Relationship between socio-economic and anthropometric status of young children in rural Bangladesh

By

Syed Moniruzzaman

Tutor : Erik Bergström

Master thesis in Public Health
Epidemiology, Department of Public Health and Clinical Medicine
Umeå University, Sweden
1999

ABBREVIATIONS

ASA	Association for Social Advancement
CDC	Centers for Disease Control
CI	Confidence Interval
HAZ	Height-for-age Z-score
HKI	Helen Keller International
ICDDR'B	International Centre for Diarrhoeal Disease Research, Bangladesh
NCHS	National Centre for Health Statistics
NGO	Non-Governmental Organization
OR	Odds Ratio
SES	Socio-Economic Status
SPSS	Statistical Packet for Social Science
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
VERC	The Village Education Resource Centre
WAZ	Weight-for-age Z-score
WHO	World Health Organization
WHZ	Weight-for-height Z-score

Contets Page

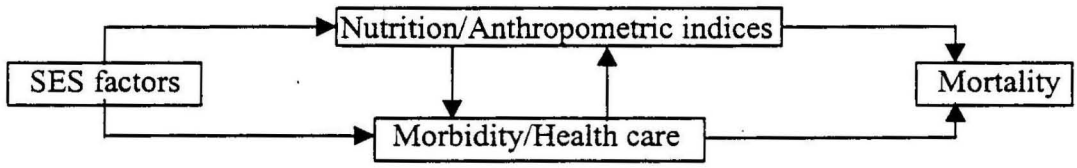
Abstract

This study investigates the interrelationship between socio-economic status and anthropometric measurements of young children in rural Bangladesh.

A nutrition surveillance system programme (the NSP) was established in April 1990. This is a collaborative effort that involves international and indigenous non-governmental organisations (NGO) and the government of Bangladesh, and is co-ordinated by Helen Keller International and funded by the US Agency for International Development. Data were collected every two months by ten NGOs and the Bangladesh government from 26 sentinel points, corresponding to 20 subdistricts and 4 urban slums. In each round of data collection, 5000-6000 households are randomly selected, and anthropometric measurements are taken from 7,000-9,000 children between the ages of 6 and 59 months. Data for this study came from Mohanpur, Manda, Bhuapur and Dagonvhuiya subdistricts, the vital registration area of the NGOs ASA, Shwanirvar Bangladesh and VERC. Anthropometric and socio-economic data concerning 1562 children aged 6-59 months were collected. From these data, it was found that the proportion of malnourished children was very high, underweight 59%, and stunted 56%. Malnutrition of the child was related to low educational level of the mother and poor condition of housing. Poor housing may be regarded as a proxy for poor socio-economic conditions. The different characteristics of the socio-economic conditions of the household were closely related, and not easily separated in relation to malnutrition of the child. The conclusion of this study is that preventive efforts improving the socio-economic condition of families with children and the educational level of mothers may have profound effects on child health.

1. Introduction

Mortality of young children is a serious problem in most developing countries. In these countries, out of 1000 livebirths, more than 100 die before completing the first year and another 50 to 100 die before completing the fifth year of life. The majority of these deaths are preventable by appropriate public health measures (1-2). However, to aid in the development of rational public health policies aimed at lowering infant and child mortality levels in these countries, one of the first steps is to ascertain the determinants of mortality at the household level. Mosley and Chen (3) designed a framework demonstrating how socio-economic variables affect mortality of young children through some proximate determinants. In this framework, nutritional status is considered as one of the proximate determinants of child mortality. It has also been established in several studies that 50% or more of the deaths of young children are directly or indirectly related to malnutrition (4-5).



The Indian subcontinent, where higher prevalence of stunting, wasting and underweight are found, is an important example. Studies conducted in Srilanka and Nepal among the young children have reported even higher prevalence of stunting – among 57 percent and 69 percent, respectively. The prevalence of wasting and underweight also are high in these areas. (6). A survey conducted by the Department of Democracy and Social Development among the under-five children in Bangladesh, have reported that 50% of the babies born in 1990 had low birth weight (less than 2,500 grams). Even for developing countries, this is an extremely high figure. Prevalence of malnutrition in children under-five (1987-92) is also one of the highest in the world. While 93% of under-five's are underweight, 16% suffer from wasting and 65% from stunting. More girls than boys suffer from third degree malnutrition (Weight-for-age less than 60% of the NCHS standard meadian. Almost 30,000 children become blind from vitamin A deficiency every year and around 70% become anaemic (7).

2. Aims of the thesis

2.1. Overall objective

The overall objective of this study was to explore the relationship between socio-economic and anthropometric status among 6-59 months children in rural Bangladesh.

2.2. Specific aims

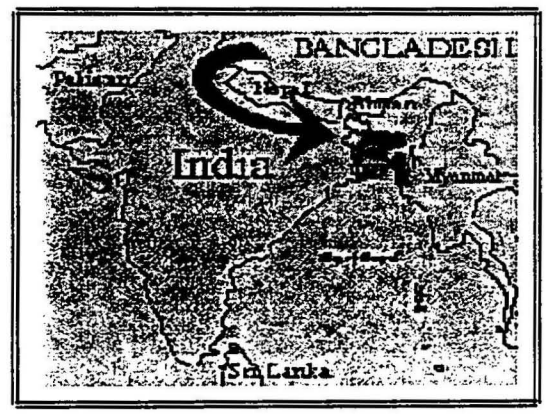
The specific aims were to

- Describe anthropometric status by age and sex.
- Describe baseline information on socio-economic status and educational level of the family of the child.
- Explore socio-economic determinants of stunting, wasting and underweight.

3. Background

3.1. Bangladesh, a general description

Bangladesh, in full, People's Republic of Bangladesh, republic of southern Asia, in the north-eastern portion of the Indian subcontinent, bordered on the west, north, and east by India, on the Southeast by Myanmar (formerly known as Burma), and on the south by the Bay of Bengal. The area of the country is 147,570 sq. km (56,977 sq. MI). The capital and largest city of Bangladesh is Dhaka.



