

Prevalence and Factors associated with Nutritional Status and Individual Level Double Burden of Malnutrition among School Going Adolescents of Bangladesh: Findings from Global School-based Student Health Survey-2014

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Abstract- Co-occurrence of two forms of malnutrition (undernutrition and over nutrition) is increasing within communities, families and even individuals through the rapid nutrition and food system transition. This study focused on investigating the extent of malnutrition including individual level double burden and associated factors influencing malnutrition amid school going adolescents of Bangladesh using 2014 Bangladesh GSHS survey data. HAZ and BAZ were used to examine the extent of malnutrition (stunting, thinness and overweight) among school going adolescents of Bangladesh. We also examined individual level double burden (coexistence of stunting and overweight at individual level). Logistic regression model was used to explore the determinants of malnutrition. Mean age, weight and height of study participants were 14.16±0.98 years, 46.09±8.29 kg and 156.97±9.1 cm respectively. 14.2% (95%CI:14.17,14.24) were stunted, 11.1% (95%CI:11.08,11.13) were thin or underweight and 10.5% (95%CI:10.42,10.59) were overweight. Individual level double burden was identified among 2.6% (95%CI:2.59-2.62) adolescents. Prevalence of stunting was significantly lower among younger adolescents, while other 2 forms of malnutrition among older adolescents was significantly higher. Odds of being stunted was 22.7% (OR=1.227, p<0.001) higher for boys, while being female gender was identified as a risk factors for other two measures. Household food insecurity was significantly correlated with stunting (OR=1.408, p<0.001) and thinness (OR=1.031, p<0.001). Furthermore, Regular soft drink consumption (OR=1.12, p<0.001) was related to overweight and regular fast-food consumption was significantly associated with thinness (OR=1.23, p<0.001). The study emphasized concurrency of undernutrition and over nutrition among school going adolescents that is a new experience for us. No single intervention can mitigate double burden of malnutrition. Major societal shifts are essential regarding nutrition and public health.

Keywords—Adolescent, Duoble burden, Malnutrition, Bangladesh

I.INTRODUCTION

Adolescence is one of the most critical but neglected age groups in most cases. Adolescence is defined as segment of life from 10 to 19 years [1]. High requirements for pubertal growth, eating pattern, risk taking behavior as well as susceptibility to socio cultural and socio-economic environmental condition make them nutritionally vulnerable [2]–[4]. Adolescence is the period when physical, cognitive, social, emotional and ethical transformation occurs rapidly[5]. Early adolescence(10-14years) is characterized by pubertal, sexual and brain development whereas late adolescence(15-19 years) is dominated by continuing psychological development and brain maturation[6], [7]. Adolescence is the second window of opportunity for growth[8] : up to 50% of adult weight and 20% adult height is achieved during this period [9]. Moreover, 40-60% peak bone mass is also attained during adolescent period[10].

Adolescents constitute about 16% of world's population, mostly (around 85%) live in developing countries [11]. In Bangladesh, adolescents constitute around 22% of total population[12], [13]. Adolescents of Low and middle - income countries (LMCs) are more likely to be undernourished (chronic undernutrition or stunting and thinness) although in recent years an upward trend is noticed for over nutrition (overweight or obesity)[14]. This is referred to as double burden of malnutrition which can occur at individual, population and country level. Individual level double burden of malnutrition (IDBM) expresses the manifestation of two forms of malnutrition (under nutrition and over nutrition) in a single person simultaneously[15].

There are couple of studies examining malnutrition among adolescents girls of Bangladesh[16], [17] but they focus primarily on adolescents girls only. However, to our knowledge this becomes the maiden study that figure out IDBM among school going adolescents of Bangladesh.

The study focused on estimating different forms of malnutrition among school going Bangladeshi adolescents using GSHS-2014 dataset. Predictors of different forms of malnutrition was also assessed through suitable statistical analyses.

This research paper is organized as following order. Section I contains the introduction and background of the research work. Section II shows the relevant works that have been done on the research topic. The procedure of the research and essential statistical analysis has been described in section III. Section IV contains the findings which have been discussed in section V. The research is concluded in section VI. Section VII shows the contribution each author and references are listed in section VIII.

