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Association between socio-economic status and childhood undernutrition in Bangladesh; a comparison of possession score and poverty index

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Abstract

Objective: To determine how much of the variation in nutritional status of Bangladeshi children under 5 years old can be attributed to the socio-economic status of the family.
Design: Nutritional status used reference *Z*-scores of weight-for-age (WAZ), height-for-age (HAZ) and weight-for-height (WHZ). A 'possession score' was generated based on ownership of a radio, television, bicycle, motorcycle and telephone, and the availability of electricity, with categories of 0 to 4+ possessions. A five-point (quintile) 'poverty index' was created using principal component analysis.
Setting: The Bangladesh Demographic and Health Survey 2004 was the source of data.
Subjects: A sample of 4891 children aged <5 years was obtained.
Results: Some 57·8% of the sample was either stunted, wasted or underweight (7·7% were stunted, wasted and underweight). Of those stunted (48·4%), 25·7% were also underweight. Underweight and wasting prevalences were 40·7% and 14·3%, respectively. Mean WAZ, HAZ and WHZ did not differ by sex. Children of mothers with no education or no possessions were, on average, about 1 SD more underweight and stunted than those with higher educated mothers or with 4+ possessions. The possession score provided much greater discrimination of undernutrition than the poverty index. Nearly 50% of children from households with no possessions were stunted, wasted or underweight (only 27% in the poorest quintile), compared with only 3–6% of children from households with 4+ possessions (over 13% in the richest quintile).
Conclusions: Maternal education and possession score were the main predictors of a child's nutritional status. Possession score was a much better indicator of undernutrition than the poverty index.

Keywords
Childhood undernutrition
Possession score
Poverty index

Childhood malnutrition is currently the leading cause of the global burden of disease in low- and middle-income countries. Recent estimates published in the *Lancet*[1] suggest that malnutrition is the underlying cause of 3·5 million deaths and 35% of the disease burden in children under 5 years of age. The fraction of total global health loss attributable to undernutrition was 9·5% in 2000 and 14·9% in high-mortality developing regions[2]. Ending malnutrition is an agenda of the current millennium, particularly for the developing world[3]. Lowering mortality and malnutrition rates among children, along with reducing the gender disparities in both these measures, have been identified as key Millennium Development Goals (MDG) for Bangladesh[4].

Socio-economic status (SES) has long been identified as a leading predictive variable of an individual's health in the epidemiological, economic and sociological literature[5,6]. However, international agencies have recently downplayed the importance of SES as a marker of malnutrition. For example, Helen Keller International[7] reported that the highest and lowest SES quintile in Bangladesh differed only by 15% in the prevalence of stunting and Semba *et al.*[8] reported only 17·9% higher prevalence of stunting among the poorest quintile compared with richest quintile. These findings suggest less importance of using SES to derive health policy recommendations.

It is well acknowledged that there is no international consensus on assessing SES. Income and household expenditures are the most commonly used measures of SES[9]. Given the difficulties in obtaining income or expenditure in developing countries, a poverty index or

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possession score has long been used as an alternative in measuring SES[5,10].

In a developing country like Bangladesh, where effective allocation of limited resources is very crucial especially at the beginning of recent economic recession, comparative analysis of different socio-economic indicators for understanding the nature and determinants of malnutrition is essential. The aim of the present study was therefore to assess the magnitude of inequalities in malnutrition of children under 5 years old that are ascribable to SES and to see whether a possession score or poverty index best explains the extent of undernutrition in Bangladesh.

Methodology

The Bangladesh Demographic and Health Survey 2004 was the source of data, which contained information on 11 400 women. The present study focused on the nutritional status of children under 5 years old. In total, 5125 families had at least one child below 5 years old, 1082 had two children, 130 families had three children and eight families had four children aged <5 years. In the analysis presented here, data on 4093 children, whose records were complete in the required individual and household level variables, were included; of whom 798 families had a second child.

