

RESEARCH ARTICLE

# Coping strategies related to food insecurity at the household level in Bangladesh

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## Abstract

### Introduction

In connection to food insecurity, adaptation of new techniques or alteration of regular behavior is executed that translates to coping strategies. This paper has used data from food security and nutrition surveillance project (FSNSP), which collects information from a nationally representative sample in Bangladesh on coping behaviors associated with household food insecurity. To complement the current understanding of different coping strategies implemented by the Bangladeshi households, the objective of this paper has been set to examine the demographic and socio-economic characteristics of the food insecure households which define their propensity towards adaptation of different types of coping strategies.

### Methodology

FSNSP follows a repeated cross-sectional survey design. Information of 23,374 food insecure households available from February 2011 to November 2013 was selected for the analyses. Coping strategies were categorized as financial, food compromised and both. Multinomial logistic regression was employed to draw inference.

### Results

Majority of the households were significantly more inclined to adopt both multiple financial and food compromised coping strategies. Post-*aman* season, educational status of the household head and household women, occupation of the household's main earner, household income, food insecurity status, asset, size and possession of agricultural land were found to be independently and significantly associated with adaptation of both financial and food compromised coping strategies relative to only financial coping strategies. The relative risk ratio of adopting food compromised coping relative to financial coping strategies when compared to mildly food insecure households, was 4.54 times higher for households with moderate food insecurity but 0.3 times lower when the households were severely food insecure. Whereas, households were 8.04 times and 4.98 times more likely to adopt both

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food compromise and financial relative to only financial coping strategies if moderately and severely food insecure respectively when compared to being mildly food insecure.

## Conclusion

Households suffering from moderate and severe food insecurity, are more likely to adopt both financial and food compromise coping strategies.

## Introduction

Food security is a complex sustainable development issue linked to health and nutrition, has been best defined by the World Food Summit as having access to sufficient, safe and nutritious food [1]. Food insecurity, the converse situation can be described as "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways" [2]. Food insecurity indeed is a major public health problem for both developing and developed nations [3]. Historically, household resilience to food insecurity has been characterized by a number of fairly regular behavioral responses which translates to coping strategies [4] or techniques that households generally apply to cope with crises moments when the resources are limited or absent [5]. Generally, households adopt coping strategies in the early stages of food insecurity [6], which however vary based on cultural and geographical differences [5].

Food insecure households reportedly exhibit a range of coping techniques that reflects their vulnerability [6]. In the phase of idiosyncratic shocks such as food price hike or natural disasters, households may employ food or non-food based coping strategy or a combination of both to protect their basic needs [7,8]. In recently conducted studies, several coping strategies were found to be associated with household food insecurity, food consumption at household and individual level. Poverty measures as income and expenditure and seasonal variation of staple food production are also related to coping strategies [9–14]. Previous experiences have indicated that, during idiosyncratic shocks such as food price hike, poor households adopt a series of coping strategies which can be differentiated as food and non-food based techniques. Purchasing less preferred food, reducing meal size, consuming only rice, skipping meals and selling of assets were the frequently reported responses at the time of food shortage [4,15–19]. These coping strategies were also commonly observed in the context of Bangladesh, a densely populated lower-middle income country which often encounters natural calamities resulting in around 40% of its households being food insecure [20,21].

Literatures have identified diverse coping strategies applied at the household level amongst population affected by natural calamity and food price shock, but not in a general population who also tend to cope at a regular basis due to food insecurity at the household level. Particularly the contexts that compel households to apply only food compromise or financial coping strategies, are not well defined. This paper is based on data collected through the food security and nutrition surveillance project (FSNSP), the single surveillance system in Bangladesh to look upon the coping behaviors of food insecure households countrywide [22]. Understanding the implemented coping strategies at household level is critical for formulating and implementing appropriate policy and design programs related to food insecurity. The objective of this paper has been set to examine the relationship of different categories of food insecurity with types of coping strategies. This is expected to complement the current understanding of different coping strategies pertaining to food insecurity implemented by the Bangladeshi

households. Moreover, this paper also tried to identify the significant demographic and socio-economic characteristics of the food insecure households that define their propensity towards adaptation of these strategies.

## Methodology

FSNSP covers three major seasons in Bangladesh: monsoon (May-August) and the two post rice harvest periods namely post-*aman* (January- April) and post-*aus* (September-December). FSNSP collects information on food insecurity at the household level from 13 strata; six strata correspond to the six surveillance zones (coastal belt, eastern hills, haor region, padma chars, northern chars and the northwest region), while the remaining seven strata (Dhaka, Chittagong, Rajshahi, Barisal, Khulna, Sylhet and Rangpur), which contain all the upazila not included in a surveillance zone, correspond to the seven administrative divisions of Bangladesh. From each stratum, a set number of upazila were selected with replacement. For each of the six surveillance zones, twelve upazila were selected in each round, while 22 upazila were selected from the other areas of the country. The number of upazila from non-surveillance zone strata varied depending on the number of upazila in the zone, ranging from one to eight.<sup>1</sup> From each of the surveillance zones, upazila were selected by rotation into the sampling frame in order to reduce random variation in estimates between rounds, as has been recommended for surveillance systems by the UN (United Nations), and is commonly done in labour participation surveillance [23].

## Study design and sample size

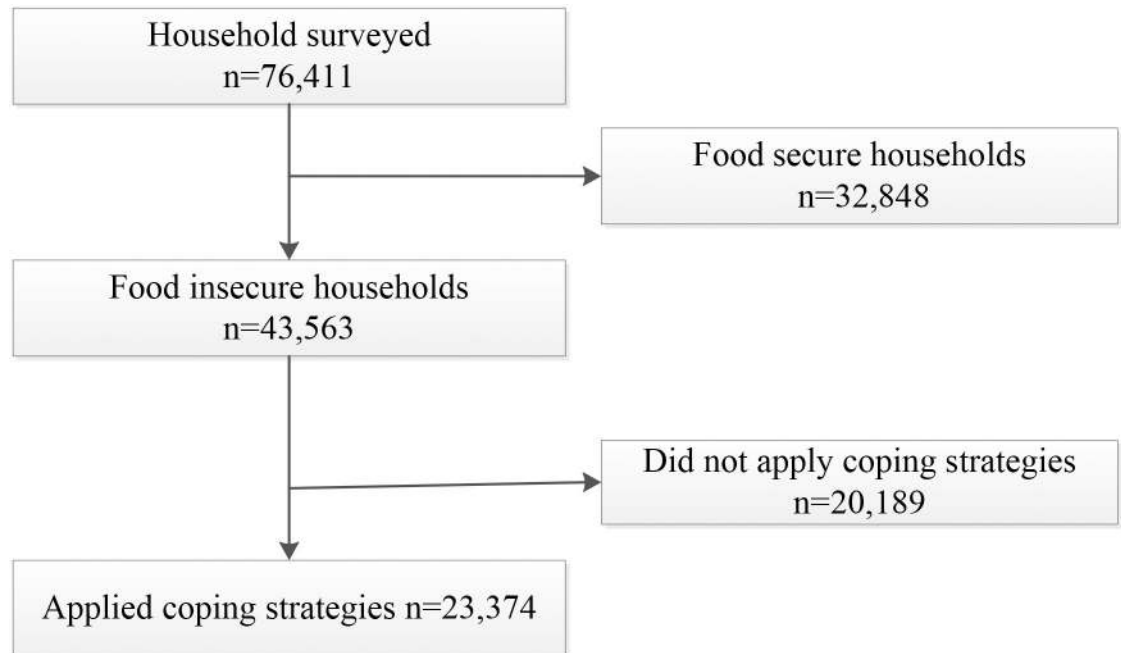
For the surveillance, FSNSP followed a repeated cross-sectional survey and data collection occurred every four months [22]. The target sample size for FSNSP surveillance was calculated considering prevalence of child wasting, underweight and stunting, women's chronic energy deficiency and household food insecurity status. Formula for a single population proportion with 95% confidence interval and 5% precision was involved for calculating sample size. Details of sample size estimation and method could be found in the FSNSP annual reports [22]. A total of 23,374 food insecure households available from February 2011 to November 2013 (9 data collection points within 3 years) who applied coping strategies were chosen for the current analyses (Fig 1).

