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SOCIOECONOMIC FACTORS INFLUENCING NUTRITIONAL STATUS OF UNDER-FIVE CHILDREN OF AGRARIAN FAMILIES IN BANGLADESH: A MULTILEVEL ANALYSIS

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ABSTRACT

The nutritional status of under five children is a sensitive sign of a country's health status as well as economic condition. This study investigated differential impact of some demographic, socioeconomic, environmental and health related factors on nutritional status among under five children in Bangladesh whose fathers' occupation was agriculture. The study used Bangladesh Demographic and Health Survey 2007 data. Bivariate analysis, multivariate analysis (Cox's linear logistic regression model) and two-level random intercept binary logistic regression analysis were used to identify the determinants of under-five malnutrition. The analyses revealed that 19.6 percent of the children were severely stunted, 29.4 percent were moderately stunted and 51 percent were not stunted. This study also found that 3.5 percent of the children were severely wasted, 16.5 percent were moderately wasted and 80 percent were not wasted. Furthermore, the analyses revealed that 14.5 percent of the children were severely underweight, 32.5 percent were moderately underweight and 53 percent children were not underweight. The main contributing factors for under five malnutrition were found to be child's age, birth order, mother's education, father's education, family wealth index, sanitation facility, place of delivery, place of residence and division. Community level variations were found significant for wasting only in the analyses.

I. INTRODUCTION

Malnutrition is a sustaining problem in many of the developing countries. It is one of the main causes of morbidity and mortality among children under five years of age (Martorell *et al.*, 1992). In developing countries malnutrition is an important root of infant and young child mortality and reduced life span (UNDP, 2008). It is associated with more than half of all deaths of children worldwide.

In Bangladesh among the under five children 43 percent were stunted (chronic malnutrition), and 16 percent were severely stunted. About 17 percent of children under five were wasted (acute malnutrition), and 3 percent were severely wasted. About 41 percent of children under five were underweight (under nutrition), and another 12 percent were severely underweight (NIPORT *et al.* 2009).

A large number of studies conducted across the world on the status and determinants of child malnutrition (for example, Hong *et al.* 2006; Islam *et al.*, 1994; Rajaretnam and Hallad, 2000;

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Rayhan and Khan, 2006; Shrimpton and Yongyout, 2003; Smith and Haddad, 2000; Tharakan and Suchindran, 1999). Tharakan and Suchindran (1999) studied the status and determinants of child malnutrition on the basis of stunting, wasting and underweight using the data of a national cross-sectional study of Botswana. The study identified several biological, social, cultural, economic, and morbidity factors such as age of child, birth weight, duration of breastfeeding, gender of household head, residence, type of house, toilet facility, parents' education, child caretaker, milk and dairy products, staple food, and incidence of cough and diarrhoea as the determinants of child malnutrition. Rajaretnam and Hallad (2000) studied the determinants of severe underweight among children of ages 12-47 months using the NFHS-II data of India. It was found that the Indian children become less and less underweight but more and more stunted after reaching 2 years of age. Sex of child, birth weight, birth order, birth interval, regional settings, mother's education, mother's age, antenatal and natal care, and incidence of diarrhoea were identified as important predictors of child underweight.

Rayhan and Khan (2006) investigated the impact of some demographic, socio-economic environmental, and health related factors on child nutritional status using the nationwide data of the Bangladesh Demographic and Health Survey (BDHS) 1999-2000. The study observed that previous birth interval, size at birth, and mother's education had significant influence on chronic malnutrition. Size at birth and mother's nutritional status had significant influence on both wasting and underweight.

Hong *et al.* (2006) found strong significant association between household wealth inequality and chronic childhood under nutrition in Bangladesh by utilizing the nationwide data of Bangladesh Demographic and Health Survey (BDHS) 2004. The findings of the study showed that children of poorest household had highest risk of being chronically malnourished than the children of wealthiest households. The study suggested to reduce poverty and to make services more available to the poor households for the improvement in overall childhood health and nutritional status in Bangladesh.