Anthropometric indices, namely *Z*-scores of weight-for-age (WAZ), height-for-age (HAZ) and weight-for-height (WHZ), were generated by using WHO 2006 reference values. The *Z*-scores of the children were analysed as continuous as well as categorical variables. The usual *Z*-score cut-off of −3 SD was used for classifying a child as severely malnourished and *Z*-score cut-off of −2 SD for classifying as malnourished. The socio-economic and demographic information included in the study were family size, parent's education and occupation, region (six divisions), residence (urban/rural), housing condition (type of floor, wall and roof), ownership of radio, television, bicycle, motorcycle and telephone, availability of electricity, type of cooking fuel, water supply and latrine, and family type. A new variable called 'possession score' was created using information about ownership of a radio, television, bicycle, motorcycle and telephone and the availability of electricity. All of these variables were binary, having 'yes' (1) or 'no' (0) categories, and adding these gave scores ranging from 0 to 6. The possession variable was then categorised into five categories of 0 to 4+, where 0 means the household had no assets and 4+ means that family had four or more assets. One- or two-child families were defined by the variable family type. For relative comparison with possession score, a 'poverty index' was created using the technique of principal component analysis (PCA); the first component was taken and the scores on that component were divided into quintiles to reflect the poorest to wealthiest households.

All continuous data were checked for skewness using the Cox test (coefficient of skewness divided by standard error of skewness) as well as by examination of the frequency distribution with a normal curve. The relationship between two categorical variables was analysed by the χ^2 test and between continuous variables by the independent-sample *t* test. One-way ANOVA using either the Hochberg or Games-Howell *post hoc* test was used in comparing the means of three or more groups. Curve estimation was done to include the quadratic effects of the continuous independent variables. General linear models (GLM) were used to analyse dependent continuous variables with two or more independent variables. When the *Z*-scores were analysed as categorical variables, binary logistic regression analyses were undertaken with the socio-economic and demographic variables. Sequential models were mainly used in the analyses. For each dependent variable two types of analysis were carried out. In the first set (analysis 1), adjustment was made for linear and quadratic effects of age and family type, before testing for the effect of any variable separately. In the second analysis (analysis 2), all the other explanatory variables in the model, as well as linear and quadratic terms of age and family type, were entered in the analysis before testing the variable of interest. In every regression model, the variance inflation factor, tolerance and Cook's distance were calculated to check for multicollinearity and outliers. Because two children were used from the same family, all analyses were weighted and heterogeneity between one- and two-child families was also taken into account. Level of significance was taken at $P < 0{\cdot}05$. Bonferroni corrections, both strict and sequential, were applied to correct for the number of statistical tests undertaken.

Results

The analysis (Table 1) revealed that 57·8% of sample was suffering from some form of undernutrition (i.e. stunted, wasted or underweight); of those stunted (48·4%), 25·7% were also underweight while a further 7·7% were stunted, wasted and underweight. Most of the Bangladeshi children were suffering from chronic malnutrition (i.e. stunting) or chronic/acute mixed malnutrition (i.e. underweight) and

Table 1 Breakdown of sample by stunting, underweight and wasting categories: children aged <5 years, Bangladesh Demographic and Health Survey 2004

Category	*n*	%
Normal	2063	42·2
Stunted only	732	15·0
Underweight only	137	2·8
Wasted only	104	2·1
Stunted and underweight	1258	25·7
Underweight and wasted	220	4·5
Stunted, underweight and wasted	377	7·7

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Table 2 Relationship between *Z*-scores and socio-economic and demographic variables: children aged <5 years, Bangladesh Demographic and Health Survey 2004

