

Assessing Inadequate Dietary Diversity among Bangladeshi Adolescent Girls using COM-B Model: A Review

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Abstract

Inadequate dietary diversity of adolescent girls has long been a problem in Bangladesh which contributed to the high prevalence of undernourishment among adolescent girls. Regardless of the socio-economic condition, the majority of the adolescent girls' diet belongs to least diverse groups compared to other members of the households. Moreover, there is a lack of evidence on the determinants of this inadequate diversity. This review aims to identify these determinants using COM-B (capability, opportunity, motivation, and behavior) model. Eight databases and other sources were searched, and after removing irrelevant literature, 18 articles and reports were included to identify and categorize determinants in three components (capability, opportunity, and motivation) of COM-B model. The evidence revealed that the most important determinants of adolescent girls' inadequate dietary diversity are: food insecurity and market availability of varieties of foods (determine the physical opportunity and capacity of girl and their households); lack of knowledge and awareness (the main driver of psychological capacity and motivations to have diverse diet); and pro-male socio-cultural and gender norms (limit girl's social opportunity and reflectively motivate household members to curb girl's accessibility to varieties of nutritious foods). Most of the determinants interact with each other to make complex nexus, making it difficult even for adolescent girls from wealthy and educated households to meet their nutritional demands by availing varieties of foods. Especially, socio-cultural and gender norms interfere with each determinant, making the adolescent girl's more vulnerable to inadequacy. Comprehensive multi-component programs and interventions are imperative, which not only remove the external factors related to the physical opportunity of having diverse foods but also abolish the attitude-behaviour gap by creating the conducive socio-cultural environment for adolescent girls.

Keywords: Adolescent girls, Bangladesh, Dietary diversity, COM-B model

Introduction

It has not been long that Bangladesh expanded its focus to the health of the adolescent population (aged between 10 and 19 years), especially adolescent girls who constitute about 12% of the total population^{1,2}. Although adolescence is marked by the second highest growth velocity after the first year of life³ many Bangladeshi adolescent girls not only fail to achieve the optimal musculoskeletal growth and development also miss the 'window of opportunity, to retrieve the growth compromised in earlier life. This situation is saliently reflected in national statistics-nationally, about 27% of adolescent girls are stunted, and 15% are thin for their age in 2015⁴.

To avert such growth flattening, it is important that adolescent girl's diet has adequate energy and essential nutrients required for growth, development, and sexual maturity⁵. Evidence from Bangladesh shows that adolescents having a more diverse diet are nutritionally

better off than their peers with a less diverse diet⁶. Moreover, animal protein intake could prevent stunting among adolescents experiencing early pregnancy⁷. Unfortunately, irrespective of the household's socio-economic status, adolescent girls' diet in Bangladesh is cereal-based, monotonous, and lacks diversity^{8,9}, thus inadequate to supply the essential nutrients they need during this crucial period^{6,8}.

To ensure adequate supply of essential nutrients, especially micronutrients, the Food and Agriculture Organisation of United Nation (FAO) recommend consumption of at least five food groups per day from ten food groups (grain, starchy roots and tubers, and plantain; pulses; nuts and seeds; dairy products; meat, poultry, and fish; eggs; dark green leafy vegetables; other vitamin A rich fruits and vegetables; other vegetables and fruits)¹⁰. According to this recommendation, it is found that 32% and 77% among women and adolescents from the highest and poorest wealth quintile have inadequate dietary diversity,

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respectively¹¹. Acknowledging this alarming situation, the national adolescent strategy set objectives to increase dietary diversity¹. Under strategic direction 3, the national strategy calls for action to improve adequate dietary diversity through school-based and community nutrition programs¹. However, addressing only dietary diversity without considering other factors in the constellation of dietary practices, for instance economic condition, market supply, cultural and gender norms, there is a possibility of not alleviating current situation. This review, therefore, aims to critically analyse and identify determinants of inadequate dietary diversity of adolescent girls in Bangladesh using COM-B (capability, opportunity, motivation, and behavior) model of Michie et al.¹². The output of this review will provide policy makers the answer of ‘what needs to change’ for designing programs or intervention

for improving dietary diversity, a way to ensure adequate nutrition, of adolescent girls in Bangladesh.

Methodology

The literature search on adolescent dietary diversity was carried out in May 2020. Eight databases—Embase, Global Health, Medline, APAPsycArticles full text, APA PsycInfo, Pubmed, Scopus, and CINAHL—were searched using search terms relevant to adolescent girls, dietary diversity, intervention, determinants, and Bangladesh. Additionally, the reference list of the articles was screened as well as google scholar, and grey literature were also explored to find relevant literature (figure 1). As the evidence is scant on Bangladeshi adolescent girls’ dietary diversity and its determinants, an arbitrary benchmark of 1980 was set to find relevant information.