Using the data of Bangladesh Demographic and Health Survey (BDHS) 1996-97, Kiess *et al.* (2000) studied the factors associated with low Height for age (HAZ) and Weight for height (WHZ), and found that parents' illiteracy and insufficient antenatal care (ANC) visits were significant factors of lower HAZ. The incidence of diarrhoea and fever in last two weeks, receiving no BCG and measles vaccines were found as the significant predictors of lower WHZ. On the other hand, birth interval, mother's body mass index (BMI) and regional settings (division) were found as significant factors of both lower HAZ and WHZ. Pryer *et al.* (2003) conducted a panel survey between 1995 and 1997 in Dhaka slum population to identify socio-economic, demographic and environmental factors that predict better HAZ for children under 5 years of age. They observed that 31 percent children had HAZ greater than - 2. Using logistic regression analysis, they found that better nourished children were more likely to have taller mothers, belonging to households having female household-head, higher income, hygienic latrines, and more floor place.

Unfortunately none of the existing literature highlighted the possibility of community effect on malnutrition. In developing countries likelihood of the presence of community effect is high (Islam, 2010). Hence this study would explore this area with suitable statistical methods, namely multi-level modeling (see Goldstein, 2003).

For the developing countries like Bangladesh prevalence of malnutrition is one of the indicators of child health. Factors influencing the malnutrition status may lead to policy formulation for the governments in these countries. Combating the problem of poor nutritional status is an ongoing process and frequent survey on the prevalence of the malnutrition is a pre-requisite in this process. Furthermore, with the presence of differences in regional settings and other contextual differences the study of malnutrition becomes complicated which requires sophisticated statistical modeling practices. Bangladesh is predominantly an agricultural based country. Furthermore, a recent study by Alom (2010) identified that malnutrition is significantly more likely among children from agriculture based families. This study aims to explore the malnutrition status of under five children in Bangladesh whose father's occupation was agriculture. Also this study will identify the significant factors influencing the malnutrition status including any community variations in the data.

II. DATA AND METHODS

The study utilizes the nationwide data of Bangladesh Demographic and Health Survey 2007 (NIPORT *et al.* 2009). The Bangladesh Demographic and Health Survey (BDHS)-2007 collected information from 10,996 women of age 15-49 years and 3,771 men of age 15-54 years covering 10,400 households from 361 sample points (clusters) throughout Bangladesh (134 clusters from urban area and 227 cluster from rural area). A children data set (N=6150) was generated from the women sample. Finally, children under five years of age whose fathers' occupation was agriculture were selected (n=1547) which was the basis of this paper. The Bangladesh Demographic and Health Survey (BDHS) data is nationally representative two-stage sample. Bangladesh is divided into six administrative divisions, 64 districts and 483 upazillas. In urban strata the primary sampling units (PSUs) *are mahalla* and in rural strata these are *mauza*. Bangladesh demographic and health survey (BDHS) data are hierarchical in nature in which the individuals are nested into PSUs and PSUs are nested into divisions. The Bangladesh Demographic and Health Survey (BDHS) 2007 was conducted under the authority of the National Institute for Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare. Mitra and Associates executed the survey with the technical assistance from Macro International and financial support from USAID/Bangladesh.

Construction of Z-scores or Standard deviation scores

The best way of measuring child nutritional status by anthropometric indices is the Z-score method (Cogill, 2003; WHO, 1986). The Z-score is a measure of an individual's value with respect to the distribution of the reference population. The formula for the calculation of Zscore is as follows:

$$\text{Z-score} = \frac{\text{Individual value (Height or Weight) - (Median value of the reference population)}}{\text{Standard deviation value of the reference population)}}$$

In calculation of Z-score, the standard deviation value for the U.S. National Center for Health Statistics (NCHS) reference population are recommend to use by WHO (1986). The anthropometric indices and their quantified ways are represented as:

Indices	Z-score	Categorized for stunting/ wasting/ underweight
Height-for-Age Weight-for-Height Weight-for-Age	HAZ (Stunting) WHZ (Wasting) WAZ (Underweight)	Severe (Z-score ≤ -3.00) Moderate (Z-score -2.99 to -2.01) Healthy (Z-score ≥ -2.00)

