1. Summary of findings

- A nutrition transition is occurring—stunting has declined but remains high (27%), overweight is increasing (currently 7%), and underweight (thinness) has remained consistent, around 12% during recent years. Stunting and underweight are both highest in Sylhet. Underweight is higher in adolescent boys (22%) than girls (17%), at least in rural areas.
- Anaemia and micronutrient deficiencies are common in adolescents, notably vitamin A, zinc, and iodine, and other deficiencies such as calcium are also likely common, since dietary intakes are far below requirements.
- Both boys and girls are vulnerable to malnutrition to varying degrees depending on the indicator.
- More than half of females 10-49 years have inadequately diverse diets, and there are strong differences by subpopulation, particularly by wealth quintile. Adolescent girls and women with low wealth, who are food insecure and live in Rangpur, Barisal, or Rajshahi, are more likely to have inadequately diverse diets, especially during the post-aus season.
- Adolescent girls 10-16 years are at least twice as likely as boys 10-16 years to go to sleep hungry, skip meals, and take smaller meals, and one-and-a-half times more likely to eat only rice, as coping strategies during food insecurity.
- Early marriage has declined but remains high—59% of ever-married women 20-24 years were married by age 18. Age at first marriage is lowest in Rangpur and highest in Sylhet.
- Secondary school enrolment is low—only 43% of adolescents 11-17 years are enrolled in secondary school. Secondary school attendance is lowest in Sylhet.
- There are large variations in malnutrition and its determinants by subpopulations, where national-level data often masks large disparities.
- Interventions are needed that prioritize foods high in micronutrients (especially animal-source foods) and/or fiber, including vegetables, legumes, fish and shellfish, eggs, meats (particularly organ meats), and milk and its products, and that aim to reduce consumption of energy-dense, nutrient-poor foods, such as refined flours, sugar, vegetable oils, and ultra-processed foods.
- Secondary school feeding programs that include conditional cash transfers and/or provide take-home food rations could incentivize school enrolment, delay marriage, increase educational attainment, improve consumption of nutritious foods, and allow targeting of the poorest households.
- Improving coverage of iodized salt should be a priority—only 58% of households have adequately iodized salt.
- Population-weighted, nationally representative nutritional and dietary data on adolescent boys and girls is lacking and should be reported by disaggregated subpopulations to provide better programmatic guidance.

2. Introduction

Adolescence, the period from 10-19 years of age, is a formative time with rapid biological and socioemotional changes as children transition to adulthood[1]. Adolescence is a period when lifelong dietary and other habits are set and therefore presents an opportunity to instill positive dietary habits and encourage cultural change

that prioritizes adequate nutrition in Bangladeshi boys and girls, which can have lasting impacts on future generations[2]. It is also a vulnerable time, particularly for Bangladeshi girls who have increased nutritional requirements due to rapid physical growth and menstruation and are disproportionately impacted by food insecurity because of gendered cultural norms[3]. Addressing nutrition in adolescent boys is also essential, to instill the value of equitable rights for girls and women and the special needs of pregnant women and children, and because they also experience a high burden of malnutrition.

Bangladeshi girls often drop out of school to get married, causing early pregnancies in which adverse birth outcomes are far more likely for mother and child[1,3]. Education plays an important role in informing adolescents about available health and family planning services, delaying marriage, improving awareness of healthy dietary and lifestyle choices, and providing greater employment and economic opportunities[4,5]. Platforms to encourage school enrollment and delay marriage and pregnancy are needed. This document highlights the national and regional trends over time in adolescent nutritional status, dietary intake, early marriage, and school enrollment, and outlines which subpopulations are most vulnerable.

3. Nutritional status

3.1. Anthropometry

Anthropometric indicators have been successfully used to assess malnutrition in children under five and adults, since they are correlated with adverse outcomes[6], 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[7]. Overweight and obesity are a risk factor for diet-related noncommunicable diseases such as diabetes and cardiovascular disease[8]. 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[9].

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 S1). However, stunting remains high at over a quarter of the adolescent girl population.

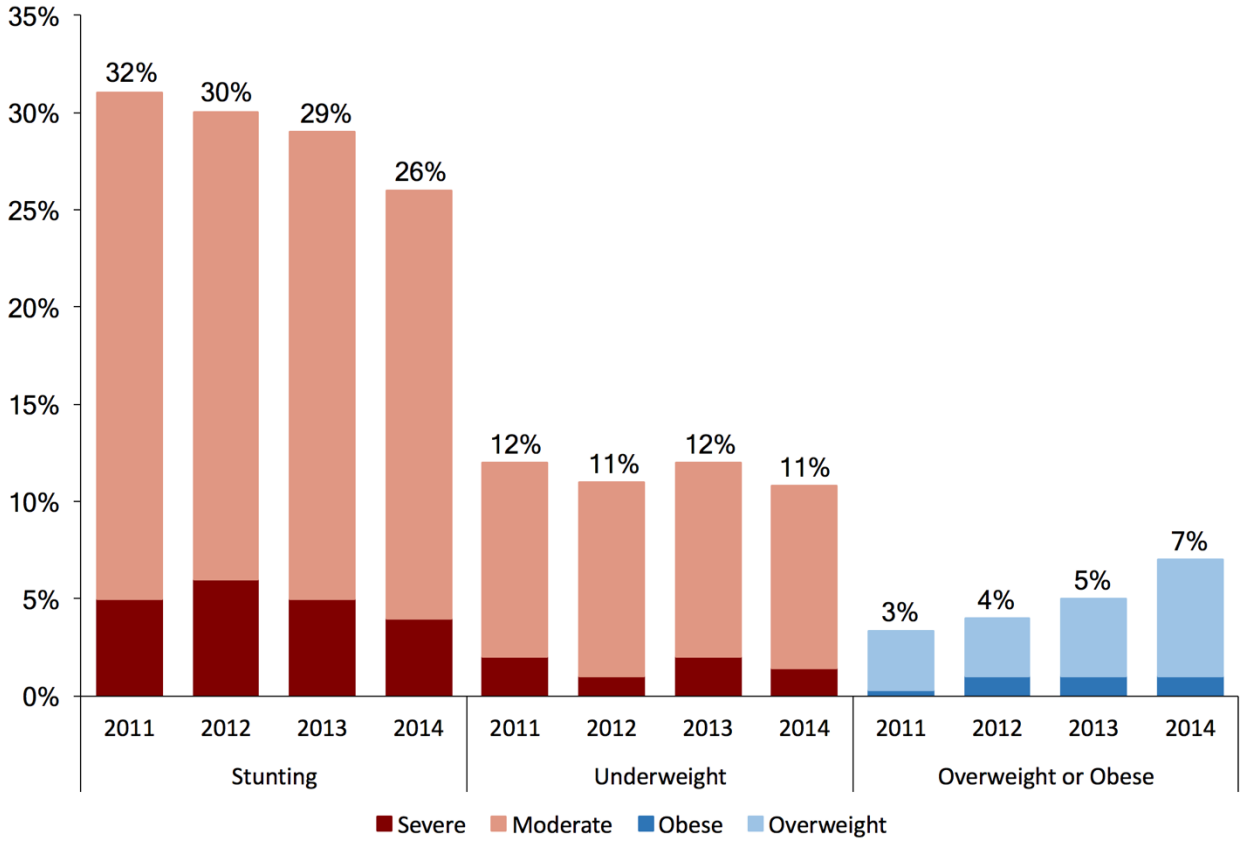

Figure 1. Anthropometry in adolescent girls (10-18 years) by year in Bangladesh. Severe stunting is defined as a height-for-age < -3 SD and moderate stunting as < -2 SD but □ -3 SD; severe underweight as a BMI-for-age < -3 SD and moderate underweight as < -2 SD but □ -3 SD; obesity as a BMI-for-age > +2 SD; and overweight as > +1 SD but ⩽ +2 SD from the WHO 2007 growth reference for children 5-19 years. Sources: State of food security and nutrition in Bangladesh 2011-201410–13.