The vast majority of Bangladesh's inhabitants are Bengalis, who are largely descended from Indo-Aryans who began to migrate into the country from the west thousands of years ago and who mixed within Bengal with indigenous groups of various racial stocks. The estimated population of Bangladesh (1998) was 127,567,002, making Bangladesh one of the ten most populous countries in the world. The overall density, 864 persons per sq. km (2,239 persons per sq. mi) in 1998, is much higher than that of other countries except for microstates such as Singapore. Bangladesh supports a large rural population, with 19 percent of the Bangladeshi people classified as urban in 1997. Most of the people are relatively young, nearly 60 percent being under the age of 25 and only 3 percent being 65 or older. Life expectancy at birth is 57 years.

Bangladesh lack sufficient numbers of schools and cultural institutions, even though facilities were increased substantially in the 1970s. Public education in Bangladesh generally follows the model established by the British prior to 1947. Elementary education is free, and 84 percent of all primary school-aged children are enrolled in schools. Secondary schools enrol just 19 percent. Poor school attendance is a major reason for a literacy rate of only 38 percent for Bangladeshis aged 15 and older.

Health and welfare services in Bangladesh are limited. In 1995 the country had one physician for every 4,970 residents and one hospital bed for every 3,280 inhabitants. Much of the welfare work in the country is administered by voluntary organizations, and Bangladesh are a major recipient of assistance from abroad.

3.2. The Nutrition Surveillance Program (NSP) in Bangladesh

The nutritional status, i.e. growth of young children is very sensitive indicator of changes in food supply and health conditions. It is also a reliable predictor of child mortality (8). Monitoring children's nutritional status in sentinel sites is thus a potentially valuable tool to anticipate, assess, plan, and co-ordinate the response to continuing and unforeseen crises related to floods and other natural disasters (9-11).

After the floods of 1988 there was lack of appropriate, timely information on health and nutrition status for effective allocation of relief programmes. To meet this need, UNICEF set up a temporary post-flood monitoring system of child nutrition status with the assistance of the United States Agency for International Development (USAID), the US Centers for Disease Control, and the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR, B). They based their analysis on data collected by non-governmental organisations (NGOs) with nutrition-monitoring activities.

The nutrition surveillance project (NSP) was started in October 1989 with the intention of establishing a permanent system for monitoring nutrition and health status of the population in Bangladesh. Helen Keller International (HKI) in collaboration with a Number of NGOs, the Bangladesh Institute of Public Health and Nutrition, and UNICEF, initiated the project; it receives financial and technical support from USAID and is co-ordinated by HKI.

3.3. Children's Health and Nutrition

Bangladesh have a large population (120 million) but is, at the same time, one of the poorest countries in the world. The morbidity and mortality are extremely high, especially among young children and mothers (12-14). Infant and child mortality in Bangladesh is among one of the highest in the world. The two principal health problems among children in Bangladesh are malnutrition and communicable diseases. Children and women, especially, the poor constitute high-risk groups. Child deaths and illness have not been appreciably diminished by modern medical technology, at least in the rural Bangladesh (15).

A significant proportion of the rural population in Bangladesh are starving, about 90 percent have some kind of dietary deficiency. Poverty is characterised by starvation and subsequent malnutrition, lack of education, unemployment, low level of health care, substandard housing, poor sanitation and overall low levels of living. A high and increasing density of the population, in relation to the country's meagre resources,

without concomitant increase in productivity and lack of determined effort for its more even distribution, further aggravate the problems of malnutrition (15).

The causes of malnutrition in a child may be separated into direct causes, i.e. inadequate nutrition or disease, and indirect causes, i.e. socio-economic factors. It is noteworthy that the same socio-economic factor may have different impact on nutritional status in different populations. For example, income was found to be an important factor of child nutritional status in Bangladesh (16), not of food intake in Kasango, Africa (17). To develop a rational policy for solving the malnutrition problem of a given population, it is necessary first to identify the "country specific" causative factors behind.

The most common procedure for identifying the causes of malnutrition is to investigate the relationship between probable causative factors and measurements of nutritional status. These measures may be clinical, biochemical, or anthropometric. Among these, anthropometric measures are the most commonly used.

3.4. Measurements of nutritional status

The two preferred anthropometric indices for determining nutritional status are height-for-age (HA) and weight-for-height (WH). Low height-for-age (HA) is considered an indicator of stunting. Low WH is considered an indicator of wasting and is generally associated with failure to gain weight or a loss of weight. Wasting and stunting may be simultaneous. The third index, weight-for-age (WA), is a composite of WH and HA, and fails to distinguish tall, thin children from short, well-proportioned children. It is important to note that each index reflects a different biological process. Although share common determinants, they cannot be used interchangeably.

The distribution of the indices is usually expressed in terms of percentiles or Z-scores (standard deviation scores). The Z-score of the reference population has a normal distribution with a mean of zero and standard deviation of one. The Z-score cut-off point recommended by WHO, CDC, and others to classify low anthropometric levels

is 2 SD below the reference median for HA, WH and WA. The proportion of the population that falls below a Z-score of –2 is generally compared with the reference population in which 2.3% fall below this cut-off (18)

Antropometric Indicator	*Terms describing Outcomes*	*Term describing Process*	*Explanation*
Low height-for-age	Stunted	Stunting (gaining insufficient height relative to age)	Implies long-term malnutrition and poor health
Low weight-for-height	Wasted	Wasting (gaining insufficient weight relative to height, or losing weight)	Implies recent or continuing current severe weight loss
Low weight-for-age	Underweight	Gaining insufficient weight relative to age or losing weight	Implies stunting and/or wasting.

