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Assessment of Nutritional Status by using Mid Upper Arm Circumference of School going Children (6-10 years) in Rajshahi District, Bangladesh: A Statistical Analysis

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Abstract

Nutrition, genes and environment are the three major factors that impact a child's development. Nutritional status of children is an important indicator of their health status of a particular population. According to the World Health Organization (WHO), malnutrition is the gravest single threat to global public health. Globally, it contributes to 45% of deaths of children aged under five children, and most of the death occurs in developing countries. Study on nutritional status of children is important for determining risk factors and current prevalence of malnutrition in a particular country to take initiative for remove or reduce malnutrition among children. Many studies have been done with under five children nutritional status in worldwide including Bangladesh, but few studies are available on nutritional status of school going children aged 6-10. To the best of our knowledge the study on nutritional status of school going children aged 6-10 years in Rajshahi district is poorly documented. The objectives of the present study was to know the nutritional status and to identify the risk factors among school going children aged 6-10 years in Rajshahi district, Bangladesh.

Sample was collected from the different selected schools of urban and rural area in Rajshahi district, Bangladesh using multistage stratified sampling. A total number 1200 school going children aged 6-10 years were selected as a sample for this study. Data were collected from selected students and their parents using a standard questionnaire from May to October 2015. The nutritional status of children was measured by mid upper arm

circumference (MUAC). The cut-off points of the anthropometric measurement were used to classify the nutritional status such as normal and under nutrition. Frequency distribution, Student's t-test, ANOVA, multiple linear regression, Chi-square test, logistic regression and Stepwise regression analysis were utilized to serve the purpose of the objectives for the present study.

The mean age of the student was 7.77±1.40 year with range 6 to 10 years. The mean MUAC of school going children was 18.20±2.85 cm with an increasing tendency was observed with increasing their age. It was found that student's HIP, student's BMI, student's age, father's age, head cercumference (HC) of student, and family monthly income were the most important predictors of children MUAC. Chi-square test demonstrated that more than 80% of our selected factors were associated with nutritional status of school going children aged 6- 10 years in Rajshahi, Bangladesh. In this study, we found some modifiable risk factors of malnutrition among school going children aged 6-10 years in Rajshahi district, Bangladesh. Consequently, malnutrition can be considered as a major health problems of Bangladeshi school going children aged 6-10 years and require attention.

Keywords: Malnutrition, Multiple regressions, School going children, Rajshahi, Bangladesh.

AMS Classification: 62P10.

1. Introduction

Worldwide acute malnutrition is a major public health concern and severely undernourished children are at high risk of mortality. Almost 16 million under 5 children are affected by severe acute malnutrition (SAM) and over half a million die annually (Ali, et al. 2013). It is currently estimated that, over 17 million children under the age of five years suffer from severe acute malnutrition (SAM), possibly translating to more than 100 million global incident cases each year(Grant, et al. 2018). Under nutrition accounts for just under half of all deaths in children aged less than 5 years worldwide. Severe acute malnutrition (SAM) is among the deadliest forms of malnutrition, linked with a disturbing mortality rate of 54% in the pediatric age group in developing countries(Chiabi, et al. 2016). MUAC measurement was reliable, had good reproducibility and led to rapid diagnosis of nourishment status in 6-59 month-old children living in areas where an emergency had been declared(Mantilla-Hernández, et al. 2014). Upper arm composition is a reflection of body protein and calorie reserves(Senbanjo, et al. 2014). It seems acceptable to rely on MUAC as a single assessment tool for case finding and for admission of children with SAM to nutritional programmers(Ali, et al. 2013). In 2009 the

World Health Organization (WHO) and United Nations Children's Fund (UNICEF) provided new guidance on the admission criteria for programs treating SAM advising to include children less than -3 z-scores from the median weight-for-height z-scores (WHZ) of the WHO 2006 growth standards or a mid-upper arm circumference (MUAC) of less than 115 mm, and/or edema (Dale, et al. 2013). It is well known that under nutrition in childhood is one of the reasons behind the high child mortality rates in developing countries. It is highly detrimental for the future of those children who survive. Chronic under-nutrition in childhood is linked to slower cognitive development and serious health impairments later in life that reduce the quality of life of individuals. Nutritional status is an important index of this quality. Improved child health and survival are considered universal humanitarian goals. In this respect, understanding the nutritional status of children has far reaching implications for the better development of future generations(Biswas, et al. 2010). Each year more children die from moderate than severe malnutrition. Home-based therapy (HBT) using Ready-to-Use Therapeutic Foods (RUTF) has proven to successfully treat uncomplicated childhood malnutrition on an outpatient basis(Connor and Manary 2011). They aimed to evaluate the classification of mid upper arm circumference (MUAC) in primary-school children by using National Center for Health Statistics (Nascimento, et al. 2010) and World Health Organization (Wright, et al. 2008) references. We evaluated 1200 children's: weight, height and MUAC were assessed and the body mass index (BMI) was calculated. The BMI values were classified into *Percentile* by the WHO referential. The MUAC was classified into two references, comparing the whole-sample value.