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%)[14]. 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 (Figure S2). 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 (Figure 3). The greatest reduction occurred in Dhaka (13% to 9%) and Khulna (18% to 14%). No change in underweight

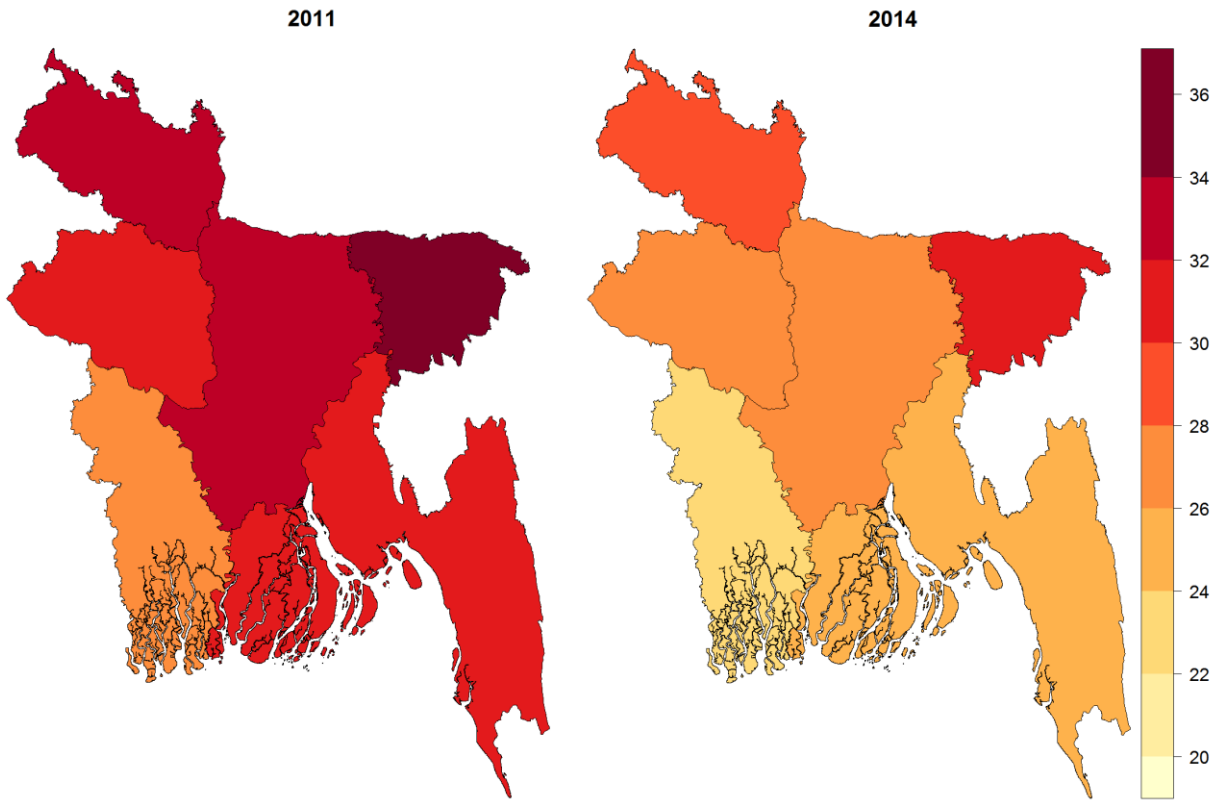

Figure 2. Prevalence of stunting in adolescent girls (10-18 years) by year and division in Bangladesh. Stunting is defined as a height-for-age < -2 SD from the WHO 2007 growth reference for children 5-19 years. Sources: State of food security and nutrition in Bangladesh 2011 and 201410,13.

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. 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 S3). 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 prevalences 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 (Figure S4).

Overweight and obesity in adolescents have been increasing globally primarily due to decreased physical activity and poor-quality diets, and Bangladesh is no exception[15]. While the