			Analysis 1				Analysis 2			
			Mean	Difference	*F*	*P*	Mean	Difference	*F*	*P*
WAZ	Mother's education level	No education	−1·98	0·97	98·72	<0·001	−1·76	0·43	9·39	<0·001
		Primary	−1·86	0·85			−1·72	0·39		
		Secondary	−1·58	0·57			−1·60	0·27		
		Higher	−1·01	0			−1·33	0		
	Possession score	0	−2·00	0·88	81·79	<0·001	−1·80	0·51	15·33	<0·001
		1	−1·88	0·76			−1·76	0·46		
		2	−1·66	0·55			−1·64	0·35		
		3	−1·46	0·34			−1·51	0·21		
		4+	−1·12	0			−1·30	0		
	Toilet	No toilet	−2·09	0·62	94·27	<0·001	−1·71	0·21	5·79	0·003
		Insanitary	−1·87	0·40			−1·60	0·09		
		Sanitary	−1·47	0			−1·50	0		
HAZ	Region	Barisal	−2·19	0·15	12·28	<0·001	−1·96	0·17	7·83	<0·001
		Chittagong	−2·06	0·02			−1·85	0·06		
		Dhaka	−2·00	−0·04			−1·81	0·02		
		Khulna	−1·72	−0·32			−1·61	−0·18		
		Rajshahi	−1·88	−0·17			−1·61	−0·17		
		Sylhet	−2·04	0			−1·79	0		
	Mother's education level	No education	−2·17	1·20	106·40	<0·001	−1·92	0·52	10·72	<0·001
		Primary	−2·09	1·13			−1·95	0·55		
		Secondary	−1·75	0·78			−1·82	0·42		
		Higher	−0·97	0			−1·40	0		
	Possession score	0	−2·22	1·06	87·29	<0·001	−1·99	0·55	14·05	<0·001
		1	−2·10	0·94			−1·96	0·52		
		2	−1·80	0·65			−1·79	0·35		
		3	−1·59	0·44			−1·68	0·24		
		4+	−1·16	0			−1·44	0		
	House type	All thatched	−2·28	0·96	62·30	<0·001	−1·91	0·32	4·66	0·001
		Tin roof	−2·13	0·81			−1·87	0·27		
		Tin wall and roof	−2·05	0·72			−1·79	0·20		
		Brick wall/roof/floor	−1·68	0·36			−1·69	0·09		
		All brick	−1·32	0			−1·59	0		
WHZ	Region	Barisal	−0·74	−0·23	7·59	<0·001	−0·67	−0·21	4·56	<0·001
		Chittagong	−0·97	−0·01			−0·89	0·02		
		Dhaka	−0·90	−0·07			−0·83	−0·05		
		Khulna	−0·97	0·00			−0·87	−0·01		
		Rajshahi	−1·07	0·10			−0·94	0·06		
		Sylhet	−0·97	0			−0·88	0		

WAZ, weight-for-age *Z*-score; HAZ, height-for-age *Z*-score; WHZ, weight-for-height *Z*-score.

very few (2·1 %) were wasted only. Nearly one-fifth (19·6 %) of the children were severely stunted. Underweight and wasting prevalences were 40·7 % and 14·3 %, respectively, of whom 12·5 % were severely underweight and 3·2 % were severely wasted.

Only those variables having a significant association with nutritional status of the children are presented in the tables. No significant difference between mean WAZ, HAZ and WHZ of male and female children was found, both before and after removing age effects. Table 2 shows that after correction for the other demographic and socio-economic variables, in analysis 2, mother's educational level and number of possessions showed strong positive associations with WAZ and HAZ; as the mother's educational level and number of possessions increased so the child's mean WAZ and HAZ improved. The difference in mean WAZ and HAZ between owning 4+ possessions and none was over half a standard deviation and for no education to higher education of mothers was 0·4 SD. Children living in households with a sanitary toilet had, on average, a better WAZ than those living in households with either an unsanitary latrine or no toilet. Upward trends of HAZ means were evident from poor to good housing. Regional heterogeneity in HAZ was also observed, with poorer HAZ mean in Barisal, Chittagong and Sylhet districts. Regional variation was also found for WHZ; children from Rajshahi district had the worst mean value (−1·07), whereas those from Barisal district had the best mean (−0·74). If a sequential Bonferroni correction was applied then the number of possessions would be just significant, with an upward trend in mean from no to 4+ possessions. Binary logistic regression analyses were undertaken to see how well the socio-economic and demographic variables predicted underweight, stunting and wasting (Table 3) and no significant relationships were found with WHZ. When all of the variables were entered together, the overall models (analysis 2) explained 18·5 % of the variation in HAZ, 10·9 % of WAZ and 3·0 % of WHZ.

