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ORIGINAL PAPER

Post-Cyclone Sidr nutritional status of women and children in coastal Bangladesh: an empirical study

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Abstract Cyclone Sidr, a Category 4 storm, struck the southwestern coast of Bangladesh on November 15, 2007, causing 3,406 deaths, 2.51 million acres of crop damage, and aggregated damage of US$1.7 billion. It significantly damaged household food availability and increased post-cyclone nutritional insecurity. This study assesses the nutritional status of household and explores influences of various socioeconomic variables on nutritional security. More specifically, it explores the impact of the cyclone on short-term nutritional status of women of reproductive age and children under 5 years. For this study, 331 households living in three villages devastated by Cyclone Sidr were selected. The nutritional status of women of reproductive age was measured based on body mass index, and that of children aged 6–59 months was measured based on weight-for-height (wasting), height-for-age (stunting), and weight-for-age (underweight). This study found that the nutritional status, along with other household characteristics, of the study groups was not remarkably different across the three selected villages. Findings of this study further suggest that the nutritional security situation was not much changed in the post-cyclone period compared with the pre-cyclone period primarily because of rapid and effective distribution of essential food items among cyclone survivors by the government of Bangladesh along with donor and other organizations. However, nutritional insecurity was more prevalent in the island village relative to inland and coastline villages. Similarly, fishermen were found to be the most vulnerable to nutritional insecurity in the post-cyclone period. Several recommendations are made to improve food aid distribution in the aftermath of a cyclone.

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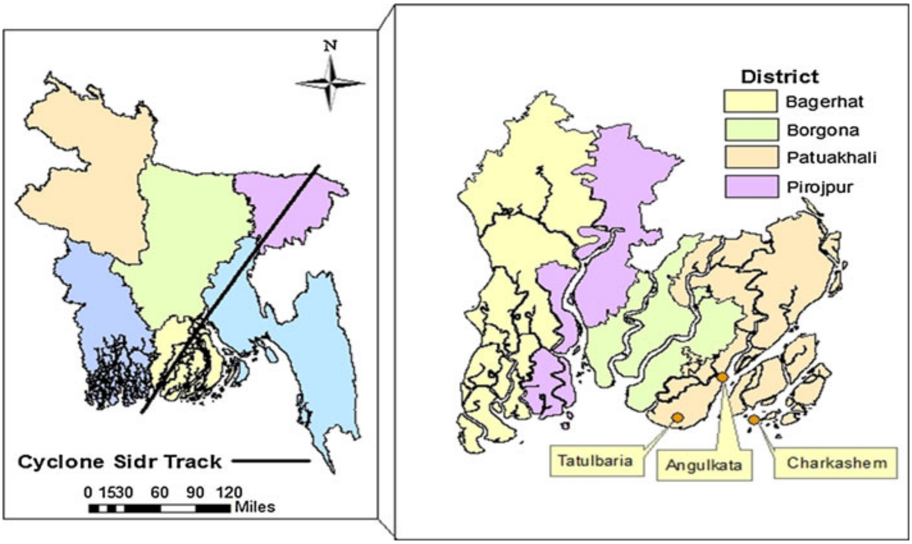

Fig. 1 Cyclone Sidr cyclone path and study villages

Keywords Nutritional status · Women of reproductive age · Children under 5 years of age · BMI · Stunting · Wasting · Cyclone Sidr · Bangladesh

1 Introduction

The entire coast of Bangladesh is vulnerable to deadly tropical cyclones and their associated storm surges. On the night of November 15, 2007, Cyclone Sidr, a Category 4 storm, made landfall across the southwestern coast and traveled through the heart of the country from the southwest to the northeast (Fig. 1). It weakened quickly into a tropical storm and dissipated on November 16 (Paul 2009). With winds recorded as strong as 248 km per hour, it triggered storm surges as high as 7.5 m in some coastal districts.[1] Cyclone Sidr caused 3,406 deaths, and over 55,000 people sustained physical injuries (GoB 2008a). An estimated 1.87 million livestock and poultry perished, and crops on 2.51 million acres have suffered complete or partial damage.[2] Livestock provides both livelihood and protein source for rural people in Bangladesh, particularly the poor. In addition, the cyclone washed away private food stockpiles and storages and destroyed 1.4 million fruit trees. Increased salinity, caused by storm surges during the cyclone and soil deposition, has further hampered agricultural productivity. All these significantly decreased cyclone survivors' purchasing power and access to daily subsistence (GoB 2008a).

The Joint Damage Loss and Needs Assessment Mission, led by the World Bank, estimated the total cost of the damage caused by Cyclone Sidr at $1.7 billion, a figure which represents about 3 % of the annual gross national product of Bangladesh (GoB 2008a). More than two-thirds of the disaster effects were physical damages and one-third were

[1] A district is the second largest administrative unit in Bangladesh, with an average population of 2.5 million.

[2] The cyclone struck right before rice harvesting time.

economic losses, with most damages and losses incurred in the housing sub-sector followed by the agriculture sub-sector (Paul 2011). The effects of the cyclone were highly concentrated in the districts of Bagerhat, Barguna, Patuakhali, and Pirojpur (Fig. 1). All coastal districts, including the affected ones, suffer from higher poverty rates than the national average (GoB 2008b).

Cyclone Sidr severely affected over 7.46 million people (GoB 2008a). According to a rapid emergency assessment completed by UN officials, 2.6 million people were found to be in need of immediate food assistance across the affected areas (WFP 2007). The officials highlighted the large-scale loss of standing crops, family food stocks, and livestock. These losses were compounded by the virtual collapse of already meager wage-earning opportunities in a region that suffers from malnutrition rates above the national average (GoB 2008b). Additionally, food commodity prices increased in the immediate aftermath of Cyclone Sidr in the affected areas. For example, wheat flour prices were up approximately 11 %, lentils 11 %, imported rice 10 %, and local rice 8 % (WFP 2007).