## Data collection and analysis

Data was collected through structured interview facilitated by paper based questionnaire and personal digital assistants (PDAs) both. In each round, 36 two-member teams were involved for collection of data. Quality control was done in around 10% randomly chosen cases within 24 hours of data collection. STATA (version 10) was employed for conducting the analysis. The analysis primarily involved descriptive statistics using appropriate cut-off values for particular variables. Multinomial logistic regression was used to establish both crude and confounder adjusted relationship between the outcome and response variables. In the multinomial logistic regression models, Relative Risk Ratio (RRR) with 95% CI was noted and variables were considered as significant predictors if the p-value was less than 0.05.

## Variables of interest

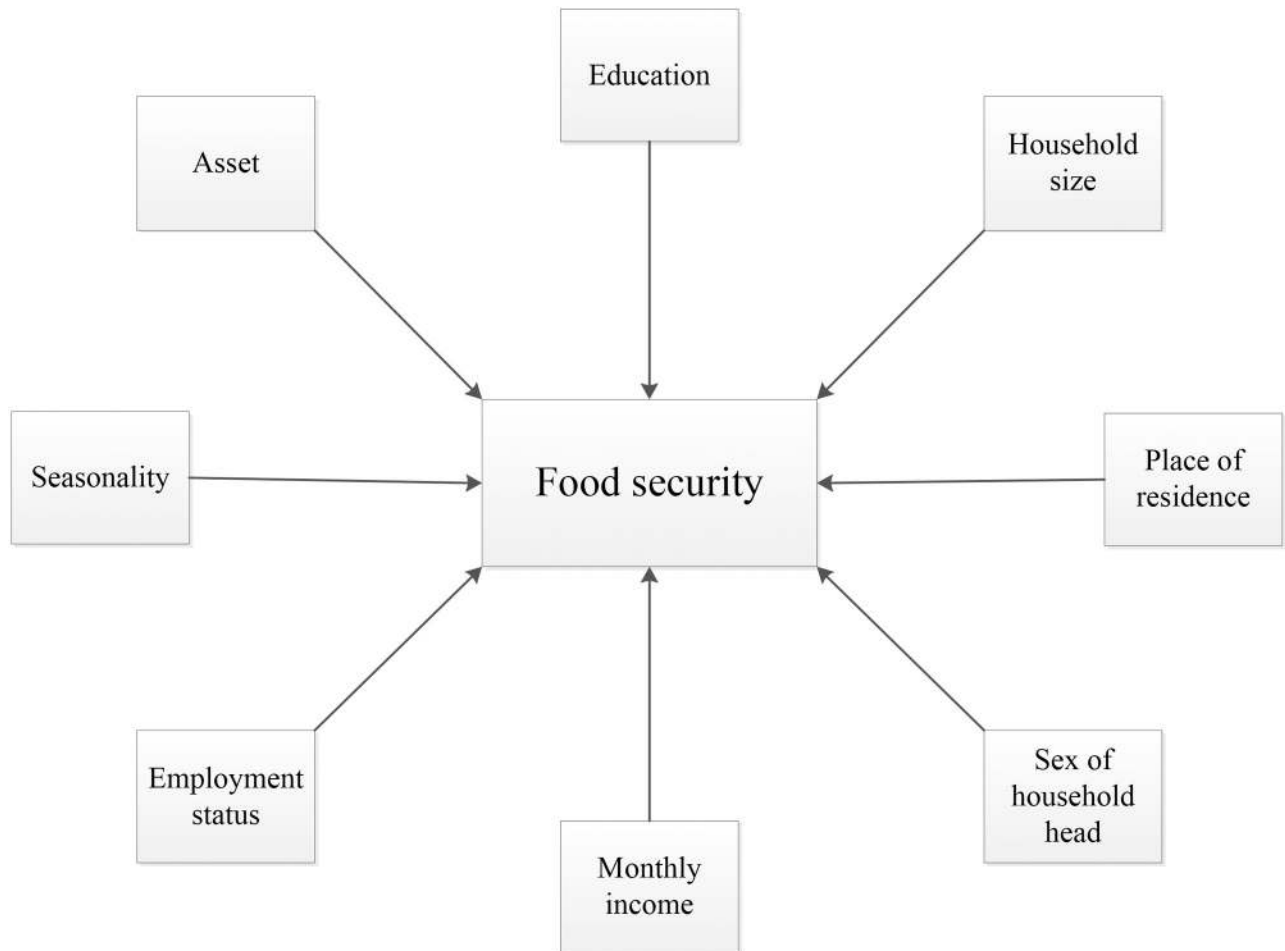
Data of previous month (30 days) was collected on food insecurity at the household level using questions to understand the level of access to food and was categorized as mild, moderate and severe according to their score at Household Food Insecurity Access Scale (HFIAS)



**Fig 1. Study profile.**

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[24]. HFIAS determines food insecurity based on lack of access due to poverty rather than shortage of supply [25]. The scale is comprised of 9 questions (worry about food, unable to eat preferred foods, eat just a few kinds of foods, eat foods they really do not want eat, eat a smaller meal, eat fewer meals in a day, no food of any kind in the household, go to sleep hungry, go a whole day and night without eating) to assess the level of anxiety and uncertainty of the participants about household food supply, insufficient quality of food and insufficient food intake [24]. The six coping strategies adopted by the food insecure households were namely sale or mortgage of assets, consumption of low quality food, consumption of fewer items of food, stop schooling of household members, borrowing food and borrowing money. The outcome variable was categorized into only financial coping (sale or mortgage of assets, stop schooling of household members, borrowing money and food), only food compromise coping (consumption of low quality food and consumption of fewer items of food) and both financial and food compromise coping strategies. Since the dependent/outcome variable had more than two categories, multinomial logistic regression was used with “financial coping” as the base outcome. Considering the relevant predictors of household food insecurity as found in relevant papers during our literature review, thirteen variables were considered for subsequent multivariate analysis (Fig 2). The selected response variables were seasonality [4,26], residence type [7,27], sex of the household head [28–31], education level of the household head [3,28,32,33], occupation of primary earner [9,34], agricultural land of the household [35,36], household homestead gardening [37], household monthly income [3,38,39], education [9,31,38,40–42] and occupational status [9] of the households’ women, household food insecurity status, asset index [41,43,44], and number of household members [45,46]. Asset index was constructed through principal component analysis as used in Bangladesh Demographic and Health Survey [47].



