



Physical and mental health status of women in disaster-affected areas in Bangladesh

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Abstract

Despite the increased risk of disasters in the Bangladesh, there is a dearth of research about women's physical and mental health vulnerability following disasters. This study aimed to explore the physical and mental health status and associated risk factors of women in recurrent disaster-affected areas of Bangladesh. Participants ($N=408$) were recruited using systematic random sampling from two purposively selected disaster-prone areas (Upazilas of *Sagata* and *Sarankhola*), using a structured questionnaire conducted in person. Physical and mental health status was assessed using the health Short Form 12 (SF-12) measure that is comprised of both physical health (PCS-12) and mental health (MCS-12) subscales. Of the 408 participants, the mean scores on PCS-12 and MCS-12 subscales were 43.85 ± 28.04 and 37.70 ± 27.29 , respectively, which were strongly correlated, $r=.71$, $p < .001$. Overall, 65.9% and 63.0% of total participants scored below the validated cut-off of PCS-12 and MCS-12 subscales which indicates both poor physical and mental health. The results indicated that physical and mental health were significantly poorer for the participants who witnessed casualties, lost family members or relatives, were relocated to shelters and sacrificed food during disasters. Moreover, poorer mental health scores were identified among participants who were physically injured and/or consulted a medical practitioner during or after the disaster. Accurate health knowledge is crucial for adequate and effective disaster preparation to decrease the health impacts on women in disaster-prone areas of Bangladesh. Research in this area is needed, and strategies to improve the public health status of women are warranted.

Keywords Women · Physical health · Mental health · Risk factors · Disasters · Bangladesh

1 Introduction

The frequency and severity of disasters is potentially the biggest global health threat of the twenty-first century, particularly for resource-poor countries (Karmakar and Pradhan 2020; Smith et al. 2022). Disaster events increase the social, physical, psychological, and

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economic vulnerabilities among populations, thereby contributing to local, regional, and global health risks (Fatema et al. 2021; Ye and Aldrich 2021).

It is worth mentioning that vulnerability is the condition and process that determines the exposure and susceptibility of an individual, a community, a system, or a unit to disaster as well as their abilities to effectively respond (Maikhuri et al. 2017). It connects people with the immediate environment in which they live. Despite the ongoing debate on how to define vulnerability, and who are the vulnerable people (Marino and Faas 2020), the operationalization of the term ‘vulnerability’ is considered as a useful concept while studying the multifaceted impacts and reasoning of disasters. It depends on context and perspective. In the context of climatic events, according to the Intergovernmental Panel on Climate Change (IPCC) the central idea of vulnerability is the degree to which a system is susceptible to and is unable to cope with adverse effects of climate (Parry et al. 2007). Vulnerability involves three interrelated sets of circumstances including physical, environmental, and social (Oliver-Smith et al. 2019; Wisner et al. 2004). The vulnerability of the various groups not only increases because of their exposure to hazards but also because of other factors including their marginality, and poorer access to resources (Bankoff 2013). Environmental disasters are considered as a major factor in increasing the vulnerability of communities, especially vulnerable or disadvantaged populations, include women, families with children, older adults, the disabled, and low-income individuals who are known to suffer disproportionate harm in disasters (Maikhuri et al. 2017; Marshall et al. 2020). Furthermore, there are irregular protective preparations and actions for disadvantaged groups before, during or after disasters in resource-poor countries such as Bangladesh.

