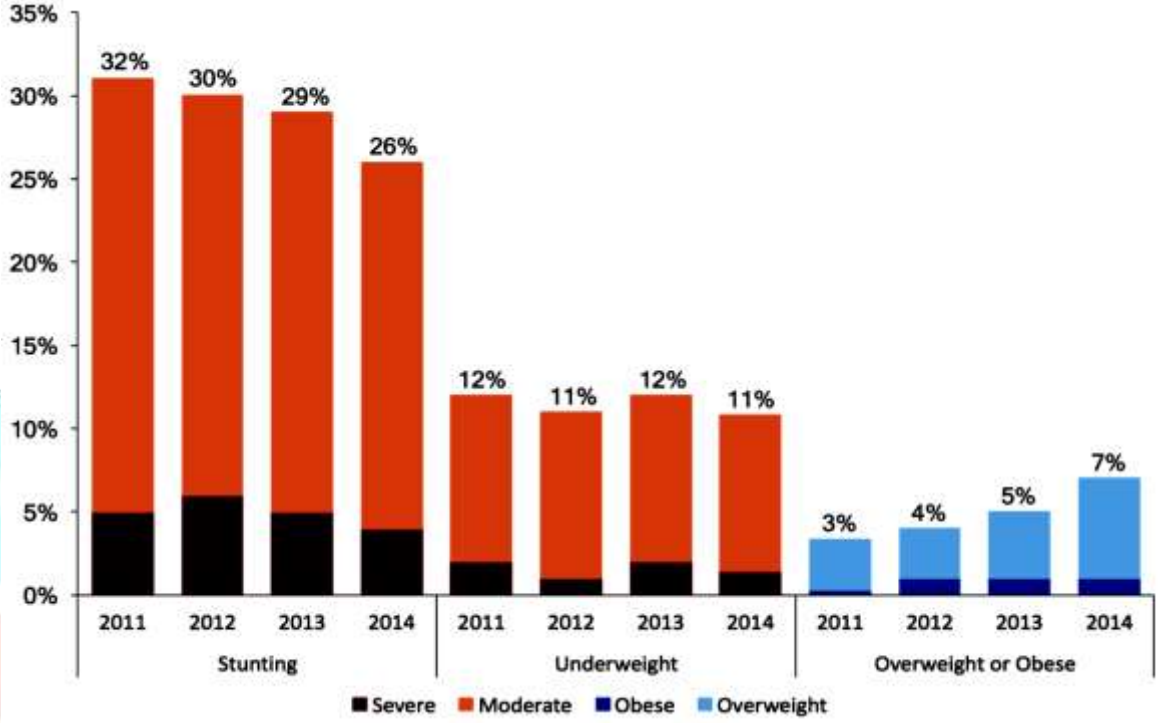
1. Anthropometry

Anthropometric indicators have been successfully used to assess malnutrition in children under five and adults, since they are correlated with adverse outcomes6, affordable to collect, and usually adhere to standard methodology. However, the associations between anthropometric indicators and adverse health outcomes have not been well validated for adolescents, especially non-Caucasian adolescents, and should be interpreted with caution. Common adolescent anthropometric measures include stunting, underweight (thinness), overweight, and obesity. Stunting reflects chronic undernutrition while underweight is indicative of acute deficiency in macronutrients, chronic undernutrition, or both. Overweight and obesity are a risk factor for diet-related noncommunicable diseases such as diabetes and cardiovascular disease. Adolescent stunting is currently defined as a height-for-age < -2 SD; underweight as a BMI-for-age < -2 SD;

overweight as a BMI-for-age > +1 SD; and obesity as a BMI-for-age > +2 SD from the World Health Organization (WHO) growth reference for children 5-19 years unless otherwise stated.

Figure 1 shows differences in stunting, underweight, and overweight/obesity in adolescent girls in 2011 through 2014 nationally in Bangladesh. Stunting reduced from 32% in 2011 to 26% in 2014. Underweight remained roughly constant at around 11-12% from 2011 to 2014. Overweight/obesity more than doubled from 3% in 2011 to 7% in 2014. Longer-term trends in ever-married girls 15-19 years by the Demographic and Health Surveys (DHS) also reveal a nutrition transition, using adult BMI cutoffs for underweight and overweight/obesity (Figure 1). However, stunting remains high at over a quarter of the adolescent girl population.

Figure 1: Anthropometry in adolescent girls (10-18 years) by year in Bangladesh.