3.4.1. Height-for-age

Height-for-age reflects achieved linear growth and Low HA indicate long-term, cumulative inadequacies of health or nutrition. Two related terms - length and stature - are also used.

"Shortness" is the descriptive definition of low HA. It explains nothing about the reason for an individual's being short, and can reflect either normal variation or a pathological process. "Stunting" implies that shortness is pathological; it reflects a process of failure to reach linear growth potential as a result of sub-optimal health and/or nutritional conditions.

Stunting is frequently associated with poor overall economic conditions and/or repeated exposure to adverse conditions. The age of the child modifies the interpretation of height-for-age. For younger children (under 2-3 years), low HA reflects a continuing process of "failing to grow" or "stunting". For older children, it reflects a state of "having failed to grow" or "being stunted".

3.4.2. Weight-for-height

Weight-for-height reflects body weight relative to height. Its use carries the advantage of requiring no information of age of the child (which may be difficult to assess in less developed areas).

The proper description of low WH is "thinness", a term that does not necessary imply a pathological process. The term "wasting", on the other hand, is widely used to describe a recent and severe pathological process that has led to significant weight loss, usually as a consequence of acute starvation and/or severe disease. Children may also be thin as a result of a chronic dietary deficit or disease. In these cases, the term wasting is considered inappropriate. The term may, however, use regarding populations in which the prevalence of thinness substantially exceeds the 2-3% expected on the basis of normal distribution. In such populations, it is probable that most thin children will be wasted and not normally thin.

3.4.3. Weight-for-age

Weight-for-age reflects body mass relative to chronological age. It is influenced by both the height of the child (HA) and his or her weight (WA) and its composite nature make interpretation complex. However, in the absence of significant wasting in a community, weight-for-age and height-for-age provides similar information, in that both reflect the long-term health and nutritional experience of the individual or the population. Short-term change, especially reduction in WA, reveals changes in WA.

Lightness has been proposed as a descriptive term for low WA, while "underweight" has been used to refer to an underlying pathological process. Low WA reflects low

HA and low WH, or both, the term "global malnutrition" has been used to describe this index, which may encompass "chronic malnutrition" and/or "acute malnutrition". For the reasons discussed above, this term should be avoided.

3.4.4. Mid-upper arm circumference

Mid-upper arm circumference (MUAC) has been proposed as an alternative index of nutritional status for use where the collection of height and weight measurements is difficult, including emergency situations such as famines or refugee crises. In these situations, low MUAC, based on a fixed cut-off point such as 12.5 cm, has been used as a proxy for low WH or wasting. Arm circumference changes relatively little from one to five years of life, implying that it may be used without age adjustment (19). However, there are studies showing that WH and MUAC are poorly correlated. The key operational advantage of MUAC is the fact that a single cut-off value (12.5 cm) can be used for children under 5 years of age.

4. Subject and methods

4.1. Sampling procedure

A total of 400-500 children were measured with each area (subdistrict) selected, making it possible to compare results among sites at the same time and to evaluate the changes in health status over time.

Data are collected only from slum areas where NGOs implement programmes. At the beginning of each round of data collection, a household is selected randomly from a list of all households maintained by the NGO, and all children between the ages of 6 and 59 months in that household are measured. The team then moves to the next household and continues systematically until the required numbers of children are measured.

For rural areas, a multi-stage random cluster design is used for the sample selection. In each targeted subdistrict, half of the unions (the next lowest administrative level) are selected randomly. Then, from a list of all villages in the selected unions, are identified. Within each of these villages, 20 children are selected systematically after a random start. On each field visit, the team selects a household from a list maintained by the expanded programme of immunization and visits to that household. Thus, for each subdistrict, 20 children are measured in each of 25 villages (clusters), a total of approximately 500 children.

4.2. Study population and data collection

Data are collected every two months by ten NGOs and the Bangladesh government from 26 sentinel points, corresponding to 20 rural subdistricts and 4 urban slums. In each round of data collection, 5000-6000 households are randomly selected, and anthropometric measurements are taken from 7,000-9,000 children between the ages of 6 and 59 months. Data for this study came from Mohanpur, Manda, Bhuapur and Dagonvhuiya subdistricts and the vital registration area of the NGOs Association for Social Advancement (ASA), Shwanirvar Bangladesh and The Village Education Resource Centre (VERC). The study poplation of this study consisted of 1562 children ageg 6-59 months (834 boys and 728 girls). Sixty-seven subjects were excluded due to missing data leaving 1493 (804 boys and 689 girls) for the study.

Each NGO team is responsible for collecting data in two geographical areas where they are currently working. There, the teams measure all children between the ages of 6 and 59 months within selected households every two months. Data are collected on four aspects relevant to disaster preparedness and the prevention of nutrition-related blindness, including nutrition status, health status, socio-economic status and distress factors.

4.3. Anthropometry

Three measurements are taken for each child- weight, height, and MUAC - and are recorded together with the child's age and sex. From these data several indicators are created, including HA, WH and WA, expressed both as percentages of median values and as scores from the international reference population recommended for international use by the World Health Organization.

To determine weight, nude or lightly clothed children were weighed to the nearest 0.1-kg on CMS scales (CMS Weighing Equipment, Ltd., 18 Camden High St., London NW1 OJH, UK), which were regularly calibrated against standard weights. Recumbent and supine lengths were measured to the nearest 0.1-cm on a locally constructed two-track length board. The MUAC was measured to the nearest millimeter using TALC numeral insertion tapes (Teaching-Aids at Low Cost, TALC, PO Box 49, St. Labanas, Herts AL1 4 AX, UK). As the date of birth is seldom accurately known it was estimated by carefully interviewing the mother, by a standard technique using the Bengali calendar.