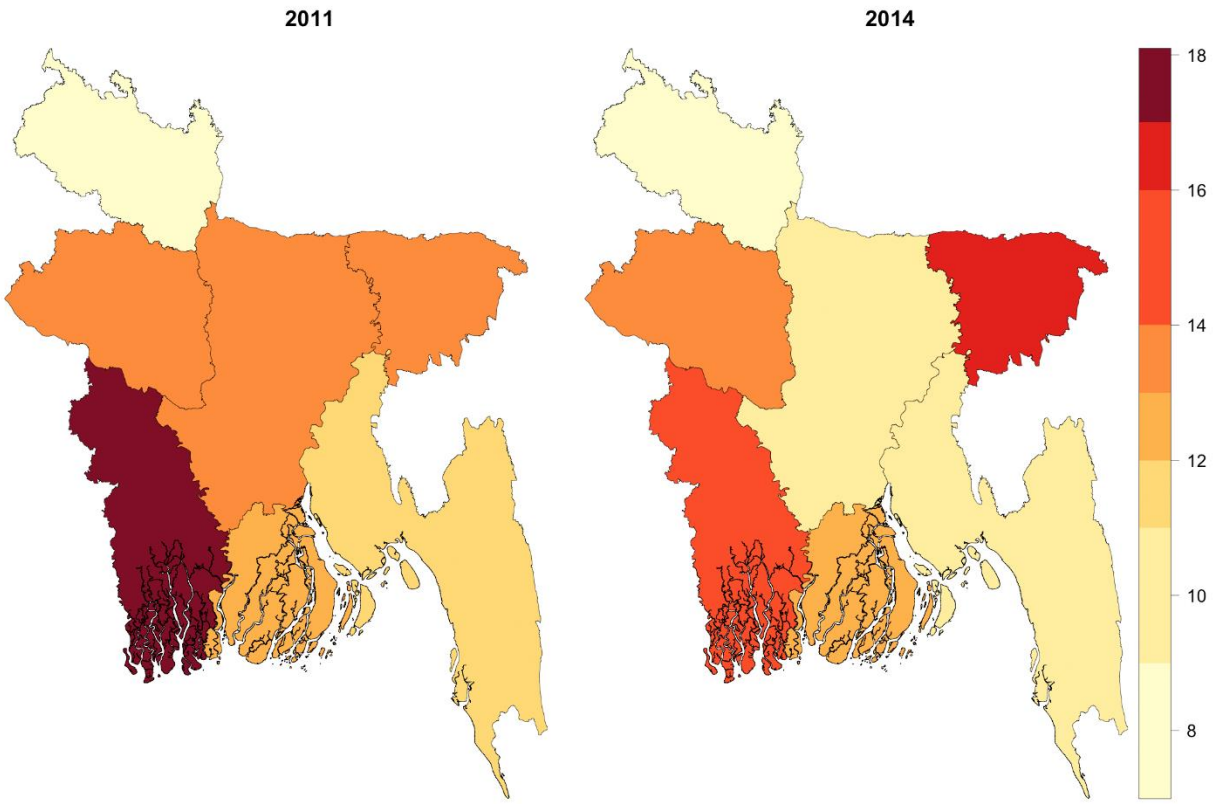

Figure 3. Prevalence of underweight in adolescent girls (10-18 years) by year and division in Bangladesh. Underweight is defined as a BMI-for-age < -2 SD from the WHO 2007 growth reference for children 5-19 years. Sources: State of food security and nutrition in Bangladesh 2011 and 201410,13.

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 S5).

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 subnational data on adolescent overweight/obesity using recommended WHO cutoffs for adolescents has not been reported from any survey.

3.2. 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[17]. Iodine deficiency impairs brain development and cognition and can cause goiter—enlargement of the thyroid gland[17]. Zinc deficiency results in many nonspecific consequences, including poor growth and increased infections[18]. 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

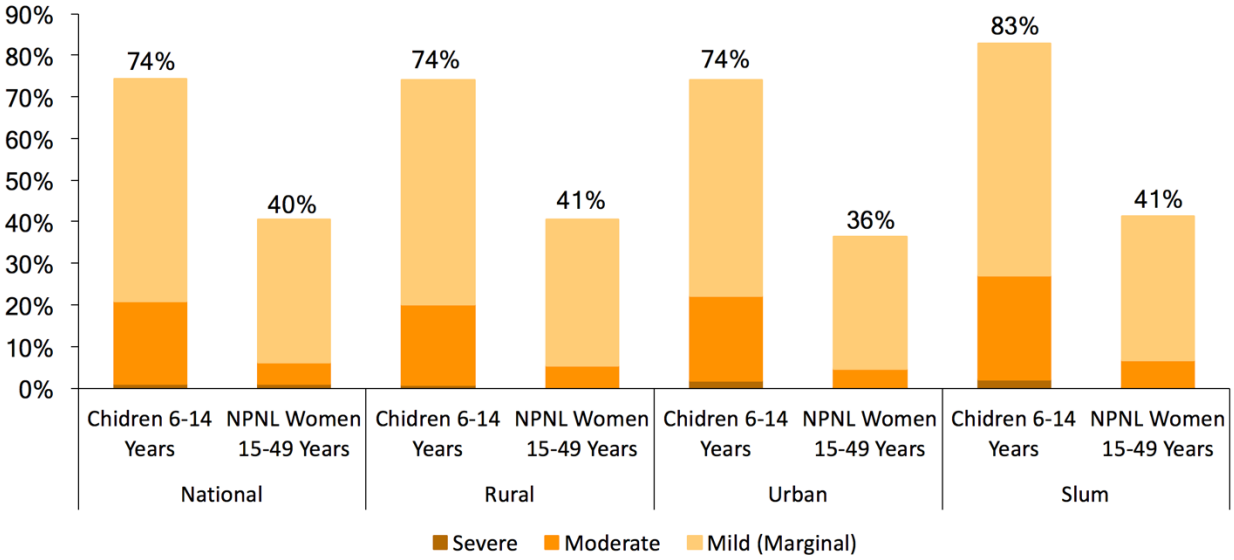

Figure 4. Prevalence of vitamin A deficiency by cohort and locality in Bangladesh in 2011-2012. Severe deficiency is defined as a serum retinol concentration < 0.35 μ mol/L; moderate deficiency as ⩾ 0.35 μ mol/L but < 0.7 μ mol/L; and mild (or marginal) deficiency as ⩾ 0.7 μ mol/L but < 1.05 μ mol/L. NPNL stands for non-pregnant non-lactating. Source: National Micronutrients Status Survey 2011-201216.

increased requirements due to muscle mass accumulation[19]. 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 [14,20,21].

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 group[16]. 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 μmol/L), deficiency nationally was 74% in children 6-14 years and 40% in NPNL women 15-49 years (Figure 4). When using a cutoff of moderately deficient (serum retinol concentration < 0.7 μmol/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[14], 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 (Figure 5)[16]. 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

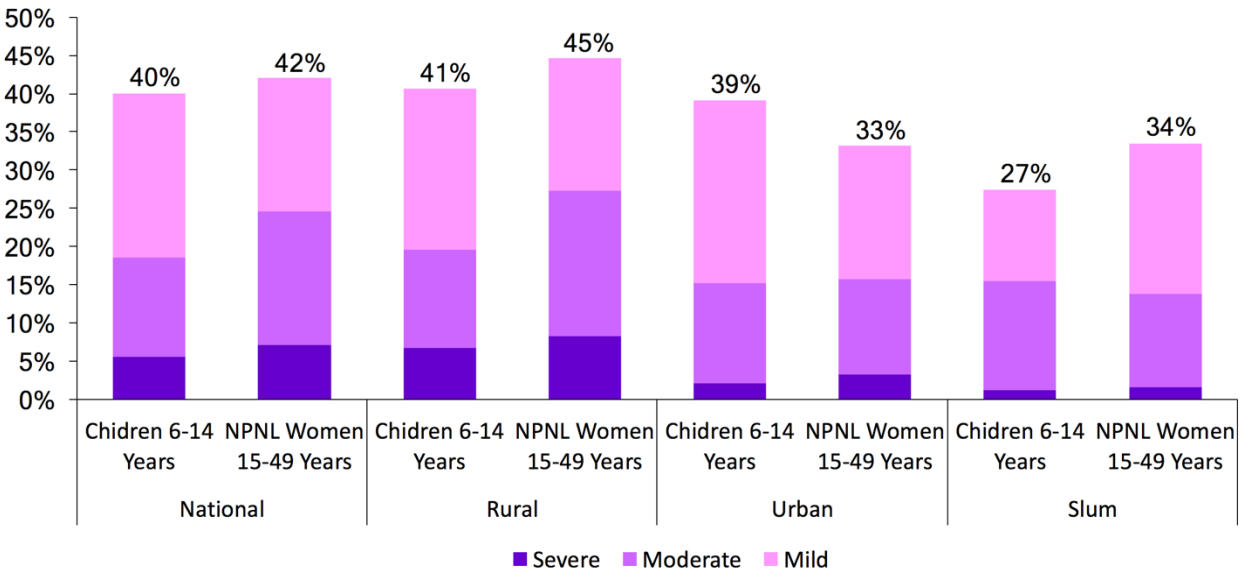

Figure 5. Prevalence of iodine deficiency by cohort and locality in Bangladesh in 2011-2012. Severe deficiency is defined as a urinary iodine concentration (UIC) < 20 µg/L; moderate deficiency as ⩾ 20 µg/L but < 50 µmol/L; and mild as ⩾ 50 µg/L but < 100 µmol/L. NPNL stands for non-pregnant non-lactating. Source: National micronutrients status survey 2011-201216.

children with reduced cognition[22].