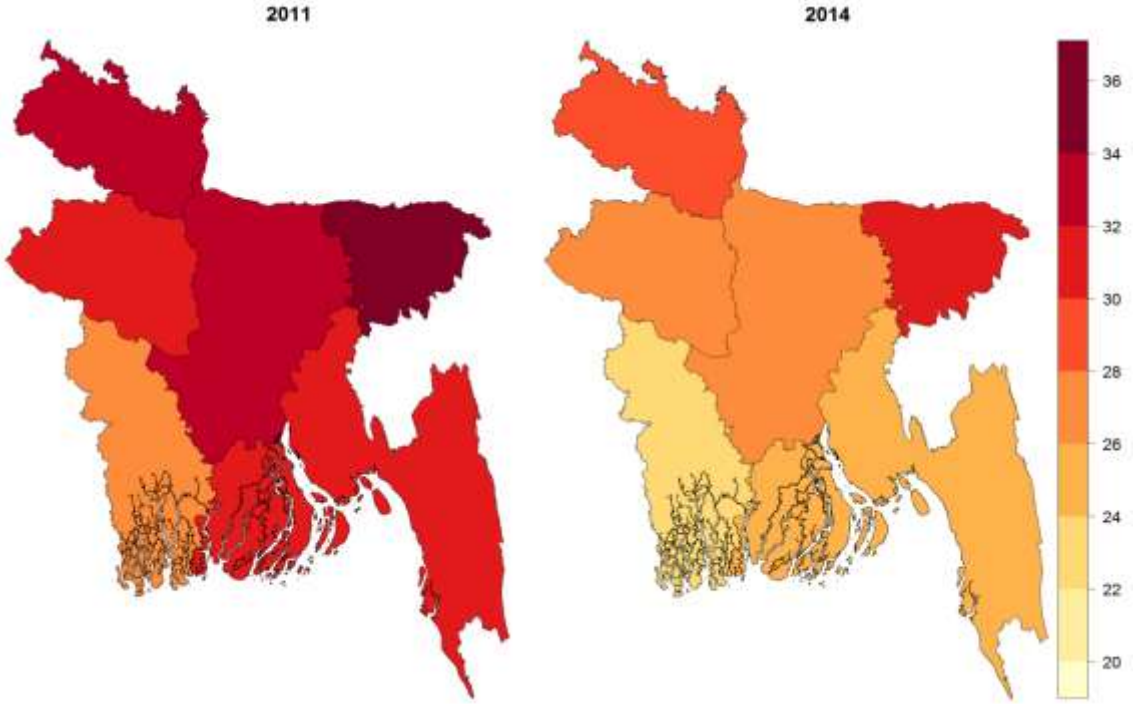


Sources: State of food security and nutrition in Bangladesh 2011-201410–13.

Severe stunting is defined as a height-for-age <-3 SD and moderate stunting as < -2 SD but -3 SD; severe underweight as a BMI-for-age < -3 SD and moderate underweight as < -2 SD but -3 SD; obesity as a BMI-for-age > +2 SD; and overweight as > +1 SD but ≤ +2 SD from the WHO 2007 growth reference for children 5-19 years.

A nationally representative study of rural Bangladesh conducted in 2011-2012 found that adolescent school-going boys had a higher prevalence of underweight than girls (22% versus 17%). The same study found no biologically significant differences in overweight between boys and girls. There were large variations in adolescent girl stunting by division between 2011 and 2014 (Figure 2). The greatest improvement took place in Dhaka (from 33% to 26%), Barisal (30% to 24%) and Sylhet (37% to 31%). Sylhet (31%) and Rangpur (29%) had the highest prevalence in 2014. In general, adolescent girls from poorer households are at a much greater risk of stunting. The largest differences appear to occur between the first and second and fourth and fifth quintiles. Unfortunately, there was no change in stunting in the poorest quintile between 2011 and 2014, where the highest burden remained in 2014 (33%). Targeting the poorest households remains important for stunting reduction. Underweight in adolescent girls between 2011 and 2014 also varied substantially by division, however, the spatial pattern was different than for stunting. The greatest reduction occurred in Dhaka (13% to 9%) and Khulna (18% to 14%). No change in underweight occurred in Barisal, Rajshahi, or Rangpur, while prevalence in Sylhet increased from 13% to 16%. In 2014, adolescent girls in Sylhet experienced the highest burden of stunting and underweight, while stunting but not underweight was high in Rangpur, and underweight but not stunting was high in Khulna.

Figure 2: Prevalence of stunting in adolescent girls (10-18 years) by year and division in Bangladesh.

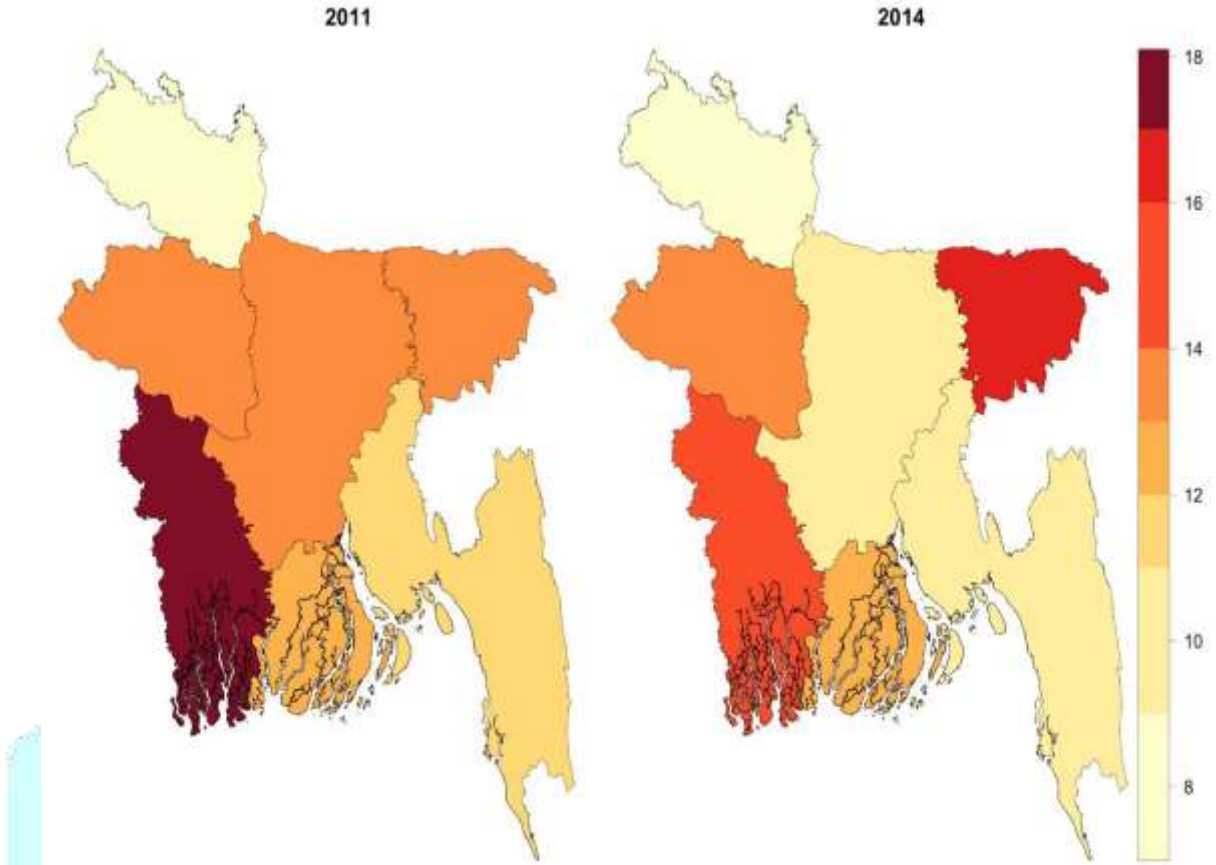


Sources: State of food security and nutrition in Bangladesh 2011 and 2014

Stunting is defined as a height-for-age < -2 SD from the WHO 2007 growth reference for children 5-19 years. This highlights the importance of tailoring interventions geographically when possible to best address the particular forms of malnutrition that are of greatest concern in each area.