4.4. Health Status

Four health indicators are used in the NSP: prevalence of diarrhoea, night blindness, acute respiratory infection, and vitamin A capsule distribution coverage. Data on the prevalence of diarrhoea, history of night blindness, and receipt of vitamin A capsules in the previous two or six months are obtained by a history from the mother or adult care taker of the child. The prevalence of diarrhoea is defined as three or more liquid or semiliquid stools in the last 24 hours. Since August 1991, data have also been collected to determine the prevalence of acute respiratory tract infection.

4.5. Socio-economic status

The indicators selected for the NSP are family size; number of children under five years old; occupation of the head of the household; previous week's salary of the main earner for those who are dependent on daily wages or services; years of education of adult household members; type, size, and actual value of the main living house; and amount of agricultural and homestead land owned. A landless household is defined as one with no agricultural land at all.

4.6. Field worker training

From the very onset the NSP incorporated extensive training: both training for the initial implementation of activities and refresher courses throughout the project. The initial training sessions of the data-collection teams were held in March 1990 and were organized into four one-week periods. Separate protocols were designed for the field supervisors and the assistant field officers. The workers received detailed instructions regarding anthropometric measurements and administering the questionnaire covering socio-economic status. Emphasis was placed on ensuring that the workers were aware of the objectives and importance of the surveillance system.

In addition to the initial training sessions, field manuals were prepared and printed both in English and in Bengali. Manuals have been developed for anthropometry. Bimonthly refresher training courses were established for field teams, who came to Dhaka to interact with HKI trainers and to share experiences from the field. During these sessions, the results of data collection were presented. Problems associated with data quality were shared and when necessary, the sources of problems were identified and resolved.

4.7. Quality control

For each round of data collection, an HKI monitoring team visits the field sentinels points for each NGO. Each is responsible for two to three NGOs, checking and calibrating equipment, and supervising the data collection and anthropometric measurements. Detailed monitoring checklists are maintained to verify whether appropriate techniques are being employed for each component of data collection.

In addition, during each round of data collection by the NGOs, a quality control team conducts random, unannounced visits to the sentinel points. The teams select a 5%-10% subsample of the children who have been measured and repeat the measurements the next day. The data collected by the HKI anthropometrist are compared with those of the NGO field worker, and the differences in observations are registered. The average differences for weight, height, MUAC, and age are detailed for each NGO team. The mean error (for each team) and standard deviation (across all NGOs field teams) are compared every month for the four measurements.

4.8. Data Entry

A key component of the NSP is the timely reporting and dissemination of data, which is heavily dependent on appropriate mechanisms for the rapid processing and analysis of data. This has been no small task, given that the data collection involves a number of independent NGOs, each operating in different regions of the country. To facilitate data processing, a standardized data entry/management software package was developed by HKI, and all data entry operations are under taken by clerks hired exclusively for the NSP in the field offices of the associated NGOs.

The data entry programmes have a number of quality controls, including validity checks, duplicate detection, and verification procedures, written in FoxPro and provided to each NGO at the time of clerk training, when all programmes were introduced and standardization exercises performed. A series of five data base files is prepared for each round of data collection for each NGO. Once completed, the files are transferred to the HKI office in Dhaka, where they are converted to SPSS system files, from which all analyses are executed.

4.9. Statistical Analysis

Anthropometric indices – HA, WH and WA – were created as percentage of the standard (median) on the basis of National Centre for Health Statistics reference (20) from the software.

Data analyses were performed with Statistical Package for Social Science (SPSS version 8.0). Bivariate logistic regressions were used to examine the relationships between socio-economic status (i.e. independent variables) and nutritional status (i.e. dependant variables) of the child. Variables significant in the bivariate logistic regression were included in multiple logistic regression analyses, where possible associated factors were evaluated simultaneously. The logistic regression analyses were constructed with stunting, wasting and underweight as dichotomous variables. The final model was built in a backward stepwise approach until those retained were significant (confidence interval not including 1).

5. Results

5.1. Prevalence of stunting, wasting and underweight

The mean Z-score for HA, WH and WA were –2.16, -1.10, and -2.15 respectively.
The prevalence of stunting and underweight (<-2SD of the WHO growth curve) were high (56% and 59%, respectively), while the prevalence of wasting was considerably lower (11%).

The results showed that for the whole study population, there was no significant sex difference with regard to stunting, wasting, or underweight (Fig 1). When analysed for each age-group separately it appeared that there were more boys than girls that were wasted and underweight in age-group 6-23 (table 2).

Prevalence of stunting, wasting, and underweight varied somewhat with age. The prevalence of stunting and underweight increased until 3 years of age and then decreased while wasting showed an opposite pattern (fig 2).

The average MUAC was higher among boys (14.3cm) than among girls (14.0cm). Prevalence of low MUAC was more than 4% among the children, showing no major variation by sex (fig.3).

5.2 Socio-economic situation and malnutrition

Table 3 presents anthropometric indices of the children in relation to socio-economic status of the parents. The results show that 42% of the fathers and 55% of the mothers did not have any formal education at all. Of those who were educated, a majority had an educational level below college level. Children of mothers without any formal education had the highest proportion of underweight (36%), stunting (34%) and wasting (6%), whereas a relatively low proportion of children of mothers and fathers with secondary school or above were underweight, stunted or wasted. The occupation of the main earners were farming, shop owners, salary worker, share cropper, rickshaw/cart/van puller/boatman, fisherman and salaried worker. The highest proportion of underweight, stunting and wasting occurred in the farmer and labour group. Twenty seven percent of the children who lived in medium size families were underweight, whereas stunting and wasting occurred among 25% and 5%, respectively.

About 67% of the respondents belong to a landless and marginal category and only 15% had more than 150 decimals of land. The proportions of underweight, stunting and wasting in the children were highest in the landless group.

Eighty percent of the total households did not have a bicycle, and 71% did not have a TV or radio. In this group, more children were stunted, wasted and underweight.