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Table 3 Binary logistic regression analysis results of *Z*-scores *v.* socio-economic and demographic variables: children aged <5 years, Bangladesh Demographic and Health Survey 2004

			Analysis 1						Analysis 2					
			% predicted*						% predicted*					
			1	2	χ^2	*P*	OR	95 % CI	1	2	χ^2	*P*	OR	95 % CI
WAZ	Mother's education level	No education	81·0	33·1	168·82	<0·001	5·31	3·80, 7·43	78·9	38·5	16·75	0·001	2·28	1·47, 3·51
		Primary					4·14	2·95, 5·80					2·05	1·34, 3·14
		Secondary					2·69	1·91, 3·79					1·75	1·16, 2·62
		Higher†												
	Possession score	0	78·8	35·7	189·47	<0·001	4·34	3·29, 5·73	78·9	38·5	38·32	<0·001	2·44	1·75, 3·41
		1					3·63	2·72, 4·82					2·34	1·70, 3·24
		2					2·48	1·84, 3·33					1·86	1·35, 2·56
		3					1·83	1·33, 2·52					1·50	1·07, 2·10
		4+†												
	Toilet	No toilet	84·6	26·4	120·48	<0·001	2·83	2·30, 3·48	78·9	38·5	14·21	0·001	1·61	1·26, 2·07
		Insanitary					1·88	1·63, 2·17					1·21	1·02, 1·44
		Sanitary†												
HAZ	Region	Barisal	57·1	64·6	39·71	<0·001	1·19	0·93, 1·51	62·0	70·6	19·92	0·001	1·20	0·92, 1·56
		Chittagong					0·99	0·80, 1·22					1·01	0·80, 1·26
		Dhaka					0·93	0·76, 1·14					0·97	0·77, 1·23
		Khulna					0·62	0·49, 0·77					0·75	0·58, 0·97
		Rajshahi					0·79	0·64, 0·98					0·76	0·60, 0·97
		Sylhet†												
	Mother's education level	No education	57·8	67·4	200·23	<0·001	6·77	4·87, 9·41	62·0	70·6	16·91	0·001	2·36	1·54, 3·61
		Primary					5·71	4·10, 7·95					2·30	1·52, 3·50
		Secondary					3·73	2·67, 5·21					2·11	1·42, 3·14
		Higher†												
	Possession score	0	59·7	68·3	236·91	<0·001	5·14	3·93, 6·71	62·0	70·6	44·61	<0·001	2·52	1·82, 3·49
		1					4·55	3·46, 6·00					2·54	1·85, 3·47
		2					2·86	2·15, 3·81					1·86	1·37, 2·54
		3					2·10	1·55, 2·85					1·56	1·13, 2·16
		4+†												
	House type	All thatched	59·4	67·8	172·24	<0·001	4·51	3·39, 6·01	62·0	70·6	16·18	0·003	1·90	1·35, 2·67
		Tin roof					3·52	2·79, 4·44					1·73	1·29, 2·30
		Tin wall and roof					3·30	2·60, 4·17					1·66	1·24, 2·23
		Brick wall/roof/floor					2·06	1·59, 2·68					1·45	1·09, 1·93
		All brick†												

WAZ, weight-for-age *Z*-score; HAZ, height-for-age *Z*-score.
Note: no significant result was found for weight-for-height *Z*-score.
*1 = normal; 2 = malnourished.
†Reference group.