Considering the grave situation, within three months of Sidr's landfall, the Bangladesh government distributed 17,290 metric tons (MT) of rice to the residents of the affected coastal area by road or via airdrops. In addition, the government distributed 4,500 packets of dry food, 450 MT of dates, and 1,200 MT of chickpeas among cyclone-impacted households. The World Food Program (WFP) distributed more than 300 tons of high-energy biscuits and other food items, including 430 MT of rice (GoB 2008b). The government together with UN bodies and non-governmental organizations (NGOs) established both mid- and long-term programs to ensure food assistance to cyclone-affected households.

While various aspects of Cyclone Sidr have received the attention of hazard researchers (e.g., Paul 2009, 2010; Paul and Dutt 2010; Paul and Routray 2010a; Islam et al. 2011), post-cyclone nutritional status among residents of the affected areas has not been the focus of any study. To address this research gap, this paper will assess the nutritional status of households in the post-Sidr period. More specifically, it explores what impact this event had on nutritional status of two groups of survivors—women of reproductive age (15–49 years) and children under 5 years of age (6–59 months). This paper also examines how different household socioeconomic and demographic characteristics influence nutritional status of women of childbearing age and young children. These two population groups are selected because members of these groups are especially vulnerable to nutritional deficits. Findings of this study should provide useful guidelines for further interventions and targeting nutritionally insecure population with more effective post-disaster nutrition-related programs.

2 Disasters and nutritional status: an overview

Natural disasters such as tropical cyclones or hurricanes severely affect the nutritional status of the impacted population, which is a crucial determinant of household health outcomes (del Ninno and Dorosh 2002; O'Donnell et al. 2002). Household food consumption is often severely disrupted in the immediate aftermath of a disaster because of several factors, which are grouped into three classes: basic, underlying, and immediate cause (Fig. 2). Disasters frequently damage or destroy standing crops, vegetables, and fruit trees. In addition, some natural disasters, such as cyclones and associated storm surge, damage, wash away, or spoil stored food. Rural residents also often experience loss of livestock due to natural disasters. All these factors are responsible for acute shortage of

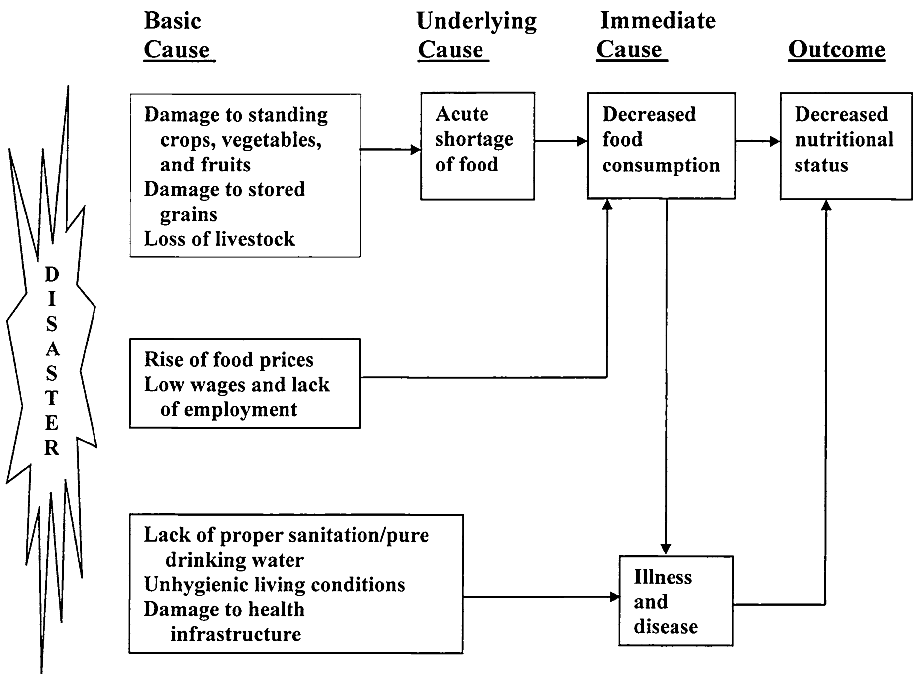

Fig. 2 Factors affecting post-disaster food consumption

food at the household level, particularly for poor households (del Ninno and Dorosh 2002; Paul and Routray 2010a, b).

In the aftermath of severe disasters, the price of food grain generally increases (WFP 2007). Studies (e.g., Torlesse et al. 2003) established positive relationship between malnutrition rates and high food prices. As prices rise, disaster-affected households, particularly poor ones, typically reduce their purchase and consumption of food items such as vegetables, fruits, meat, and pulses. Affected households also compromise their food consumption by relying on cheaper and less nutritional food, reducing amount, and the number of meals consumed in a day. With fewer nutrient-rich foods in one's diet, food consumption related-malnutrition normally worsens (WFP 2007).

Similar to food prices, in the immediate aftermath of a disaster, the unemployment rate generally increases and wages drop in the impacted area (Paul 2011). These outcomes are also true during slow onset disasters, such as floods. Decrease in employment opportunities along with low wages means decreased food consumption for households that survive a natural disaster (Fig. 2). It should be noted that irrespective of socioeconomic conditions, people in rural areas of developing countries generally sell a portion of their agricultural and livestock products in the market to buy some agricultural and non-agricultural items, such as clothing. Loss of crops and livestock due to natural disasters also reduces their earnings, leading to reduced food consumption in the aftermath of a disaster (see Fig. 2).

Natural disasters frequently cause a severe deterioration in the quality and supply of drinking water and disruption of the operation of sanitation facilities. Drinking water sources may become contaminated by the carcasses of domestic animals and dead fish. In the case of cyclones, surface water resources (e.g., ponds, canals, and rivers), generally the main source of drinking water in coastal areas, are often contaminated by saline intrusion.