Dwelling space was considered as the sole indicator of the household socio-economic status, because in a separate study, it was found to be a good proxy for household economic resources in the area (21). In that area, 37% of the main living houses were

less than 181 feet. More than 35% villagers had big houses (300+ feet) where almost 30% of the people lived in medium size house (181-300 feet). In rural Bangladesh, Pucca houses are rare. Only four percent of the villagers lived in Pucca houses whereas almost 40% of them lived in mud wall/tin/straw/talley roof and tin roof with stick, bamboo, and straw made house. Underweight, stunting and wasting were most common among children with medium type of house.

5.3. Relationship between socio-economic and nutritional status

In a bivariate logistic regression analyses, Stunting and underweight was significantly associated with education of the parents, occupation of the main earner, ownership of land, ownership of bicycle and Radio/TV, type of house and place of defecation. Multivariate analyses showed that mother's education, bicycle ownership, type of house and place of defecation were all significantly associated with stunting and underweight. The association between stunting, wasting and father's education, occupation of the main earner, ownership of land, ownership of Radio/TV, housing space became non-significant.

6. Discussion

This study has shown that 56% of the children under five years of age in four subdistricts, Bangladesh were stunted, while 59% were underweight and 11% were wasted. As expected, there was a positive association between anthropometric indices and various expressions of poverty, especially between poor housing quality, low educational level of the mother.

The worldwide variation of prevalence of low HA (below -2SD of the NCHS/WHO reference) is considerable, ranging from 5 to 65% among the less developed country (7). In many such settings, prevalence starts to rise at the age of about 3 months; the process of stunting slows down at around 3 years of age, after which mean heights tend to run parallel to the reference. In contrast to low HA, low WH in non-disaster areas is of relatively constant prevalence, usually less than 5% (7).

In this study well-trained staff under close supervision performed the anthropometric measurements. More than three standardisation sessions were performed to control the accuracy and precision of the measurements and the results was satisfactory. The quality of age information, based on date of birth, was carefully controlled. In the calculation of anthropometric Z-scores it was observed, that only one child had extreme and probably incorrect values, indicating an overall high quality of the performed measurements.

The study confirms the frequently demonstrated association between conditions of poverty and stunting (height-for-age<-2SD). The different characteristics of the socio-economic conditions of the household are closely related and not easily separated in relation to stunting and underweight of the child. It is beyond the scope of this study to analyse the immediate causes of stunting, underweight, which may include the nutritional situation during foetal growth, feeding habits and dietary intake, exposure to infections and other conditions over time.

The association between low anthropometric measures and social conditions of individuals and households is well-documented (22,23).

Chowdhury (24) followed up nearly 200 children aged 13 to 23 months from 86 villages in Matlab field station of the ICDDR, B, for about 2 years. The proportion of severely malnourished children was significantly higher among illiterate than literate mothers. The conclusions of some other studies (25-41), which report a significant relationship between mother's education and stunting, also support the findings in this present study.

In a society where food availability is determined only by family economic resources and not by any sustained charity or welfare programme, the observed association is much as expected. It may be noted that housing condition may be regarded as a proxy for fixed assets. This may be the reason why the relationship between housing condition and WH, which is reflecting short-term health, was not significant in table 6.

In conclusion we found that more than half of the children in this study were stunted and underweight. Prevalence of stunting and underweight were high in comparison with previous studies from other countries. The growth retardation implied by the growth retardation may be a sign of seriously impaired health of these children, as well as a sign of increase risk of mortality. A child living in a poor household or with a low educated mother is more prone to be stunted and underweight. It is noteworthy that the stunted children had been growth monitored to the same extent as non-stunted children indicating that growth monitoring alone is not sufficient to protect the child from malnutrition. There is a need to develop adequate intervention strategies, where the child health services could be on of the entry-points. However, preventive measures improving standard of housing and educational level of the families are undoubtedly the most important efforts.

7. Acknowledgements

I would like to acknowledge the Department of Public Health and Clinical Medicine, Epidemiology, Umeå University, Sweden, for providing a rare opportunity to pursue a Master degree in Public Health.

I wish to express my sincere gratitude and appreciation to my wonderful parents and my family for always giving me unconditional support and love, and for helping me make my dreams become reality. They have been my strength and my inspiration. There is no greater love than the love of a family. I love them, always.

Special thanks go to Erik Bergström, my supervisor whose advice, guidance, directions, vision and critical reading of this thesis; revealed a reservoir of epidemiological knowledge and analytical skills.

I am also grateful to S.M. Ziaudding Hyder and Mostaque Ahmed of BRAC, Bangladesh for their support and providing me with data on my topic.

I would like to express my warmest thanks and appreciation to my friend Jahangir Khan and Shahnaz Afroze for the unconditional support for myself. A special recognition goes to Niaz Ahmed for encouraging me.

I would also extend my thanks to Ishrat Hasan Tina for sharing wisdom and most of all, friendship with me. I am eternally grateful for all her support and encouragement.

Last but not least, to all my friends from around the world who I met in Umeå and wish to keep in contact with, who have made my stay in Umeå most memorable; and to my friends who have given me warmth through the electronic mail.