In 2011 there was a linear trend in reduction of adolescent girl underweight from the richest to poorest wealth quintiles (Figure 3). In 2013 there was a substantial reduction in underweight from the fourth to fifth quintiles (14% to 9%). However, only mild changes in underweight occurred in 2012 and 2014. The general trends suggest wealthier households have on average lower prevalence of underweight than poorer households, but this appears less important for underweight than it does for stunting. Moreover, there are inconsistencies in differences in underweight between wealth quintiles by year. There is also large seasonal variation in underweight by surveillance zone, but the only clear pattern between 2011 and 2014, was in Northern chars, where prevalence was highest in the monsoon each year. Overweight and obesity in adolescents have been increasing globally primarily due to decreased physical activity and poor-quality diets, and Bangladesh is no exception15. While the 7% prevalence in adolescent girls may seem small, overweight/obesity in ever-married women increases rapidly immediately following adolescence prevalence was more than twice as high for women 31-40 years (45%) than for women 19-22 years (22%) in 2014.

Figure 3: Prevalence of underweight in adolescent girls (10-18 years) by year and division in Bangladesh. Underweight is defined as a BMI-for-age < -2 SD from the WHO 2007 growth reference for children 5-19 years.



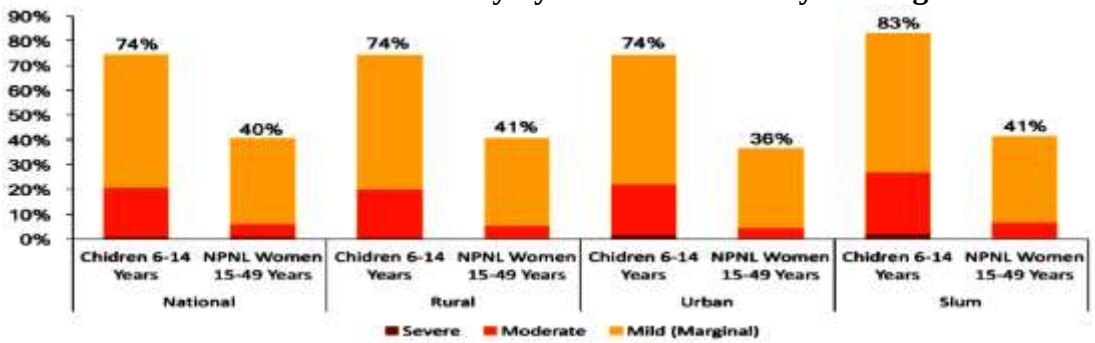
Sources: State of food security and nutrition in Bangladesh 2011 and 2014.

There are large gaps in adolescent anthropometric data in Bangladesh. Nationally representative data on overweight/obesity in urban adolescent boys is unavailable. No recent nationally representative anthropometric indicators have been reported for subpopulations of boys, such as by differences in age, wealth, or geography. Additionally, nationally representative sub-national data on adolescent overweight/obesity using recommended WHO cutoffs for adolescents has not been reported from any survey.

2. Micronutrient status and anaemia

Adequate micronutrients are essential for growth and development during adolescence. Vitamin A deficiency can cause night blindness and reduce immunity to infections. Iodine deficiency impairs brain development and cognition and can cause goiter enlargement of the thyroid gland. Zinc deficiency results in many nonspecific consequences, including poor growth and increased infections. Iron deficiency is the leading cause of anemia one of the largest contributors to the global disease burden, including increased morbidity and mortality. Adolescent girls have increased iron requirements due to menstrual blood loss and boys have.

Figure 4: Prevalence of vitamin A deficiency by cohort and locality in Bangladesh in 2011-2012



Source: National Micronutrients Status Survey 2011-2012.

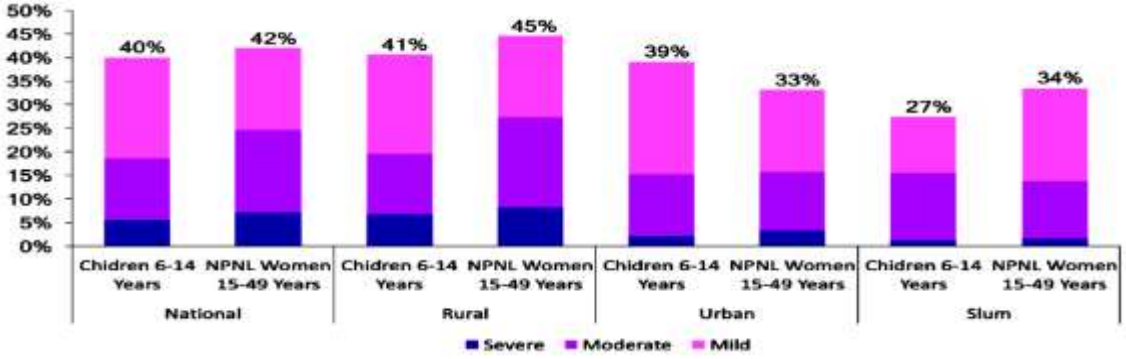
Severe deficiency is defined as a serum retinol concentration < 0.35 µmol/L; moderate deficiency as ≥ 0.35 µmol/L but < 0.7 µmol/L; and mild (or marginal) deficiency as ≥ 0.7 µmol/L but < 1.05 µmol/L. NPNL stands for non-pregnant non-lactating.