During floods, waters are often polluted with contaminants, allowing vectors of disease and bacteria to flourish. Floodwaters frequently contain a mixture of debris, raw sewage, and toxic chemicals (Few and Matthies 2006; Paul and Routray 2010a; Paul 2011; Caldin and Murray 2012). Because of the partial or complete destruction of their homes, disaster survivors in developing countries are forced to live in temporary make-shift shelters—often for an extended period of time. Living in such damp and unsanitary shelters in cramped conditions poses a serious threat to overall health and well-being (Paul et al. 2011).

Natural disasters also damage or destroy health infrastructure, such as hospitals, medical clinics, and ambulatory services. As a result, it is difficult to provide necessary care to the survivors of natural disasters. Lack of proper medical attention may also result from absence or displacement of physicians and other health personnel as well as an insufficient supply of appropriate medicine (Paul 2011). All the conditions just mentioned increase the potential for the emergence of communicable, waterborne, and other diseases and illnesses (Fig. 2). Illnesses are also caused by damaged health infrastructure, such as hospitals, medical clinics, and ambulatory services. Because of either complete or partial damage to such facilities, it is difficult to provide necessary care to the ill. Lack of proper medical attention may also result from the absence of physicians and/or an insufficient supply of appropriate medicine in disaster-affected areas. Such conditions prolong suffering and may cause substantial weight loss—another link with decreased nutritional status (Paul et al. 2011).

Decreased nutrition is widely considered an important risk factor for malnutrition, which is widespread in developing countries (Fernandez et al. 2002; Reinhard and Wijayratne 2002; FAO 2005). The nutritional situation in these countries further worsens after a disaster due to decreased food consumption (del Ninno and Dorosh 2002; O'Donnell et al. 2002; IFRC and RCS 2011). As noted, natural disasters disrupt normal food production, damage existing food stocks, and interrupt income-earning activities (O'Donnell et al. 2002). All these lead to decreased food consumption, which, in turn, decreases the nutritional status of disaster survivors. Figure 2 illustrates that there are three main groups of basic causes. These are as follows: (1) damages caused by natural disasters, (2) consequent rise of food prices, non-availability of work and low wages, and (3) unhealthy environment and inadequate health services. The first group of basic causes directly influences the underlying causes and indirectly to immediate causes, while other two basic causes directly influence one of the two immediate causes. As noted, all disaster survivors suffer from lower nutritional intake in the aftermath of a natural disaster, but it is the women of reproductive age and under 5-year-old children who suffer the most. Any types of malnutrition and under-nutrition cause adverse health impacts of childbearing women and young children (Fernandez et al. 2002; Reinhard and Wijayratne 2002).

3 Data and methods

3.1 Selection of study villages

Three villages from two of the four most severely Sidr-affected districts in Bangladesh were selected for this study (Fig. 1). The selected villages are Angulkata of the Amtoli thana; Tatulbaria of the Taltoli thana, and Charkashem of the Rangabali thana.[3] The first

[3] A thana is the third largest administrative unit in Bangladesh, with an average population of 500,000.

two villages are located in the Barguna district, and the last one in the Patuakhali district. Charkashem is on an offshore island; Tatulbaria is located on the shoreline of the Bay of Bengal; and Angulkata is approximately 30 km away from the sea, on the bank of the river *Paira.* All three villages experienced storm surges ranging from 3.0 to 7.0 m. Angulkata and Tatulbaria are surrounded by polder. In contrast, the southern part of Charkashem is covered by mangrove trees planted under a coastal afforestation program. For the purpose of making locational distinctions, Angulkata is termed an inland village, Tatulbaria a shoreline village, and Charkashem an island village.

Of the 788 households in three selected villages, a sample size of 331 was determined using an assumed 95 % confidence level (Yamane 1967). The number of samples selected from Angulkata and Tatulbaria was proportional to their total household size. Due to its small size, all 47 households in Charkashem were selected for this study. The individual household was the study unit, and the households were selected from Angulkata and Tatulbaria using a simple random sampling procedure. Nutritional-related information was collected from women of reproductive age and children under 5 years of age from the selected households. Other relevant information was collected from the head of the selected households and local leaders through informal dialogue. One focus group discussion (FGD) was also held in each study village. Informal discussions and FGDs were conducted to gain additional insights regarding nutritional status at household and village levels.

3.2 Selection of nutritional status indicators

Two sets of nutritional status indicators have been selected in this study—one for the women of reproductive age and the other for the young children (6–59 months). The body mass index (BMI) is used here as the sole indicator of nutritional status of women age 15–49. This is a robust indicator and widely used in nutritional studies to measure nutritional status of women of reproductive age (Reinhard and Wijayratne 2002; NIPORT 2009). Height and body weight are carefully recorded to measure the BMI that characterizes underweight (malnutrition) or overweight women. BMI is a numerical measure of body mass based on weight and height of a person (Quetelet 1969). A BMI does not indicate actual body fat, but it approximates a person's healthy body weight based on height. Due to the simplicity in measurement and calculation, it is widely used as a diagnostic tool for identifying whether a person is underweight, normal weight, overweight, or obese. The main advantage of the BMI is that it does not require a reference table from a well-nourished population. Calculation of BMI includes body weight of individual divided by the square of individual's height. This formula is universally used in medical science to calculate a unit of measure of kilogram/meter square.

$$\text{Body Mass Index (BMI)} = \text{Body Weight in kilogram}/(\text{Height in meter})^2$$

The BMI is frequently used to assess the deviation of an individual's body weight from a "normal" or more desirable weight. Recommended distinctions or cutoff points along the linear scale may vary over time and space. Therefore, making a universal global longitudinal survey for BMI is problematic. Considering this limitation, the World Health Organization's (WHO) standard is used in the present study to identify the nominal categories of underweight, normal weight, overweight, and obese. According to WHO (1995), a BMI of less than 18.5 is considered underweight, a BMI 18.5–25 is normal, and a BMI greater than 25 is overweight; anything above 30 is regarded as obese. Women are considered severely malnourished if the BMI is lower than 17 (Reinhard and Wijayratne 2002; NIPORT 2009).