**Fig 2. Factors influencing household food security status.**

<https://doi.org/10.1371/journal.pone.0171411.g002>

### Ethical consideration and consent procedure

This study was approved by the research review committee and ethical review committee, the two obligatory components of the institutional review board of International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b). Verbal informed consent was taken instead of written due to the cultural stigma towards signing paper documents especially in rural areas of Bangladesh. At the beginning of each interview, the data collection officers informed the respondent about the purpose of surveillance through reading a consent statement aloud. They were also informed about their participation to be voluntary and it is also allowed to withdraw their participation at any time. Verbal consent from the caretaker was also taken regarding anthropometric measurement of the study child.

### Results

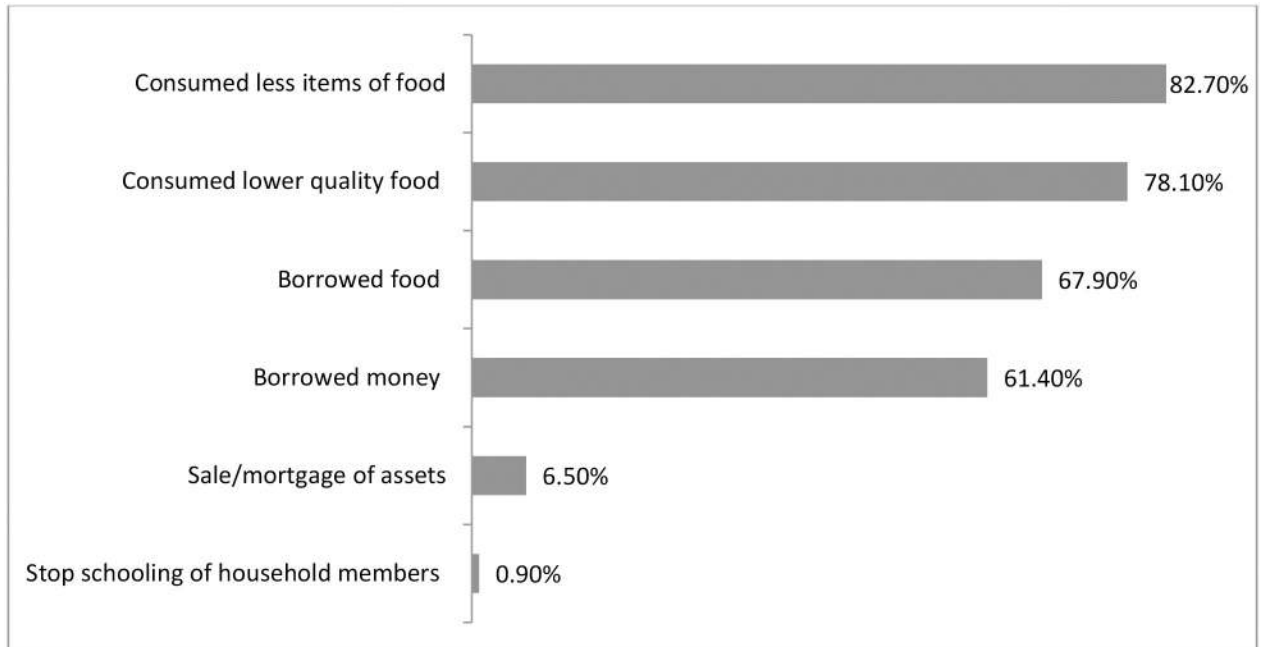
Descriptive statistics derived from the analysis, are tabulated in [Table 1](#). Our result dictates that around four-fifth of all food insecure households were severely food insecure, mostly belonged to rural areas, majority of the families were headed by male members. As for the household heads, around half had no formal education and major occupation was day labor.

**Table 1. Descriptive statistics of food insecure households applying coping strategies.**

Continuous variable		Mean (95% CI)
Household size		4.81 (4.80–4.84)
<b>Categorical variables</b>		<b>n (%)</b>
Household food insecurity	Mildly food insecure	1901 (8.13)
	Moderately food insecure	1977 (8.46)
	Severely food insecure	19496 (83.41)
Residential area	Rural	21506 (92.01)
	Urban	1868 (7.99)
Seasonality	Post-aus	7362 (31.5)
	Post-aman	8164 (34.93)
	Monsoon	7848 (33.58)
Sex of household head	Male	20989 (89.8)
	Female	2385 (10.2)
Education level of household head	SSC complete and above	1193 (5.11)
	Below SSC	9770 (41.88)
	No formal education	12363 (53)
Occupation of household head	Farmer	4611 (19.73)
	Day laborer	11815 (50.55)
	Businessman	2999 (12.83)
	Professional wage earner	1535 (6.57)
	No income	2216 (9.48)
	Others	198 (0.85)
Occupation of primary earner	Farmer	4283 (18.32)
	Businessman	3121 (13.35)
	Day labor	12911 (55.24)
	Professional wage earner	2112 (9.04)
	Foreign employment	722 (3.09)
	No income	46 (0.2)
	Others	179 (0.77)
At least one women with income generating activity in the household		9044 (38.69)
At least one educated women in household		19624 (83.96)
Possession of agricultural land		6144 (26.29)
Possession of homestead gardening		14385 (61.54)
Beneficiary of at least one safety net program		9151 (39.15)
Received remittance from abroad		2416 (10.34)
Household income (last month) (Tk.)	<3000	6199 (26.52)
	3000 to <6000	8000 (34.23)
	6000 to <10000	5239 (22.41)
	10000 to <20000	2457 (10.51)
	≥ 20,000	1479 (6.33)
Asset index*	1 <sup>st</sup> quintile	5738 (24.55)
	2nd quintile	5830 (24.94)
	3rd quintile	5054 (21.62)
	4th quintile	3600 (15.4)
	5th quintile	3152 (13.49)

\*5<sup>th</sup> quintile = richest, 4<sup>th</sup> quintile = richer, 3<sup>rd</sup> quintile = middle, 2<sup>nd</sup> = poorer, 1<sup>st</sup> = poorest