II. RELATED WORK

Trends from 1975 to 2016 in Body Mass Index, overweight, obesity and underweight amid adolescents in 200 countries explored that mean BMI, overweight and obesity in most of the regions are increasing [18]. Despite this rise, global prevalence of thinness or underweight among children and adolescents are 8.4 % for girls and 12.4% in boys[19]. Moreover, 20% girls aged 5-19 years and nearly one third boys are underweight in South Asia[18]. In Bangladesh, both underweight and stunting prevalence is quite high but in compliance with global trend, overweight prevalence is also increasing[19], [20]. From literature, no study is available regarding individual level double burden of malnutrition among school going adolescents of Bangladesh.

III. METHODOLOGY

Study design and participants

Relevant data for the current study were extracted from Bangladesh GSHS-2014. GSHS is conducted among school going adolescents primarily aged 13-17 years. World Health Organization and Centers for Disease Control and Prevention (CDC) in alliance with UNICEF, UNESCO and UNAIDS developed GSHS [21].

Standardized scientific sample selection procedure was used to ensure representativeness of data for all students in class 7 to 10 in Bangladesh [22]. Two stage cluster sampling method was applied where schools were selected at first stage with probability proportion to enrollment size. At second stage, after selecting the classes randomly all students of selected classes were included in the study.

Students self-reported their response to each question. A total of 2989 students participated in the study and overall response rate was 91%.

Anthropometric measurement and nutritional status

Two widely used measures for malnutrition, height-for-age z score (HAZ) and BMI-for-age z score (BAZ) were used to examine the nutritional status of Bangladeshi school going adolescents. The value of HAZ and BAZ were calculated using WHO-2006 growth standard[23] and following WHO recommendations, any adolescent with HAZ either above +6 or below -6 and BAZ above +5 or below -5 were excluded[24]. Stunting was defined as HAZ less than -2SD below the median of the height-for-age WHO reference population. Thinness was defined as BAZ less than -2SD below the WHO growth standard median and overweight as BAZ greater than +1SD of the WHO growth standard median[25], [26].

Data analysis

WHO Anthro plus software (version 3.3.2) was used to calculate z scores. The anthropometric data were converted to z score and then transformed to SPSS (version 25) for further analysis. Prevalence of different forms of malnutrition was calculated with 95% confidence interval. Chi square test was performed to estimate the association between selected factors and malnutrition. We also fitted bivariate logistic regression model to estimate the role of different variables on nutritional status. Three different logistic regression models were considered for three dependent variables (stunting, thinness and overweight). All analyses were adjusted for sample design. Statistical significance was defined as p value less than 0.05.

IV. RESULT

Nutritional status of school going adolescents of Bangladesh

Mean body weight and height were significantly higher among boys as compared to girls ($p < 0.001$). According to Global School based Students Health Survey-2014, 14.2% school going adolescents were stunted, while only 3.6% were severely stunted table 1. One in every ten adolescents (10.5%) were overweight and almost equal proportion (11.1%) were thin. Moreover, a few of them (1.5%) were obese. Almost one third (29.86%) of adolescents were with at least one form of malnutrition (stunting or thinness or overweight).

Table1: Nutritional status of school going Bangladeshi adolescents

Indicator	Mean z score (SD)	Weighted percentage (95%CI)
Stunting		
Total (HAZ <-2SD)	-0.71	14.2(14.17-10.24)
Moderate (HAZ <-2SD to ≥-3SD)		10.6(10.13-11.08)
Severe (HAZ <-3SD)		3.6(3.52-3.69)
Thinness		
Total (BAZ <-2SD)		11.1(11.08-11.13)

Moderate (HAZ <-2SD to ≥-3SD)	-0.48	8.1(8.02-8.19)
Severe (BAZ <-3SD)		3 (2.92-3.09)
Overweight/obesity		
Overweight (BAZ > +1 SD)	-0.48	10.5 (10.42-10.59)
Obesity (BAZ > +2SD)		1.5 (1.42-1.59)

Abbreviation: CI: confidence interval

Proportion of adolescents with different forms of malnutrition (stunting, thinness and overweight) among selected factors are presented in table 2. Among the three nutritional measures, stunting was significantly less prevalent among boys ($p < 0.001$); other two forms of malnutrition rates were significantly higher among boys in comparison to girls ($p < 0.001$). Age specific difference in prevalence of adulthood malnutrition was also observed in

our study. In contrast to stunting, malnutrition for overweight and thinness were relatively higher in younger adolescents (less than 14 years). However, adolescents with habitual intake of fruits and vegetables had lower rate of stunting ($p < 0.001$ for both measures). On the other hand, who had a regular carbonated soft drink consumption, had significantly higher overweight rate ($p < 0.001$).