Three standard indices of physical growth are widely used to describe the nutritional status of children under age five. These are weight-for height (wasting), height-for-age (stunting), and weight-for-age (underweight) (Reinhard and Wijayratne 2002). Each of these indices provides different information about growth and body composition that can be used to assess nutritional status. Wasting reflects a deficit in weight relative to height, and epidemiological evidence suggests that the first response to a nutritional and/or infectious insult is weight loss (wasting), followed by retardation in linear growth (stunting) (Fernandez et al. 2002). Stunting describes a failure to receive adequate nutrition over a long period of time and is worsened by recurrent and chronic illnesses. Height-for-age reflects the long-term effects of malnutrition in a population and does not vary appreciably relative to recent dietary intake. Underweight is a composite index of weight-for-height and height-for-age. Thus, it does not distinguish between acute malnutrition (wasting) and chronic malnutrition (stunting) (NIPORT 2009). In the present case, a comparison of wasting with the other two indicators, particularly stunting, will indicate impact of Cyclone Sidr on the nutritional status of children under five.

Wasting of children under age five is assessed by comparing the weight of a malnourished child according to his/her height with the weight of a well-nourished child of the same height. This is one of the methods of defining acute malnutrition considering that there is no *edema* present. A normal and well-nourished child of a certain height can be expected to have a certain body weight. A series of such "normal" weights has been calculated and is considered to be 100 % of standard weight-for-height and used as a reference weight. Any child having *edema* is considered malnourished irrespective of body weight. Percentage weight-for-height is calculated using the following formula (Rahman 1994) that is,

$$\begin{aligned}\text{Percent weight-for-height} &= \text{Child's weight}\\ &\quad * 100/\text{Reference weight for same sex and height}\end{aligned}$$

Stunting is the height of a child expressed as a percentage of, or as a standard deviation from, the reference height of a child of the same age and sex. Age must be known to the nearest month. Stunting (short for age) is defined as a height-for-age of less than 90 % of the reference median. The calculation is as follows (Rahman 1994):

$$\text{Percent height-for-age} = \text{Child's height-for-age} * 100/\text{Reference height-for-age}$$

Finally, the last indicator, weight-for-age, is calculated by expressing the child's weight as a percentage of a reference weight for a child of the same age and sex (Rahman 1994). The formula is as follows:

$$\text{Percent weight-for-age} = \text{Child's weight for age} * 100/\text{Reference weight-forage}$$

For the purpose of accomplishing the objective of this study, height and weight of all children of the selected households aged 6–59 months were measured using appropriate instruments. Height was measured by tape with the child laying down on a flat bed. Weight was measured directly by standing the child on measuring scale. In some cases where the child was unable to stand on the measuring scale, weight of both mother and child was taken with the mother's weight then deducted from total weight. In rural Bangladesh, there is no provision for recording date of birth for new born children. For this reason, parents of participant children were asked about the date of birth of their children. "Recall error" on the part of the parents was not a problem because of the relatively short length of the reference period where they had to remember birth events only for the last 5 years. Additionally, the assumed problem of "recall error" was tackled using important local and national events that took place during the past five years. Considering the tradition that women in rural Bangladesh are generally reluctant to appear in front of any unknown person, a local woman was hired from each study village to take these measures needed to calculate BMI. All these measures were taken in October–November 2008 during a 2-month period.

4 Results

Socioeconomic and demographic information collected from 331 heads of sampled households reveals that about 90 % of all households were headed by a male, and the remaining 10 % by a female. Average age of the household head at the time of survey was 46 years, and average duration of stay in the study village for the head of the household was about 31 years. A majority of the household heads in island (86 %) and shoreline (64 %) villages migrated from other areas two to three decades ago. This type of migration is a common practice along coastal Bangladesh. More than 64 % of the household heads were illiterate. Thirty-one percent of all heads had an educational attainment of up to fifth grade, and the remaining 5 % had education beyond grade five. The dominant primary occupation of all household heads was fishing (34 %), followed by agriculture (29 %), and day laborer (15 %). Other occupations included petty trade, business, and government service. Dependency on agriculture is higher in the inland study village than either the shoreline or the island study villages. Average agricultural land owned by sample households was 0.35 acres. However, more than half (52.3 %) of all households did not have any farmland, indicating farmland ownership is highly skewed. Annual average household income was 76,347 taka (US$ 1,106).

4.1 Body mass index of women of reproductive age

Table 1 presents BMI for reproductive women by various background (i.e., location of home village, gender, educational level and occupation of household head, and annual household income) characteristics. The table shows that the relevant information was collected from 307 women and indicates that 24 sampled households had no women of reproductive age. Given the increasing trend toward a nuclear family, this was not unexpected. A considerable proportion of the households in the study villages consisted of only two members—older father and mothers most of whom were living in the same home compound with the family of their sons.