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 µmol/L)[16]. 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 marginal 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%).

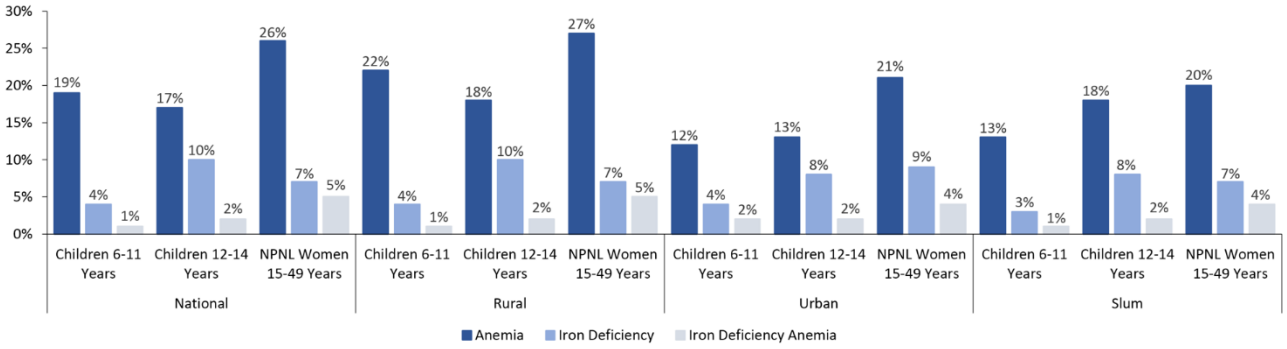

Figure 6. Prevalence of anaemia, iron deficiency, and iron deficiency anaemia by cohort and locality in Bangladesh in 2011-2012. Anaemia is defined as a hemoglobin level < 12.0 g/dL in non-pregnant non-lactating (NPNL) women and children 12-14 years, and < 11.5 g/dL in children 6-11 years. Iron deficiency 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. Source: National micronutrients status survey 2011-201216

4. Key determinants of malnutrition in adolescent girls

4.1. 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[10–13] 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[23].

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[13]. The largest variation in dietary diversity scores occurred between higher and lower wealth quintiles (Figure 7). 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[13]. However, the majority of the burden of food insecurity falls on adult women[13].

Urban adolescent girls and women had more diverse diets than rural adolescent girls and women—mean DDS of 4.8 versus 4.4[13]. 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 (Figure S7).

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[14]. National-level household consumption and expenditure surveys (HIES) and Food

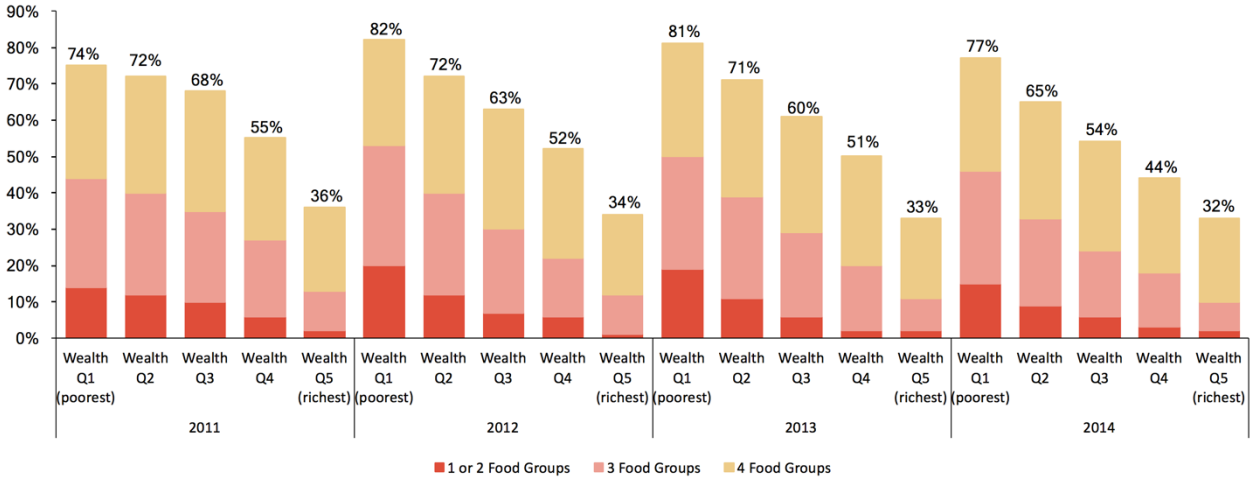

Figure 7. Prevalence of inadequate dietary diversity (< 5 food groups out of 9) in women and adolescent girls (10-49 years) by wealth quintile and year in Bangladesh. Sources: State of food security and nutrition in Bangladesh 2011-201410–13.

and Agricultural Organization Food Balance Sheets (FBS) (http://www.fao.org/faostat/) provide insight into particular food groups that are available for consumption. 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 adolescents[14]). 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 [20,21].