3. Increased requirements due to muscle mass accumulation

Anemia and deficiencies in Vitamin A, iodine, and zinc are common in Bangladeshi adolescents. Dietary, purchasing, and food availability data confirm these micronutrients are inadequate in the diet and suggest other deficiencies, such as calcium, are also common. While some subgroups of adolescents were sampled in the National Micronutrients Status Survey (NMSS) 2011-2012 in Bangladesh, they were not disaggregated to a broad adolescent age group16. Therefore, data are presented by age and sex groups—school-aged children (boys and girls) 6-14 years and non-pregnant non-lactating (NPNL) women 15-49 years. Figures are provided for the status of anemia and micronutrients that have been reported in both school-aged children and NPNL women (vitamin A, iodine, and iron). Vitamin A deficiency was high for all localities in Bangladesh, particularly in younger adolescents—especially those from slums. When considering a cutoff of mildly (or marginally) deficient (serum retinol concentration < 1.05 mol/L), deficiency nationally was 74% in children 6-14 years and 40% in NPNL women 15-49 years. When using a cutoff of moderately deficient (serum retinol concentration < 0.7 mol/L), prevalence was much lower—21% for children 6-14 years and 5% for NPNL women 15-49 years. However, given that over 99% of rural adolescents are estimated to consume inadequate vitamin A from food, the mildly deficient cutoff may better represent the burden of vitamin A deficiency.

Iodine deficiency was also high in children 6-14 years and NPNL women 15-49 years, but there were smaller differences between cohorts and more variation between localities. Children 6-14 years and NPNL women 15-49 years from rural populations had the highest prevalence of deficiency—greater than 40%, while children 6-14 years from urban populations also had a high prevalence (39%). The high prevalence in adolescents in Bangladesh is particularly concerning; given that iodine deficient mothers are at greater risk of having children with reduced cognition.

Figure 5: Prevalence of iodine deficiency by cohort and locality in Bangladesh in 2011-2012.



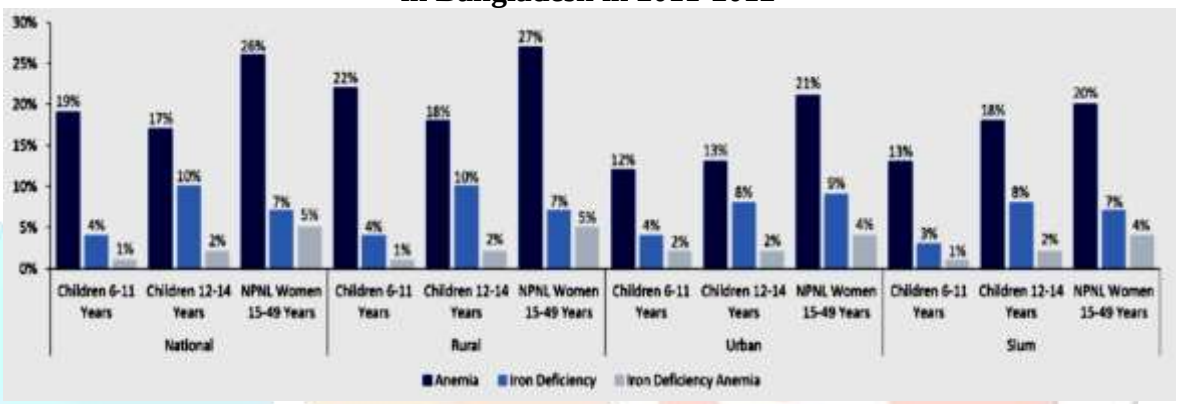
Source: National micronutrients status survey 2011-2012.

Severe deficiency is defined as a urinary iodine concentration (UIC) < 20 µg/L; moderate deficiency as ≥ 20 µg/L but < 50 µmol/L; and mild as ≥ 50 µg/L but < 100 µmol/L. NPNL stands for non-pregnant non-lactating.

Zinc deficiency was only reported for preschool-aged children and NPNL women 15-49 years in the National Micronutrients Status Survey. Over half (57%) of NPNL women 15-49 years were found to be zinc deficient (serum zinc concentration < 10.1 mol/L). Prevalence was highest in slums at 66%. Vitamin B12 and folate deficiency were only reported for NPNL women 15-49 years and were both below 10% nationally. However, when including arginal status, 16% of NPNL women 15-49 years were considered deficient.

Anemia and iron deficiency in adolescents are not as high as vitamin A, iodine, and zinc deficiency. Figure 6 shows the variation in anemia, iron deficiency, and iron deficiency anemia by locality for three cohorts that include adolescents. Nationally, anemia is highest for NPNL women 15-49 years (26%) compared to children 6-11 years (19%) and 12-14 years (17%), yet iron deficiency is highest in children 12-14 years (10%). A similar trend is found in rural populations. Anemia in children 6-11 years in urban (12%) and slum (13%) populations is much lower than in rural populations (22%). Anemia in children 12-14 years is lowest in urban populations (13%).

Figure 6: Prevalence of anaemia, iron deficiency, and iron deficiency anaemia by cohort and locality in Bangladesh in 2011-2012



Source: National micronutrients status survey 2011-2012

Anaemia is defined as a hemoglobin level < 12.0 g/dL in non-pregnant non-lactating (NPNL) women and children 12-14 years, and < 11.5 g/dL in children 6-11 years. Iron deficiency is defined as a serum ferritin level < 15.0 ng/mL in NPNL women and children 6-14 years, adjusted for elevated C-reactive protein (CRP) (> 10.0 mg/L) or elevated alpha-1-acid glycoprotein (AGP) (> 1.0 g/L) by mathematical correction. Iron deficiency anaemia is defined as a hemoglobin < 12.0 g/dL plus a ferritin level < 15.0 ng/mL in NPNL women and children 12-14 years, and a hemoglobin < 11.5 g/dL plus a ferritin level < 15.0 ng/mL in children 6-11 years.