Based on the BMI scale mentioned earlier, the present study found that 30.56, 22.09, and 31.71 % of sampled women of reproductive age were underweight in inland, shoreline, and island villages, respectively (Table 1). Relatively more women fall in the underweight category in the island and inland study villages, revealing a higher level of nutritional insecurity in the both village types. Table 1 further shows that about 52.78, 68.60, and 60.98 % of women of reproductive age were found to have normal weight in inland, shoreline, and island villages, respectively. Corresponding percentages for women belonging to the overweight category were 14.44, 6.98, and 4.88 in inland, shoreline, and island villages, respectively. The percentage of women having a BMI of more than

Table 1 Body mass index of reproductive women ($N = 307$)

	Body mass index				
	Underweight Number (%)	Normal weight Number (%)	Overweight Number (%)	Obese[a] Number (%)	Total Number (%)
Village					
Inland	55 (30.56)	95 (52.78)	26 (14.44)	4 (2.22)	180 (100)
Shoreline	19 (22.09)	59 (68.60)	6 (6.98)	2 (2.33)	86 (100)
Island	13 (31.71)	25 (60.98)	2 (4.88)	1 (2.44)	41 (100)
Chi-square	7.873 (*df* = 4; *p* = 0.096)				
Gender of household head					
Male female	80 (28.67)	159 (56.99)	33 (11.83)	7 (2.51)	279 (100)
Female	7 (25.00)	20 (71.43)	1 (3.57)	–	28 (100)
Chi-square	3.200 (*df* = 2; *p* = 0.3582)				
Educational level of household head					
Illiterate	58 (29.29)	117 (59.09)	19 (9.60)	4 (2.02)	198 (100)
Can read and write	13 (35.14)	20 (54.05)	2 (5.41)	2 (5.41)	37 (100)
1–5 Grade	12 (22.22)	30 (55.56)	11 (20.37)	1 (1.85)	54 (100)
>5 Grade	4 (22.22)	12 (66.67)	2 (11.11)	–	18 (100)
Chi-square	10.970 (*df* = 6; *p* = 0.089)				
Primary occupation of household head					
Agriculture	17 (18.89)	60 (66.67)	11 (12.22)	2 (2.22)	90 (100)
Fishing	43 (40.57)	53 (50.00)	9 (8.49)	1 (0.94)	106 (100)
Wage and other laborer	23 (25.27)	52 (57.14)	12 (13.19)	4 (4.40)	91 (100)
Service and business	4 (20.00)	14 (70.00)	2 (10.00)	–	20 (100)
Chi-square	14.730 (*df* = 6; *p* = 0.023)				
Annual household income (in Taka)					
<45,000	20 (25.97)	47 (61.04)	7 (9.09)	3 (3.90)	77 (100)
45,000–90,000	53 (30.29)	100 (57.14)	19 (10.86)	3 (3.90)	175 (100)
>90,000	14 (25.45)	32 (58.18)	8 (14.55)	1 (1.30)	55 (100)
Chi-square	1.148 (*df* = 4; *p* = 0.887)				

[a] Merge with the overweight category to calculate chi-square value

30 (obese) is very similar by village type (2.22, 2.23, and 2.44 % in inland, shoreline, and island village, respectively).

Information presented in Table 1 suggests that, as in the rest of rural Bangladesh, obesity was not a problem in the study villages subsequent to Cyclone Sidr. Consistent with the national situation, a considerable proportion of women of reproductive age were found to be underweight in the study villages. Underweight reproductive women reveal prevalence of malnutrition. This is a particular concern not only because the health of the malnutritioned women was at risk but also because their offspring are at greater risk of mortality due to lower level of maternal BMI (Ronnenberg et al., 2003). Low maternal BMI is linked with certain severe adverse pregnancy outcomes such as premature birth and low birth weight (Schieve et al. 2000; Ronnenberg et al. 2003). Moreover, even if a child survives, health risks, such as asthma and neuro-developmental delays, etc., remain persistent throughout life (Allen et al. 2006; Gessner and Chimonas 2007).

Table 1 also suggests variation in the levels of BMI across the study villages. To confirm this variation, a chi-square test was performed. However, the calculated chi-square value clearly shows that the study villages do not statistically differ with regard to the BMI of women at reproductive age. It is worthwhile to mention that the obese category was merged with the overweight category in order to avoid too many cell frequencies under 5. This is also true for other background characteristics included in Table 1.

Due to the absence of pre-cyclone BMI data for the women included in this study, it is difficult to ascertain whether their post-Cyclone Sidr nutritional status increased or decreased relative to the pre-cyclone period. However, some indication of the pre-cyclone BMI status of reproductive-aged women in the study villages can be gained after comparing the relevant information reported in the 2007 Bangladesh Demographic and Health Survey (BDHS) (NIPORT 2009). This is a nationally representative survey of 10,996 women aged 15–49 and 3,771 men aged 15–54 from 10,400 households covering 361 sample points throughout Bangladesh. Field work for this survey was carried out from March 24, 2007, to August 11, 2007.[4] Because of the higher incidence of poverty and devastating impact of Cyclone Sidr on the lives of the affected coastal residents, we expected a much higher incidence of underweight women of reproductive age in the study villages compared with the relevant information provided in the 2007 BDHS.

Surprisingly, the 2007 BDHS reported almost the same proportion of underweight and normal weight women of reproductive age as found in the present study. This means the nutritional status among reproductive-aged women in the study villages was not that different than the nation in general. For example, the 2007 BDHS reported mean BMI for women aged 15–49 was 20.6 (NIPORT 2009). About six in 10 women (59 %) were considered to have normal BMI, while 30 % were underweight, and 11 % were overweight or obese. The corresponding figures for the study villages together were 29, 59, and 12 %, respectively (Fig. 3). This means the proportion of underweight, normal weight, and overweight women was not much different between these two studies.

However, the above finding indicates that nutritionally, the women of reproductive age in the study villages were better off than our expectation. This may be partly explained in terms of the generous food aid provided by public authorities in the Sidr-affected areas via their short-, medium-, and long-term programs. Informal conversations with respondents and local residents, and FGDs have confirmed such an association. Additionally, it has been found that nutritional conditions typically reach peak levels during the months of December–January and lowest during the months of May–June (WFP 2007). The nutritional information collected for this study fall within the context of the seasonal pattern, which might also explain why no significant difference was found between BMI of this study and the 2007 BDHS.