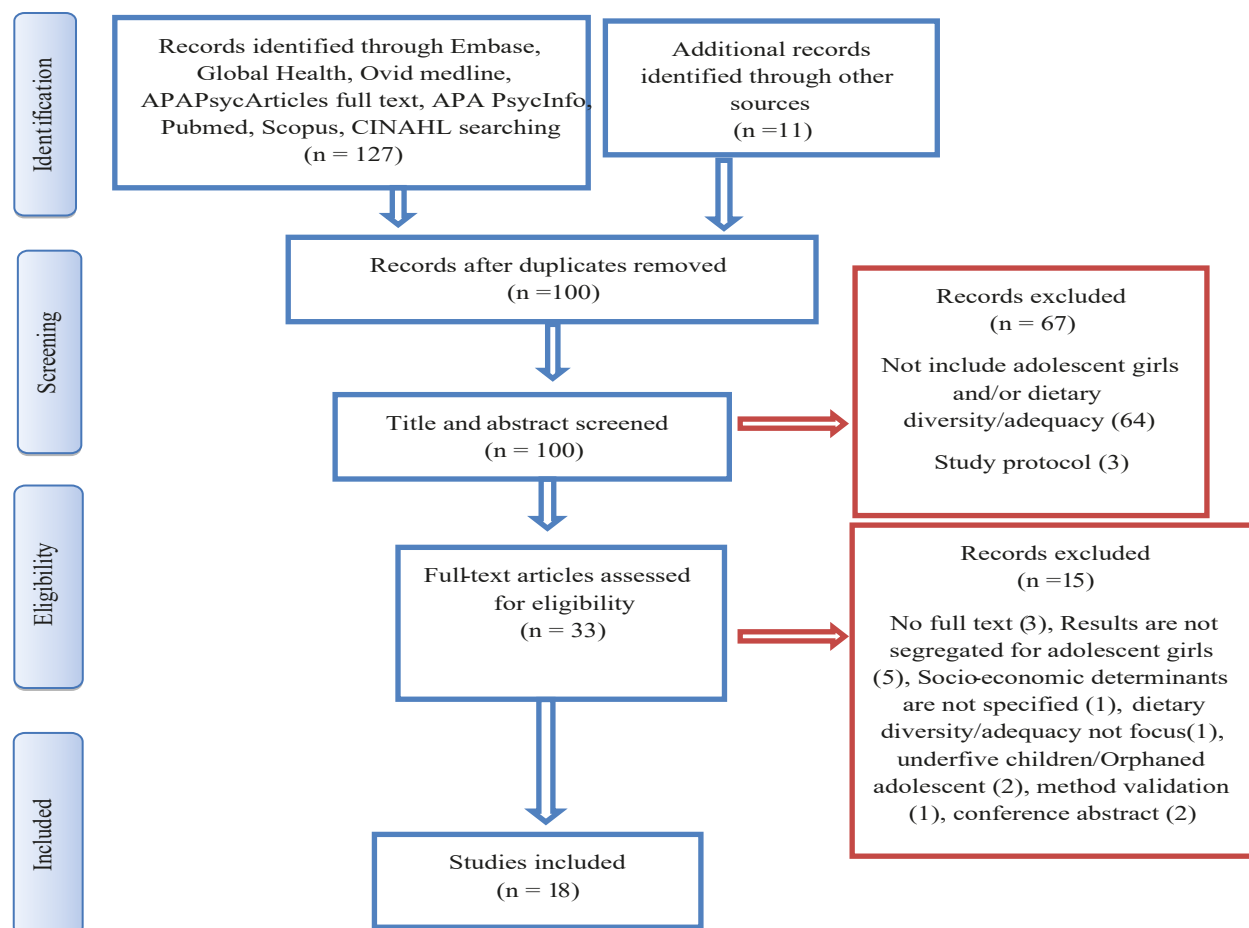


Figure 1. Literature search strategy (adapted PRISMA figure from Moher et al.¹³)

The COM-B model of Michie et al.¹² used to categories the determinants as a comprehensive tool that allows to identify each determinants linked to specific behavioural components—capability, opportunity, and motivation that engender certain practice among individuals or community (figure 2). In this article, that practice is the inadequate dietary diversity of adolescent girls in Bangladesh. Determinants and influencing factors related to adolescent this practice are categorised into each of these components using the following definitions.

1. Capability accounts for “*individual’s psychological and physical capacity to engage in the activity concerned*”^{12(p.4)}. It could be either physical or psychological. Physical capability here is accessing diverse foods while constrained by other intrinsic factors such as limiting resources of the household. Psychological capability is to have necessary knowledge and awareness and to perceive the importance of having diverse foods and the consequences of inadequate ones.
2. Opportunity denotes “*all the factors that lie outside the individual that make the behaviour possible or*

prompt it”^{12(p.4)}. It is further subdivided into physical opportunity and social opportunity. The physical opportunity comprises all environmental factors that determine or influence individual’s behaviour that is adolescent girls’ dietary diversity. On the other hand, social opportunity includes socio-cultural and gender norms and values that hinder or encourage the diversity of adolescent girls.

3. Motivation comprises “*all those brain processes that energise and direct behaviour, not just goals and conscious decision-making*”^{12(p.4)}. Reflective motivation denotes the self-conscious intention (plan) and evaluations (what is desirable or not) whereas the automatic motivation is the desire, impulses, and suppression that arise from associative learning regarding the dietary diversity of adolescent girls.

If any determinant belongs to more than one component, it was included in each of them.