D. KEY DETERMINANTS OF MALNUTRITION IN ADOLESCENT GIRLS

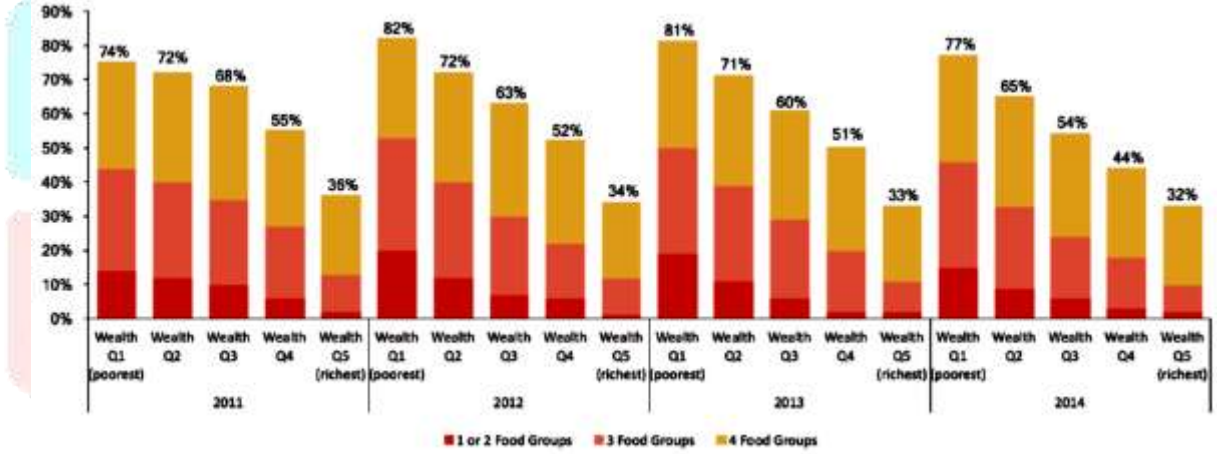
1. Dietary intake

Dietary quality is essential for adequate nutrition. Nutrition indicators discussed above anthropometry and micronutrient deficiencies are largely dependent on a healthy diet. Inadequate diets lead to poor nutritional outcomes, further downstream diseases, and mortality. Dietary diversity is a measure of how many food groups out of a set number of food groups an individual consumes over a given period of time. Population-level dietary diversity scores (DDSs) provide an estimate of dietary quality and micronutrient density, since more diverse diets are more nutritionally adequate. Data on adolescent dietary intake in Bangladesh is limited. The Food Security Nutrition Surveillance Project (FSNSP) 2011-2014 asked adolescent girls and women 10-49 years whether they consumed particular food groups in the day before the survey. While not quantitative, this information did allow for estimation of DDSs. Most of the data are not disaggregated by adolescents, so information is presented on adolescent girls and women 10-49 years. Because of this, it's not clear if or to what extent the relationships presented also exist in adolescent girls. The FSNSP 2011-2014 defined inadequate dietary diversity as an individual consuming fewer than five food groups on a nine-point scale. While overall dietary diversity has improved modestly between 2011 and 2014 in Bangladesh, more than half of adolescent girls and women consumed inadequately diverse diets nationally in 2014. The largest variation in dietary diversity scores occurred between higher and lower wealth quintiles. Clearly, poverty is a major barrier to adolescent girls obtaining adequately diverse diets. In all years, the prevalence of inadequate dietary diversity was more than double in the poorest compared to the richest quintile. Moreover,

adolescent girls 10-16 years are at least twice as likely than boys 10-16 years to go to sleep hungry, skip meals, and take smaller meals, and 50% more likely to eat only rice as coping strategies during food insecurity. However, the majority of the burden of food insecurity falls on adult women.

Urban adolescent girls and women had more diverse diets than rural adolescent girls and women—mean DDS of 4.8 versus 4.413. Figure 8 shows the variation in inadequate dietary diversity by division in 2011 and 2014. In 2014, all divisions in Bangladesh had a prevalence of inadequate dietary diversity greater than 50% except Dhaka (44%). The divisions with the highest prevalence of inadequate dietary diversity in 2014 were Rangpur (66%), Barisal (64%), and Rajshahi (60%). The largest change in the prevalence of inadequate dietary diversity between 2011 and 2014 occurred in Khulna (69% to 53%) and Sylhet (67% to 55%). Nationally, dietary diversity has varied by season somewhat consistently over time in Bangladesh. From 2011-2014, adolescent girls and women 10-49 years had the highest prevalence of inadequate dietary diversity in the post-aus harvest season (September-December) and the lowest in the monsoon (May-August) (Figure S6). From 2011-2014, inadequate dietary diversity seemed to trend downward in the post-aman harvest period (January-April) and the monsoon but remained steady and high for the post-aus season. The same trends hold regionally to varying degrees depending on surveillance zone. Available dietary data on adolescents in Bangladesh is limited to aggregated dietary diversity scores for women and adolescent girls, discussed above, and dietary intake of rural adolescents. National-level household consumption and expenditure surveys (HIES) and Food and Agricultural Organization Food Balance Sheets (FBS) (http://www.fao.org/faostat/) provide insight into particular food groups that are available for consumption.

Figure 7: Prevalence of inadequate dietary diversity (< 5 food groups out of 9) in women and adolescent girls (10-49 years) by wealth quintile and year in Bangladesh.



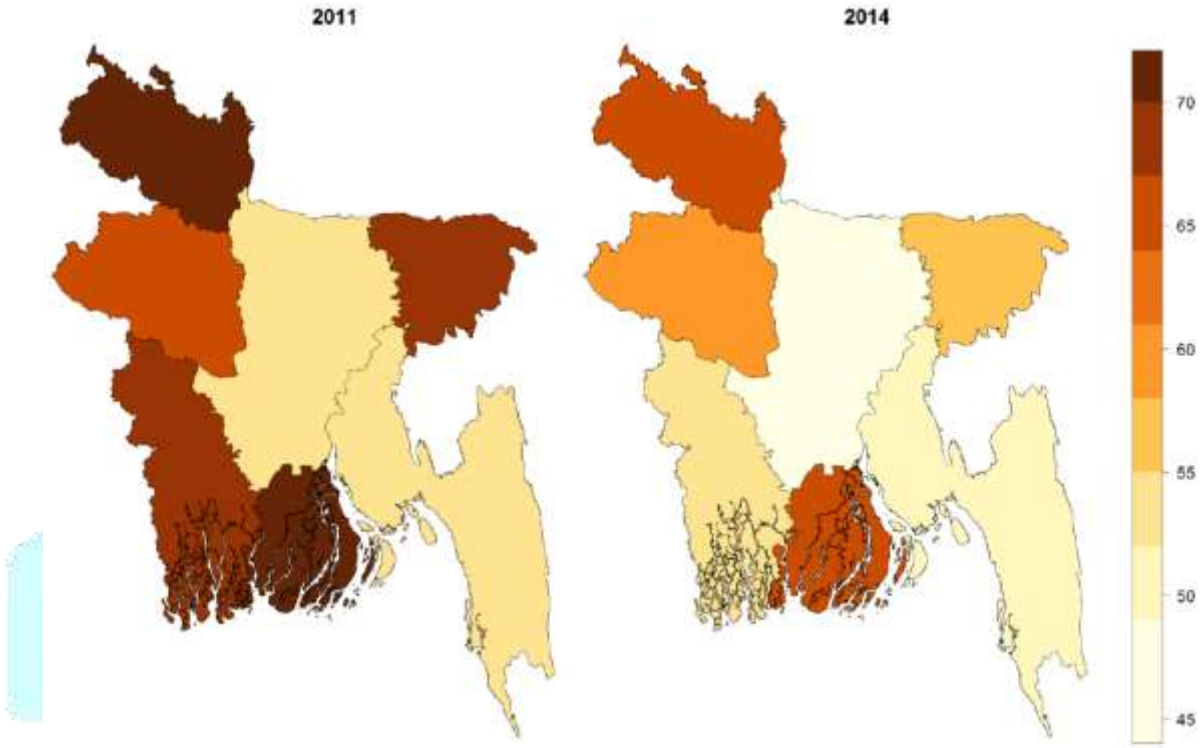
Sources: State of food security and nutrition in Bangladesh 2011-2014.