After adjustment for the other socio-economic and demographic variables, children of less educated mothers and from households having fewer possessions were more likely to be underweight, as well as stunted. For example, children with no educated mothers were 2·28 and 2·36 times more likely to be underweight and stunted, respectively, than children whose mothers had higher education. Children having no toilet facilities in their house were 1·61 times more likely to be underweight compared with children having sanitary latrine facilities; whereas children from all-thatched households were 1·90 times more likely to be stunted compared with children from all-brick households. No significant associations were found between wasting and any of the socio-economic and demographic variables (results not shown). Prediction of normal children by the models varied from 62 % to 100 %, while 39 % of those underweight, 71 % of those stunted and only 0·1 % of the wasted children were correctly predicted.

A comparison of the percentages of stunting, underweight and wasting using the quintiles from the poverty index and the categories of possession score is presented in Table 4. The percentage of stunted children varied from 26·3 % to 13·7 % in the poorest and richest quintiles, respectively, while the range was 45·6 % to 3·4 % for possession score of 0 and 4+. For underweight children, corresponding percentages ranged from 28·1 % to 13·0 % for the poverty index and from 46·7 % to 3·5 % for possession score. The percentage difference of wasted children in the richest and poorest quintile was 12·3 % only, whereas it was 39·2 % between owners of 0 and 4+ possessions. Table 4 also shows that the average difference between possession score categories was much larger than between poverty index quintiles, e.g. stunting 10·5 % and 3·3 %, respectively. Regression analyses showed that the slopes of the lines were all significantly greater for possession score than for poverty index.

Overall, these results suggest that the possession score provided greater discrimination than the poverty index (minimum 39 % in possession score (wasting) *v.* maximum 15 % (underweight) in poverty index). GLM analyses (tables not shown) found that the mean *Z*-score differences between the richest and poorest generated by possession score were greater compared with poverty index. Binary logistic regression analyses were also used to estimate the predictive accuracy of poverty index in identifying underweight or stunted children, which revealed that the correct identification rate of underweight children was 4·5 % lower when poverty index rather than possession score was used. Both of these indicate better discriminatory power of the possession score over the poverty index.

Table 5 presents the various combinations of stunting, wasting and underweight in relation to poverty index and possession score. The possession score provides much greater discrimination of the children who were stunted,

Table 4 Separate comparisons between the percentages of stunting, underweight and wasting using the possession score categories and poverty index quintiles: children aged <5 years, Bangladesh Demographic and Health Survey 2004

		0 (poorest)	1	2	3	4+ (richest)	*b*	P	Difference between possession score and poverty index regression lines
Possession score	Underweight (%)	46·7	26·6	15·3	8·0	3·5	−10·50	0·009	0·008
	Stunted (%)	45·6	27·0	15·6	8·4	3·4	−10·30	0·007	0·004
	Wasted (%)	44·8	26·4	15·7	7·6	5·6	−9·72	0·011	0·009
		Quintile 1 (poorest)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (richest)			
Poverty index	Underweight (%)	28·1	20·6	20·5	17·8	13·0	−3·30	0·012	
	Stunted (%)	26·3	20·5	21·5	18·0	13·7	−2·77	0·015	
	Wasted (%)	27·0	20·1	21·0	17·3	14·7	−2·74	0·019	

Table 5 Comparison between the percentages of stunting, underweight and wasting using the possession score categories and poverty index quintiles: children aged <5 years, Bangladesh Demographic and Health Survey 2004