Single level binary logistic regression

Let Y be a dichotomous dependent variable, say nutritional status taking values 0 and 1 and suppose that Y=l if a child is malnourished and Y=0 otherwise. Also let X be an independent variable. Then the form of the logistic regression model is

$$P = p(Y = 1/X) = \frac{e^{\beta_0 + \beta_1 X}}{1 + e^{\beta_0 + \beta_1 X}}$$

and, $1 - P = p(Y = 0/X) = \frac{1}{1 + e^{\beta_0 + \beta_1 X}}$

Then a transformation of P known as the logit transformation and is defined as

g(x)= logit P= $\log\left[\frac{P}{1-P}\right] = \beta_0 + \beta_1 X$

The importance of this transformation is that g(x) has many of the desirable properties of a linear regression model. The logit, g(x) is linear in its parameters, may be continuous, and may range from $-\infty$ to $+\infty$ depending on the range of x. For more than one independent variable the model can be generalized as

g(x) = $\text{logit}(p_{ij}) = \beta_{0j} + \sum_{l=1}^{K} \beta_l X_{ijl}$

Two-level random intercept binary logistic regression model

Two-level random intercept binary logistic regression model is the extension of the single level binary logistic regression model (for details see Goldstein, 2003). Let binary response be Y_{ij} which equals 1 if individual i in community j is malnourished (for example) and 0 otherwise. Then the probability that the individual is malnourished is P_{ij} = Pr (Y_{ij}=1). If k independent variables X_{ij1}, $X_{ij2},\ldots,X_{ijk}$ are measured at the individual level, then a two-level random intercept binary logistic regression model can be written as follows:

$$\text{logit}(p_{ij}) = \beta_{0j} + \sum_{l=1}^{K} \beta_l X_{ijl} \qquad \text{with } \beta_{0j} = \beta_0 + u_{0j}$$

where β_0 is a fixed component and u_{0j} is a community-specific component, the random effect which is assumed to follow a Normal distribution with mean zero and variance σ^2_{u0}. When σ^2_{u0} is found to be significant in the model, we conclude that there is a community effect in the model, which means that two individuals from different communities with same set of characteristics will show different values on the response variable (malnutrition). Note that communities refer to primary samples units (PSUs).

Model fitting and Software used in the study

To determine the factors associated with the response variables (e.g., stunting, wasting and underweight) the cox's (Cox, 1970) logistic regression model (single level) was fitted and the odds of occurring an event was calculated for different independent variables using SPSS 16. Once, a single level model is identified a two-level random intercept binary logistic regression model was fitted using MLwiN 2.0 software considering the same set of independent variables. All the variables identified in literature review were considered in the regression analyses. Only the independent variables found significant at the bi-variate analyses were considered and retained in the final models. Possibility of multicolinearity and confounding was also explored. Interaction effects were tested and reported in the result section where found.

III. RESULTS AND DISCUSSION

The frequency distribution of malnutrition of the under five children of agrarian families revealed that 19.6 percent of the children were severely stunted, 29.4 percent were moderately stunted and 51 percent were not stunted. This study also found that 3.5 percent of the children were severely wasted, 16.5 percent were moderately wasted and 80 percent were not wasted. Furthermore, the analyses revealed that 14.5 percent of the children were severely underweight, 32.5 percent were moderately underweight and 53 percent children were not underweight. Figure 1 shows that the proportion of under-five children of agrarian families falling under severely malnourished category is greater than that of the national level for all three types of nutritional status.