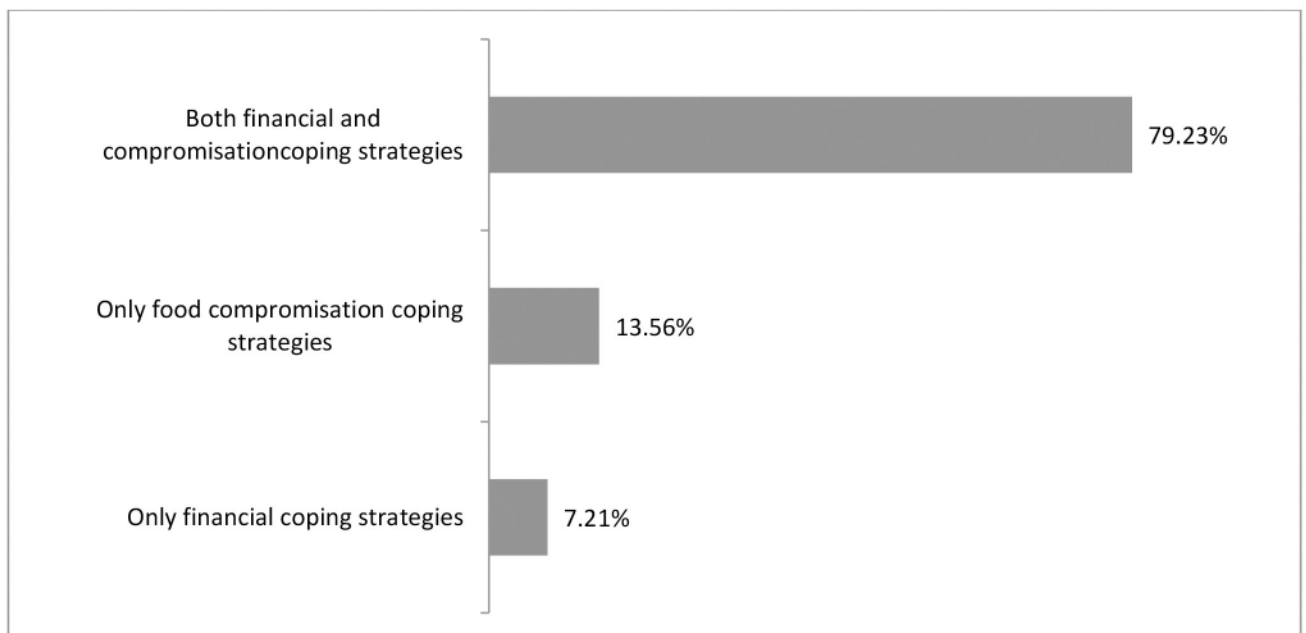
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**Fig 3. Adopted coping strategies of the household [multiple response].**

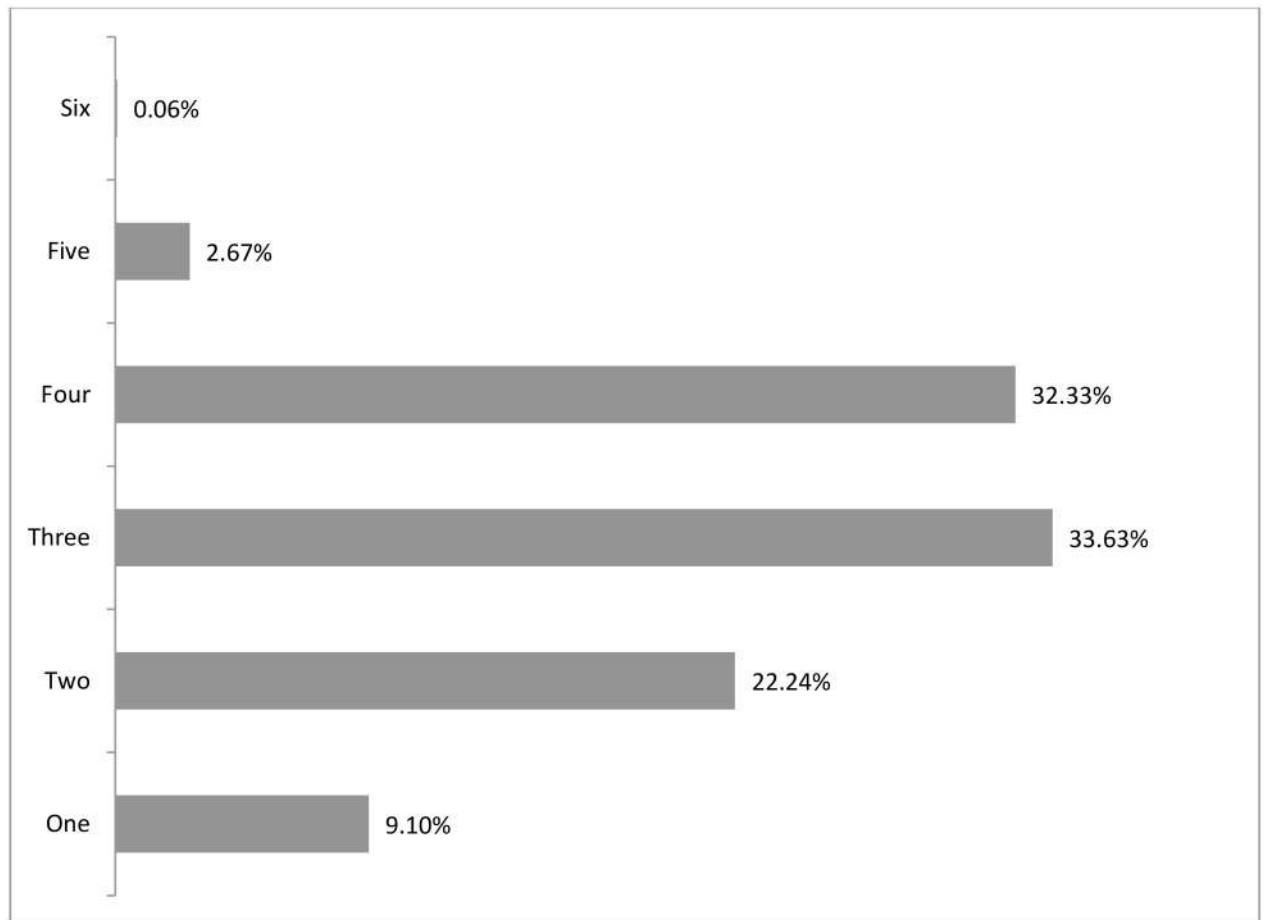
<https://doi.org/10.1371/journal.pone.0171411.g003>

Compromising the quality and quantity of food were the two most common coping strategies adopted (Fig 3) and when the coping strategies were categorized, 79.2% households adopted both financial and food compromising strategies (Fig 4) in general. One third of the households applied three to four coping strategies (Fig 5). Moreover, more than 85% of