Table 2: Cross classification types of malnutrition

Characteristics	Stunting (HAZ <-2SD)	Thinness (BAZ <-2SD)	Overweight (BAZ >+1SD)
	Weighted percentage (95% CI)	Weighted percentage (95% CI)	Weighted percentage (95% CI)
Sex			
Boys	13.5(13.47,13.54)	12.3(12.27,12.34)	11.5(11.47,11.54)
Girls	15.4(15.35,15.46)	9(8.96,9.05)	8.8(8.76,8.84)
p-value (χ^2)	P < 0.001	P < 0.001	P < 0.001
Age (in years)			
12	3.3(3.2,3.41)	6.4(6.26,6.55)	22.6(22.36,22.85)
13	7.4(7.36,7.45)	16.8(16.74,16.87)	10.2(10.15,10.26)
14	15.3(15.25,15.36)	10.8(10.76,10.85)	10.9(10.86,10.95)
15	17.3(17.24,17.37)	8.1(8.06,8.15)	10.4(10.35,10.46)
16	21.8(21.67,21.94)	8.1(8.02,8.19)	5.65(5.53,5.68)
17	19.4(18.91,19.9)	3.4(3.18,3.63)	7.5(7.18,7.83)
p-value (χ^2)	P < 0.001	P < 0.001	P < 0.0001
Usual intake of fruit			
Yes	12.6(12.56,12.65)	11.2(11.16,11.25)	11.3(11.26,11.35)
No	15.8(15.76,15.85)	11(10.96,11.05)	9.8(9.77,9.84)
p-value (χ^2)	P < 0.001	P < 0.001	P < 0.001
Usual intake of vegetables			
Yes	13.3(13.27,13.34)	12(11.97,12.04)	11.8(11.77,11.84)
No	17.4(17.34,17.47)	8.6(8.55,8.66)	7.1(7.06,7.15)
p-value (χ^2)	P < 0.001	P < 0.001	P < 0.001
Regular soft drink consumption			
Yes	12.7(12.66,12.75)	9.8(9.76,9.85)	10.9(10.86,10.95)
No	15.6(15.56,15.65)	12.3(12.26,12.35)	10.2(10.17,10.24)
p-value (χ^2)	P < 0.001	P < 0.001	P < 0.001
Regular fast-food consumption			
Yes	12.7(12.66,12.75)	11.7(11.66,11.75)	9(8.97,9.04)
No	15.7(15.66,15.75)	10.6(10.56,10.65)	12.1(12.06,12.15)
p-value (χ^2)	P < 0.0001	P < 0.001	P < 0.001
Household food security			
Secure	13.8(13.77,13.84)	11.1(11.07,11.14)	10.6(10.57,10.64)
Insecure	17.3(17.21,17.4)	10.4(10.32,10.49)	9.9(9.83,9.98)
p-value (χ^2)	P < 0.001	P < 0.001	P < 0.001
Regular physical activity			
Yes	13.4(13.37,13.44)	9.9(9.87,9.94)	10.9(10.87,10.94)
No	17(16.93,17.08)	15.2(15.14,15.27)	9.4(9.35,9.46)
p-value (χ^2)	P < 0.001	P < 0.001	P < 0.001

Individual level double burden of malnutrition

Concurrency of stunting and thinness was observed in 2.6%(95%CI:2.59-2.62) school going Bangladeshi adolescents; whereas 18.06% stunted adolescents were overweight table 3. Individual -level Double Burden

(IDB)was least among boys as compared to girls (2.4% vs 2. 9%). Therefore, IDM rate was also higher among younger adolescents and who had regular carbonated soft drink consumption and physical activity

Table 3: Number and proportion of school going adolescents of Bangladesh experiencing individual level double burden