Information presented in Table 1 reveals that the BMI of the study population does not reflect any significant relationship with gender, educational level of household head, or annual household income. However, a statistically significant association is found between BMI and the primary occupation of household head. A careful review of the table suggests that the prevalence of underweight women of reproductive age was relatively higher among families engaged in fishing. This probably made the relationship between BMI and occupation of household head statistically significant. Field survey data and focus group

4 This survey is the fifth in a series of national-level population and health surveys conducted as part of the global Demographic and Health Surveys (DHS) program. It is designed to provide data to monitor the demographic and health situations in Bangladesh as a followup to the 193–1994, 1996–1997, 1999–2000, and 2004 BDHS surveys (NIPORT 2009).

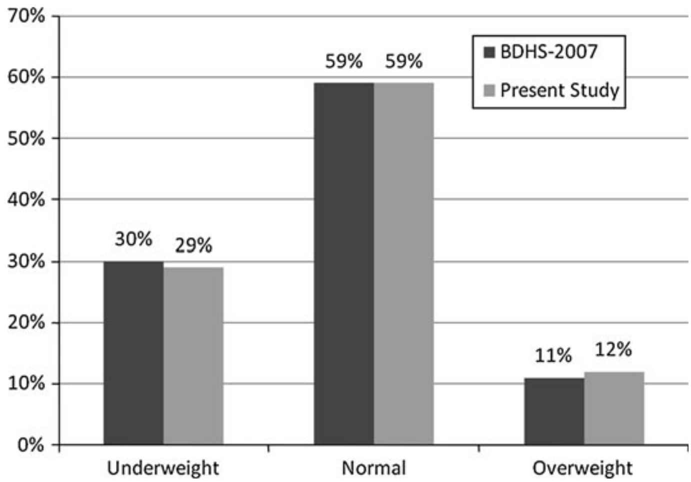

Fig. 3 A comparison of BMI of women of reproductive age

meetings reveal that food aid was generally fairly distributed among residents of the study villages. This likely was the reason no significant difference was found (other than the primary occupation of the household head) between BMI and background characteristics considered in this study.

It is suspected that a considerable number of household heads engaged in fishing were not present when public food assistance was distributed, which lasted almost for two years after Cyclone Sidr. Those engaged in fishing along the coastal area of Bangladesh spend many days a year in the Bay of Bengal for catching fish (Paul 2009). Existing literature on disaster relief distribution in developing countries clearly suggests a male-bias in such distributions (Paul 2006, 2007). Because many of the household heads engaged in fishing were away from home, it seems possible that their female spouses may have been unable to receive an equitable share of food assistance. Perhaps for this reason, more women of reproductive age in such families were found to be underweight.

4.2 Weight-for-height of under five children (wasting)

Information on weight-for-height for children 6–59 months is presented in Table 2. The table shows only 158 children belonging to the age group considered in this study. Among these children, 21.52 % were malnourished or underweight (wasted) at the time of the field survey. This percentage is higher than earlier findings reported by the 2007 BDHS that 17.4 % of all Bangladeshi children were wasted (Fig. 4). This BDHS included children from both rural and urban areas. However, if only rural area children were considered, the above percentage would have been increased and the gap between the proportions of undernourished children reported in these two studies reduced. Table 2 further shows that 20.93, 19.15, and 28 % of children from inland, shoreline, and island villages were malnourished or underweight (wasted), respectively. This clearly suggests that a significantly higher number of children were wasted in the island village compared with children from the inland and shoreline study villages. Surprisingly, among the three study villages, the percentage of adequately nourished children was highest in the island village, and the percentage of overweight children was highest in the inland village (Table 2).

Table 2 Percentage weight-for-height for children under 5 years of age

Weight-for-height category	Study villages			
	Inland Number (%)	Shoreline Number (%)	Island Number (%)	All Number (%)
Malnourished (<80)	18 (20.93)	9 (19.15)	7 (28)	34 (21.52)
Adequately nourished (80–100)	46 (53.49)	27 (57.45)	15 (60)	88 (55.7)
Over weight (>100)	22 (25.58)	11 (23.4)	3 (12)	36 (22.78)
Total	86 (100)	47 (100)	25 (100)	158 (100)
Average weight-for-height percent	97.23	87.89	85.51	92.61
ANOVA	$F = 3.109$, $df = 2$, $p = 0.044$			
	Livelihood groups			
	Farmer Number (%)	Fisher Number (%)	Wage laborer Number (%)	All Number (%)
Malnourished (<80)	16 (30.19)	22 (32.84)	12 (31.58)	50 (31.65)
Adequately nourished (80–100)	23 (43.40)	27 (40.30)	17 (44.74)	67 (42.41)
Over weight (>100)	14 (26.42)	18 (26.87)	9 (23.68)	41 (25.95)
Total	53 (100)	67 (100)	38 (100)	158 (100)
Average weight-for-height percent	94.91	90.87	92.47	92.61
ANOVA	$F = 0.363$, $df = 2$, $p = 0.696$			