**Fig 4. Categories of coping strategies adopted by household.**

<https://doi.org/10.1371/journal.pone.0171411.g004>



**Fig 5. Number of coping strategies adopted by the households.**

<https://doi.org/10.1371/journal.pone.0171411.g005>

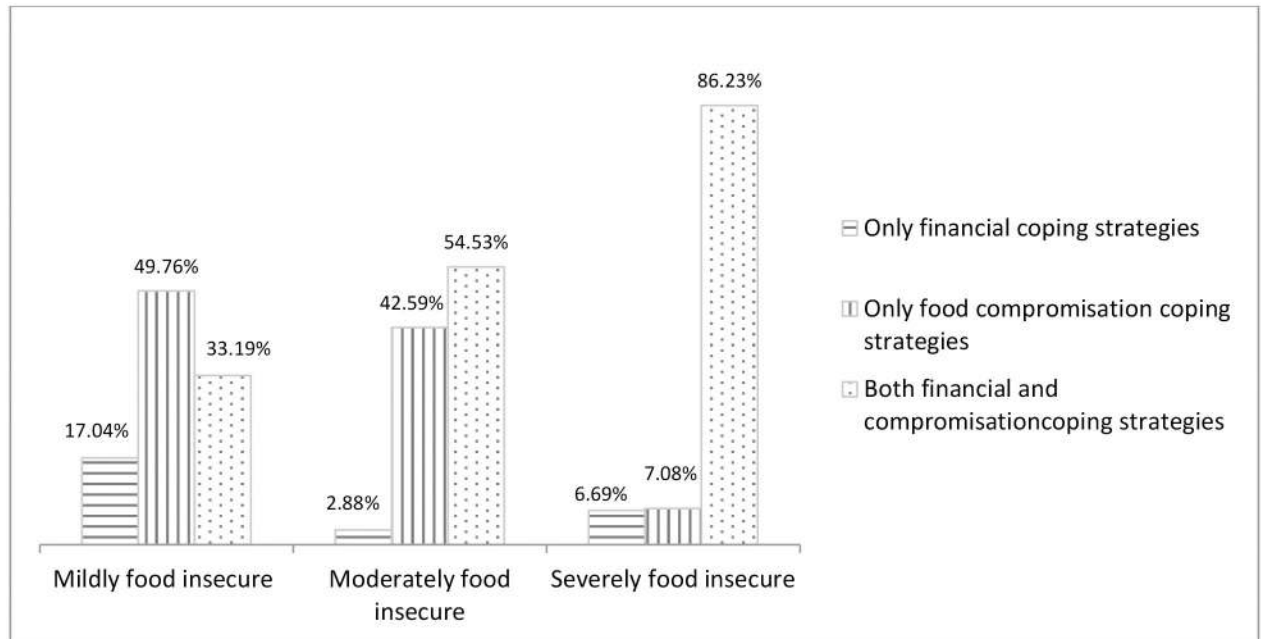
severely food insecure households (Fig 6) implemented mixed compromise strategies of both financial and food domain.

Table 2 represents the determinants of food compromised coping strategies and both food compromised and financial coping strategies while the variables were unadjusted.

Table 3 illustrates the determinants of only food compromised coping and both food compromised and financial coping when adjusted. Our result also indicates the existence of significant association between different types of coping strategies and the level of existing household food insecurity. The result implies that compared to mildly food insecure, severely food insecure households were significantly more inclined to adopt both financial and food compromise coping strategies. Whereas, moderately food insecure households were also found to be significantly more opted to implement mixed coping strategies rather than only financial coping strategies. However, moderate food insecure households were significantly more likely to adopt food compromise coping relative to only financial coping strategies but for severely food insecure households, that RRR were significantly less.

While on other socio-demographic determinants of food compromise relative to financial coping strategies, our result indicates educational level of household head, occupation of primary earner, absence of homestead gardening, household income level, women education status and household size as significant predictors. Whereas, educational level of household





**Fig 6. Categories of coping strategies by household stratified by food insecurity status.**

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head, occupation of primary earner, possession of agricultural land and homestead gardening, household income, household women education status, asset index and household size were significant predictors for adaptation of both financial and food compromise in comparison to only financial coping strategies.

### Discussion

Coping strategies pertaining to compromising quality and quantity of food consumption were observed to be the first step taken in order to mitigate the adverse effect of food shortage at the household level [18]. More exorbitant strategies involving financial compromise such as selling or mortgaging assets were adopted when food insecurity condition worsens. Literature on the topic is relatively scarce and lack inference based on quantitative analysis. Nonetheless, a study conducted on Bangladeshi marginal farmers affected by idiosyncratic shocks showed compromising the frequency and amount of food to be the most common coping strategy implemented by the households followed by consumption of wild uncultivated food and taking loans [20]. The study also found that as assisted coping strategy, over two-third of the population opted for food relief provided through different safety net programs by the government, non-governmental organizations (NGOs) or other organizations. Another study on the economically vulnerable *haor* zone of Bangladesh showed that nearly 80% of the households primarily preferred borrowing money to circumvent poverty and food insecurity, while half of the population also implemented food compromise strategies [48]. This study result, in concordance with our finding, also showed that the coping strategies adopted by the vulnerable households were not mutually exclusive, rather a mixed approach comprising strategies of multiple financial and food compromise domain were adopted. Prior work on household food insecurity suggested that families access an array of informal assistance programs and that they also use financial coping mechanisms i.e. selling assets; these informal assistances are the social safety-net programs can help alleviate food insecurity [19]. However, it is crucial to

**Table 2. Determinants (unadjusted) of coping strategies at the household level (Outcome: Food compromised coping and both food compromised and financial coping; reference category: Financial coping).**

Variables	n	Unadjusted RRR (95%CI) of food compromised coping	p-value	Unadjusted RRR (95%CI) of both food compromised and financial coping	p-value
Seasonality	23374				
		Reference		Reference	
		0.55 (0.41–0.74)	<0.001	0.64 (0.51–0.8)	<0.001
		0.7 (0.53–0.94)	0.018	0.77 (0.61–0.98)	0.031
Residential area	23374				
		Reference		Reference	
		0.99 (0.69–1.41)	0.947	1.3 (0.97–1.76)	0.083
Sex of household head	23374				
		Reference		Reference	
		0.92 (0.74–1.14)	0.449	0.86 (0.72–1.03)	0.094
Education level of household head	23326				
		Reference		Reference	
		1.21 (0.97–1.51)	0.094	1.83 (1.54–2.19)	<0.001
		1.58 (1.25–2)	<0.001	2.82 (2.33–3.41)	<0.001
Occupation of primary earner	23374				
		Reference		Reference	
		1.3 (1.09–1.56)	0.005	2.11 (1.81–2.47)	<0.001
		1.28 (1.03–1.58)	0.026	1.18 (0.98–1.42)	0.086
		0.99 (0.79–1.24)	0.931	0.93 (0.76–1.14)	0.509
		0.86 (0.6–1.23)	0.399	0.73 (0.56–0.96)	0.027
		0.81 (0.37–1.75)	0.587	0.94 (0.52–1.7)	0.835
		1.23 (0.21–7.32)	0.823	2.64 (0.59–11.79)	0.202
Agricultural land	23374				
		Reference		Reference	
		1.16 (0.99–1.34)	0.059	1.86 (1.65–2.1)	<0.001
Homestead gardening	23374				
		Reference		Reference	
		1.11 (0.96–1.28)	0.148	1.18 (1.05–1.33)	0.007
Income of last month (Tk)	23374				
		Reference		Reference	
		1.21 (0.93–1.57)	0.162	1.28 (1.01–1.62)	0.045
		1.46 (1.14–1.86)	0.003	2.05 (1.66–2.52)	<0.001
		1.54 (1.21–1.96)	<0.001	2.93 (2.37–3.63)	<0.001
		1.62 (1.24–2.11)	<0.001	3.47 (2.76–4.36)	<0.001
Women education status	23374				
		Reference		Reference	
		1.64 (1.32–2.03)	<0.001	1.65 (1.37–1.98)	<0.001
Women with income generating activity (IGA)	23374				
		Reference		Reference	

(Continued)

Table 2. (Continued)

Variables	n	Unadjusted RRR (95%CI) of food compromised coping	p-value	Unadjusted RRR (95%CI) of both food compromised and financial coping	p-value
Household food insecurity	No IGA	0.96 (0.83–1.11)	0.593	0.8 (0.71–0.9)	<0.001
	Mildly food insecure	Reference		Reference	
	Moderately food insecure	5.06 (3.67–6.98)	<0.001	9.71 (6.94–13.59)	<0.001
Asset index*	Severely food insecure	0.36 (0.29–0.45)	<0.001	6.62 (5.5–7.97)	<0.001
	5 <sup>th</sup> quintile	Reference		Reference	
	4 <sup>th</sup> quintile	1.01 (0.83–1.22)	0.951	1.19 (1–1.41)	0.051
	3 <sup>rd</sup> quintile	1.05 (0.85–1.31)	0.654	1.62 (1.36–1.93)	<0.001
	2 <sup>nd</sup> quintile	1.17 (0.92–1.48)	0.204	2.13 (1.76–2.58)	<0.001
Household size	23374	1.02 (0.98–1.07)	0.285	1.06 (1.02–1.1)	0.002