Based on food availability data from the FBS in 2013, about 80% of kilocalories (kcal) per capita per day in Bangladesh are from very micronutrient-poor foods: rice (1,711 kcal), palm oil (85 kcal), sugar (53 kcal), soybean oil (45 kcal), "sugar non-centrifugal" (16 kcal), rape and mustard oil (16 kcal) and "sweeteners, other" (6 kcal) 70% from rice alone (75% for rural adolescents14). The only animal-source foods (ASF) in double-digit calories are "milk – excluding butter" (37 kcal) and freshwater fish (29 kcal). All other nutrient-rich ASF, are in single digits the highest being eggs (9 kcal), bovine meat (6 kcal), mutton and goat meat (6 kcal), and poultry meat (6 kcal). The only micronutrient-rich plant foods in double digits are "pulses other and products" (35 kcal), peas (24 kcal), "fruits, other" (18 kcal), "spices, other" (17 kcal), "vegetables, other" (14 kcal) and onions (10 kcal). Studies using FBS, HIES, and dietary intake to estimate dietary inadequacy of micronutrients suggest dietary intake of calcium, vitamin A, iron, folate, and zinc are far below recommendations.

In the context of the ongoing nutrition transition and high prevalence of micronutrient deficiencies in Bangladesh, it would be ideal to improve the quality of adolescent diets by increasing consumption of whole foods high in micronutrients and/or fiber, especially ASF. ASF compared to plant foods contain much higher levels of bioavailable micronutrients identified to be inadequate in the Bangladeshi adolescent diet, particularly vitamin A, zinc, calcium, and iron. Adolescents in Bangladesh would benefit from increased consumption of vegetables, legumes, fish and shellfish, eggs, meats (especially organ meats), and milk, and reducing consumption of energy-rich, nutrient-poor foods, such as refined flours, sugar, vegetable oils, and

ultra-processed foods—which also contain harmful substances. However, there are financial, sociocultural, and infrastructural challenges to modifying adolescent diets, and identification of bottlenecks is needed. A qualitative study in 4 districts in Bangladesh found that most adolescent girls preferred protein-rich ASF and snack foods, and many disliked vegetables (Khan and Blum, unpublished data). Fruits were also desirable, but rarely consumed due to the assumption that they are expensive.

Figure 8: Prevalence of inadequate dietary diversity (< 5 food groups out of 9) in women and adolescent girls (10-49 years) by year and division in Bangladesh.



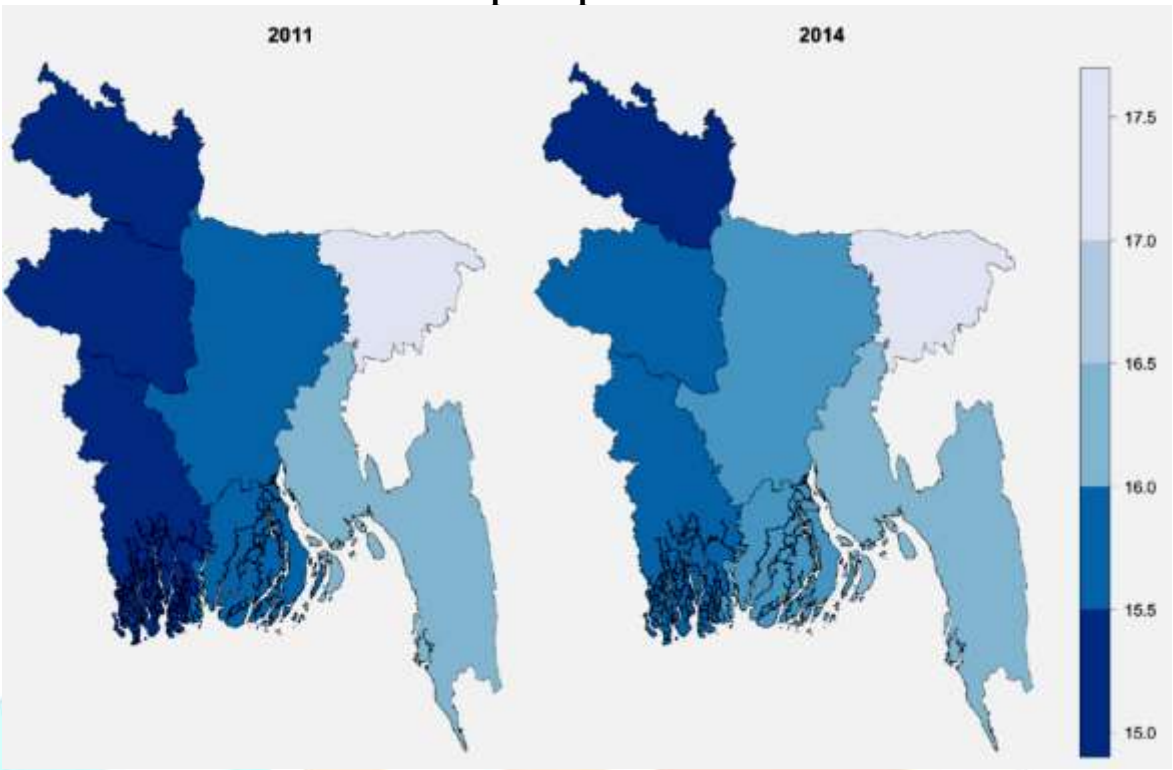
Sources: State of food security and nutrition in Bangladesh 2011 and 2014.