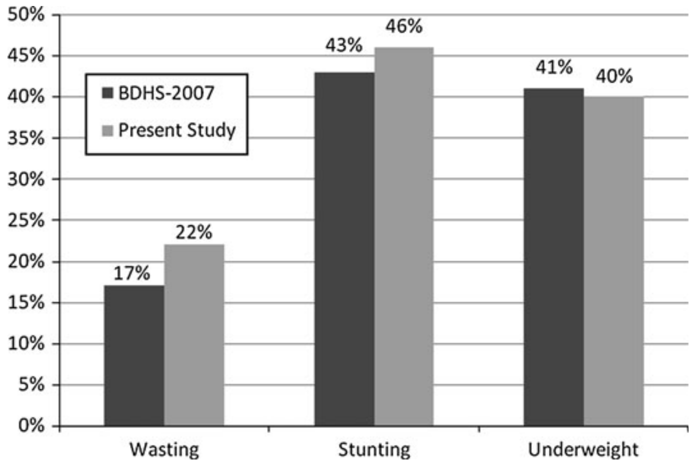

Fig. 4 A comparison of nutritional status of children under five

Among the three selected villages, figures for the island village were highest in the cases of malnourished and adequately nourished children and lowest for overweight children. As a result, the average weight-for-height percentage varies considerably across the study villages. This percentage is 97.23 for the inland village, 87.89 for the shoreline village, and

85.51 for the island village, respectively (Table 2). Application of the analysis of variation (ANOVA) indicates that the selected villages significantly differ in terms of weight-for-height category of children under age five. However, a careful examination of the information presented in Table 2 suggests that figures associated with wasted (malnourished or underweight) children are similar for the inland and the shoreline villages. Scheffe's test, which is a post hoc test of multiple comparisons (Sirkin 1999), confirms that there is no significant difference between the inland and the shoreline village in terms of nutritional status of children under 5 years of age.

The above difference between the inland and shoreline village versus the island village might be associated with the relatively lower socioeconomic status of islanders. Although most food aid was believed to be properly distributed, the aid package itself was not targeted to improving the nutritional status of children. Specifically, no special consideration was given to include food items for children in the package. Further analysis reveals no significant difference in terms of weight-for-height for children under five among the background characteristics considered in this study.[5] This suggests that variation in socioeconomic conditions was not associated with weight-for-height status of children among the study villages. However, the number of children included in this study from the island village was much smaller relative to the other two study villages (Table 2), and this is suspected to play some role in the statistical significant difference reported earlier among the study villages with respect to wasting status of children under five.

4.3 Height-for-age of under five children (stunting)

Because stunting reflects chronic malnutrition, this indicator is used in this study to indirectly measure the impact of Cyclone Sidr on the nutritional status of children under age five. Information presented in Table 3 shows that 45.35, 46.81, and 48.0 % of children were stunted in the inland, the shoreline, and the island village, respectively. This indicates that a higher proportion of children in all three study villages were stunted compared with the national average. The overall percentage (46.10) of stunting children in the study villages was higher than the national average of 43.0 % (Fig. 4). Table 3 further shows that the prevalence of stunting was relatively higher among children of the island study village. However, the relationship was not statistically significant. Once again, this could be linked with either the lower socioeconomic condition among people of island village and/or the small sample size of households drawn from it.

Table 3 further shows that 54.65, 53.19, and 52.0 % of children from the inland, shoreline, and island villages, respectively, were normal according to the height-for-age index. Although stunted and normal status of children of the study villages vary, the difference is not statistically significant because the p-value of the calculated F-value is very large (Table 3). Further analysis (not presented in Table 3), reveals that the height-for-age index of children does not significantly differ by the selected background characteristics considered in this study.

A comparison of wasting and stunting figures for the study villages clearly indicates that the latter figure is higher than the former figure (Tables 2, 3). This is also true when study villages are considered individually. This suggests that the food aid provided in the study villages by the Bangladesh government, NGOs, and other agencies had at least a

[5] Results are not reported in Table 2.

Table 3 Percent height-for-age for children under 5 years of age

Height-for-age category	Study villages			
	Inland Number (%)	Shoreline Number (%)	Island Number (%)	All Number (%)
<90 (Stunted)	39 (45.35)	22 (46.81)	12 (48.00)	73 (46.20)
>89 (Normal)	47 (54.65)	25 (53.19)	13 (52.00)	85 (53.80
Total	86 (100.00)	47 (100.00)	25 (100.00)	158 (100.00)
ANOVA $F = 0.512$, $df = 2$, and $p = 0.600$				

Table 4 Percentage weight-for-age for children under 5 years of age

	Study villages			
	Inland Number (%)	Shoreline Number (%)	Island Number (%)	All Number (%)
Underweight	35 (40.70)	17 (36.17)	11 (44.00)	63 (39.87)
Normal weight	44 (51.16)	25 (53.19)	13 (52.00)	82 (51.90)
Overweight	7 (8.14)	5 (10.64)	1 (4.00)	13 (8.23)
Total	86 (100.00)	47 (100.00)	25 (100.00)	158 (100.00)
ANOVA $F = 3.422$, $df = 2$, $p = 0.035$				

short-term positive impact on the nutritional status of the children in the study villages. Without such assistance, wasting status would likely have been considerably lower than stunting status.

4.4 Weight-for-age of under five children (underweight)

The present study found that 40.70, 36.17, and 44 % of children in inland, shoreline, and island villages, respectively, fall in the underweight category in terms of weight-for-age of children under five (Table 4). When children of all three study villages are considered together, 39.87 % were underweight, a figure close to, but lower than, the national average of 41 % (Fig. 4). However, the study villages do differ with respect to proportion of underweight children. A relatively higher number of underweight children were found in the island village relative to the shoreline or the inland study village.

Table 4 shows that 51.16, 53.19, and 52 % of children fall in the adequately nourished category in the inland, shoreline, and island villages, respectively. This table further shows that 8.14, 10.64, and 4 % of children in the inland, shoreline, and island villages, respectively, were overweight in terms of the weight-for-age index. However, children in the shoreline village exhibit relatively better nutritional status than those in either the island or inland study village. The average weight-for-age index of children under five varies across the three study villages (Table 4), but the differences are not statistically significant. This is also true for the background variables considered in this study. For this reason, the data on weight-for-age by background characteristics are not presented in Table 4.