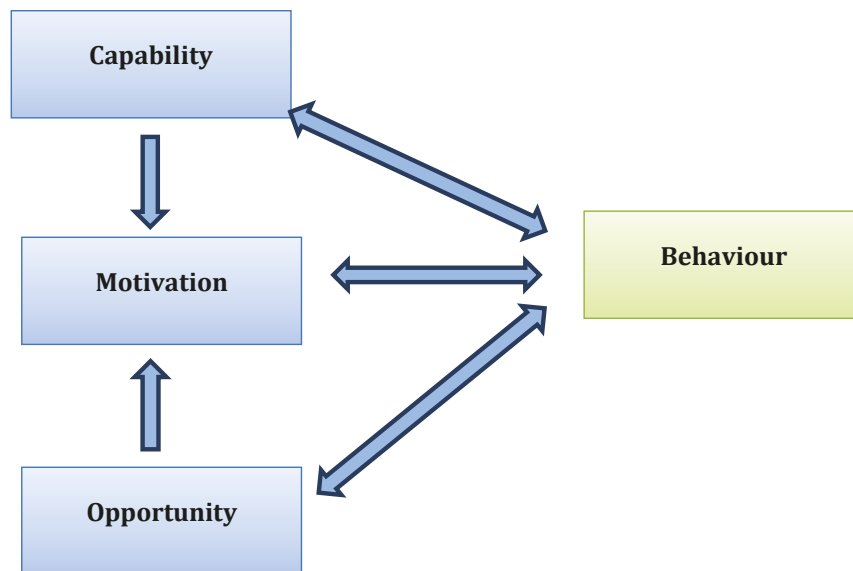


Figure 2. COM-B model¹²

Determinants of inadequate dietary diversity as per COM-B components

The primary parameters, population, and COM-B components discussed in 18 articles and reports reviewed in this paper are summarized in table 01. Interestingly, most of the reviewed literature discussed and focused on the physical capability, that is inability to afford, regarding adequate dietary diversity of the adolescent girls. At the same time, most of the literature had encompasses multiple components of the COM-B model as the primary objectives of these studies were around nutritional status, dietary intake, dietary habits, or knowledge regarding nutrition and diet (table 01). Same article or reports thus often refer to more than one component of the COM-B models in the table 01 and sub-sequent sections.

Table 1. Articles and reports reviewed to identify determinants of inadequate dietary diversity of adolescent girls in Bangladesh.

Article and report	Primary Parameter(s)	Population	COM-B components
Thorne -Lyman et al. 2020 ⁶	Dietary pattern	9 to 15 years adolescent living in rural areas situated in northwest of Bangladesh	Physical and psychological capacity, Physical and social opportunity, and Automatic motivation
Khan and Ahmed, 2005 ⁸	Nutrient intake, dietary pattern, and physical status	14 to 19 years old girls working at readymade garment industries in Dhaka city	Physical opportunity
Leroy et al. 2018 ⁹	Determinants of undernutrition	10 to 20 years old rural adolescent	Physical capability, Physical and social opportunity, and Reflective motivation
Ahmed et al. 1998 ¹⁴	Dietary pattern and nutrient intake	10 to 16 years old urban school girls	Physical and psychological capacity
Alam et al. 2010 ¹⁵	Nutritional status, dietary intake, and nutrition knowledge	13 to 18 years old rural adolescent girls	Physical and psychological capacity and Physical opportunity
Ghosh et al. 2020 ¹⁶	Knowledge, attitude, and practice regarding balance diet	13 to 17 years old school girls from Noakhali district	Physical and psychological capacity
Sraboni and	Women empowerment	Household with agriculture activities	Physical capability, Social

Table 1. (Continued)

Quisumbing, 2018 ¹⁷	(agriculture) and dietary quality			opportunity, and Reflective motivation
Islam et al. 2019 ¹⁸	Dietary preferences and sociocultural factors	Mother of adolescents and adolescent girls and boys		Physical and psychological capacity, Physical opportunity, and Automatic motivation
Blum, 2019 ¹⁹	Eating behavior	15 to 19 years old girls from low-income households		Physical capability, Physical and social opportunity, Reflective and automatic motivation
Saha, 2014 ²⁰	Dietary pattern and anemia status	18 to 19 years old girls working at readymade garment industries in Gazipur		Physical capability, Physical opportunity
Akter et al., 2017 ²¹	Eating behavior and factors influencing eating pattern	10 to 19 years old girls from Dhaka and Jamalpur districts		Physical and psychological capacity, Physical and social opportunity, and Automatic motivation
Lee et al. 2019 ²²	Dietary intake, perception regarding health, healthy food, and anemia, and exposure to nutrition knowledge	14 to 17 years of old school girls from Rangpur district		Psychological capacity, Physical opportunity, Reflective and automatic motivation
Akhter, 2013 ²³	Knowledge on calcium and vitamin D and dietary intake of these two nutrients	16 to 18 years old girls and boys		Psychological capacity
Hossain et al. 2016 ²⁴	Dietary diversity, nutrient intake, food consumption scores, and farming diversity index	Households from household income and expenditure surveys (HIES) conducted in 2000 and 2010		Physical opportunity
Hossain et al. 2010 ²⁵	Consumption pattern and perception and attitude toward changes in consumption pattern	People born before and after 1971		Physical opportunity
Kabir et al. 2010 ²⁶	Dietary pattern, nutritional status including anemia, and knowledge regarding anemia	15 to 19 years old girls from a college located in Dhaka city		Physical opportunity
Islam, 2015 ²⁷	Policies regarding public food distribution	Not applicable		Physical opportunity
Nipun et al. 2017 ²⁸	Prevalence and frequency of fast food consumption and factors for food preference	Students from universities located in Dhaka		Automatic motivation

Capability

Physical capability

Determinants of the physical capability of the adolescent girls are pertaining to the inability of affording varieties of foods due to absolute or relative price of foods (food insecurity) and how they cope with such situation. Other aspects are the skill and stamina of the girls as a dependent on their parents or in-laws house or as a wage-earner to accessing diverse foods when food insecurity is not an issue.

It is well established that household wealth is directly linked to dietary diversity and adolescent girls are no exception^{6,9,14,15}. As household's wealth status increases, there is an increase in consumption of non-staple foods, especially animal foods, which results in increase intake of the micronutrients abundant in these foods^{9,16}. It is reported that adolescent girls from the lower wealth quintile have a less diverse diet and consume less processed foods than their peers from the upper quintile⁶. However, unlike household food diversity and diversity of adolescent boys, it is more related to overall wealth status rather than ownership of land. In rural Bangladesh, Sraboni et al.¹⁷ found that ownership of land positively correlated with increased dietary diversity of adolescent boys, not girls, implying that components of social opportunity such as gender norms may interfere with this determinant of physical capability (section social opportunity).