\*5<sup>th</sup> quintile = richest, 4<sup>th</sup> quintile = richer, 3<sup>rd</sup> quintile = middle, 2<sup>nd</sup> = poorer, 1<sup>st</sup> = poorest

<https://doi.org/10.1371/journal.pone.0171411.t002>

highlight that in Bangladesh, safety net programs run by government aim to mitigate food insecurity, involves transfer of food mostly [49]. The top few social safety net programs in Bangladesh are the Vulnerable Group Development (VGD) [50,51] with more than 480,000 recipient households [52], the Food for Work (FFW) [52,53] serving more than 75,000,000 hours of work and the Vulnerable Group Feeding (VGF) [54], which are all food oriented. Therefore, considering the inclination of the moderate and severe food insecure households towards adaptation of mixed food and financial compromise strategies, it should be highly advisable that the government and the NGOs modify their existing food insecurity alleviation oriented safety net programs and incorporate financial modalities such as cash/asset transfer or small loans alongside with food transfer. Comparison of food and cash transfer programs in Bangladesh has shown increased caloric intakes of school age children and elderlies if they are benefited by cash transfer programs [55], however, irregularity in receiving cash payments in terms of timeliness has challenged its efficacy [56].

On the seasonal dynamics of adopted coping strategies, it is needed to be mentioned that rice is the staple cereal grain and the fundamental driver of the agro-based economy of Bangladesh [43,57]. However, rice production is invariably related to seasonal variation and the interim period between different harvests threatens the employment opportunities of around 75% of the population who depends on the agricultural sector as the primary means of livelihood [58,59]. Food insecurity prevails during the transitory post-harvest periods [43] due to seasonal unemployment and lack of food stock which forces households to adopt different coping strategies. In Bangladesh, the *post-aman* season between September to December observes less severity of household food insecurity due to the boosted cumulative harvest of two varieties of rice in the time period [60], coupled with employment availability for the upcoming winter crop transplantation [61,62]. Our result suggests that despite having no difference between *post-aman* and *monsoon* season, households were less likely to adopt both food compromise and financial coping strategies during the *post-aman* season. It is noteworthy that, when coping strategies are originated following a crisis, they can also lead to a new livelihood pattern [11] which this study could not illustrate.

**Table 3. Determinants (adjusted) of coping strategies at the household level (Outcome: Food compromised coping and both food compromised and financial coping; reference category: Financial coping)\*.**

Variables	n	Adjusted RRR (95%CI)* of food compromised coping	p-value	Adjusted RRR (95%CI) of both food compromised and financial coping	p-value
Seasonality	23374				
		Reference		Reference	
		0.6 (0.44–0.82)	0.001	0.71 (0.57–0.89)	0.003
		0.75 (0.56–1.01)	0.060	0.87 (0.69–1.1)	0.259
Residential area	23374				
		Reference		Reference	
		0.84 (0.57–1.25)	0.394	1.14 (0.86–1.53)	0.363
Sex of household head	23374				
		Reference		Reference	
		1.13 (0.89–1.43)	0.320	1.01 (0.82–1.23)	0.950
Education level of household head	23326				
		Reference		Reference	
		1.1 (0.86–1.39)	0.452	1.17 (0.96–1.44)	0.119
		1.31 (1.01–1.71)	0.043	1.37 (1.1–1.71)	0.005
Occupation of primary earner	23374				
		Reference		Reference	
		1.21 (0.99–1.47)	0.064	1.8 (1.52–2.14)	<0.001
		1.23 (0.98–1.54)	0.072	1.41 (1.16–1.71)	<0.001
		1.08 (0.84–1.38)	0.550	1.26 (1.02–1.57)	0.032
		1.09 (0.71–1.69)	0.696	1.54 (1.1–2.15)	0.012
		0.85 (0.4–1.79)	0.660	1.42 (0.82–2.48)	0.212
		1.01 (0.16–6.4)	0.988	2.72 (0.61–12.25)	0.191
Agricultural land	23374				
		Reference		Reference	
		1.12 (0.95–1.33)	0.174	1.37 (1.19–1.58)	<0.001
Homestead gardening	23374				
		Reference		Reference	
		1.2 (1.04–1.4)	0.016	1.1 (0.97–1.25)	0.141
Income of last month (Tk)	23374				
		Reference		Reference	
		1.13 (0.84–1.52)	0.429	1.03 (0.8–1.33)	0.838
		1.38 (1.05–1.82)	0.021	1.42 (1.12–1.8)	0.003
		1.61 (1.23–2.12)	0.001	1.92 (1.51–2.45)	<0.001
		1.72 (1.29–2.29)	<0.001	2.58 (2.01–3.32)	<0.001
Women education status	23374				
		Reference		Reference	
		1.63 (1.3–2.04)	<0.001	1.32 (1.09–1.61)	0.004
Women with income generating activity (IGA)	23374				
		Reference		Reference	
		0.89 (0.76–1.04)	0.131	0.85 (0.74–0.96)	0.010

(Continued)

Table 3. (Continued)

Variables	n	Adjusted RRR (95%CI)* of food compromised coping	p-value	Adjusted RRR (95%CI) of both food compromised and financial coping	p-value
Household food insecurity	23374				
	Mildly food insecure	Reference		Reference	
	Moderately food insecure	4.54 (3.3–6.25)	<0.001	8.04 (5.75–11.26)	<0.001
	Severely food insecure	0.3 (0.25–0.38)	<0.001	4.98 (4.13–6.01)	<0.001
Asset index**	23374				
	5 <sup>th</sup> quintile	Reference		Reference	
	4 <sup>th</sup> quintile	0.95 (0.78–1.16)	0.614	1.02 (0.85–1.22)	0.838
	3 <sup>rd</sup> quintile	1 (0.8–1.25)	0.997	1.14 (0.95–1.37)	0.151
	2 <sup>nd</sup> quintile	1.11 (0.87–1.42)	0.396	1.34 (1.11–1.62)	0.003
	1 <sup>st</sup> quintile	1.2 (0.93–1.54)	0.159	1.32 (1.07–1.62)	0.009
Household size	23374	1.07 (1.02–1.12)	0.006	1.14 (1.1–1.19)	<0.001

\*Sex of the household head, residence, and seasonality were adjusted in the model;

\*\*5<sup>th</sup> quintile = richest, 4<sup>th</sup> quintile = richer, 3<sup>rd</sup> quintile = middle, 2<sup>nd</sup> = poorer, 1<sup>st</sup> = poorest

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Our study has illustrated that, moderate food insecure households were significantly more likely to adopt food compromise coping relative to only financial coping strategies but for severely food insecure households, significantly less RRR was observed. This finding highlights the reduced tendency of severely food insecure households towards food compromise strategies comparing to financial coping strategies which is perhaps due to the pragmatic scenario that severely food insecure households never have enough food at reserve which could be further compromised. While on other socio-demographic determinants of food compromise and both food compromise and financial coping relative financial coping strategies, our result indicated education level of household head, household income level, household size and women education status as significant predictors. Our findings of the significant association between coping strategy and education level of household head supports similar findings from previously conducted studies [9,45,63]. In concordance with our study, household income level was also reported by other studies to be significantly associated with food insecurity derived coping strategies [63,64]. Households with large family size are food insecure compared to those with small numbers of members, which favors previous study findings [45,46]. We have also found women education status as a significant determinant of coping strategy previously reported [9]. Educated women may have their established role or voice in household decision making, which in turn could influence household food insecurity situation as well as adaptation of coping strategies.