	Concurrently stunted and overweight	% of stunted who are overweight
Total	2.6(2.59,2.62)	18.06
Sex		
Boys	2.4(2.39,2.420)	2.74
Girls	2.9(2.88,2.93)	3.43
Age (in years)		
12	1.6(1.53,1.68)	48.88
13	3.5(3.47,3.54)	47.23
14	2.4(2.38,2.43)	15.76
15	2.5(2.48,2.53)	14.17
16	1.4(1.37,1.44)	6.64
Usual intake of fruit		
Yes	2.7(2.68,2.73)	20.99
No	2.5(2.48,2.53)	15.96
Usual intake of vegetables		
Yes	3(2.99,3.02)	22.59
No	1.3(1.28,1.33)	7.48
Regular soft drink consumption		
Yes	2.9(2.88,2.930)	22.38
No	2.4(1.39,2.42)	15.15
Regular fast-food consumption		
Yes	1.6(1.59,1.62)	12.28
No	3.5(3.48,3.53)	22.4
Household food security		
Secure	2.2(2.19,2.22)	16.02
Insecure	5.2(5.15,5.26)	30
Regular physical activity		
Yes	2.5(2.48,2.53)	18.68
No	2.8(2.79,2.82)	16.47

Determinants of adulthood malnutrition

Age of adolescents; gender; usual intake of fruits, vegetables, carbonated soft drink and fast food; household food security were significantly associated (p<0.001) with stunting table 2. The same factors also have an association with thinness and overweight (p<0.001). A multivariable logistic regression model was fitted to determine the contribution of associated factors on different nutritional measures. The multivariable result of correlates of stunting, thinness and overweight are listed in table 4.

being stunted was 22.7% higher (OR=1.227; P<0.001) as compared to girls. Contrariwise, likelihood of thinness and overweight was 32.9% (OR=0.671, p<0.001) and 35.8% (OR=0.642, p<0.001) lower respectively among boys. Adolescents who had a usual intake of carbonated soft drinks had higher odds of being overweight (OR=1.12; p<0.001). Household food security was also an important covariate for each measure. Odds of undernutrition (both stunting and thinness) were significantly lower in food secure households(p<0.001); while odds of over nutrition (overweight and obesity) were significantly higher(p<0.001).

The odds for stunting were 47.6% higher for each one-year increment. Conversely, age of adolescents was negatively associated with thinness and overweight. For boys, odds of

Table 4: Determinants of stunting, thinness and overweight

variable	Stunting (HAZ<-2SD)	Thinness (BAZ<-2SD)	Overweight (BAZ >+1SD)
	AOR (95% CI)	AOR (95% CI)	AOR(CI)
Sex			
Male	1(Ref.)	1(Ref.)	1(Ref.)
Female	1.227(1.22,1.235)***	0.671(0.667,0.675)***	0.642(0.638,0.647)***
Age (in years)	1.476(1.472,1.48)***	0.794(0.791,0.796)***	0.805(0.802,0.807)***

Usual intake of fruit			
Yes	0.961(0.955,0.967) ***	1.05(1.048,1.062) ***	1.098(1.09,1.105) ***
No	1 (Ref.)	1 (Ref.)	1 (Ref.)
Usual intake of vegetables			
Yes	0.808(0.803,0.813) ***	1.32(1.316,1.336) ***	1.848(1.832,1.863) ***
No	1 (Ref.)	1 (Ref.)	1 (Ref.)
Regular soft drink consumption			
Yes	0.839(0.834,0.844) ***	0.716(0.711,0.721) ***	1.12(1.112,1.127) ***
No	1 (Ref.)	1 (Ref.)	1 (Ref.)
Regular fast-food consumption			
Yes	0.851(0.846,0.855) ***	1.232(1.224,1.239) ***	0.588(0.584,0.592) ***
No	1 (Ref.)	1 (Ref.)	1 (Ref.)
Household food security			
Secure	1 (Ref.)	1 (Ref.)	1 (Ref.)
Insecure	1.408(1.397,1.417) ***	1.031(1.021,1.041) ***	0.934(0.925,0.944) ***
Regular physical activity			
Yes	1 (Ref.)	1 (Ref.)	1 (Ref.)
No	1.501(1.492,1.511) ***	1.621(1.611,1.632) ***	0.799(0.793,0.805) ***

Abbreviations: Ref: reference; AOR: Adjusted odds ratio; CI: confidence interval

Level of significance: *** P <0.001

V. DISCUSSION

Nutritional status is potential for current and future health of adolescents [27]. The global strategy for women's, children's and adolescent's health (2016-2030) targets to achieve their highest attainable standard of health in every setting [28]. Improved nutritional status of adolescents is crucial for improved wellbeing and productivity in future adult life as well as reducing health risk for next generation.