Adolescent girls from food insecure household, thus, consume more vegetables, which are less costly to afford, than animal foods such as eggs, meat, and milk^{15,18}. Besides, many of these girls' households purchase low-quality deteriorated foods at low price to cope with food insecurity¹⁹. Inadequacy of a variety of foods is more severe for girls living in the urban area. This is because urban household usually owns no land and need to purchase all kind of foods whereas rural girl could avail foods, for instance, vegetables, from homestead production^{18,19}. To include meat items in their meal, destitute urban dwellers purchase leftover

chicken offals, skin, and legs from food shops or market¹⁹.

While the dependent adolescent girl has little control over their dietary diversity, the working adolescent has more grasp on it; they regularly consume fish, fruits, and vegetables²⁰. Albeit, most of their meal lacks egg, meat, and milk²⁰. Such aberration could be rationalised from the fact that these girls are bread-earner with a large family; thus they need to support their family both financially and by compromising their share of food with other members^{8,19,20}. In addition, with incomplete education and working skill, many of these adolescent girls earn little as unskilled workers. In the urban area, much of their earnings spent to pay rent of housing and foods. In contrast, rural area adolescent girls could enjoy more dietary diversity as they might not need to pay for housing, and several plant foods which could be produced or fetched^{8,20,21}.

Regardless of their residency or working status, adolescent girls curtail a variety of foods to only rice, rice and chili, or rice and egg to adjust with the fluctuation of the income, especially those whose family depends on daily wage¹⁹. It is observed that after receiving salary, they could have more food items per day which plummet as the last quarter of the month approaches. When food insecurity strikes hard, they skip meals or to appease hunger take traditional rice-based snacks in stead of breakfast, lunch, or dinner¹⁹. Many of them even could not afford rice-based snacks during long working hours or school schedule due to limited income, consequently they remain hungry until they return home and have whatever is left for them¹⁹⁻²⁰.

Psychological capability

Important determinants of the psychological capacity are lack of knowledge and awareness about dietary diversity and specific nutrient rich foods, not to perceive the consequences of having less varieties of foods, and unable to link the idea of nutritious diverse foods and its connection with good health and nutritional status.

When inquired about knowledge regarding nutrition and nutritious foods, most of the adolescent girls are found to have adequate knowledge; but knowledge about dietary diversity or specific nutrient rich foods is wanting, specifically about quality protein and individual micronutrients^{18,21,22}. Moreover, knowledge about healthy and good foods are often perceived as free of hazardous compounds and microbes and not as nutritious, implying wanting perception about nutritional quality¹⁸. Girls are also oblivious of increased nutritional demand during the adolescent period. However, girls who live in adolescent nutrition intervention areas or indirectly exposed to relevant messages through community health worker and media acquire some knowledge on nutritional need during adolescent period¹⁵. Such nutrition interventions are usually conducted in rural areas. Akter et al.²¹ reported that rural adolescent girls have more grasp on knowledge and awareness about nutritious foods than urban girls, which also reflected in their consumption pattern and dietary diversity.

While lack of knowledge stymies appropriate combination of foods for adolescent girls' diet, willful ignorance also curbs dietary adequacy of girls with nutrition knowledge. Over generation, it has been instilled among female children and adolescents that they are not successor of family, not priority member of a family, and economically not profitable to invest as they are going to leave their parents' house permanently after marriage^{19,21}. As a result, adolescent girls, aware of their nutritional needs, let forgo the opportunity to access diverse diet and assume it is normal behavior or practice which creates attitude-behaviour gap¹⁹. These issues are more pertaining to social opportunity and reflective motivation and thus expounded in sections social opportunity and reflective motivation.

Parent's knowledge and perception are also important determinants of adolescent girl's knowledge and of the diversity of their diet^{6,21}. Parent's education is positively correlated with adolescent girl's dietary diversity⁶. Interestingly, a separate analysis of father

and mother education revealed that it is the mother education that results in the inclusion of varieties of foods in their daughter's plate^{14,16}. Mother education and knowledge, in addition, increase girl's psychological capacity regarding nutrition and health¹⁶. However, many mothers do not have knowledge about low cost nutrient rich vegetables and leafy vegetables or how to utilise those to diversify their diet¹⁸.

The most common source from where adolescent girls acquire knowledge pertaining to nutritious foods and dietary diversity is academic sources that is textbooks and teachers^{21,22}. This is because Bangladesh National Curriculum and Textbook Board (NCTB) includes this information in student's curriculum at school as well as at college (only for science students)²³. Other important sources are parents, community health workers, and media espoused by non-government organizations' (NGOs) adolescent nutrition intervention^{15,22,23}.

Opportunity

Physical opportunity

Physical opportunity of adolescent girls to include FAO recommended varieties of food determined by several external factors such as household's food availability (agricultural diversity, market availability, and food prices), accessibility (time and situation to eat), and loopholes in education and health systems' approaches (food aid and school feeding programme).

The monotony of adolescent girls diet is largely result of poor agricultural diversity; the principal crop of Bangladesh is rice^{6,24,25}. Along with rice other frequently harvested high yielding foods are potato and wheat. Production of vegetables and fruits are highly seasonal^{24,25}. Consequently, two third of the food basket of adolescent girls predominantly contain rice or other cereals, only become more diverse during pick season (summer and winter), and plummet significantly during agricultural off-period^{6,15,19,26}. Moreover, seasonality of agricultural production and dearth of cold-storage for non-staple foods influences food

prices—vegetable and fruit prices at nadir during season and hike during off-pick periods. Rise in rice price however has a conducive effect, it shifts food expenditure toward non-staple foods²⁴.

The consumption of non-staple food partly depends on homestead production in rural area. For instance, vegetables, leafy vegetables, fruits, and eggs could be produced and/or gathered (leafy vegetables)¹⁹. Other animal foods need to buy, most commonly purchased and consumed animal food both in rural and urban is fish^{19,21,26}. Meat and milk are expensive to buy^{19,21}, but protein intake of girls in household with cow is more than household without cow¹⁷. Urban girls do not have such opportunity. Their household need to buy all kind of foods^{8,20}, thus poor urban household buy animal products which are thrown away as a substitute of meat¹⁹.