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

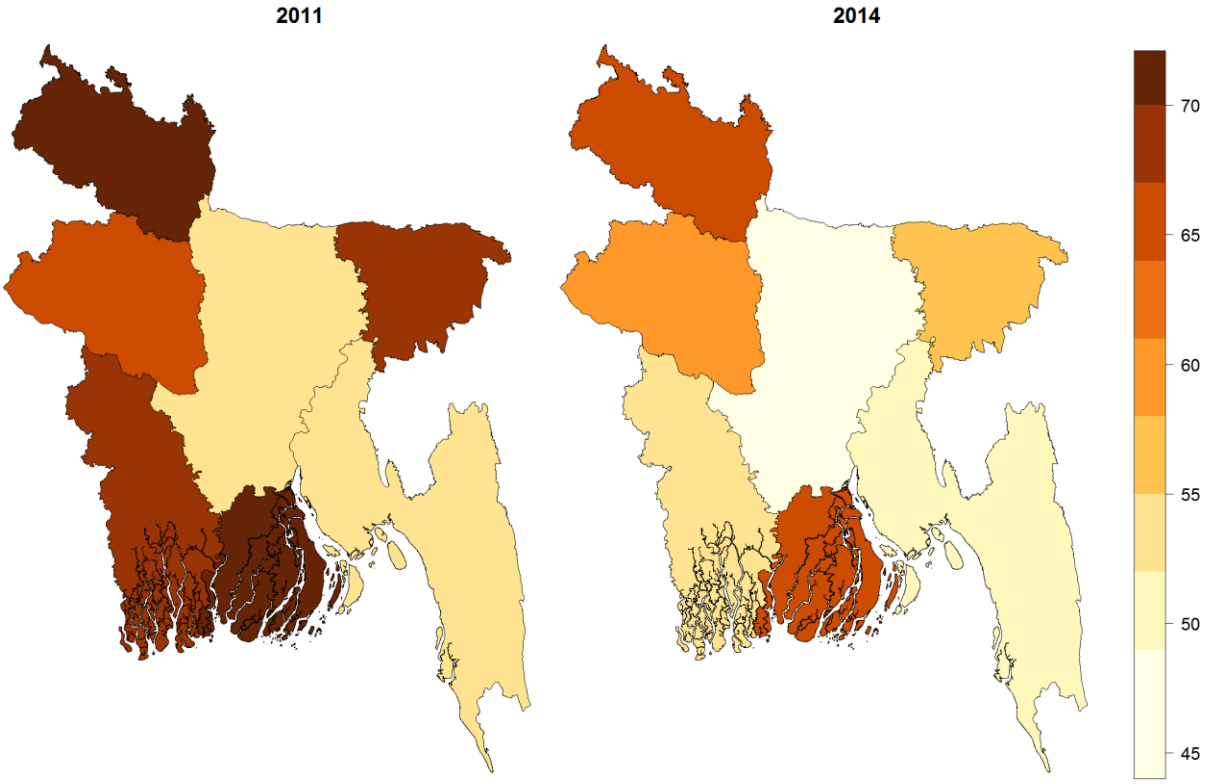

Figure 8. Prevalence of inadequate dietary diversity (< 5 food groups out of 9) in women and adolescent girls (10-49 years) by year and division in Bangladesh. Sources: State of food security and nutrition in Bangladesh 2011 and 201410,13.

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. 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[24]. 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[14].

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[25]. 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.

4.2. Early marriage

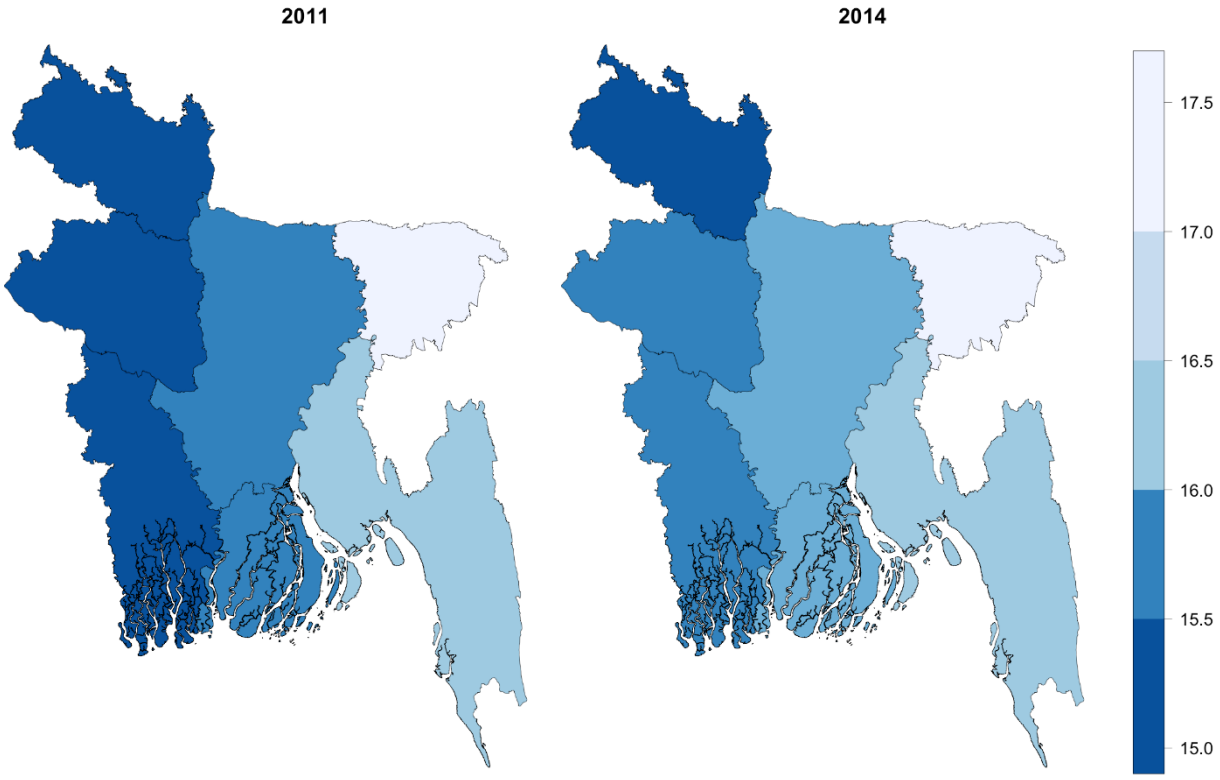

Figure 9. Median age at first marriage among women 20-49 years by year and division in Bangladesh. Age at first marriage is defined as the age at which the respondent began living with her first spouse/partner. Source: Bangladesh Demographic and Health Survey 201426,3.

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[27]. 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 twenties[3]. 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[3]. In 2014, 59% of ever-married women 20-24 years were married by the 18 years of age[3]. 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].

4.3. School enrolment

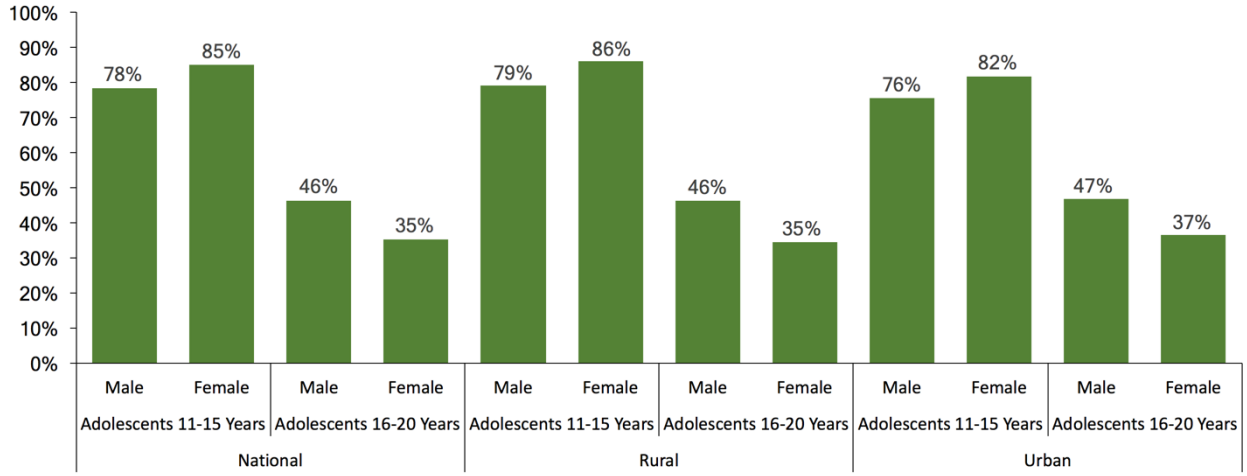

Figure 10. Prevalence of adolescents 11-20 years attending school in 2014 in Bangladesh. Source: Bangladesh Demographic and Health Survey 20143.