5 Discussion and conclusions

This study examined the nutritional status of women of reproductive age and children aged 6-59 months in three coastal villages severely impacted by Cyclone Sidr in 2007. A negative impact of natural disasters on the health of female and child nutrition in rural Bangladesh has been reported by several studies (e.g., Choudhury and Bhuiya 1993; del Ninno and Dorosh 2002; Hossain and Kolsteren 2003) in rural Bangladesh. We therefore expected deterioration of health and nutrition status of the study populations during post-Sidr period relative to their pre-Sidr status. Due to the absence of data on pre-Sidr health status of reproductive-aged women in study villages, their BMI was compared with the BMI figures available from a nationally representative sample survey. Average BMI lower than this national survey will indicate that Cyclone Sidr had a negative impact on the health of reproductive-aged women of the study villages.

There are three components (underweight, normal weight, and overweight) of the BMI (Table 1). Surprisingly, the proportion of underweight and normal weight women of reproductive age found in the study villages was not significantly different than the figures reported in the nationally representative sample survey previously mentioned. This indicates that Cyclone Sidr did not have a discernable negative impact on nutritional status among reproductive-aged women in the study villages.

Again no information on pre-Sidr child nutritional status was available for children in the selected households of the study villages. For this reason, the impact of the Cyclone Sidr on their nutritional status is indirectly gained by comparing the difference between height-for-age (stunting) and weight-for-height (wasting) figures reported in these two studies. Stunting refers to a failure to receive adequate nutrition over a relatively long period of time, while wasting describes more current nutritional status. Because of the negative impact of natural disasters on current nutritional status, we expected a large difference between figures representing stunting and wasting of each selected child. However, the differences we found were not statistically significant, indicating that nutritional interventions undertaken in the study villages had a positive impact on the wasting indicator of the reference population. In other words, in spite of the severe disruption of food production, the government of Bangladesh, together with donors, NGOs, and cyclone survivors themselves were successful in mitigating some of the effects of Cyclone Sidr and in avoiding a major nutritional crisis.

Data we collected on BMI and nutritional indicators from the study villages do not support the two major hypotheses outlined above. Failure to accept both hypotheses is thought to be associated with successful nutritional intervention measures undertaken in the affected areas. These measures included distribution of rice and wheat in the cyclone-affected areas through the Vulnerable Group Feeding (VGF) program as well as other nutritional programs, including the distribution of general rations among households in cyclone-affected areas.[6] These rations included distribution of rice, lentils, oil, and other food items. Such assistance helped to secure the food needs of the most food insecure families, and as such prevented suffering associated with hunger, malnutrition, and the further deterioration of livelihoods. Both the government of Bangladesh and its partners such as UN agencies and NGOs were quick to respond to the food security needs of cyclone survivors.

The Bangladesh government introduced the VGF program in the month of December 2007 to address food shortages among the poor and vulnerable in the 12 most

[6] The VGF program is aiming to ensuring food security of the poor and the disaster survivors.

cyclone-impacted districts (GoB 2008b). It distributed a total of 2.59 million VGF cards in these districts. Under this program, 15–22 kg of rice was provided for each VGF card-holder on a monthly basis (December through March). Through this program, the government planned to distribute more than 150,000 tons of rice up to the end of March 2008. Among other agencies, the WFP initiated a food-assistance program (worth US$ 51.8 million), involving 2.2 million beneficiaries in the eight most affected districts for 6 months (GoB 2008b). Both the government and NGOs provided special food assistance to female-headed households, female domestic workers, elderly citizens with no income support, and to those with disabilities. In addition, the Bangladesh government established district-level monitoring of the food security system to ensure that no one suffered starvation or malnutrition in the aftermath of Cyclone Sidr (GoB 2008b).

Although timely national surveillance was undertaken in Sidr-affected areas to find how many children and mothers were suffering from malnutrition, the food aid was mainly aimed at the general population. This is in contrast to the situation reported during the 1998 flood period when supplementary feeding for those households containing a malnourished child was provided, including the distribution of a vitamin A capsule to a child with symptoms of night blindness (Hossain and Kolsteren 2003). To address nutritional intervention program deficiencies against future extreme events, the government should specifically target the needs of children.

Findings of this study suggest that Cyclone Sidr may produce positive impacts on the health and nutritional status of affected people in Bangladesh. This study also suggests that food aid coming from outside sources to the study villages contributed to maintaining regular nutritional intake despite experienced food shortages due to the cyclone. Thankfully, the study villages also did not experience any serious outbreak of disease or illness in the aftermath of the cyclone. Such an outbreak could cause a severe shortage of clean drinking water, and unhygienic living conditions. The non-experience of epidemic was associated with proper and timely distribution of food and relief goods, including bottled water and water-purifying tablets (see Paul et al. 2011). NGOs along with government, military, and relief agencies also cleansed water supplies very quickly and efficiently. Surprisingly, as became evident from informal interviews and focus group meetings, a considerable number of survivors claimed that their nutritional status improved after the cyclone. They also indicated there were improvements in the availability of pure drinking water and sanitary facilities subsequent to Sidr due to the timely provision of humanitarian, medical, and other assistance by the government agencies, NGOs, and others.

Although no significant differences were found in terms of the nutritional level among the reference populations, this study indicates that cyclone survivors of the island study village and fisher households are more vulnerable to nutritional deficiencies than other types of villages and occupational groups considered in this study. Thus, targeting vulnerable locations, such as the island village, and vulnerable groups, such as households engaged in fishing, may more adequately address post-disaster nutritional insecurity in coastal Bangladesh. However, given the absence of data on post-disaster nutritional status of survivors, nutritional surveys should be initiated after the occurrence of each extreme natural event. Finally, the results of the present study have to be interpreted with care. As noted, ideally a longitudinal study design is more appropriate to examine the impact of a natural disaster on the nutritional status of women of reproductive age and children under five.

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