Lack of conducive food environment in school premises, work places, and surroundings places has derogative effects on dietary adequacy and diversity. School girls mentioned to avoid bringing foods from home as there is no place to eat in school, thus they opted to skip lunch or purchase junk snacks from shops in vicinity of school premises^{18,22}. Also the long hours of school schedule from early morning with little break in between mentioned by the girls as a cause of skipping meals and then having whatever left after returning home^{19,21}. Similar difficulties are mentioned by working adolescent: long working hour, busy work schedule, and insufficient breaks²⁰. To soothe hunger adolescent girls at school and at workplace regularly eat snacks (carbohydrate rich, fried, sweet or savoury foods) and soft drinks which are readily available in surrounding area^{6,18,21,22}. Though adolescent girls, shop keepers, and vendors acknowledge these foods as anything except nutritious and healthy, there is little scope to avoid purchasing or selling these foods. Supply and availability of these pervasively advertised foods

are controlled by business interest of food manufacturer, vendors, and shop keepers²¹.

Gaps in intersectoral approach of education, food, and health sectors further avert dietary diversity of adolescent girls. To ensure girl's education, staple foods (rice or wheat) are provided to girls attending school; to eradicate hunger, few necessary foods (rice, wheat, pulses, and oils) are sold at low cost to food insecure households; and to ensure micronutrient supply, fortified biscuits are provided to students in school^{9,24,27}. These approaches are not conducive to promote dietary diversity nor sufficient to address inadequate dietary diversity of adolescent girls out-of-school.

Social opportunity

The patriarchal society of Bangladesh harbors cultural values and gender norms that synergistically create biased intrahousehold food allocation favoring males over females. Adolescent boys get preference as a primal descendant and future bread earner in both food secure and insecure households, limiting the dietary diversity of adolescent girls.

Adolescent girls irrespective of their residence area (rural and urban) and marital status, get the limited number of food items and a smaller portion of the same food than their male peers^{6,9,19}. Not only that: when compared with both adolescent boys and adult women, the adolescent girl found to have inadequate energy and iron (found predominantly in foods of animal origin) intake, implying consumption of less nutritious foods and/or food items than the required one. This discrepancy exists in even wealthier households; as households become more affluent, boys enjoy more advantages, widen the gender gap in nutrient intake^{6,9}. In destitute families, girls skip meals or eat traditional rice snacks (if any) so that the other members, especially males, could have enough food¹⁹.

The condition of married adolescent girls is graver. Daughter-in-law has lower social status compared to unmarried adolescent girls^{17,19}. At the same time, they must maintain social and cultural expectations. It is found that even the adolescent girl has knowledge about their nutritional need and appropriate foods, they opted to eat less (both in terms of amount and items) to express her respect and affection to her husband and other members of the in-law house; creating an attitude-behaviour gap^{17,19}.

In such pro-male milieu, these norms are so inveterately instilled that women education and empowerment could not erase the malpractice of biased intrahousehold food allocation—adolescent boys with educated and empowered mother have more diverse diet in rural Bangladesh^{9,17}. This is largely attributed to the pro-male labour market and property right^{17,19} (section 3.3.1). Women's access to market is also limited, it is the male household head who decides what foods to purchase which curtail women's purchasing opportunity and in turn their daughter's dietary diversity^{19,21}.

Motivation

Reflective motivation

While it is established that food insecurity, financial hardship, lack of knowledge and awareness, and insufficient women empowerment are primal factors of inadequate dietary diversity of girls in Bangladesh, several recent studies found that improvement of these issues could not ensure dietary adequacy of adolescent girls. The factors that are reported to interfere and explain such aberration are: pro-male labour market, pro-male property right, and culture of detachment of married girls with their parents. These three factors motivate mother and family members to allocate unproportionate foods to the adolescent girls.

Leroy and his colleagues⁹ (2018) found that as households in rural Bangladesh stride to a wealthier stratum the gap between adolescent girls and boys in

terms of consumption widen. Similarly, women education and empowerment could not narrow down this gap^{17,22}. The findings are quite telling—women empowerment in agriculture increases household dietary diversity but could not ensure equal intrahousehold food distribution. As boys are future wage-earner (pro-male labour market), future household head (pro-male property right), and will be the decision maker of the family, empowered women invest more on adolescent boys to ensure care and support during old-age. Thus, they opted to deprive their daughters and provide nutritious and prestigious foods to the adolescent boys¹⁷. Moreover, as girls leave their parents' house permanently after marriage and it is the boys who will inherit the property, it is economically profitable to invest on boys than girls^{17,19}. Parents who opined that adolescent girls also need adequate foods, rationalise it with the fact that the adolescent girls are future bride rather than with the nutritional demand during adolescent period²¹. Such perception is found backed by the dowry culture—to find suitable future husband for girl and win the bargain over dowry¹⁹.

Automatic motivation

Adolescent girls habitual intake and self-preference significantly contributed to their dietary diversity. Most of the adolescent girls reported skipping breakfast, and one of the reasons is not having an appetite. In addition, they mentioned that they do not want to eat leftover food from dinner as breakfast. Many girls also skip dinner if they had lunch late in the afternoon¹⁹. Regarding preference for certain foods, almost all studies found that girls do not like milk, in the case of other foods, there is wide variation in preference^{18,19,21}.