Between 2000 and 2019, Bangladesh ranked 7th highest among the disaster-affected countries and in the long-term climate risk index (CRI) worldwide, as well as 9th in annual disaster related fatalities (Eckstein et al. 2021). The country’s unique meteorological and geographical conditions, coupled with its mass population, poor infrastructure, gender, and social discrimination contribute to the generation of disasters, and long-term disaster risks and fatalities (Hoque et al. 2018; Neumayer and Plümper 2007). The health of disadvantaged or vulnerable populations within the country is at greater risk when emergency situations such as disasters occur (Eckstein et al. 2021; Kabir et al. 2019). Exposure to disasters is associated with poor physical health and mental health, partly due to the disruption of the pre-existing risk factors and social structure that accompanies these events (Bhattacharya and Ghosh 2020; Karaye et al. 2019). In Bangladesh, women, as a vulnerable group, experience more severe impacts because of personal, social, and health service factors (Fatema 2020; Kabir et al. 2021). Women are also vulnerable in the face of disasters because of the disparities in their accessibility to resources, and opportunities, as well as their sensitivity to risk (Hasan et al. 2020; Neumayer and Plümper 2007). For example, women are socially homebound and often stay at home due to inadequate access to a safe shelter during disasters which results in high numbers of female injuries and mortality from disasters (Fatema et al. 2019; Juran and Trivedi 2015) as many of these women are tied to social roles (e.g., mother, daughter, daughter-in-law, and wife) and responsibilities which may limit their relocation to shelters. Research has shown that women’s health needs receive lower priority and in some cases are even ignored, due to poverty and gender inequality (Fatema et al. 2019; Kabir et al. 2019). Women also may experience inadequate nutrition and poorer health related to their tendency to sacrifice available food for children and other family members at times when food is scarce (Beier et al. 2015; Kabir et al. 2019). These pre-existing factors combined with disasters therefore have a greater impact on women’s physical and mental well-being during and after disasters, compared to men (Fatema et al. 2021; Smith et al. 2022; Wickrama and Ketring 2012).

Several studies have examined the physical and mental health global consequences of disasters (Hasan et al. 2020; Karmakar and Pradhan 2020; Liang and Cao 2014). Most of these studies reported that disaster-affected people often suffer from a wide range of physical and mental health problems immediately, as well as years after the event (Brooks et al. 2020; Karmakar and Pradhan 2020; Khachadourian et al. 2015). The consequences of disaster exposures include decreased survivors' health-related quality of life (HRQoL) affecting physical and psychological domains through multiple disaster exposure, physical injury, bereavement, death of close family members and witnessing fatalities (Khachadourian et al. 2015; Massazza et al. 2021). HRQoL is a multidimensional concept that includes physical, psychological, and social domains of health status (Bhattacharya and Ghosh 2020; Liang and Cao 2014). The physical health impact of disasters is evident in the number of injuries, fractures, increased ill health, and prevalence of infectious diseases (Beier et al. 2015; Karmakar and Pradhan 2020; Paul 2010; Paul et al. 2011). Disasters also have the potential to trigger psychological problems in disaster victims ranging from sleep disorders to serious mental health conditions, especially posttraumatic stress disorder (PTSD) (Baral and Bhagawati 2019; Morganstein and Ursano 2020). However, research shows that disaster-affected people who have social, economic, and psychological resources, such as robust social support and self-esteem, typically endure these events with few physical or psychological problems (Brooks et al. 2020; Hasan et al. 2020).

Bangladesh has already suffered from many harsh environmental disasters, which have adversely affected the health of the people, particularly women due to vulnerable sociocultural constructs, gender inequality, and living in environmentally fragile areas. Yet, only a few researchers have explored the physical health impact of disasters or emphasized the need for mental health care for the vulnerable women in Bangladesh (Fatema et al. 2021; Nahar et al. 2014; Hasan et al. 2020). Research on women's health in the context of disasters in Bangladesh is needed to facilitate disaster preparedness, response, recovery, reconstruction, and health management strategies.

1.1 The present study

The current study aimed to investigate the physical and mental health symptoms of disaster-affected women in Bangladesh, and the risk factors associated with health status. The study specifically aimed to:

- (i) investigate the socio-demographic profile (level of education and family's monthly income) and *frequency* of disaster exposures [experiencing disasters, injury during disasters, witnessing casualties (death/injury), and loss of family members or relatives] of the disaster-affected women in Bangladesh.
- (ii) investigate self-reported health status (post-disaster illness, and type of illness), as well as facts related to accessing healthcare (visiting medical practitioners, and reasons of not visiting medical practitioners) and disaster evacuation (moving to shelters, displacement experiences, and reasons of not moving to shelters) of the disaster-affected women in Bangladesh.
- (iii) explore the physical health outcomes of the disaster-affected women in Bangladesh.
- (iv) explore the mental health outcomes of the disaster-affected women in Bangladesh.
- (v) explore the relationship between physical and mental health outcomes of the disaster-affected women in Bangladesh

The following hypotheses were formulated:

Hypothesis 1 It is predicted that women who were physically injured by a disaster will have lower mental health outcomes than women who were not physically injured in a disaster.