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[27]. 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[28]. Incentivizing continued school enrollment can be used as a strategy to delay marriage, empower women, improve nutrition, and increase economic potential[27,29].

Nationally in Bangladesh, younger adolescents have much higher school attendance (82%) than older adolescents (40%) (Figure 10). 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 sexes[3]. 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[3]. There are not large differences in enrollment by locality. Regional variation in secondary school enrollment of adolescents 11-17 years is considerable (Figure 11). 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%)[3]

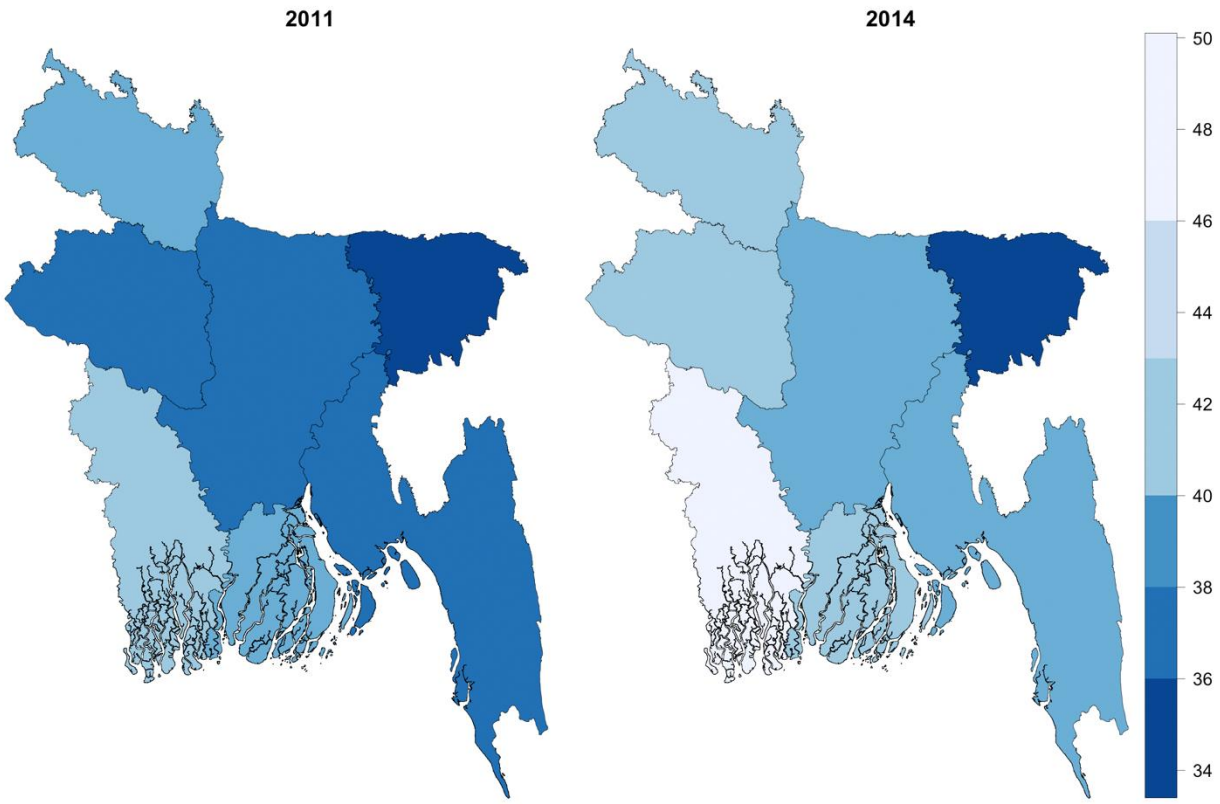

Figure 11. Percentage of secondary-school-age adolescents 11-17 years attending secondary school in 2011 and 2014 in Bangladesh. Source: Bangladesh Demographic and Health Survey 2011 and 20143,30.

Conclusion

A nutrition transition from undernutrition to overweight is occurring in Bangladeshi adolescents, but undernutrition remains a large concern, particularly stunting and micronutrient deficiencies. Diet quality of adolescents is very poor, and they would benefit from increased intakes of micronutrient-dense and fiber-rich whole foods, especially ASFs. Early marriage is declining but still common and secondary school enrolment is low.

The prevalence and determinants of malnutrition indicators for adolescents often vary considerably by subpopulation. This presents opportunities to intervene along the pathway to poor nutrition outcomes in adolescents as well as challenges in understanding the complexity of interactions between these and other factors. While each indicator varies by subpopulation, in general, targeting by wealth and/or geography is particularly important, since the most nutritionally vulnerable subpopulations are poorer and often live in particular areas. Secondary school feeding programs along with conditional cash transfers or take-home rations are an ideal way to reach in-school adolescents and have potential for multiple benefits. Further disaggregation of available data on adolescents is needed to provide more detailed insight into the complex nutritional issues of adolescents in Bangladesh. This could be done by secondary analysis of raw data where available. However, collection of nationally representative data on adolescents, including boys, is essential to better guide interventions and monitor progress.

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6. Appendix

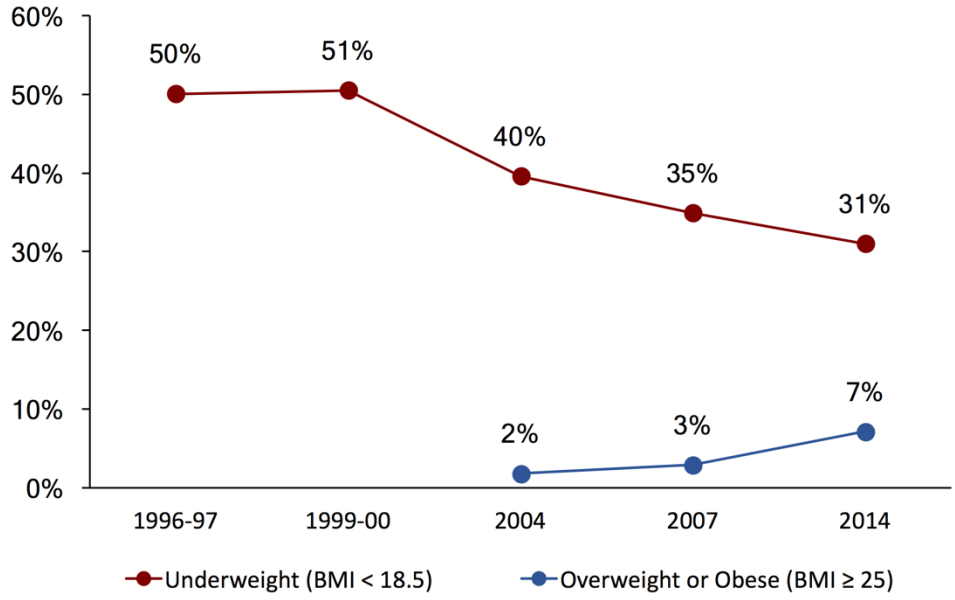

Figure S1. Trends in underweight and overweight in girls 15-19 years by adult Body Mass Index (BMI) cutoffs. Note: Adult BMI cutoffs are fixed and not ideal for adolescents since they are still physically developing. Data from 2011 was excluded since the sample size of girls 15-19 years was only 102. Source: Bangladesh Demographic and Health Surveys 1996-97, 1999-00, 2004, 2007, and 2014[1–5].