### Limitations and strengths

The study did not look upon the causes behind the households being food insecure; i.e. the situation that compelled them to apply different coping strategy and whether they got back to a normal situation thereafter. Data was derived through cross sectional surveillance from which, causal relationships cannot be determined. A possibility of recall bias remains, as information was gathered mostly through maternal response. Nevertheless, a large sample size added to the strength of the study.

## Conclusion

This study is the first of its kind to examine the relationship between the degrees of severity of household food insecurity and the types of coping strategies adopted by Bangladeshi households. The study showed that, majority of the households were significantly more inclined to adopt both financial and food compromise coping strategies. Moreover, severe and moderately food insecure households were more likely to adopt both food compromise and financial coping strategies when compared to being mildly food insecure. Adopting coping strategies decrease the vulnerability of the poor, exacerbating the scope for breaking the cycle of poverty. Support for further analysis and deeper understanding of people's livelihood and coping mechanisms in order to strengthen their livelihood and enhance the effectiveness of assistance programs is advisable. The evidence gathered and subsequently shown in this paper along with the recommendation is expected to be vital for the policymakers and NGO personnel to formulate and instrumentalize in new interventions in the existing safety net programs.

## Supporting information

**S1 Data. Description: Data file (in Stata).**  
(DTA)

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## References

1. Food and Agriculture Organization of the United Nations (FAO). Rome declaration on World Food Security; 13–17 November, 1996; Rome, Italy.
2. Bickel G, Nord M, Price C, Hamilton W, Cook J (2000) Guide to measuring household food security. US Department of Agriculture, Food and Nutrition Service, Office of Analysis, Nutrition, and Evaluation [http://www.fns.usda.gov/fsec/FILES/Guide%20to%20Measuring%20Household%20Food%20Security%20\(3-23-00\).pdf](http://www.fns.usda.gov/fsec/FILES/Guide%20to%20Measuring%20Household%20Food%20Security%20(3-23-00).pdf).
3. Endale W, Mengesha ZB, Atinafa A, Adane AA (2014) Food Insecurity in Farta District, Northwest Ethiopia: a community based cross-sectional study. BMC research notes 7: 130. <https://doi.org/10.1186/1756-0500-7-130> PMID: 24606757
4. Maxwell DG (1996) Measuring food insecurity: the frequency and severity of “coping strategies”. Food Policy 21: 291–303.
5. Maxwell D, Caldwell R (2008) The Coping Strategies Index Field Methods Manual.
6. Kyaw D (2009) Rural Household’s Food Security Status and Coping: Strategies to Food Insecurity in Myanmar: Institute of Developing Economies, Japan External Trade Organization.
7. Ruel MT, Garrett JL, Hawkes C, Cohen MJ (2010) The food, fuel, and financial crises affect the urban and rural poor disproportionately: a review of the evidence. the Journal of Nutrition 140: 170S–176S. <https://doi.org/10.3945/jn.109.110791> PMID: 19939990
8. Food U, Organization A (2008) The State of Food Insecurity in the World 2008. Rome. pp. 22–31.
9. Shariff ZM, Khor GL (2008) Household food insecurity and coping strategies in a poor rural community in Malaysia. Nutrition research and practice 2: 26–34. <https://doi.org/10.4162/nrp.2008.2.1.26> PMID: 20126362
10. Quaye W (2008) Food security situation in northern Ghana, coping strategies and related constraints.
11. Liwenga ET (2003) Food insecurity and coping strategies in semiarid areas: the case of Mvumi in Central Tanzania.
12. Chilowa W (1991) Food Insecurity and Coping Strategies Among the Low Income Urban Households in Malawi.
13. Ahamad M, Khondker RK (2010) Climate Risks, Seasonal Food Insecurity and Consumption Coping Strategies: Evidences from a Micro-level Study from Northern Bangladesh. Seasonal Food Insecurity and Consumption Coping Strategies: Evidences from a Micro-Level Study from Northern Bangladesh (April 7, 2010).
14. Ayieko MA, Midikila K (2010) Seasonality of Food Supply, Coping Strategies and Child Nutritional Outcome in Sabatia-Kenya. Advance Journal of Food Science and Technology.
15. Fintrac Inc. (2014) Bangladesh USAID-BEST Analysis. NW, USA .: USAID Office of Food For Peace.
16. Nord M, Andrews M, Carlson S (2005) Household food security in the United States, 2004. USDA-ERS Economic Research Report.
17. United States Agency for International Development (USAID) (2015) Draft Country Specific Information: Bangladesh.
18. Gupta P, Singh K, Seth V, Agarwal S, Mathur P (2015) Coping Strategies Adopted by Households to Prevent Food Insecurity in Urban Slums of Delhi, India. Journal of Food Security 3: 6–10.
19. Gundersen C, Ziliak JP (2014) Childhood food insecurity in the US: trends, causes, and policy options. Future of children.
20. Uddin ME (2012) Household Food Security Status of Marginal Farmers in Selected Storm Surge Prone Coastal Area of Bangladesh. The Agriculturists 10: 98–103.
21. Hossain M, Naher F, Shahabuddin Q (2005) Food security and nutrition in Bangladesh: progress and determinants. Electronic Journal of Agricultural and Development Economics 2: 103–132.
22. Helen Keller International (HKI) JPGSoPHJ (2013) State of food security and nutrition in Bangladesh 2013. Dhaka, Bangladesh: HKI and JPGSPH.