2. Materials and Methods

2.1 Materials

This cross-sectional study was conducted using multistage stratified sampling procedure. Four types of schools (government, semi-government, private and madrasah) were selected for the findings of socio-economic differences of nutritional status of school going children. It has been assumed that students from lower and middle class family go to government or semi-government schools or madrasah, whereas children from upper middle and high income groups attend private or English medium schools. The age range of the subject was 6 to 10 years, who were generally studying in class one to five of Rajshahi district in Bangladesh. The date of birth of each student has been taken from the school records and cross checked from their respective parents or guardian. Information on the whole day activities of the last seven days as well as food habit has been

collected from the student or from their respective parents by re-call methods. Information also was collected about distance of school from the residence and the mode of transport used to go to school. Besides this, height and weight of the children as well as their parents has been taken to see the hereditary of obesity through anthropometric rod and weighing machines.Body mass index (BMI), defined as the ratio of weight in kilograms to height squared in meters, was calculated. The parent's socio-economic and demographic factors were collected using a standard questionnaire. This study consisted 1200 samples (boys 686 and girls 514) at the primary school, kindergarten and madrasah of Rajshahi, Bangladesh. Data was collected from May to October 2015.

The outcome variable of this study was child's nutritional status and mid upper arm circumference (MUAC), and the independent variables were: student's age (SA), mother's age (MA), father's age (FA), family monthly income (FMI), HIP circumference, students' head circumference (SHC), body mass index of children (SBMI), father's body mass index (FBMI), mother's body mass index (MBMI).

2.2 Methods

The nutritional status of children was measured by MUAC. The MUAC was subdivided into two classes according to the most widely used categories of the MUAC for children. These were (i) under nutrition (MUAC<18 cm) and (ii) normal (MUAC≥18cm) [WHO,2006].

2.3 Target population of the study

Target population of a study is a group of individuals which are interested by researcher/s to generalize the conclusion. The characteristics of target population usually have varying. The samples are selected from the population. The study population of this study was the school going children aged 6-10 years in Rajshahi district, Bangladesh

2.4 Sample size determination

Sample size determination is the act of choosing the number of observations or replicates to include in a statistical sample. The sample size is a crucial feature of any empirical study during which the goal is to create inferences a couple of population from a sample. In observe, the sample size employed in a study is set supported the expense of data assortment, and therefore they ought to have

enough applied mathematics power. Since, the entire variety of study population (number of faculty going students aged 6-10 years). The following formula has been used for assembling sample size:

$$n = \frac{N}{1 + Nd^2}$$

Where n=required sample size, N = population size (in here 354546), d = marginal error (we considered, d=0.05), 95% confidence level has been considered. The formula provided that the significant sample size was 400 approximately but we considered 1200 for this study, but initially 1250 were selected (4% extra).

2.5 Statistical Analysis

Descriptive analysis was done for the health status, nutritional status, socio-economic, demographic and student activities factors. Multiple regressions were performed to identify the significant factors associated with MUAC. Stepwise regression analysis was used in this study for identified the best model.

The data was analyzed with Statistical Package for Social Sciences (SPSS) version 20.0. A value of $p<0.05$ was regarded as statistically significant in the analysis.

3. Results and Discussion

In this study 1200 (boys 686 and girls 514) primary school students were considered as participants for investigating their nutritional status, and it was measured by their mid upper arms circumference (MUAC). The Kolmogorov-Smirnov test was used for testing the normality, and this test showed that our data (MUAC) were normally distributed. MUAC of children was clasified into two classes such as (i) under nutrition (MUAC<18 cm) and (ii) normal (MUAC≥18cm).

According to the cut-off points of children MUAC, it was noted that more than 63% school going students aged 6-10 years was under nourished while 36.1% children were healthy. When It is indicated that according to the prevalence of nutritional status boys was more number (64.4%) of under nourished than that of girls (42.4%) students (Table 1).