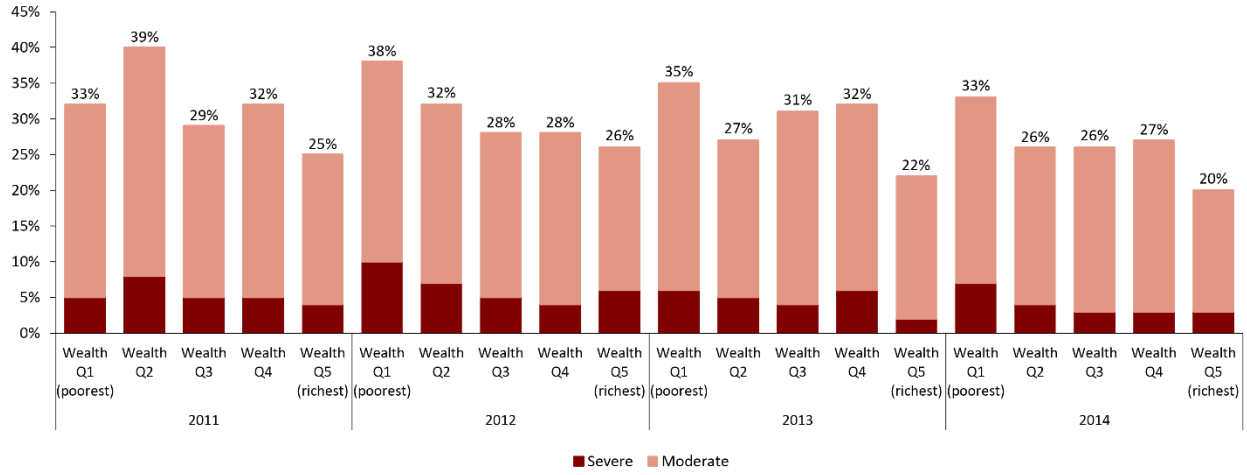

Figure S2. Prevalence of stunting in adolescent girls (10-18 years) by wealth quintile and year in Bangladesh. Severe stunting is defined as a height-for-age < -3 SD and moderate stunting as < -2 SD but ≥ -3 SD from the WHO 2007 growth reference for children 5-19. Sources: State of food security and nutrition in Bangladesh 2011 and 2014[6–9].

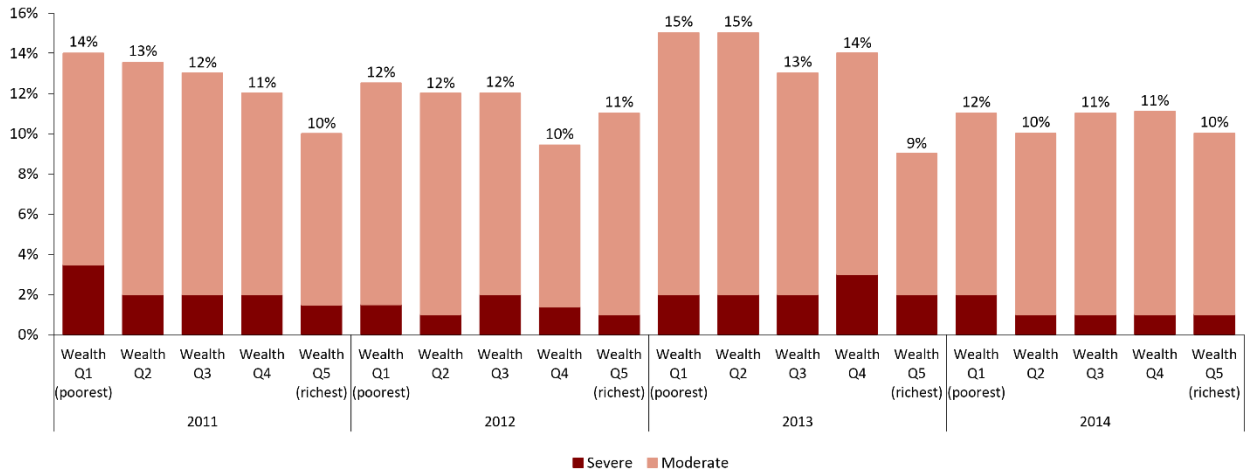

Figure S3. Prevalence of underweight in adolescent girls (10-18 years) by wealth quintile and year in Bangladesh. Severe underweight is defined as a BMI-for-age < -3 SD and moderate underweight as < -2 SD but ≥ -3 SD from the WHO 2007 growth reference for children 5-19. Sources: State of food security and nutrition in Bangladesh 2011 and 2014[6–9].

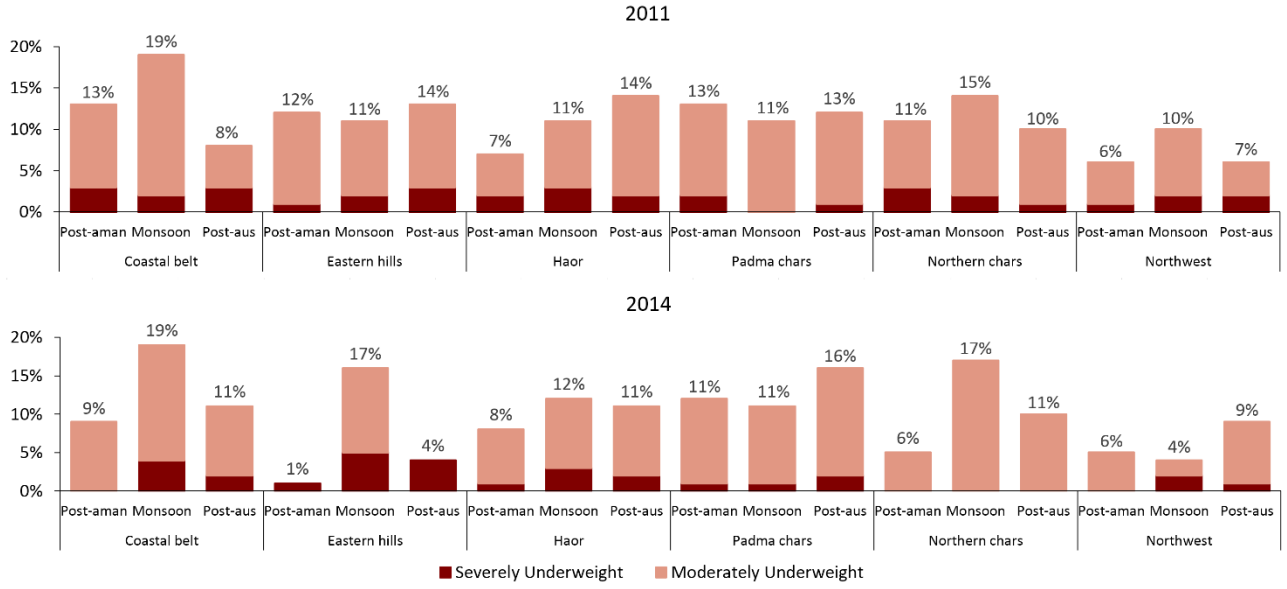

Figure S4. Seasonal trends in underweight in adolescent girls (10-18 years) by surveillance zone and year in Bangladesh. Severe underweight is defined as a BMI-for-age < -3 SD and moderate underweight as < -2 SD but ≥ -3 SD from the WHO 2007 growth reference for children 5-19. Sources: State of food security and nutrition in Bangladesh 2011 and 2014[6,9].