Hypothesis 2 It is predicted that women who did not visit medical practitioners will have poorer mental health outcomes compared to women who did visit medical practitioners.

Hypothesis 3 It is predicted that women who have witnessed casualties during disasters will have poorer physical health and mental health outcomes than those who have not witnessed casualties during the disasters.

Hypothesis 4 It is predicted that women who lost family members or relatives during disasters will have poorer physical health and mental health compared to those who did not experience the loss of family members or relatives.

Hypothesis 5 It is predicted that women who moved to shelters as a result of disasters will have poorer physical health and mental health compared to women who did not move to shelters as a result of the disaster.

Hypothesis 6 It is predicted that women who have sacrificed their food for family during disasters will have poorer physical health and mental health than those who did not sacrifice food during disasters.

2 Data and method

2.1 Study areas

The study was conducted in two Upazilas, namely *Sagata* and *Sarankhola* of Bangladesh. The Upazila is a local government area in Bangladesh and functions as a sub-unit of the district. *Sagata* Upazila is located in the northeast riverine area, and *Sarankhola* is the southernmost coastal area. Bangladesh government recognized both sites as ‘disaster-prone’ districts. Figure 1 shows the location of the selected Upazilas.

Sarankhola is one of the disaster hotspots in the world for frequent and devastating tropical cyclones (Hoque 2018) due to being located at the mouth of the Bay of Bengal. On 15 November 2007, a category 4 cyclone (*Sidr*) hit this region causing 3406 death and damaging approximately 0.65 million hectares of cropland as well as some other parts of Bangladesh. Furthermore, this area has been devastated almost every year by severe tropical cyclones. In addition to tropical cyclones, monsoon floods, waterlogging, and riverbank erosions are frequent (Beier et al. 2015; Fatema 2020) in low-lying riverine areas and the coastal areas of Bangladesh. The *Sagata* Upazila of *Gaibandha* district is among the 32 flood-prone districts that experienced the worst flood in the last four decades causing 145 deaths and affecting 8 million people (Annual flood report 2017). The study unions are riverine islands (*Chars*) in *Jamuna* River, adding that *Brahmaputra*, *Tista*, *Kartoa*, and *Ghaghot* are notable rivers in this district that cause flood and riverbank erosion almost every year. In June 2020, around 20,000

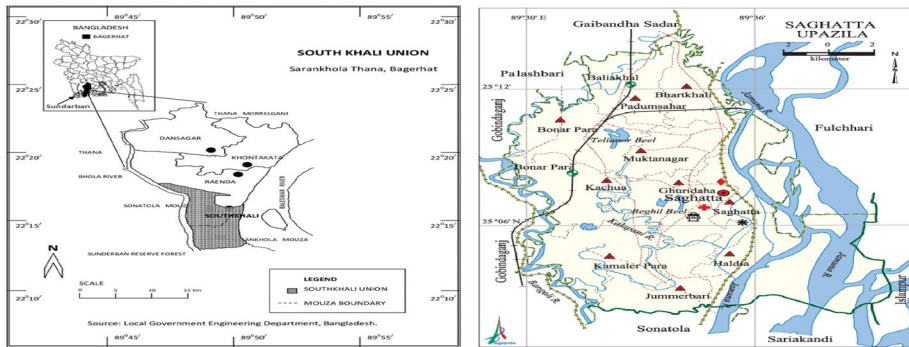


Fig. 1 Location of the *Sagata* and *Sarankhola* Upazilas of Bangladesh

residents in *Sadar*, *Fulchari*, and *Saghatta* of *Gaibhandha* district were marooned when the rivers inundated over danger levels. In 2016, the flood situation lasted for about 23 days in this region.

These two districts were included in the study to assess the health impact of disaster-affected women in coastal areas and riverine households in the context of different geographical regions and patterns of disasters.

2.2 Participants and procedure

The university Human Research Ethics Committee provided approval prior to commencement of data collection. The quantitative survey method was employed to investigate the research objectives for this study. The measures for the present study were selected from the existing literature, and the questions were validated with a pilot study of 30 disaster-affected women in Bangladesh. All measures were administered by interviews in Bangla after translating in accordance with the widely used Brislin (1970) translation model.