Following the global trends overweight prevalence is increasing in Bangladesh although like other low-income countries, burden of underweight and stunting is also high. The GSHS surveys reported that 4% girls aged 13–15 years are underweight which was above 10% in Mauritius, Sudan, Bangladesh, Maldives, Cambodia, and Vietnam previously [29]. Previous studies estimated that thinness or underweight prevalence was higher among boys in compared to girls (22.8% vs 12.8%) among adolescents of Bangladesh [20]. Our study also suggests that males are more likely to be underweight than females. Stunting prevalence declined from 17% in 2012 to 11% in 2014 among younger adolescent (aged 10-14 years) girls of Bangladesh. At the same time, among older adolescents (aged 15-19 years), stunting prevalence increased from 38% to 42% [17]. Participants of our study was primarily aged 13-17 years and we identified 15.4% adolescent girls as stunted.

In line with undernutrition, incidence of over nutrition is also increasing worldwide including, low- and middle-income countries. Globally, age standardized occurrence of obesity among children and adolescents increased from <1 % in 1975 to 5.6 % and nearly 8% in girls and boys in 2016 respectively [19]. In Bangladesh, overweight prevalence is almost equal among boys and girls (8.5 % in boys, 8.4% in girls) [20]. 11.5% boys and 8.8% girls were overweight in the present study that closely resembles the

previous findings. There is no study yet that reveals individual level double burden among school going adolescents of Bangladesh. Although an unpublished study claimed that 1.32% percent adolescents of rural Bangladesh were concurrently stunted and overweight in 2015.

Poverty, poor maternal health and nutrition, recurring illness as well as inappropriate Infant and Young child feeding and care in early stage of life are key determinants of chronic undernutrition (stunting). Adolescence pregnancy is very common in Bangladesh like other developing countries. Since pre-pregnancy stunting adversely affect pregnancy outcome i.e., risk of Small for Gestational Age (SGA) and preterm birth, stunting is especially considerable for adolescent girls. Furthermore, stature of mother is associated with her pelvic size. A small pelvic size can lead to obstructive labor and finally to maternal death [30]. As a result of upward changes in country's economic condition and food system that makes less nutritious foods including different ultra-processed foods cheaper and more accessible and lower physical activity makes overweight more prevalent in Low-income countries like Bangladesh. Overweight and obesity poses risk for future health including non-communicable disease like diabetes, cardiovascular disease, stroke, cancer and obstructive sleep apnea [31].

VI. CONCLUSION AND FUTURE SCOPE

Almost an equal proportion of school going adolescents were thin and overweight although stunting prevalence was also noteworthy that made a new nutrition reality for Bangladesh, double burden of malnutrition. Comparatively higher prevalence of individual level double burden and overweight among younger adolescents was noticeable. Inadequate physical activity and regular consumption of carbonated soft drinks were key determinants of overweight and obesity. Despite these important findings,

our study was not free from limitation. First, the data used in this study were extracted from open access datasets of Bangladesh GSHS-2014. Second, the datasets contained variables of various behavioral risk factors and protective factors but did not include socio-economic and socio-demographic factors which could potentially influence nutritional status of adolescents. As a result, to identify determinants of malnutrition we were unable to consider these variables. Third, student's height and weight were collected via self-administered questionnaire which may not reflect the actual nutritional status of an individual. It is noted that, various background characteristics of adolescents should be included to assess determinants of different forms of malnutrition. However, our study findings will be helpful for policymakers to undertake policies and strategies related to nutrition and health of adolescents. A joint effort by the government, non-governmental organization and community involvement is needed to overcome the malnutrition problem among adolescents.

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CONFLICT OF INTEREST

There was no conflict of interest among the authors in any part of the study

AUTHOR'S CONTRIBUTION

Conceptualization: AJ and MNIK; Data extraction and cleaning: AJ; Formal analysis: AJ, MHI and MMN; Supervision: MNIK; Original draft writing: AJ; Review and editing of manuscript: AJ, MHI, MMN and MNIK. All of these authors reviewed and approved the final version of the paper

AUTHORS PROFILE

Ahmed Jubayer had pursued BSc in Nutrition and Food Science from University of Dhaka, Bangladesh in the year 2019. Currently he is doing MSc from same institute. He has sound statistical knowledge with proficiency in Microsoft Excel, SPSS, STATA, R programming, ENA, WHO anthro and anthro plus software. His main research work focuses on nutrition epidemiology and non-communicable disease. He was involved in data analysis and scientific report writing in several research projects and some of his research works are submitted for peer review in several journals.



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