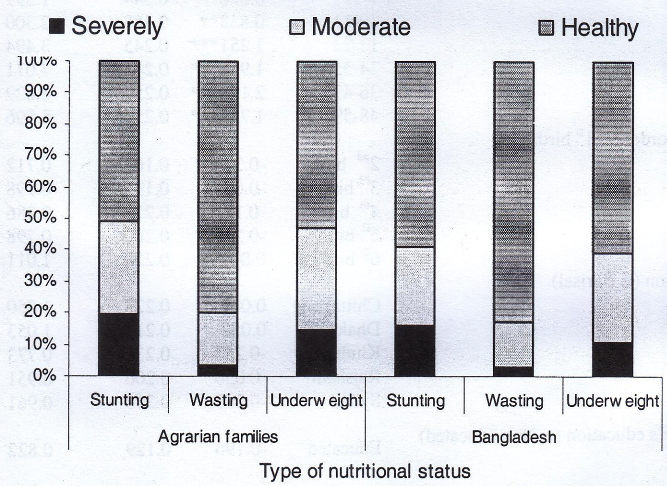

Figure 1. Distribution of nutritional status of under five children

Determinants of Child Malnutrition

This study fitted a two-level random intercept binary logistic regression model to find out the determinants of child malnutrition. The dependent variable of the study is child nutritional status, which was categorized into three groups according to the value of Z-score as (i) severely malnourished (≤-3.0 Z-score), (ii) moderately malnourished (-2.99 to -2.01 Z-score) and (iii) healthy (≥-2.0 Z-score). However, due to low frequencies in severely malnourished category we re-categorized the dependent variable into two groups (dichotomous) as (i) malnourished (≤-2.01 Z-score) and (ii) healthy (≥-2.00 Z-score) (reference category) in logistic regression analysis.

Determinants of stunting (child chronic malnutrition)

The two-level random intercept binary logistic regression model identified some significant determinants of stunting (child chronic malnutrition) (Table 1). The results indicate that children aged 10-11, 12-23, 24-35, 36-47 and 48-59 months had 2.30, 3.49, 7.07, 8.83 and 5.60 times higher risk of stunting respectively in comparison to the children aged ≤ 6 months.

Table 1. Two-level random intercept binary logistic regression model for stunting

Independent variable	Categories	B	S.E.	Odds Ratio
Intercept		-0.751	0.530	0.472
Child's age in months (*r*: ≤ 6)				
	7-9	0.336	0.344	1.399
	10-11	0.833**	0.388	2.300
	12-23	1.251***	0.245	3.494
	24-35	1.956***	0.245	7.071
	36-47	2.178***	0.256	8.829
	48-59	1.722***	0.259	5.596
Birth order (*r*: 1st birth)				
	2nd birth	-0.340**	0.167	0.712
	3rd birth	-0.002	0.191	0.998
	4th birth	-0.121	0.212	0.886
	5th birth	-0.226	0.260	0.798
	6th birth	0.011	0.228	1.011
Division (*r*: Barisal)				
	Chittagong	0.049	0.223	1.050
	Dhaka	0.052	0.215	1.053
	Khulna	-0.257	0.235	0.773
	Rajshahi	-0.050	0.206	0.951
	Sylhet	-0.040	0.218	0.961
Father's education (*r*: Non educated)	Educated	-0.196	0.129	0.822
Mother's education (*r*: No education)	Primary	0.111	0.152	1.117
	Secondary	0.040	0.185	1.041
	higher	0.122	0.488	1.130

Wealth Index (*r*: Poorest)	Poorer	0.137	0.15	1.147
	Middle	-0.223	0.174	0.800
	Richer	-0.227	0.232	0.797
	Richest	-0.982***	0.365	0.375
Sanitation facility (*r:* Septic tank/toilet)	Modern toiled	-0.141	0.390	-0.362
	Pit latrine	-0.472	0.360	-1.311
	Unhygienic	-0.275	0.378	-0.728
Currently breastfeeding (*r*: No)	Yes	0.133	0.159	1.142
Place of residence (*r:* Urban)	Rural	-0.228	0.186	0.796
Watch television (*r:* No)	Yes	-0.127	0.139	0.881
Random effect variance		0.922	0.650	

*Note: Level of significance: *p<0.10, **p<0.05, ***p<0.01; S.E. denotes Standard Error.*

The reason may be the deficiency of proper supplementary food for the children after six months of age since only mother's milk is not adequate to maintain adequate nutrition beyond 6 months (Mishra and Retherford, 2000).

From the results of birth order for stunting it was observed that children with 2[nd] birth order had significant lower risk of being stunted compare to the children of 1[st] birth order. The fact behind the result may be that at the time of first birth mothers were inexperienced to handle a child while at second birth they overcome some problems.

Household income factors are strong indicators of child nutrition status. Usually, children belonging to higher income households have better nutritional status than the children of lower income households (Vella *et al.*, 1994). Results obtained from the model indicate that the risk of being stunted for the children decreased with the increase of household wealth index. The children of households having richest wealth index were 0.375 times significantly less likely to be stunted than that of households with poorest wealth index.

No significant community effect was found in the analysis indicating that children from different communities with same set of characteristics will exhibit almost similar influence on their stunting status.