Participants were recruited using systematic random sampling, one per household. The eligibility criteria for participation were: (1) women aged 18 years and above; (2) living in the disaster-affected study areas; (3) have experienced at least one environmental disaster; (4) willing to consent and participate in the study; and (5) able to communicate their experience. Eligible participants were invited to participate in the study, and the researcher read the information sheet to prospective participants. Each participant provided verbal and written consent prior to proceeding. The first author collected data in hard copies with the assistance of two local contact persons, who introduced the researcher to the participants in each area. All the interviews were conducted in a private space at a location nearby to the participants' house, with the presence of the researcher and participant only. Privacy and confidentiality were maintained at all times during interviews, and responses were de-identified. The completed survey interview consisted of 104 items and took approximately 30 to 40 min to complete. Data were collected from July 2019 to January 2020.

2.3 Measures

2.3.1 Socio-demographic measures

Socio-demographic information was collected on age, level of education, and monthly income of the respondents.

2.3.2 Health and disaster variables

Respondents were asked to provide information about their general health and post-disaster illness. In addition, disaster exposures were measured by asking respondents how many disasters they have experienced, whether they have witnessed casualties, and lost families or relatives, and whether they have been injured during disasters. The disaster related and self-reported health information of the participants are shown in Tables 1 and 2 accordingly.

2.3.3 The short form 12 health survey

The Short Form 12 (SF-12; Ware et al. 1996) scale was used to measure physical health and mental health outcomes. The SF-12 was developed as a short form of the original 36-item version (SF-36), with the same eight health domains (Ware et al. 1996). The SF-12 is commonly used to measure HRQOL in the context of disasters, and the 12-item version was selected to minimize the time required to complete the questionnaire and maximize the response rate (Ware et al. 1996). The SF-12 comprises 12 questions within two subscale scores: Physical Component Summary (PCS-12) and Mental Component Summary (MCS-12) (Ware et al. 1996). Composite scores were created by adding relevant items, range from 0 (worst health) to 100 (best health), with a higher score corresponding to a better health status. A score of 50 or less on the PCS-12 has been recommended as a cut-off to determine a physical condition, while a score of 42 or less on the MCS-12 may suggest symptoms of ‘clinical depression’ (Ware et al. 1995). The SF-12 has well-established validity and reliability even after translating into different languages (Bhattacharya and Gosh 2020; Karaye et al. 2019). The internal consistency (Cronbach’s α) of the SF-12 in our study was 0.90, with Cronbach’s α of PCS-12 and MCS-12, 0.82 and 0.84, respectively.

2.4 Descriptive statistics

All hard-copy data were entered into the IBM SPSS Statistics for Windows, Version 25.0. Statistical analyses included descriptive statistics and inferential statistics. Baseline and demographic characteristics were summarized by standard descriptive statistics (mean, standard deviation, and percentage). Cronbach’s alphas of key measures (SF-12 subscales) used in the study were conducted. Participants with missing values for one or more of the variables were excluded from the analyses.

Table 1 Socio-demographic and disasters associates' information of the participants ($N=408$)

Characteristics	Number	Percentage (%)
Age group		
18–33	146	35.4
34–49	152	36.8
50–65	94	22.8
Above 65	19	4.6
Education		
No formal education	249	60.3
Primary level	91	22.0
Secondary level	61	14.8
Higher Secondary level	8	1.9
Degree pass	2	.5
Monthly family income (tk)		
Under 5000	176	42.6
5000–8000	169	40.9
9000–12,000	49	11.9
13,000–16,000	13	3.1
17,000–20,000	4	1.0
Number of disasters experienced		
1–2	33	8.0
3–4	176	42.6
Above 4	200	48.4
Injury during the disaster		
Yes	196	47.5
No	214	51.8
Witnessing casualties in disasters		
Yes	234	56.7
No	176	42.6
Loss of family/relatives in disasters		
Yes	154	37.3
No	255	61.7
Did you ever move/relocate to a shelter as a result of the disaster?		
Yes	267	64.6
No	143	34.6
If yes, being a woman, how was your displacement experience?		
Secure	144	34.9
Insecure	126	30.5
Displacement worries (Why you did not go to a shelter?)		
Lack of safety reason	35	8.5
Did not get pre-disaster warning	6	1.5
Feeling emotional about own house	69	16.7
Because of previous negative experience	31	7.5
Sacrificing food		
Yes	316	76.5
No	92	22.3