Ready-to-eat snacks which are available nearby the school and home are very popular among adolescent girls^{6,18,21}. These ready-to-eat snacks are mostly fried, salty, rice or pulse based, sweet savory item, and soft drinks; that is nutritionally lacking and not diverse. Though adolescent girls acknowledge the health and

safety issue of these snacks, the choice of snacks largely influenced by taste, appeal, other peer's preference, and availability^{21,28}. Girls mentioned having snacks together in school as a way of socialising and thus many prefer ready-to-eat snacks over homemade foods or snacks¹⁸.

Adolescent girls are reported to restrict certain foods for themselves. Two reasons are identified: menstruation and body image^{18,21}. Many girls mentioned that they avoid animal food, especially fish during menstruation due to loss of appetite and to avert bad smell of body^{19, 21-22}. For maintaining preferred body image, they voluntarily limit amount or totally avoid certain items such as carbohydrate rich food or oily foods¹⁸.

Addressing the determinants to improve dietary diversity of adolescent girls

Findings from the reviewed articles and reports indicate that determinants in each component are interlinked with determinants under other components creating a complex constellation which make it challenging to address a single factor of adequate dietary diversity of adolescent girls without considering several others. It could be plausible to incorporate at least two components of COM-B model at a time to have combined positive impact on girls' dietary diversity.

Increasing social opportunity and modulating reflecting motivation for changing social milieu

While it is imperative to design intervention or programme focusing on each group of determinants, it is also essential to incorporate intervening components for other groups to each programme for expected outcomes and impact. For example, homestead food production (HFP) interventions have been found to improve household food security, increase consumption of micronutrient rich foods among household members, and empower women²⁹. However, this is not beneficial to adolescent girls to the same extent in terms of

increasing physical opportunity and capacity unless include gender-transforming components to change socio-cultural and gender norms (*social opportunity and reflective motivation*)^{17, 30}. A similar issue is true for crop-diversification interventions such as nutrition-sensitive agriculture aimed to increase the market availability of nutrition rich varieties of foods³⁰. Many low- and middle-income countries, for example Tanzania, are benefited from nutrition-sensitive agriculture to the diversity diet of women³¹. When these programs coupled with nutrition education and behaviour change communication (*psychological capacity and motivation*), effectiveness is found to be greater³⁰. In Bangladesh, to benefit adolescent girls through such programs, issues related to the pro-male market and property rights (*social opportunity and reflective motivation*) need to address so that household members could take appropriate nutrition-related decisions pertaining to girl's dietary diversity^{17, 32}.

Increasing physical opportunity and capability for accessing diverse foods

Adolescent girls will benefit passively if market availability and household accessibility to varieties of foods could be ensured, that is, increasing food supply (especially non-staple foods) throughout all seasons and averting price volatility (*physical opportunity and capability*). Apart from seasonality, the lack of a cold-storage facility for fruits and vegetables contributes to market availability and the prices during the off-pick season. Thus, during season household might afford fruits and vegetables to eat, but not during the off-pick season. The girls living in these households become more vulnerable to inadequate dietary diversity during the agricultural off-pick season. If market availability of these fruit and vegetables could be ensured at affordable price by establishing the cold-storage facility and the governing body to control food price volatility^{33,34}, there would be the improvement in dietary diversity of adolescent girls'. Moreover, food policies to distribute foods to poor households at low cost need to shift from selling fixed

non-perishable items (rice, wheat, pulses, and oils) to include vegetables and fruits to broaden the scope of adolescent girls' households food accessibility.

Increasing physical capacity, psychological capacity, and motivation for dietary diversity

After availing required varieties of foods, it is imperative to ensure that adolescent girls, household members, and community people has appropriate knowledge and skill to include these foods to adolescent girls' diet (*physical capacity, psychological capacity, and motivation*). Many mothers do not aware of the nutritional potential of readily available low-cost fruits and vegetables and there are girls who have diverse food preferences—limiting consumption nutritionally rich foods. These barriers could be removed by educating, persuading, and training them to utilise already available food items. As most of the adolescent girls reported to acquire relevant knowledge from academic sources, school could serve as an excellent intervening point. School gardening program have found to increase the knowledge and skill of the students, whereas school-based multi-component programs targeting students, parents, and community are reported to increase not only knowledge but also varieties consumed by girls³⁵⁻³⁷.

Limiting physical opportunity and psychological capacity around unhealthy foods

Another important issue is to curtail physical opportunity to accessing unhealthy junk snacks as adolescent girls are more inclined to consume these foods due to physical opportunity and self-preference. It could be done by increasing the price and regulating the supply of these foods. A report of Work for a Better Bangladesh (WBB) Trust³⁸ delineate the extend of powerful marketing of junk foods and its effect on the knowledge of children compared to healthy foods from an observational study and the findings are quite alarming. It is recommended in the report to follow World Health Organization (WHO)³⁹ guidelines on marketing of foods and non-alcoholic beverages to

children to control pervasive and unregulated advertising of these junk snacks³⁸. Recently, India has taken similar initiatives to control marketing of unhealthy junk foods at school canteen⁴⁰. Other countries, such as United Kingdom imposed high taxes on junk snacks to keep those out of the affordability of adolescents⁴¹. While such policies will limit the accessibility of unhealthy snacks, complementary initiatives are essential to appease hunger and bring diversity to girls' diet during school schedule. Many western countries have school lunch programs that ensure intake of varieties of healthy foods, whereas in Bangladesh school feeding programs are limited to staple food aid (for female students) and fortified biscuits (all students). School feeding programs could replace fortified biscuits with hot-cooked meals, which has evinced significantly increasing dietary diversity as well as nutritional knowledge (*physical opportunity and psychological capacity*)^{42,43}.