8. References

1. Walsh, J A, Warren K. Selective primary health care: an interim strategy for disease control in developing countries. Soc Sci Med 1980; 145-63.
2. UNICEF. The state of the world's Children, Oxford: Oxford University press, 1991.
3. Mosley W H, Chen L C. An analytical framework for the study of child survival in developing countries. In: Population and Development Review – Child Survival: Strategies for Research, Mosley W H, Chen L C (eds). 10 (suppl): 25-45.
4. FAO, Livs in peril, protein and child. Food and Agriculture Organization of the United Nations, Rome 1970; 298:1607-11.
5. Puffer R, Serrano C V. Patterns of Mortality in Childhood. Washington, DC: Pan American Health Organization. Pan American Sanitary Bureau, 1973.
6. WHO. Physical status: The use and interpretation of anthropometry. WHO Technical Report Series, no. 854 Geneva: World Health Organization, 1996.
7. Health profile Bangladesh, Health Division, Department of Democracy and Social Development, Sida, Zarina Kabir, Göran Thomson, IHCAR, 1995; 4).
8. Stewart NM, Fauveau V, Chakraborty J et al. Post floods nutritional anthropometry of children in Matlab, Bangladesh. Ecol. Food Nutr 1990; 24:121-31.
9. Mason J, Habitch JP, Tabatabai H, Valverde V. Nutritional surveillance. Geneva: WHO, 1984.
10. SCN/AGN. Suggested approaches for nutritional surveillance for the inter-agency Food and Nutritional Surveillance Programme. Food and Nutr Bull 1989; 11(2): 62-73.
11. Tucker K, Pelletier D, Rasmussen K et al. advances in nutritional surveillance: the Cornell Nutritional Surveillance Program 1981-1987. CFNPP Monograph 98-2. Ithaca, NY, USA: Cornell University, 1989.
12. BBS. Report of the child nutrition survey, 1985-86. Bangladesh Bureau of Statistics, Government of People's Republic of Bangladesh, Dhaka, Bangladesh, 1987.

13. Chowdhury AKMA. Child mortality in Bangladesh: food versus health care. Food Nutr Bull 1988; 10(2): 3-8.
14. Schulz LO, Csele J. Nutrition concerns in Bangladesh: the focus for improvement. Progr Food Nutr Sci 1990:14:259-76.
15. Mannan MA. Mother and child health in Bangladesh: Evidence from field data. BIDS Research report no.117. Dhaka, Bangladesh: BIDS, 1990.
16. Radheshyam. A comparison of five anthropometric indices for identifying factors of malnutrition. American Journal of Epidemiology 1987, 126(2): 258.
17. Kasango Project Team. Anthropometric assessment of young children's nutritional status as an indicator of subsequent risk of dying. J Trop Pediatr 1983; 29: 69-75.
18. WHO. Physical status: The use and interpretation of anthropometry. WHO Technical Report Series, no. 854 Geneva: World Health Organization, 1996.
19. Jelliffe, P E P, Jelliffe D B. The arm circumference as a public health index of protein-calorie malnutrition. J Trop Paediarr 1969; 15: 179-88.
20. National Centre for Health Statistics. NCHS growth curves for children birth – 18 years, United States. Washington, DC: US Department of Health, Education and Welfare, 1977. (Vital and health statistics, series II)(DHEW publication no. (PHS) 78-1650.
21. Islam M S, Becker S. Interrelationship among certain socio-economic variables in a rural population of Bangladesh. Rural Demography 1979; 6:51-65.
22. Vitora C G, Vuaghan P, Kirkwood B R, Martines J C and Barcelos L B. Risk factors for malnutrition in Brazilian children: the role of social and environmental variables. Bull WHO 1986; 64:299-309.
23. Radheshyam Bairagi and Mridul K chowdhury. Socio-economic and thropometric status, and mortality of young children in Rural Bangladesh. International Journal of Epidemiology 1994:23.
24. Chowdhury, A.K.M.A. (1984), "Differentials of child Mortality in Bangladesh: Food Versus Health Care", Paper presented at the IUSSP/NIRA joint seminar on Biological and Social Correlates of mortality, Tokyo, 24-25 November 1984.
25. UNICEF. State of the World's children. New York: Oxford University Press, 1998.
26. World Health Organisation. Third report on the world nutrition situation: Stunting and young child development 1997:3-18

27. Margetts and Nelson. Design Concepts in Nutritional Epidemiology. 2nd Ed. New York: Oxford University Press. UK;1997
28. LH Allen ET al. Nutritional influences on linear growth; a general review. European Journal of Clinical nutrition 1994;48: 75-89
29. TM Skerry. The effect of the inflammatory response on bone growth, European Journal of Clinical Nutrition 1994;48:190-198
30. Porrini M, Walter P. Nutrition in pregnancy and growth. Bibl Nutr Dieta. Basel, Krager. 1996;53:45-54
31. Golden M.H.N. Is complete catch-up possible for stunted malnourished children? European Journal of Clinical Nutrition 1994; 48:58-71
32. Martorell R et al. Reversibility of stunting: epidemiological findings in children from developing countries. European Journal of Clinical Nutrition 1994; 48: S45-S57
33. Bairgagi et al. Alternative anthropometric indicators of mortality. American Journal of Clinical Nutrition 1985; 42:296-306
34. Jelliffe DB et al. Community nutrition assessment. London: Oxford academy press;1990
35. Downie et al. Are short normal children at a disadvantage? The Wessex growth study. BMJ 1997; 314:97-100
36. Frongillo EA et al. Socio-economic and demographic factors are associated with world-wide patterns of stunting and wasting 1997;127(12):2302-9
37. Panter-Brick L et al. Growth status of homeless Nepali boys. Do they differ from rural and urban controls? Soc Sci Med. 1996;Vol.43:pp441-551
38. Pan America Health Organisation. Country health profiles: Nicaragua. Http.//www.paho.org/English/nicarag.htm
39. Oberhelman et al. Correlation's between intestinal parasitosis, physical growth, and psychomotor development among infants and children from rural Nicaragua, Am J Trop Med Hyg. 1998; 58(4):470-275
40. Pena R et al. Infant mortality in transitional Nicaragua; inequity adds to the importance of absolute poverty. In press
41. Sandiford P. Does intelligence account for the link between maternal literacy and child survival. Soc Sci Med. 1997;8:1231-1239

9. List of Tables and Figures

Table 1 Height-for-age, weight-for-height and weight-for-age Z-score among the children under 5 years of age in rural Bangladesh.