Table 2 Health-related information of the participants ($N=408$)

Characteristics	Number	Percentage (%)
Health complains		
Yes	289	70.0
No	122	29.5
Post-disaster illness		
Yes	313	75.8
No	97	23.5
Type of Illness		
Waterborne diseases	179	43.3
Skin diseases	54	13.1
Chronic pain	64	15.5
Severe fracture/disability from disaster	7	1.7
Gynaecological problems	11	2.7
Consulting medical practitioners for illness		
Yes	197	47.7
No	189	45.8
Did not consult medical practitioners because of		
Financial crisis	148	35.8
Lack of health care facilities	35	8.5

2.5 Assumption testing

Prior to conducting the main analysis, several assumptions were evaluated. For the Chi-square test, the assumption of independence was met during data collection and expected frequencies were checked within the SPSS statistics output. Prior to calculating r , linearity and homoscedasticity were assessed and found to be supported. The assumption of normality was violated, but with a sufficiently large enough sample size (> 30 or 40) this should not cause major problems (Pallant 2020). Subsequently, normality and homogeneity of variance were assessed before conducting the independent t test. The Shapiro–Wilk test of normality for the data was statistically significant, but the t test is considered to be robust regarding violations of normality if the sample size is sufficiently large (Allen et al. 2019). In addition, Levene’s test was also significant; thus, we reported the t -test for equal variances was not assumed. Consequently, Welch’s t test was used. Next, the univariate normality, multicollinearity, multivariate outliers, and homogeneity of variance were assessed before conducting the one-way between groups multivariate analysis of variance (MANOVA). The assumption of normality was violated although this is not considered problematic, as MANOVA is considered robust when group sizes exceed 30; in this study, the sample size is 408 (Allen et al. 2019). No multivariate outliers were found in the data, multicollinearity was not of concern, and the assumption of homogeneity of variance–covariance matrices was not violated.

2.6 Statistical analysis

Differences between groups were examined using parametric and nonparametric methods depending on the data. First, a Chi-square test for goodness of fit ($\alpha=0.05$) was used to assess the statistical significance of the physical health and mental health of the disaster-affected women in Bangladesh. In addition, Pearson's r was used to assess the strength of the relationship between physical health and mental health. Second, two separate independent samples t -tests were conducted ($\alpha=0.05$) to investigate differences between (1) participants who reported to be 'injured' during disasters versus 'not injured,' and (2) participants who 'visited medical practitioners' versus those who 'did not visit medical practitioners' regarding their mental health variable. Third, one-way between groups MANOVAs was performed for physical health and mental health, in order to examine the statistical difference in three independent variables each consisting of two groups (women who have witnessed casualties during disasters vs. those who did not, women who lost family members or relatives during disasters vs. those who did not, women who have moved to shelters during disasters against those who did not, and women who have sacrificed food for their family during disasters versus those who did not). The alpha for the multivariate effect (i.e., the combined dependent variables) was set at 0.05. The univariate effect (i.e., the individual dependent variables) Bonferroni was adjusted to 0.025. To evaluate the magnitude of the study findings, the measure of effect size is also included, using Cohen's d and partial η^2 where applicable.

3 Results

3.1 Socio-demographic characteristics and disasters information

Participants' socio-demographic characteristics and their experiences of disasters are shown in Table 1. It is apparent from this table that most of the participants belong to low socio-demographic profiles and disaster impacted them in many ways.

3.2 Participants' health characteristics

The self-reported health information of the participants is shown in Table 2. Taken as a whole, most participants had health complaints and were unable to consult with medical practitioners due to financial crisis.

3.3 Physical health and mental health (SF-12 subscales)

The mean scores of physical health (PCS-12) and mental health (MCS-12) of all participants were 43.85 and 37.70 (Table 3). Participants were grouped as to whether they met the clinical cut-off for physical health and mental health, based on the cut-off scores of 50 for PCS-12 and 42 for MCS-12 (Ware et al. 1995). The PCS-12 scores and MCS-12 scores were significantly positively correlated ($r=0.71$, $p<0.001$), and most participants met the clinical cut-offs regarding poor physical health (66%) and poor mental health (63%).