Improving social opportunity and reflective motivation

Changing socio-cultural and gender norms in favor of adolescent girls' adequate dietary practices requires the involvement of multiple sectors and long-term efforts as those values and norms are deeply embedded (*social opportunity and reflective motivation*). Women's education and empowerment are not enough to change the situation rather gender-transforming programs and empowering adolescent girls and women to overcome discriminating social norms are imperative^{17,44}. An international NGO, BRAC (formally known as Rural Advancement Committee) has made significant changes regarding few negative social issues around adolescent girls through adolescent programme⁴⁵. This programme has multiple components including empowerment and nutrition to address disparate situation of the adolescent girls. However, more efforts are necessary to change the perception and practices induced by pro-male labour market and property to household members and mothers, which are more difficult to change.

Conclusion

Critical analysis using COM-B model identified three important groups of determinants: (a) food insecurity and market availability (*physical opportunity and physical capability*), (b) lack of knowledge and awareness (*psychological capacity and motivation*), and (c) socio-cultural and gender norms (*social opportunity and reflective motivation*). Multisectoral approach with intergrated gender-transforming components are key to create conducive environment for adolescent girls to have adequate dietary diversity. Especially, cultural and social norms around adolescent girl's diet and inability to afford diverse diet need immediate attention in policy formulation and during designing nutrition programs for adolescent girls.

Strengths and Limitations

The strength of this review is that it identified several underlying factors that could and possibly jeopardise

programs that target to improve adolescent girl's nutrition and dietary diversity in Bangladesh. These determinants interact with intervening points of the programme, such as nutrition education or dissemination of nutritional knowledge, to limit the outcomes or sustainability of the programme effect. To the author's knowledge, this the first time COM-B model is used to identify and categorise these determinants. The limitation of this review is imposed by scant evidence on determinants of inadequate dietary diversity of adolescent girls in Bangladesh. None of the literature contains 'determinants of dietary diversity of adolescent girls' as primary objective, which might weaken the validity of the findings of this review.

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References

1. Ministry of Health and Family Welfare Bangladesh (MOHFW Bangladesh). National Strategy for Adolescent Health 2017-2030. Dhaka, Bangladesh: MCH Services Unit, Directorate General of Family Planning; 2016.
2. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ICF International. Bangladesh Demographic and Health Survey 2014. Dhaka, Bangladesh, and Rockville, Maryland, USA: NIPORT, Mitra and Associates, and ICF International; 2016.
3. Christian P, Smith ER. Adolescent undernutrition: global burden, physiology, and nutritional risks. *Annals of Nutrition and Metabolism*. 2018;72(4):316-28.
4. Sanin KI, Haque A, Khanam M, Ara G, Ahmed T. Underweight and stunting among Bangladeshi female adolescents: Findings of a nationally representative survey. *American Journal of Tropical Medicine and Hygiene*. 2019;101 (5 Supplement):434.
5. Soliman A, De Sanctis V, Elalaily R. Nutrition and pubertal development. *Indian J Endocrinol Metab*. 2014;18(Suppl 1):S39-S47.
6. Thorne-Lyman AL, Shaikh S, Mehra S, Wu LSF, Ali H, Alland K, et al. Dietary patterns of >30,000 adolescents 9-15 years of age in rural Bangladesh. *Annals of the New York Academy of Sciences*. 2020;1468(1):3-15.
7. Mridha MK, Matias SL, Arnold CD, Dewey KG. Factors associated with nutritional status and dietary practices of Bangladeshi adolescents in early pregnancy. *Annals of the New York Academy of Sciences*. 2018;1416(1):66-76.

8. Khan MR, Ahmed F. Physical status, nutrient intake and dietary pattern of adolescent female factory workers in urban Bangladesh. *Asia Pacific Journal of Clinical Nutrition*. 2005;14(1):19-26.
9. Leroy JL, Ruel M, Sununtasuk C, Ahmed A. Understanding the determinants of adolescent nutrition in Bangladesh. *Annals of the New York Academy of Sciences*. 2018;1416(1):18-30.
10. Food and Agriculture Organisation (FAO) and FHI 360. *Minimum Dietary Diversity for Women: A Guide for Measurement*. Rome: FAO; 2016.
11. Global Alliance for Improved Nutrition (GAIN). *Adolescent nutrition in Bangladesh*. Dhaka, Bangladesh: GAIN; 2018.
12. Michie S, Atkins L, West R. The behaviour change wheel: a guide to designing interventions. *Needed: physician leaders*. 2014;26:146.
13. Moher D, Liberati A, Tetzlaff J, Altman DG, The PG. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLOS Medicine*. 2009;6(7):e1000097.
14. Ahmed F, Zareen M, Khan MR, Banu CP, Haq MN, Jackson AA. Dietary pattern, nutrient intake and growth of adolescent school girls in urban Bangladesh. *Public health nutrition*. 1998;1(2):83-92.
15. Alam N, Roy SK, Ahmed T, Ahmed AM. Nutritional status, dietary intake, and relevant knowledge of adolescent girls in rural Bangladesh. *Journal of health, population, and nutrition*. 2010;28(1):86-94.
16. Ghosh S, Kabir MR, Alam MR, Chowdhury AI, Al Mamun MA. Balanced diet related knowledge, attitude and practices (KAP) among adolescent school girls in Noakhali district, Bangladesh: a cross sectional study. *International journal of adolescent medicine and health*. 2020;04.
17. Sraboni E, Quisumbing A. Women's empowerment in agriculture and dietary quality across the life course: Evidence from Bangladesh. *Food Policy*. 2018;81:21-36.
18. Islam MR, Trenholm J, Pervin J, Ekstrom E-C, Rahman SM. Sociocultural Influences on Dietary Practices and Physical Activity Behaviors of Rural Adolescents—A Qualitative Exploration. *Nutrients*. 2019;11(12):2916.
19. Blum LS, Khan R, Sultana M, Soltana N, Siddiqua Y, Khondker R, et al. Using a gender lens to understand eating behaviours of adolescent females living in low-income households in Bangladesh. *Maternal & Child Nutrition*. 2019;15(4).
20. Saha S, Farzana S, Begum A. Dietary pattern and anaemia among female adolescent garment workers in Bangladesh. *Acta Medica International*. 2014;1(2):103-6.
21. Akter F, Mistry SK, Mukta U, Rahman M. *Exploration of Eating Behaviours among Adolescent Girls from Two Selected Districts of Bangladesh*. Dhaka, Bangladesh: BRAC; 2017.
22. Lee J, Pelto GH, Habicht JP, Bhuiyan MMI, Jalal CS. Identifying nutrition and health-relevant behaviors, beliefs, and values of school-going adolescent girls in rural Bangladesh: Context for interventions. *Current Developments in Nutrition*. 2019;3(5).
23. Akhter DT, Uddin R, Yasmin D, Nijhu RS. Calcium and Vitamin D Related Knowledge in 16-18 Years Old Adolescents: Does Living in Urban or Rural Areas Matter? *Journal of Nutrition and Food Sciences*. 2013;3(6):1.