Determinants of wasting (child acute malnutrition)

The results of two-level random intercept binary logistic regression model for wasting indicate that the children belonging to age group 10-11 months had higher risk to be wasted than the children aged ≤ 6 months. For the children belonging to the age group 10-11 months of age, the likelihood of being wasted was found about 2.25 times higher than that of the reference group (Table 2).

The children of higher educated mother were 4.336 times significantly more likely to be wasted than that of uneducated mothers. The reason may be that these mothers used to work outside of home and hence could not take care of their children properly. Also the children of these mothers may experience infrequent breasting. Father's education had a significant positive influence on child wasting. Children of educated father were 0.73 times less likely to be wasted compared to that of uneducated father. The sanitation facility also had significant positive influence on wasting. The children of households having unhygienic toilet had 2.32 times higher odds of being wasted than those having septic toilets.

A significant community effect was found in the analysis indicating that children from different communities with same set of characteristics will exhibit different influence on wasting.

Table 2. Two-level random intercept binary logistic regression model for wasting

Independent variables	Categories	B	S.E.	Odds Ratio
Intercept		-2.101***	0.573	0.122
Child's age in months (*r*: ≤6)	7-9	-0.351	0.388	0.704
	10-11	0.811**	0.384	2.250
	12-23	0.195	0.255	1.215
	24-35	-0.424	0.271	0.654
	36-47	-0.129	0.275	0.879
	48-59	0.052	0.279	1.053
Religion (*r*: Muslim)	Non-Muslim	0.034	0.256	1.035
Mother's education (*r*: No education)				
	Primary	0.012	0.179	1.012
	Secondary	-0.217	0.214	0.805
	Higher	1.467**	0.482	4.336
Father's education (*r*: Non educated)	Educated	-0.320**	0.160	0.726
Sanitation facility (*r*: Septic tank/toilet)	Modern toiled	0.473	0.512	1.605
	Pit latrine	0.552	0.472	1.737
	Unhygienic	0.841*	0.488	2.319
Currently breastfeeding (*r*: No)	Yes	0.260	0.204	1.297
Wealth Index (*r*: Poorest)	Poorer	-0.036	0.185	0.965
	Middle	0.042	0.209	1.043
	Richer	0.001	0.281	1.001
	Richest	-0.005	0.413	0.995
Watch television (*r*: No)	Yes	0.260	0.204	1.297
Random effect variance		0.206*	0.118	

*Note: Level of Significance: *p<0.10, **p<0.05, ***p<0.01; S.E. denotes Standard Error.*

Determinants of child underweight (under nutrition)

Results of logistic regression model for underweight show that the risk to be underweight increased with the increase of age (Table 3). Compared to the reference group (≤ 6 months), children aged 10-11 months had 2.09 times more risk to be underweight. However, the likelihoods to be underweight for the children of the age groups 12-23, 24-35, 36-47 and 48-59 months were found to be 1.64, 2.03, 2.67 and 2.67 times higher respectively compared to the reference group. The reason may be the deficiency of proper supplementary food for the children after six months of age since only mother's milk is not adequate to maintain adequate nutrition beyond 6 months (Mishra and Retherford, 2000).

Birth order had significant association with underweight; children of the sixth birth order had 1.48 times significantly higher risk of being underweight compared to the children of first birth order.

Table 3. Two-level random intercept binary logistic regression model for underweight

Independent variables	Categories	B	S.E.	Odds Ratio
Intercept		-0.422	0.523	0.656
Child's Age in months (*r:* ≤ 6)	7-9	-0.464	0.329	0.629
	10-11	0.736**	0.360	2.088
	12-23	0.496**	0.218	1.642
	24-35	0.711***	0.218	2.036
	36-47	0.983***	0.227	2.672
	48-59	0.981***	0.235	2.667
Division (*r:* Barisal)	Chittagong	-0.403*	0.232	0.668
	Dhaka	-0.314	0.222	0.731
	Khulna	-0.469*	0.244	0.626
	Rajshahi	-0.128	0.215	0.879
	Sylhet	-0.315	0.228	0.729
Father's education (*r*: Non educated)	Educated	-0.110	0.129	0.896
Mother's education (*r*: No education)	Primary	0.129	0.150	1.138
	Secondary	0.110	0.183	1.116
	higher	0.808*	0.476	2.243
Type of place of residence (*r:* Urban)	Rural	-0.357*	0.192	0.699
Birth order (*r*: 1st birth)	2nd birth	-0.089	0.163	0.915
	3rd birth	-0.146	0.188	0.864
	4th birth	0.085	0.210	1.089
	5th birth	0.007	0.255	1.007
	6th birth	0.392*	0.226	1.479
Wealth Index (*r*: Poorest)	Poorer	0.075	0.148	1.078
	Middle	-0.104	0.173	0.901
	Richer	0.051	0.230	1.052
	Richest	-0.611*	0.356	0.543