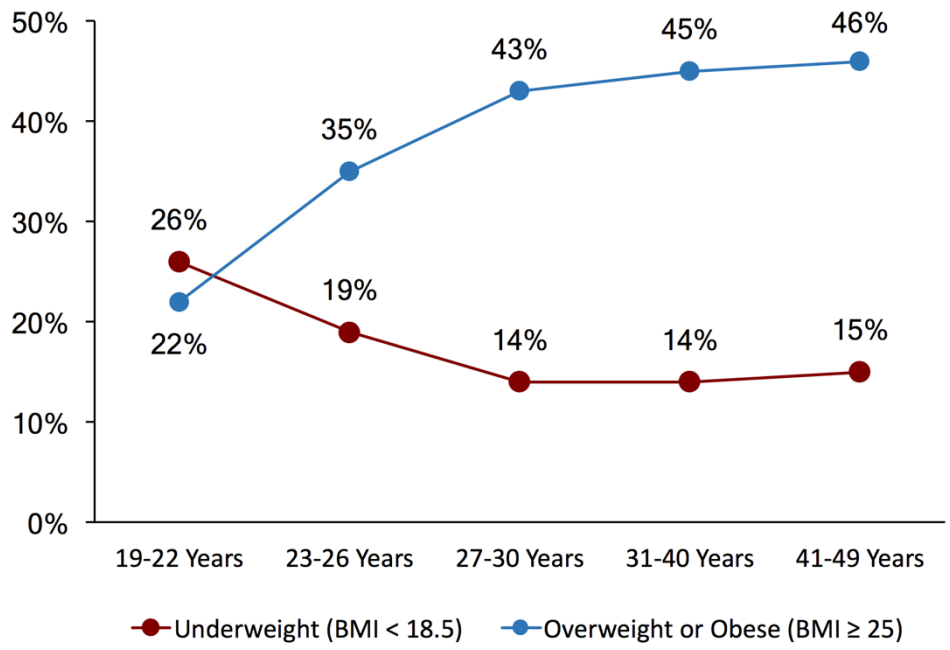

Figure S5. Prevalence of underweight and overweight in women by age group. Source: State of food security and nutrition in Bangladesh 2014[9].

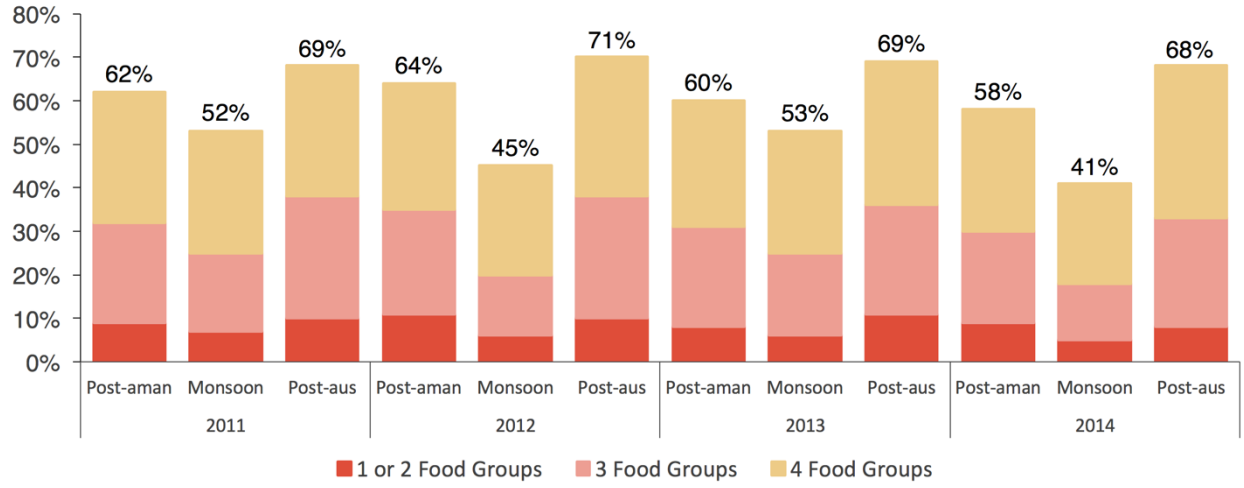

Figure S6. Prevalence of inadequate dietary diversity (< 5 food groups out of 9) in women and adolescent girls (10-49 years) by season and year in Bangladesh. Sources: State of food security and nutrition in Bangladesh 2011-2014[6–9].

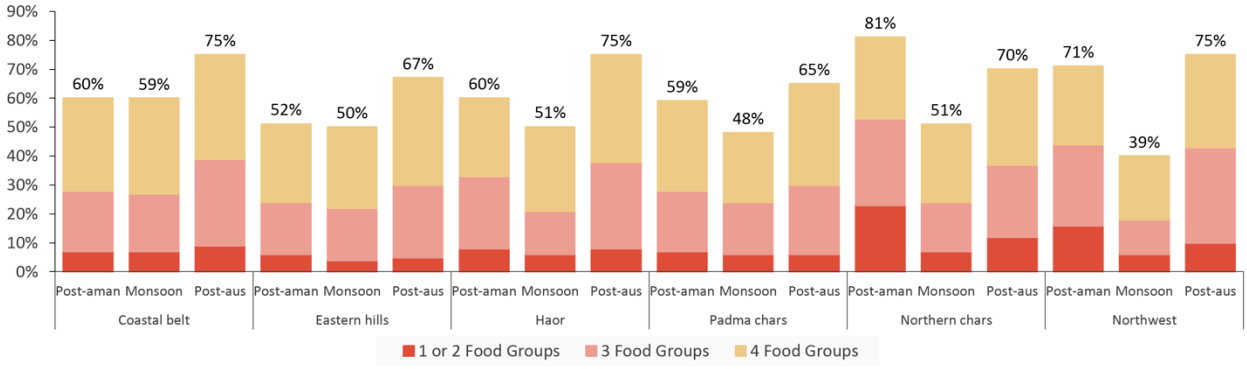

Figure S7. Prevalence of inadequate dietary diversity (< 5 food groups out of 9) in women and adolescent girls (10-49 years) by season and zone in Bangladesh in 2014. Source: State of food security and nutrition in Bangladesh 2014[9].

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