Indices	<-2SD(%)	Mean Z-score (SD)	
Height-for-age	56.1	-2.16	(1.29)
Weight-for-height	11.1	-1.10	(0.81)
Weight-for-age	58.8	-2.15	(0.92)

Table 2 Prevalence of children <5 years of age who were classified as stunted, wasted and underweight according to anthropometric indices of nutritional status; height-for-age, weight-for-height and weight-for-age.

Age Group	No	Stunted		Wasted		Underweight	
(months)		Boys	Girls	Boys	Girls	Boys	Girls
6-23	405	128(59.0)	97(51.6)	38(17.5)	20(10.6)	132(60.8)	98(52.1)
24-35	330	102(60.4)	92(57.1)	22(13.0)	16(9.9)	104(61.5)	113(70.2)
36-47	316	104(59.8)	88(62.4)	8(4.6)	12(8.5)	98(43.7)	85(60.3)
48-60	442	123(50.6)	103(51.8)	28(11.5)	22(11.1)	139(57.2)	109(54.8)
Total	1493	457(56.9)	380(55.2)	96(12.0)	70(10.2)	473(58.7)	405(58.8)

Table 3 Socio-economic status and nutritional status of the child. Background factor in relation to stunting, wasting and underweight (n=1493).

Variable	No	(%)	Stunted	Wasted	Underweight
Father's Education :					
No	627	(42)	25.6	4.4	27.4
Primary	317	(21)	13.2	2.6	13.0
Secondary/college	374	(25)	12.2	2.4	12.6
Functional	146	(10)	5.2	1.6	5.6
Mother's Education :					
No	825	(55)	33.8	6.3	35.7
Primary	322	(22)	11.2	2.1	11.7
Secondary/college	219	(15)	7.3	1.7	7.7
Functional	118	(8)	3.8	1.1	3.8
Occupation of the main earner :					
Labour	512	(34)	21.5	4.2	22.9
Farmer	534	(36)	19.4	3.7	20.4
Businessman	247	(17)	8.8	1.9	9.2
Salary worker	168	(11)	6.1	1.2	5.9
Unemployed	10	(1)	0.5	0.1	0.6
Family Size :					
5-7	656	(44)	25.3	5.3	27.0
2-4	524	(35)	19.4	3.5	20.2
8+	313	(21)	11.5	2.3	11.7
Number of children under 5 years of old :					
1	821	(55)	30.9	5.4	32.1
2	574	(38)	22.2	4.6	23.3
3-5	98	(7)	3.0	1.1	3.4
Land owned in decimals :					
0	690	(46)	27.7	5.5	29.5
1-50	317	(21)	11.6	2.1	11.7
51-150	269	(18)	9.9	2.1	10.5
151 +	217	(15)	7.0	1.5	7.2
Ownership of Bicycle :					
No	1200	(80)	46.9	9.2	49.5
Yes	292	(20)	9.2	1.9	9.3
Ownership of Radio/TV :					
No	1061	(71)	41.3	7.8	43.3
Yes	430	(29)	14.9	3.3	15.5

Housing Space :					
<181-	545	(37)	21.2	4.2	21.6
300+	531	(36)	18.8	3.4	19.2
181-300	417	(28)	16.1	3.5	18.0
Type of main house :					
Type II (med)	1159	(78)	44.5	8.2	46.1
Type I (better)	212	(14)	6.4	1.5	6.8
Type III(low)	121	(8)	5.2	1.4	5.9
Place of defecation :					
Open latrine	794	(53)	31.9	6.4	33.6
Elsewhere	353	(27)	12.7	2.7	13.6
Close latrine	346	(23)	11.5	1.9	11.7

Table 4 Relationship between Socio-economic variables and Stunting: Odds ratios (OR) and 95% confidence intervals (CI) are given according to logistic regression analysis.

Variable	n	Bivariate analysis		Multivariate analysis	
		OR	95% CI	OR	95% CI
Father's Education					
Secondary/college	374	1.00			
Primary	317	1.71	1.26-2.32		
Functional	146	1.19	0.81-1.75		
No	627	1.64	1.26-2.12		
Mother's Education					
Secondary/college	220	1.00		1.00	
Primary	322	1.08	0.77-1.52	0.62	0.41-0.93
Functional	118	0.95	0.61-1.49	0.74	0.56-0.96
No	825	1.58	1.17-2.13	0.82	0.58-1.14
Occupation of the main earner					
Businessman					
Farmer	247	1.00			
Salary worker	534	1.05	0.78-1.43		
Labour	168	1.05	0.71-1.56		
Unemployed	512	1.47	1.08-2.00		
	10	2.13	0.54-8.44		
Family Size					
2-4	524	1.00			
5-7	656	1.09	0.86-1.37		
8+	313	0.97	0.73-1.28		
Number of children under 5 years of old					
1	821	1.00			
2	574	1.05	0.85-1.31		
3-5	98	0.65	0.42-1.00		
Land owned in decimals					
151+	217	1.00			
51-150	269	1.33	0.93-1.90		
1-50	317	1.30	0.92-1.84		
0	690	1.62	1.19-2.20		
Ownership of Bicycle					
Yes	292	1.00		1.00	
No	1200	1.58	1.22-2.04	1.38	1.05-1.81
Ownership of Radio/TV					
Yes	430	1.00			
No	1061	1.29	1.03-1.62		
Housing Space :					
300+	555	1.00			
181-300	393	1.18	0.91-1.53		
<181-	545	1.20	0.95-1.53		
Type of main house					
Type I (better)	212	1.00		1.00	
Type II (med)	1159	1.65	1.23-2.21	1.56	1.14-2.14
Type III(low)	121	2.23	1.41-3.54	1.78	1.09-2.90
Place of defecation					
Close Latrine	346	1.00		1.00	
Open Latrine	794	1.51	1.17-1.95	1.30	0.99-1.71
Elsewhere	353	1.18	0.87-1.58	0.99	0.71-1.37

Table 5 Relationship between Socio-economic variables and Underweight: Odds ratios (OR) and 95% confidence intervals (CI) are given according to logistic regression analysis.