Table1: Prevalence of nutritional status on the basis of MUAC cut-off points among school children aged 6-10 years in Rajshahi district of Bangladesh

MUAC category of Students	Boys N (%)	Girls N (%)	Total N (%)
Undernourished	442 (64.4)	325 (42.4)	767 (63.9)
Normal	244 (35.6)	189 (36.8)	433 (36.1)
Total	686 (57.2)	514 (42.8)	1200 (100.0)

The mean MUAC of all students was 18.20±2.85 cm, among them boys 18.10±2.88 cm and girls 18.32±2.79 cm, however the difference in MUAC between boys and girls were not statistically significant ($p>0.05$). Only significant difference was found in MUAC between boys and girls at age 7 ($p<0.05$) and age at 10 years ($p<0.05$) (Table 2).

Table 2: MUAC of school going children in Rajshahi district by gender

	Boys		Girls		Total	
Age	N	Mean ± SD	N	Mean ± SD	Mean ± SD	MD
6	217	16.76±2.17	147	17.01±2.28	16.85±2.21	0.250
7	185	17.07±2.29	139	17.56±2.92	17.32±2.64	0.490*
8	76	18.50±3.02	102	18.35±2.42	18.41±2.69	-0.150
9	109	19.60±3.02	96	19.47±2.73	19.55±2.91	-0.130
10	99	19.27±2.78	30	20.40±2.34	19.68±2.68	1.130*
Total	686	18.10±2.88	514	18.32±2.79	18.20±2.85	0.220

Note: *:5% level of significance, SD=Standard deviation, MD= Mean differences

From similar study, we have found the mean mid upper arm circumference alone sufficient for deciding admission to a nutritional programmed for childhood severe acute malnutrition in Bangladesh. It seems acceptable to rely on MUAC as a single assessment tool for case finding and for admission of children with SAM to nutritional programmers [Connor and Manary, 2011].

3.1 The multiple regression models for MUAC

The model was,

$$MUAC=\beta_0+\beta_1SA+\beta_2MA+\beta_3FA+\beta_4FMI+\beta_5HIP+\beta_6MBMI+\beta_7FBMI+$$

$$\beta_8SBMI+\beta_9SHC+\varepsilon \quad (3.1)$$

where, MUAC was the response variable and the predictors were: student's age (SA), mother's age (MA), father's age (FA), family monthly income (FMI), HIP circumference, student's head circumference (SHC), body mass index of children (SBMI), father's body mass index (FBMI), mother's body mass index (MBMI).The estimated model was:

$$MUAC=-2.628+0.123SA-0.032MA-0.093FA-0.079FMI+0.603HIP+0.018MBMI-0.012FBMI+0.255SBMI+0.105SHC+\varepsilon \quad (3.2)$$

Table 3: Effect of some quantitative variables on students' MUAC

Variable	B	SE	t-value	p-value	95% Cl for B		Colinearity Statistics	
					LB	UB	Tolerance	VIF
(Constant)		1.133	-2.320	0.021	-4.851	-0.406		
Age of student	0.123	0.036	6.967	0.000	0.181	0.322	0.730	1.370
Mother's age	-0.032	0.015	-1.169	0.243	-0.047	0.012	0.314	3.190
Father's age	-0.093	0.014	-3.508	0.000	-0.074	-0.021	0.325	3.079
Family monthly income (Taka)	-0.079	0.000	-4.171	0.000	0.000	0.000	0.637	1.571
Student's HIP (cm)	0.603	0.008	25.371	0.000	0.177	0.206	0.406	2.464
Mothers' BMI	0.018	0.014	1.018	0.309	-0.013	0.041	0.769	1.300
Father's BMI	-0.012	0.011	-0.701	0.484	-0.029	0.014	0.752	1.330

Variable	B	SE	t-value	p-value	95% Cl for B		Colinearity Statistics	
					LB	UB	Tolerance	VIF
Student's BMI	0.255	0.015	13.880	0.000	0.175	0.233	0.680	1.472
Student's head circumference (cm)	0.105	0.024	5.554	0.000	0.088	0.184	0.643	1.554
R-Square Value= 0.727					Durbin-Watson value=1.694			

N.B.: B: regression co-efficient, SE: standard error, CI: confidence interval, LB: lower bound and UB: upper bound.