23. James P Grant School of Public Health (JPGSPH) HKIH (2011) State of Food Security and Nutrition in Bangladesh. Dhaka, Bangladesh.: JPGSPH. HKI.
24. Coates J, Swindale A, Bilinsky P (2007) Household Food Insecurity Access Scale (HFIAS) for measurement of food access: indicator guide. Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development.
25. Diaz-Bonilla E, Robinson S (2001) Shaping globalization for poverty alleviation and food security. International Food Policy Research Institute (IFPRI).
26. Hillbruner C, Egan R (2008) Seasonality, household food security, and nutritional status in Dinajpur, Bangladesh. *Food Nutr Bull* 29: 221–231. <https://doi.org/10.1177/156482650802900308> PMID: [18947035](https://pubmed.ncbi.nlm.nih.gov/18947035/)
27. Garrett JL, Ruel MT (1999) Are determinants of rural and urban food security and nutritional status different? Some insights from Mozambique. *World Development* 27: 1955–1975.
28. Arene C, Anyaeji C (2010) Determinants of food security among households in Nsukka Metropolis of Enugu State, Nigeria. *Pakistan Journal of Social Sciences* 30: 9–16.
29. Endale W, Mengesha ZB, Atinafu A, Adane AA (2014) Food Insecurity in Farta District, Northwest Ethiopia: a community based cross-sectional study. *BMC research notes* 7: 1.
30. Gill GJ, Farrington J, Anderson E, Luttrell C, Conway T, et al. (2003) Food security and the Millennium Development Goal on hunger in Asia: Overseas development institute (ODI).
31. Quisumbing AR, Brown LR, Feldstein HS, Haddad L, Peña C (1995) Women: The key to food security. *Food policy statement* 21.
32. Babatunde R, Omotesho O, Olorunsanya E, Owotoki G (2008) Determinants of vulnerability to food insecurity: A gender-based analysis of farming households in Nigeria. *Indian Journal of Agricultural Economics* 63: 116.
33. Babatunde R, Omotesho O, Sholotan O (2007) Socio-economic characteristics and food security status of farming households in Kwara State, North-Central Nigeria. *Pakistan Journal of Nutrition* 6: 49–58.
34. Faridi R, Wadood SN (2010) An econometric assessment of household food security in Bangladesh. *The Bangladesh Development Studies*: 97–111.
35. McDonald CM, McLean J, Kroeun H, Talukder A, Lynd LD, et al. (2015) Correlates of household food insecurity and low dietary diversity in rural Cambodia. *Asia Pacific journal of clinical nutrition* 24: 720–730. <https://doi.org/10.6133/apjcn.2015.24.4.14> PMID: [26693758](https://pubmed.ncbi.nlm.nih.gov/26693758/)
36. Ghattas H, Barbour JM, Nord M, Zurayk R, Sahyoun NR (2013) Household food security is associated with agricultural livelihoods and diet quality in a marginalized community of rural Bedouins in Lebanon. *The Journal of nutrition* 143: 1666–1671. <https://doi.org/10.3945/jn.113.176388> PMID: [23946340](https://pubmed.ncbi.nlm.nih.gov/23946340/)
37. Bushamuka VN, de Pee S, Talukder A, Kiess L, Panagides D, et al. (2005) Impact of a homestead gardening program on household food security and empowerment of women in Bangladesh. *Food and Nutrition Bulletin* 26: 17–25. <https://doi.org/10.1177/156482650502600102> PMID: [15810795](https://pubmed.ncbi.nlm.nih.gov/15810795/)
38. Chinnakali P, Upadhyay RP, Shokeen D, Singh K, Kaur M, et al. (2014) Prevalence of household-level food insecurity and its determinants in an urban resettlement colony in north India. *Journal of health, population, and nutrition* 32: 227. PMID: [25076660](https://pubmed.ncbi.nlm.nih.gov/25076660/)
39. Thorne-Lyman AL, Valpiani N, Sun K, Semba RD, Klotz CL, et al. (2010) Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to the financial crisis. *The Journal of nutrition* 140: 182S–188S. <https://doi.org/10.3945/jn.109.110809> PMID: [19923385](https://pubmed.ncbi.nlm.nih.gov/19923385/)
40. Guha-Khasnobis B, Acharya SS, Davis B (2007) *Food insecurity, vulnerability and human rights failure*: Springer.
41. Regassa N (2011) Small holder farmers coping strategies to household food insecurity and hunger in Southern Ethiopia. *Ethiopian Journal of Environmental Studies and Management* 4.
42. Olumakaiye M, Ajayi A (2006) Women's empowerment for household food security: The place of education. *Journal of Human Ecology* 19: 51–55.
43. Faridi R, Naimul Wadood S (2010) An econometric assessment of household food security in Bangladesh. *Bangladesh Development Studies* 33: 97.
44. Feleke ST, Kilmer RL, Gladwin CH (2005) Determinants of food security in Southern Ethiopia at the household level. *Agricultural Economics* 33: 351–363.
45. Tefera T, Tefera F (2014) Determinants of Households Food Security and Coping Strategies for Food Shortfall in Mareko District, Guraghe Zone Southern Ethiopia. *Journal of Food Security* 2: 92–99.
46. Olayemi AO (2012) Effects of family size on household food security in Osun State, Nigeria. *Asian journal of agriculture and rural development* 2: 136.



47. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ICF International (2013) Bangladesh Demographic and Health Survey 2011. In: DHS M, editor. Dhaka, Bangladesh Calverton, Maryland, USA.
48. Kazal MMH, Villinueva CC, Hossain MZ, Das TK (2010) Food security strategies of the people living in haor areas: status and prospects. American International University, Dhaka, Bangladesh.
49. Bangladesh National Web Portal (2015) Social Safety Net. Social Safety Net 2015.
50. Gardener J, Wüstefeld M, Taher M, Genequand MM (2009) Country Programme Bangladesh CP 10410.0 (2007–2010).
51. Hossain N (2007) The politics of what works: the case of the Vulnerable Group Development Programme in Bangladesh. Available at SSRN 1629297.
52. The World Bank (2006) Social Safety Nets in Bangladesh: An Assessment. Paper no.9 Paper no.9.
53. Osmani SR, Chowdhury OH (1983) Short run impacts of food for work programme in Bangladesh. *The Bangladesh Development Studies* 11: 135–190.
54. Matin I, Hulme D (2003) Programs for the Poorest: Learning from the IGVDG Program in Bangladesh. *World development* 31: 647–665.
55. Ahmed AU, Quisumbing AR, Nasreen M, Hoddinott JF, Bryan E (2009) Comparing food and cash transfers to the ultra-poor in Bangladesh. International Food Policy Research Institute (IFPRI).
56. Ahmed AU, Quisumbing AR, Hoddinott JF, Nasreen M, Bryan E (2007) Relative efficacy of food and cash transfers in improving food security and livelihoods of the ultra-poor in Bangladesh. Dhaka: World Food Programme Bangladesh and Washington, DC: International Food Policy Research Institute.
57. Hossain M (2009) The impact of shallow tubewells and boro rice on food security in Bangladesh: Intl Food Policy Res Inst.
58. Alam GM, Hoque KE, Siraj SB, Muhammad Faizal A (2009) The role of agriculture education and training on agriculture economics and national development of Bangladesh. *African Journal of Agricultural Research* 4: 1334–1350.
59. Zug S (2006) Monga-Seasonal Food Insecurity in Bangladesh: Bringing the Information Together. *JOURNAL OF SOCIAL STUDIES-DHAKA*- 111: 21.
60. Hossain M, Bose ML, Mustafi BA (2006) Adoption and productivity impact of modern rice varieties in Bangladesh. *The Developing Economies* 44: 149–166.
61. Mostofa M, Karim MR, Miah MM (2010) Growth and Supply Response of Winter Vegetables Production in Bangladesh. *Thai Journal of Agricultural Science* 43: 175–182.
62. Rahman S (2009) Whether crop diversification is a desired strategy for agricultural growth in Bangladesh? *Food Policy* 34: 340–349.
63. Bird K, Shepherd A, Scott A, Butaumocho B (1998) Coping strategies of poor households in semi-arid Zimbabwe. *Analysis*: 97.
64. Rashid DA, Langworthy M, Aradhyula S. Livelihood shocks and coping strategies: an empirical study of Bangladesh households; 2006. pp. 23–26.