24. Hossain M, Jimi NA, Islam M. Does agriculture promote diet diversity? A Bangladesh study. Dhaka, Bangladesh: BRAC; 2016.
25. Hossain MM. Changing consumption patterns in rural Bangladesh. *International Journal of Consumer Studies*. 2010;34(3):349-56.
26. Kabir Y, Shahjalal HM, Saleh F, Obaid W. Dietary pattern, nutritional status, anaemia and anaemia-related knowledge in urban adolescent college girls of Bangladesh. *Journal of the Pakistan Medical Association*. 2010;60(8):633-8.
27. Islam MM. The politics of the public food distribution system in Bangladesh: regime survival or promoting food security? *Journal of Asian and African Studies*. 2015;50(6):702-15.
28. Nipun T, Debnath D, Sium-Ul M, Miah H, Kabir A, Hossain MK. Bangladeshi Student's Standpoint on Junk Food Consumption and Social Behaviour. *IOSR Journal of Pharmacy and Biological Sciences*. 2017;12:68-75.
29. Iannotti L, Cunningham K, Ruel M. Improving diet quality and micronutrient nutrition: homestead food production in Bangladesh: Intl Food Policy Research Institute; 2009.
30. Ruel MT, Quisumbing AR, Balagamwala M. Nutrition-sensitive agriculture: What have we learned so far? *Global Food Security*. 2018;17:128-53.
31. Frison EA, Smith IF, Johns T, Cherfas J, Eyzaguirre PB. Agricultural biodiversity, nutrition, and health: making a difference to hunger and nutrition in the developing world. *Food Nutr Bull*. 2006;27(2):167-79. doi: 10.1177/156482650602700208.
32. Yosef S, Jones AD, Chakraborty B, Gillespie S. Agriculture and nutrition in Bangladesh: Mapping evidence to pathways. *Food and nutrition Bulletin*. 2015;36(4):387-404.
33. Islam M, Kabir M, Sattar M, Kabir M. Management practices in some selected cold storage in Bangladesh. *Journal of innovative strategy*. 2008;2(3):48-54.
34. Raihan S. The Political economy of food price policy in Bangladesh. *Food Price Policy in an Era of Market Instability*. 2013:231.
35. Kapadia-Kundu N, Storey D, Safi B, Trivedi G, Tupe R, Narayana G. Seeds of prevention: The impact on health behaviors of young adolescent girls in Uttar Pradesh, India, a cluster randomized control trial. *Social Science & Medicine*. 2014;120:169-79.
36. Singhal N, Misra A, Shah P, Gulati S. Effects of controlled school-based multi-component model of nutrition and lifestyle interventions on behavior modification, anthropometry and metabolic risk profile of urban Asian Indian adolescents in North India. *European Journal of Clinical Nutrition*. 2010;64(4):364-73.
37. Tamiru D, Argaw A, Gerbaba M, Nigussie A, Ayana G, Belachew T. Improving dietary diversity of school adolescents through school based nutrition education and home gardening in Jimma Zone: Quasi-experimental design. *Eating Behaviors*. 2016;23:180-6.
38. Work for a Better Bangladesh (WBB) Trust. Advertising of Unhealthy Foods in Bangladesh: The Current Situation and Suggestions for Action. Dhaka: Work for a Better Bangladesh (WBB) Trust; (no date).

39. World Health Organization (WHO). Set of recommendations on the marketing of foods and non-alcoholic beverages to children. 2010.
40. India Today. FSSAI bans junk food, advertisement in school canteens. India Today. 2019 7 November 2019.
41. Dubois P, Griffith R, O'Connell M. The Effects of Banning Advertising in Junk Food Markets. *The Review of Economic Studies*. 2017;85(1):396-436.
42. Afroze R, Basak Tukun A. Evaluation of School Nutrition Programme of BRAC and BanchteShekha: Learning from a Pilot Project. Dhaka, Bangladesh: BRAC; 2014.
43. Shamim AA, Mayna J, Jahan I, Ridwan SM, Khondker R. Weekly menu for midday meal in Bangladeshi schools: Caregivers' choices. *Field Exchange*. 2018(58):27.
44. Levy JK, Darmstadt GL, Ashby C, Quandt M, Halsey E, Nagar A, et al. Characteristics of successful programmes targeting gender inequality and restrictive gender norms for the health and wellbeing of children, adolescents, and young adults: a systematic review. *The Lancet Global Health*. 2020;8(2):e225-e36.
45. Nawaz F, Ahmed S. The Effectiveness of Adolescent Development Program of Bangladesh Rural Advancement Committee (BRAC) in Strengthening Awareness Regarding Social Issues among Rural Adolescent Girls in Bangladesh: An Empirical Study. *Studies on Home and Community Science*. 2009;3(1):7-11.