The regression coefficients and the VIF of the independent variables are presented in Table 3. The value of VIF showed that there was no multicolinearity problem among the independent variables. This model demonstrated that significant positive relationship was found between children MUAC and their age ($p<0.01$), HIP ($p<0.01$), HC ($p<0.01$) and their BMI ($p<0.01$), but negative relationship was observed between student's MUAC and their family monthly income ($p<0.01$) and father age ($p<0.01$). On the other hand, the relationship between children MUAC and their parents' BMI was not significant ($p>0.05$), also the relationship between student's MUAC and their HC was not significant ($p>0.05$). R-square value showed that our selected model can be explained the variation of dependent variable (MUAC) by 72.7%. The Durbin-Watson demonstrated that data points were independent, because estimated value was 1.694; hence the independence assumption was satisfied for this model (Table 3).

3.2 Stepwise regression analysis for MUAC

The results of stepwise regression analysis presented in table-4. The R^2 value indicated that there was a 62.7% reduction in the total variation of the MUAC due to the predictor variable of student's HIP for their MUAC. The second step included both the student's HIP and student's BMI, and the R^2 value indicated a 68.4% reduction in the total variation of MUAC due to these two predictors. The third step included student HIP, Students BMI and students' age with the R^2 value, indicating a 70.3% reduction in the total variation in the MUAC due to these three variables. The fourth step included student's HIP, student's BMI, student's age and Father's age with an R^2 demonstrating a 71.6% reduction in the

total variation of the MUAC due to these four variables. The fifth step included student's HIP, Student's BMI, student's age, father's age and HC of student, which led to a 72.2% reduction in the total variation of the MUAC. The sixth step (final step) included student's HIP, student's BMI, student's age, father's age, HC of student, and family monthly income, which led to a 72.7% reduction in the total variation of the MUAC. The value of C_p decreased with each increment, and the smallest value (6.360) was found in the final step. These results demonstrated that student's HIP, student's BMI, student's age, father's age, HC of student, and family monthly income were the most important predictors of school going children (age, 6-10 years) MUAC in Rajshahi district, Bangladesh (Table- 4).

Table 4: Summary of the stepwise regression analysis for selected quantitative independent variables of children MUAC

	Coefficients					
	Step1	Step2	Step3	Step4	Step5	Step6
Students' HIP	0.792**	0.653**	0.626**	0.601**	0.555**	0.607**
SBMI		0.275**	0.248**	0.268**	0.264**	0.254**
SA			0.148*	0.167**	0.143**	0.122**
Father age				-0.118**	-0.121**	-0.117**
SHC					0.101**	0.104**
FMI						-0.082**
No. of variable	1	2	3	4	5	6
R-square (%)	62.7	68.4	70.3	71.6	72.2	72.7
R-square (adj) (%)	62.7	68.3	70.2	71.5	72.1	72.6
Mallows'	430.973	186.627	105.655	50.727	23.686	6.360

Note: *:5% level of significance.

4. Conclusions

In this study, 1200 school going students aged 6-10 were considered as samples from our targeted population in Rajshahi district, Bangladesh to investigate their nutritional status. Data were collected from different selected government and non-government primary school, Kindergarten, English medium school and Madrasa in urban and rural area of Rajshahi district, Bangladesh. Child'

nutritional status was measured by anthropological measurement MUAC circumference. Descriptive statistics, multiple linear regressions, linear stepwise regression, Chi-square test, were employed to analyze our data. These selected techniques/models were provided the following results: The prevalence of under nutrition among school going children aged 6-10 years was measured by MUAC. The mean MUAC of all students was 18.20±2.85 cm, among them boys 18.10±2.88 cm and girls 18.32±2.79 cm, the difference in MUAC between boys and girls were statistically significant in MUAC at age 7 ($p<0.05$) and age 10 years ($p<0.05$).The variation of mean MUAC of school going children was significant among their father's occupation ($p<0.05$). 4. The variation of MUAC of school going children was significant ($p<0.01$) among the type of education institutions. It was found that the variation of MUAC of children was statistically significant ($p<0.01$) among their age. It was found that mean MUAC of children increased with increasing their parent's education levels.

This results demonstrated that significant positive relationship was found between children MUAC and their age ($p<0.01$), HIP ($p<0.01$), head circumference (HC) ($p<0.01$) and their BMI ($p<0.01$), but negative relationship was observed between student's MUAC and their family monthly income ($p<0.01$) and father's age ($p<0.01$). It is noted that student's HIP, student's BMI, student's age, father's age, HC of student, and family monthly income were the most important predictors of children MUAC. The association between children nutritional status measured by MUAC and parents' education level, father's occupation, type of residence, parent's body size, mother's body size, cut-off points of HIP circumference was statistically significant.

In conclusion, malnutrition can be considered as major health problems of Bangladeshi school going children and requires attention.

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