Table 3 Participants' physical and mental health outcomes (number/mean \pm SD)

Variable description	Groups	Number (%) of participants above or below the cut-off	χ^2 (p value)	Effect size (w)
Physical health (PCS-12)	50 and below	272 (65.9%)	< .001	0.33
	51 and above	136 (32.9%)		
Mental health (MCS-12)	42 and below	260 (63.0%)	< .001	0.28
	43 and above	147 (35.6%)		
SF-12 measure		Mean (\pm SD)		
Physical component summary score (PCS-12)		43.85 (\pm 28.04)		
Mental component summary score (MCS-12)		37.70 (\pm 27.29)		
Pearson's r		.71	< .001	

A Chi-square test for goodness of fit test was used to assess the prevalence of physical health (50 and below, versus 51 and above) among disaster-affected women in Bangladesh. The result was statistically significant, $\chi^2(1, N=407)=45.33, p<0.001$, Cohen's $w=0.28$, which can be considered a small-to-medium effect (Allen et al. 2019). Additionally, a Chi-square test for goodness of fit test was used to assess the prevalence of mental health (42 and below, versus 43 and above) among disaster-affected women in Bangladesh. The result was statistically significant, $\chi^2(1, N=407)=31.37, p<0.001$ Cohen's $w=0.33$, which can be considered a medium effect size (Allen et al. 2019).

3.4 Participants' incidence of physical health and mental health outcomes depending on disaster experiences

Table 4 presents physical health (PCS-12) and mental health (MCS-12) scores based on participants' general health complaints, post-disaster illness, witnessing casualty, loss of families, injury, and experience of disasters. Results show that disaster-associated independent factors are positively related to poor physical health and poor mental health. Participants who consulted medical practitioners reported (50%) poor physical health compared to those who did not (46%). However, the majority (48%) of participants who did not consult medical practitioners indicated physical health and mental health above the cut-off scores. Similarly, most participants who moved to shelters reported poor physical health (70%) and lower mental health (72%) outcomes based on the cut-off scores. On the other hand, of those who did not move to shelters, 45% scored above the cut-off of PCS-12 and 47% scored above the cut-off of MCS-12. Most participants who sacrificed food (84% and 82%), and participants who were insecure during displacement (36% and 37%), scored below the cut-off of PCS-12 and MCS-12, respectively. Also, most participants who sacrificed food (84% and 82%) scored below the cut-off of PCS-12 and MCS-12, respectively. In addition, participants who were insecure during displacement (36% and 37%) reported poor physical and mental health separately.

A series of one-way between group MANOVAs was conducted to examine the differences between physical health and mental health (dependent variables) regarding the following independent variables: (1) participants who had witnessed casualties versus those that did not, (2) who had lost family members or relatives contrasted with

Table 4 Percentage (%) of demographic and disaster variables by the participants PCS-12 and MCS-12

Variable description	Physical component summary Score (PCS-12)		Mental component summary Score (MCS-12)	
	50 and below <i>n</i> (%)	51 and above	42 and below	43 and above
Participants general health complaints				
Yes	225 (82.7%)	62 (45.6%)	210 (80.8%)	77 (52.4%)
No	47 (17.3%)	74 (54.4%)	50 (19.2%)	70 (47.6%)
Post-disaster illness				
Yes	235 (75.1%)	77 (24.6%)	225 (71.9%)	86 (27.5%)
No	37 (38.1%)	59 (60.8%)	35 (36.1%)	61 (62.9%)
Consulting medical practitioners for illness				
Yes	136 (50%)	59 (43.4%)	132 (50.8%)	62 (42.2%)
No	124 (45.6%)	65 (47.8%)	116 (44.6%)	73 (49.7%)
Witnessed casualties				
Yes	177 (75.6%)	57 (24.4%)	177 (75.6%)	57 (24.4%)
No	95 (54.0%)	79 (44.9%)	83 (47.2%)	90 (51.1%)
Loss of family members or relatives				
Yes	126 (81.8%)	28 (18.2%)	122 (79.2%)	32 (20.8%)
No	145 (56.9%)	108 (42.4%)	137 (53.7%)	115 (45.1%)
Injury during disasters				
Yes	164 (83.7%)	32 (16.3%)	159 (81.1%)	36 (18.4%)
No	108 (50.5%)	104 (48.6%)	101 (47.2%)	111 (51.9%)
Number of disasters experienced				
1–2	5 (15.2%)	28 (84.8%)	8 (24.2%)	25 (75.8%)
3–4	112 (63.6%)	64 (36.4%)	109 (61.9%)	66 (37.5%)
Above 4	155 (77.5%)	44 (22.0%)	143 (71.5%)	56 (28.0%)
Were you ever moved to a shelter as a result of the disaster?				
Yes	191 (70.2%)	75 (55.1%)	187 (71.9%)	78 (53.1%)
No	81 (29.8%)	61 (44.9%)	73 (28.1%)	69 (46.9%)
Displacement experiences				
Secure	95 (34.9%)	48 (35.3%)	92 (35.4%)	50 (34.0%)
Insecure	98 (36.0%)	28 (20.6%)	97 (37.3%)	29 (19.7%)
Sacrificing food				
Yes	228 (83.8%)	88 (64.7%)	213 (81.9%)	102 (69.4%)
No	44 (16.2%)	47 (34.6%)	47 (18.1%)	44 (29.9%)