Since Bangladeshi adolescents desire both healthy and unhealthy foods, there is opportunity to steer food choices towards healthier whole food options and away from unhealthy processed snack foods. However, food security is a primary bottleneck for inadequate diets in Bangladesh. Although not specific to adolescents, individuals from households with lower income, less education, and more family members are more likely to compromise the quality and quantity of food consumed in response to food insecurity. Implementing secondary school feeding programs along with conditional cash transfers and/or the provision of take-home food rations could simultaneously incentivize school enrollment, delay marriage, increase educational attainment, improve consumption of nutritious foods, and allow targeting of the poorest households.

Fortification is another important method of increasing the micronutrients in foods. Because of the high prevalence of iodine deficiency in Bangladeshi adolescents, it's important to ensure iodine fortification is effectively implemented. About 58% of households have adequately iodized salt. Increasing the proportion of households with adequately iodized salt through improving fortification practices can have a substantial impact on iodine deficiency in adolescents. Similarly, fortification of edible oil with vitamin A and rice with folic acid, iron, zinc, and vitamins A, B1, and B12, has been recently implemented in Bangladesh and could be strengthened to reduce deficiencies in adolescents.

2. Early marriage

Figure 9: Median age at first marriage among women 20-49 years by year and division in Bangladesh. Age at first marriage is defined as the age at which the respondent began living with her first spouse/partner.

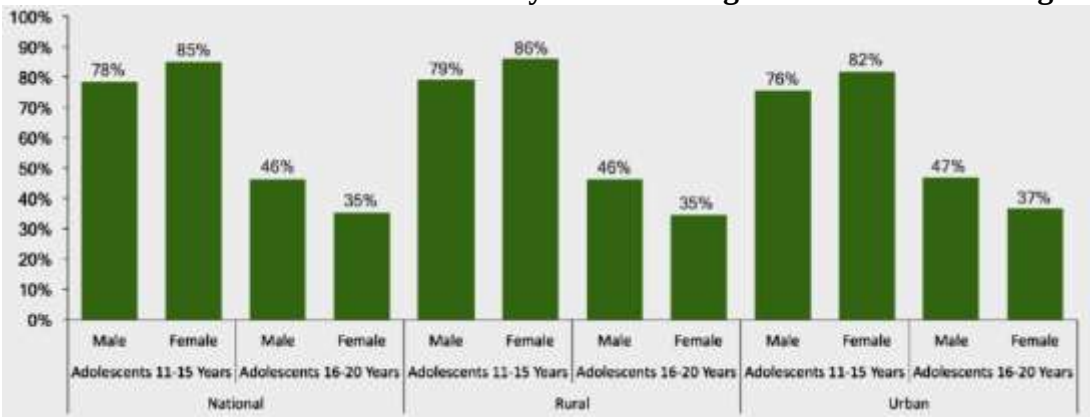


Source: Bangladesh Demographic and Health Survey 2014.

Strong cultural norms in Bangladesh encourage adolescent girls to marry early. Child marriage increases the likelihood of becoming pregnant in adolescence, while girls are still developing. Early pregnancy is associated with poor birth outcomes for mother and child, reduced time in school and lower literacy, and numerous negative socioemotional outcomes. The median age at first marriage in Bangladesh is low but has risen over the past few decades from about 15 years for women in their late forties to about 17 years for women in their early twenties3. In 2014, while nearly half (46%) of women 45-49 years were married by age 15, only 16% of women 15-19 years were married by this age, showing a large reduction in the proportion of girls marrying very young. In 2014, 59% of ever-married women 20-24 years were married by the 18 years of age. Regionally, the median age at first marriage is highest in the west, particularly in Rangpur, and lowest in the east, particularly in Sylhet (Figure 9). This does not correspond exactly with indicators of adolescent girl undernutrition by division, but it is likely an important determinant to varying degrees throughout Bangladesh. The median age at first marriage for women 20-49 years is lower for women with lower income and education and from rural areas.

3. School enrolment

Figure 10: Prevalence of adolescents 11-20 years attending school in 2014 in Bangladesh.

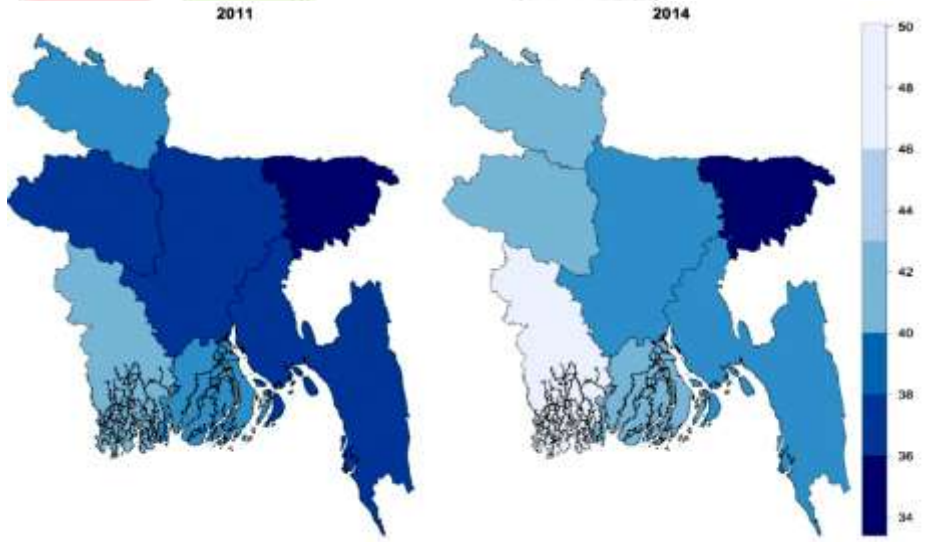


Source: Bangladesh Demographic and Health Survey 2014.