Currently breastfeeding (*r*: No)	Yes	0.214	0.158	1.239
Place of delivery (*r*: Home)	Govt. Hospital	-0.498*	0.303	0.608
	Pvt. Hospital	-0.324	0.385	0.723
	Others	-1.851	1.155	0.157
Watch television (*r*: No)	Yes	-0.078	0.138	0.925
Random effect variance		0.111	0.073	

*Note: Level of significance: *p<0.10, **p<0.05, ***p<0.01; S.E. denotes Standard Error.*

However, significant regional difference was observed in child underweight. The likelihood of a child being underweight was significantly lower in Khulna and Chittagong divisions compared to the Barisal division.

Type of place of residence had significant effect on child underweight. The likelihood of a child being underweight was lower in rural area compared to urban area. This may be due to the fact that the children in urban areas belong to single families and might have less care from other relatives when parents are working outside. Another reason may be that these children have less access to physical exercise compared to children in rural areas.

The children of households with higher income have better nutritional status than that of lower income households (Vella *et al.*, 1994). The results also indicate that the better the household's wealth condition the lower the risk of the child being underweight. The children of households having richest wealth index was 0.54 times significantly less likely to be underweight than that of households with poorest wealth index.

Place of delivery is an important factor of child underweight. From the Table 3 we can see that children whose place of delivery was Government Hospital they were significantly less likely to be underweight than those who were delivered at home.

No significant community effect was found in the analysis indicating that children from different communities with same set of characteristics will exhibit almost similar influence on underweight.

IV. CONCLUSION AND RECOMMENDATION

The study attempts to examine the nutritional status of the children under five years of age whose fathers' occupation was agriculture using the data from Bangladesh Demographic and Health Survey (BDHS)-2007 in terms of stunting, wasting, and underweight. The anthropometric indices HAZ, WHZ and WAZ were constructed using the NCHS standard recommended by World Health Organization (WHO) and were utilized to assess the nutritional status of children. The levels of stunting (HAZ $\leq$ -2.0), wasting (WHZ $\leq$ -2.0) and underweight (WAZ $\leq$ -2.0) among the study population were found above the threshold (2.28%; see Cogill, 2003) of "very high" prevalence, which is a matter of great concern for the country. If compared with the national level children under five years of age from agrarian families were experiencing more severe level of malnutrition, which is a matter of immediate policy intervention.

The logistic regression models indicate that child's age in months, birth order and wealth index were found to be the significant determinants of stunting. For wasting child's age in months, mother's education and sanitation facility were found as the significant determinants in the logistic regression model. The logistic regression model indicates that child's age in months, division, mother's education, wealth index, type of place of residence, birth order and place of delivery were the significant determinants of underweight. One important finding of this study is that there were significant community variations in the data for wasting. This paper suggests that different communities may require different strategies to overcome the problem of wasting.

Child malnutrition may be reduced by improving mother's education, mother's nutrition status and health service. Appropriate efforts are needed to reduce hunger and malnutrition in areas where prevalence of underweight was found highest (Barisal) and especially among lower socio-economic groups. Poor performing communities should be given special attention.

Height and weight of children should be measured every month after birth to monitor the growth of child for the first five years of life since in this period children are easily affected by malnutrition and failed to grow properly. In this regard Government of Bangladesh and other non-Government institutions related with health and nutrition sector should generate a long term programme to increase awareness of parents about the standard height and weight of child according to his/her age and sex so that they can easily assess the nutritional status of the child and make appropriate steps for improving nutritional status, if necessary.

It is necessary to aware women about hazardous effects of higher number children. For improving overall childhood health and nutrition, it is necessary to reduce household wealth inequality since most of the children belonging to poor households had highest risk of being malnourished of any form.

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