those who did not, (3) who had moved to shelters during disasters counter to who did not, and (4) who had sacrificed food for their family compared with those who did not. As presented in Table 4, the MANOVAs were statistically significant on the combined dependent variables for each of the four independent variables: casualty [$F(2, 405) = 22.543$, Wilks' $\Lambda = 0.900$, $p = 0.000$, partial $\eta^2 = 0.100$], loss [$F(2, 404) = 19.446$, Wilks' $\Lambda = 0.912$, $p = 0.000$, partial $\eta^2 = 0.088$.], moving to shelters [$F(2, 405) = 11.154$, $\Lambda = 0.948$, $p = 0.000$, partial $\eta^2 = 0.052$], and sacrificing food [$F(2, 404) = 10.089$, $p = 0.000$, $\Lambda = 0.952$, partial $\eta^2 = 0.048$]. The results (Table 5) also indicate the mean scores of physical health (PCS-12) and mental health (MCS-12) were significantly

Table 5 MANOVA between groups on two dependent variables (physical health and mental health)

Dependent variables	Independent variables			
	Casualty	Loss of family or relatives	Moving in shelters	Sacrificing food for family
Physical health				
Yes (mean)	37.08	33.76	40.58	40.53
No (mean)	52.96	50.06	49.99	55.09
Mental health				
Yes (mean)	30.59	28.44	33.15	35.66
No (mean)	47.28	43.34	46.23	44.55
Wilks' Λ	.900	.912	.948	.952
P	.000	.000	.000	.000
Partial η^2	.100	.088	.052	.048

Table 6 Multivariate test of between subjects (physical health and mental health variable)

IV	DV	F	P	Partial η^2
Casualty factor	Physical health	34.658	.000	.079
	Mental health	40.976	.000	.092
Loss variable	Physical health	34.999	.000	.080
	Mental health	30.552	.000	.070
Moving to shelter variable	Physical health	10.662	.001	.026
	Mental health	22.355	.000	.052
Sacrificing food	Physical health	19.921	.000	.047
	Mental health	7.610	.006	.018

Table 7 The relationship between disaster-associated variables and MCS12 ($N=408$)

Variable	N	Mean	t	Mean Difference	p	95% CI	Cohen's d
Injury during the disaster						-27.308 to -17.731	.91
Yes	196	26.00	-9.247	22.519	.000		
No	212	48.52					
Visiting medical practitioners						-11.464 to -.588	.49
Yes	195	34.24	-2.179	-6.026	.030		
No	189	40.26					

poorer for the participants who witnessed casualties, lost family or relatives, moved to shelters, and sacrificed their food during disasters. Table 6 shows the statistical significance of the physical health and mental health variable at a Bonferroni adjusted alpha level of 0.025. Notably, the support was obtained for our hypotheses three to six.

3.5 Mental health causation

Two separate independent samples *t*-tests were conducted to compare the mental health of (1) participants who reported to be ‘physically injured’ ($n=196$) during disasters versus ‘not physically injured’ ($n=212$), and (2) participants who ‘visited medical practitioners due to illness’ ($n=195$) versus those who ‘did not visit medical practitioners due to illness’ ($n=189$) on MCS-12.