Variable	n	Bivariate analysis		Multivariate analysis	
		OR	95% CI	OR	95% CI
Father's Education					
Secondary/college	374	1.00			
Primary	317	1.55	1.14-2.09		
Functional	146	1.31	0.89-1.92		
No	627	1.81	1.40-2.35		
Mother's Education					
Secondary/college	220	1.00		1.00	
Primary	322	1.09	0.77-1.54	0.50	0.33-0.75
Functional	118	0.84	0.54-1.31	0.72	0.55-0.94
No	825	1.67	1.24-2.25	0.79	0.56-1.12
Occupation of the main earner					
Businessman					
Farmer	247	1.00			
Salary worker	534	1.05	0.77-1.41		
Labour	168	0.88	0.59-1.30		
Unemployed	512	1.54	1.13-2.10		
	10	7.31	0.91-58.36		
Family Size					
2-4	524	1.00			
5-7	656	1.17	0.93-1.47		
8+	313	0.92	0.69-1.22		
Number of children under 5 years of old					
1	821	1.00			
2	574	1.09	0.88-1.36		
3-5	98	0.80	0.54-1.22		
Land owned in decimals					
151+	217	1.00			
51-150	269	1.41	0.99-1.02		
1-50	317	1.22	0.87-1.73		
0	690	1.77	1.30-2.41		
Ownership of Bicycle					
Yes	292	1.00		1.00	
No	1200	1.36	1.36-2.28	1.51	1.15-1.98
Ownership of Radio/TV					
Yes					
No	430	1.00			
	1061	1.34	1.07-1.68		
Housing Space					
300+	555	1.00			
181-300	393	1.47	1.13-1.92		
<181-	545	1.20	0.94-1.52		
Type of main house					
Type I (better)	212	1.00		1.00	
Type II (med)	1159	1.57	1.17-2.11	1.42	1.03-1.95
Type III(low)	121	2.87	1.77-4.65	2.28	1.36-3.81
Place of defecation					
Close Latrine	346	1.00		1.00	
Open Latrine	794	1.70	1.31-2.19	1.46	1.11-1.92
Elsewhere	353	1.34	0.99-1.80	1.21	0.87-1.68

Table 6 Relationship between Socio-economic variables and Wasting: Odds ratios (OR) and 95% confidence intervals (CI) are given according to logistic regression analysis.

Variable	n	Bivariate analysis		Multivariate analysis	
		OR	95% CI	OR	95% CI
Father's Education					
Secondary/college	374	1.00			
Primary	317	0.89	0.58-1.37		
Functional	146	1.18	0.77-1.80		
No	627	1.70	1.02-2.82		
Mother's Education					
Secondary/college	220	1.00			
Primary	322	0.99	0.62-1.59		
Functional	118	0.83	0.54-1.27		
No	825	1.22	0.69-2.15		
Occupation of the main earner					
Businessman					
Farmer	247	1.00			
Salary worker	534	1.15	0.14-9.42		
Labour	168	1.01	0.12-8.14		
Unemployed	512	1.01	0.12-8.49		
	10	1.24	0.15-9.95		
Family Size					
2-4	524	1.00			
5-7	656	0.92	0.58-1.45		
8+	313	1.12	0.73-1.72		
Number of children under 5 years of old					
1	821	1.00			
2	574	1.22	0.87-1.72		
3-5	98	1.91	1.08-2.40		
Land owned in decimals					
151 +	217	1.00			
51-150	269	1.15	0.65-2.05		
1-50	317	0.94	0.54-1.70		
0	690	1.19	0.73-1.96		
Ownership of Bicycle					
Yes	292	1.00			
No	1200	1.16	0.76-1.78		
Ownership of Radio/TV					
Yes	430	1.00			
No	1061	0.96	0.67-1.37		
Housing Space					
300+	555	1.00			
181-300	393	1.26	0.84-1.90		
<181-	545	1.18	0.81-1.74		
Type of main house					
Type I (better)	212	1.00			
Type II (med)	1159	1.02	0.63-1.65		
Type III(low)	121	1.81	0.95-3.45		
Place of defecation					
Close Latrine	346	1.00			
Open Latrine	794	1.26	0.84-1.90		
Elsewhere	353	1.18	0.81-1.74		

Figure 1 Prevalence of stunting, wasting and underweight by sex.

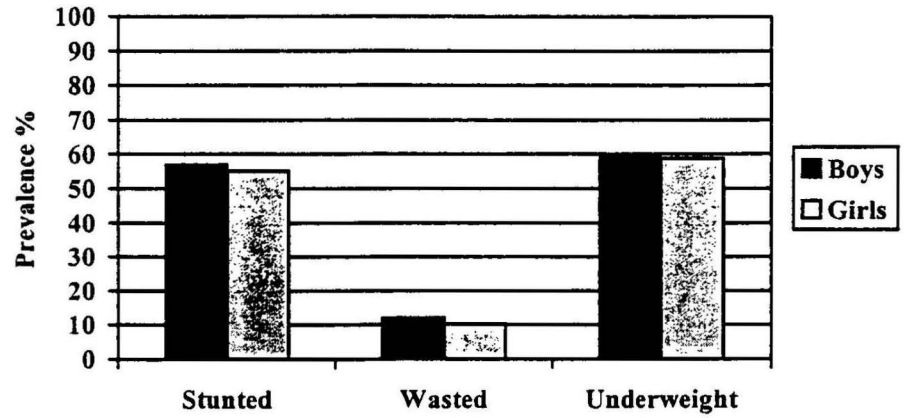


Figure 2 Nutritional status of children <5 years of age in Bangladesh.