Early marriage and school attendance are linked. Delaying marriage by 1 year in Bangladesh has been associated with nearly a quarter-of-a-year increase in schooling as well as increased literacy for adolescent girls. Educational attainment is associated with a host of nutritional outcomes. Children often drop out of school in Bangladesh when their families face economic hardships, such as increased food prices. Incentivizing continued school enrollment can be used as a strategy to delay marriage, empower women, improve nutrition, and increase economic potential.

Nationally in Bangladesh, younger adolescents have much higher school attendance (82%) than older adolescents (40%). In adolescents 16-20 years, males (46%) have higher attendance than females (35%), but for adolescents 11-17 years, there are no significant differences between sexes3. In adolescents 11-15 years, girls (85%) have moderately higher attendance than boys (78%), however, this is likely due to recent efforts to promote education of girls. There are not large differences in enrollment by locality. Regional variation in secondary school enrollment of adolescents 11-17 years is considerable. There is an apparent decreasing gradient of enrollment from the southwest to the northeast at the divisional level. Enrollment in Sylhet is only 34% while it is 50% in Khulna. Secondary school enrollment of adolescents 11-17 years also varies substantially by wealth households in the lowest wealth quintile have an enrollment of 30% compared to those in the highest (50%)

Figure 11: Percentage of secondary-school-age adolescents 11-17 years attending secondary school in 2011 and 2014 in Bangladesh.



Source: Bangladesh Demographic and Health Survey 2011 and 2014.

CONCLUSION

It is known that the adolescence stage of lifespan is one of the key stages of physical growth and development. In general, specific and several unique changes occur in an individual during this time. Bangladesh is a developing country. Alike other developing countries malnutrition in adolescence period is a serious problem in Bangladesh. Lack in nutritional balance intake food along with minimum physical activities and pitiable socio-economic situation of the adolescent girls may be affected their future unexpected problem during motherhood and hamper their cognitive development. The nutritional status of the adolescent girls should not be over looked and nutrition education programs need to be implemented to improve the nutritional status. Suitable approaches should be designed to improve their nutrition and studies elaborately in the future. Growth occurs in skeleton, in the muscle, and in almost every system and organ of the body in adolescence except the brain and the head. During adolescence, more than 20% total growth in stature and up to 45% of adult bone masses are achieved, and weight gained during the period contributes about 50% to adult weight. Accelerated growth during adolescence places increased demand on energy, protein, and other nutrients. Tempo of growth during adolescence is slower in undernourished populations. Protein deficiency has been shown to reduce growth during adolescence. It is very well known that for the wellbeing of society, adolescents are the important stage of life and adolescents are the future generation of any country. In most developing countries the adolescent's nutritional needs are very essential and critical but also neglecting adolescents than other groups of people like children and women. Fulfill of nutrition demands of adolescents could be the important step towards breaking the cycle of intergenerational malnutrition, chronic diseases and poverty as well.

The majority of adolescents' girls of Bangladesh followed a traditional three-meals-a-day routine, with a notable percentage indicating a tendency to skip a more meal. Most of the adolescents' girls don't maintain a balanced diet. They maintain with a normal BMI consuming less amounts of vegetables, fruits, and milk products. However, most of the adolescents' girls prefer higher consumption of rice/bread and frequent fast-food intake read-to-eat foods which are associated with being overweight. Associations were explored, revealing significant links between stunting severity and BMI of adolescents with various demographic and physical characteristics such as age, gender, parents' income, etc. Moreover, gender and food habits demonstrate a strong association with BMI categories. These findings underscore the complexity of factors influencing the dietary patterns and health status of adolescents in rural areas of Bangladesh. Targeted interventions should address nutritional disparities and consider sociodemographic nuances to promote holistic adolescent health in the region. In efforts to improve the dietary patterns and health status of adolescents in urban, semi-urban, and rural areas, it is very important for a country to enhance nutritional education, improve food security, and foster healthier eating habits to ensure a healthier adolescent population. There is a notable gap in comprehensive data regarding adolescent health in Bangladesh, particularly for rural areas.

RECOMMENDATIONS

The recommendations of the study are as follows:

1. Deworming has the highest return on investment. Less than $1 invested per adolescent in deworming returns $72 for school-going adolescents and $46 in out-of-school adolescents. Heavy worm infestation inhibits the body from absorbing nutrients, decreases immunity to illnesses, and reduces school attendance. A minimal cost can return huge benefits.
2. Weekly iron-folic acid (IFA) supplements cost less than $1.50 per school-going adolescent and less than $2 per out-of-school adolescent. The prevalence of anemia among adolescent girls is over 50 percent. IFA supplementation for all adolescent girls is a highly cost-effective investment to reduce anemia and improve their health and school performance.
3. Multiple micronutrient supplements (MMS) costs $4 per adolescent annually for in-school and out-of-school adolescents. Investing $1 per year for MMS for each adolescent would return 17 times the cost for school-going adolescents and 10 times the cost for out-of-school adolescents. Inadequate intake of critical micronutrients can impair brain development and increase infection.
4. School-based nutrition education for dietary diversity and physical activities costs $4 per adolescent and is extremely important to reduce undernutrition and obesity. A healthy lifestyle delays the onset of diseases and increases productivity. Education helps to establish good nutrition, healthy eating, and regular physical activity habits among children, teachers, and guardians.
5. Mid-day meals or fortified snacks at schools cost $50 per adolescent a year—less than 20 cents per adolescent a day. Many students go to school hungry. A nutrient-rich meal will provide the necessary food

and nutrition students need, which can also improve their school performance. The main cost of the program is for mid-day meals.

6. Education and livelihood training to reduce child marriage costs $42 per adolescent with a return 10 times the cost. Bangladesh has the highest prevalence of child marriage in South Asia—65 percent of girls marry before the age of 18. Adolescent pregnancy increases the health risks for teenage mothers and their unborn babies. The children of teenagers are at greater risk of poor nutrition, increasing the risk of intergenerational undernutrition.

Limited studies have been conducted to understand and address the health status of adolescents, where healthcare facilities are less accessible compared to urban areas. More studies should be conducted related to adolescent girls' nutrition in Bangladesh.

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