		0 (poorest)	1	2	3	4+ (richest)	*b*	*P*	Difference between possession score and poverty index regression lines
Possession score	Stunted only (%)	41·0	25·7	17·2	11·6	4·5	−8·71	0·004	0·001
	Underweight only (%)	39·4	23·4	15·3	15·3	6·6	−7·37	0·016	0·028
	Wasted only (%)	30·8	25·0	22·1	11·5	10·6	−5·39	0·005	0·018
	Stunted and underweight (%)	47·3	26·9	15·6	7·7	2·5	−10·88	0·008	0·006
	Underweight and wasted (%)	44·1	21·4	17·7	11·4	5·5	−8·72	0·020	0·022
	Stunted, underweight and wasted (%)	49·1	29·7	12·7	4·2	4·2	−11·53	0·016	0·020
		Quintile 1 (poorest)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (richest)			
Poverty index	Stunted only (%)	21·3	18·9	23·5	19·9	16·4	−0·88	NS	
	Underweight only (%)	25·5	14·6	18·2	24·8	16·8	−0·72	NS	
	Wasted only (%)	23·1	15·4	17·3	16·3	27·9	1·05	NS	
	Stunted and underweight (%)	28·5	21·1	20·3	17·2	12·8	−3·53	0·007	
	Underweight and wasted (%)	25·9	20·0	21·4	18·6	14·1	−2·50	0·026	
	Stunted, underweight and wasted (%)	28·6	21·5	21·8	16·7	11·4	−3·92	0·007	

wasted and underweight: 49·1 % lived in houses with no possessions compared with only 4·2 % of children with 4+ possessions. The equivalent percentages for the poverty index were 28·6 % and 11·4 %. With the possession score all of the percentages decreased from 0 to 4+ possessions, whereas this was not found using the poverty index. Furthermore, only 58·4 % of children in the richest quintile were not stunted, wasted or underweight compared with 71·0 % of children living in households with 4+ possessions.

Discussion and conclusions

Chronic undernutrition was very common in these Bangladeshi children aged <5 years: more than half of the children were suffering from stunting or stunting with underweight or wasting, while very few children were observed with only acute undernutrition. This result implies a long-term burden of frequent infections and poor diet.

Numerous studies have documented gender differences in health and nutritional status in developing countries, generally finding that boys do better than girls[11]. In patriarchal societies it is common for the intra-household allocation of resources to strongly favour sons, to the detriment of daughters' health and educational status. The present study, however, found that there was no obvious, overall gender differential in child nutritional status; underweight, stunting and wasting prevalences were almost identical in boys and girls. Bangladesh is generally thought to be a patriarchal society, but the apparent lack of a gender differential in undernutrition indicates that intra-household gender bias in feeding and health care for children in Bangladesh may be much more equal than hitherto suspected. Paternal education was not found to be associated with any of the malnutrition indicators after adjusting for the other socio-economic and demographic variables and with Bonferroni correction; whereas, contradicting many other studies[12], maternal education showed strong associations with childhood underweight and stunting, even after controlling for all socio-economic and demographic variables and with Bonferroni correction. Thus female education should still be one of the key policy options to achieve the MDG on malnutrition in Bangladesh. After controlling for all socio-economic and demographic factors, a trend of improvement in mean WAZ and HAZ was evident with possession score, indicating a strong association of malnutrition and socio-economic factors.

Moreover, the current study suggests that the simple and easy-to-construct possession score is a better indicator of SES, as this score gives greater discrimination in identifying malnourished children than a poverty index. The poorer discrimination using the poverty index may be because there was insufficient variation in assets;

it was evident that the first principal component generated from the Bangladesh Demographic and Health Survey data described only 31·7% of the variation of the assets. This limitation of the PCA technique was also observed in the Baseline Result and Impact Management System Survey conducted in Bangladesh in 2006[13], where the distribution of different assets used for constructing the poverty index showed little variation among households; for example, the floor material was essentially the same and very few (0·3%) owned a car.

Urban–rural discrepancies in malnutrition seem to be reducing, thus current policies need to address urban malnutrition. Education (especially of females) should still be one of the key policy options to achieve the MDG on malnutrition in Bangladesh. The multifaceted nature of malnutrition means that it may be effectively addressed only when several sectors and strategies work together. So, for example, combining income-generation projects and infant feeding programmes together with better household access to food (food security), more accessible health services, regular deworming of children and improved sanitation, can bring the desirable nutritional status.

In conclusion, the current study has shown that undernutrition in Bangladeshi children aged <5 years has strong associations with poor SES, which can be measured by a simple asset count or possession score. Maternal education is a key variable in improving nutritional status among young children.

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