Table 7 reveals there was a significant difference [$t(382)=-9.25$, $p=0.000$, two-tailed, 95% CI -27.31 to -17.73 , $d=0.91$] in the mental health scores with a lower mean score for physically injured women ($M=26.00$, $SD=20.36$) compared to those who were not physically injured ($M=48.52$, $SD=28.44$). Likewise, the independent samples *t*-test was statistically significant [$t(369)=-2.179$, $p=0.03$, two-tailed, 95% CI -11.46 to -0.59 , $d=0.49$], with the women who visited a medical practitioner ($M=34.24$, $SD=24.92$) reporting high prevalence of lower mental health scores compare to the women who did not visit medical practitioners ($M=40.26$, $SD=29.05$). The support was obtained for the hypothesis one; however, hypothesis two was not supported.

4 Discussion

To the best of our knowledge, this empirical study is the first of its kind that measures disaster-affected women’s physical and mental health status and associated risk factors in disaster-prone rural areas of Bangladesh. Specifically, to gain a comprehensive understanding of women’s health impacts from disasters, physical and mental health status of disaster-affected women was explored. Also, we investigated the association between physical health outcomes and mental health outcomes, participants’ self-reported health characteristics, as well as the differences in physical and mental health effects depending on their disaster experiences.

Studies which take an epidemiological perspective tend to show that disasters have negative consequences on physical and mental health (Karaye et al. 2019; Liang and Cao 2014; Smith et al. 2022). Research also shows that disasters have an immediate and sometimes wide range of long-term effects on the survivors’ health including post-traumatic growth in disaster survivors (Brooks et al. 2020; Karaye et al. 2019). The health impact of disasters on women compared to men has been evident in the literature (Fatema et al. 2021; Hasan et al. 2020; Smith et al. 2022). Numerous reasons, such as poor-socioeconomic background, poor environmental conditions, social roles, inadequate health facilities, economic, and cultural influences, can affect participants health and lead to the complexity of many social and health problems as well as suicidal deaths (Fatema 2020; Kabir et al. 2021; Massazza et al. 2021; Morganstein and Ursano 2020).

In the face of growing disasters, exploring women’s health-related risk factors are urgent and important, particularly in disaster-prone developing countries such as Bangladesh. The results of this study revealed that a large number of disaster-affected women reported poor physical and mental health outcomes in Bangladesh. This result is consistent with previous studies in the context of disasters in both well-off and resource-poor countries (Hugelius et al. 2017; Karaye et al. 2019; Smith et al. 2022).

The prevalence of post-disaster illness such as dysentery, diarrhea, viral infections, jaundice, typhoid, anemia, and lack of nutrition among participants was also consistent

with previous studies (Beier et al. 2015; Nahar et al. 2014). The study reported the high incidence of waterborne diseases such as diarrhea, which is a substantial cause of morbidity and mortality in developing countries supporting past studies (Abedin et al. 2019; Beier et al. 2015). This outcome of disasters may be explained by the poor socio-demographic profile, living standard, income level, and health status of the participants. Women with a higher frequency of disaster experience mostly reported poorer physical and mental health compared to those who have less exposure to disasters; this is also similar to the findings of previous studies (Fatema et al. 2021; Naushad et al. 2019). Understandings of the health impact of disasters are not a new phenomenon, but the growing disasters and larger population sizes over the years have increased the global health risk of disaster survivors emphasizing the need for more attention in this area. This study denotes that urgent need for proper attention and support should be given to the physical and mental health of disaster-affected rural women in Bangladesh.

Overall, the hypotheses were supported. In relation to the first hypothesis, the results suggest that compared with non-injured women in disasters, the mental health of injured women is poorer. Notably, the proportion of women injured in disasters was almost half of the participants; the non-injured participants scored three-time better mental health compared to the injured women. These results suggest that injury during disasters can cause negative mental health effects, which corresponds with previous studies on the health impact and HRQOL of female disaster victims in Nepal and China, respectively (Liang et al. 2019; Thapa and Acharya 2017). These results provide support for the urgent need for attention to the mental health needs of disaster survivors in Bangladesh as emphasized in recent times (Hasan et al. 2020; Mamun et al. 2019).

Interestingly, women who had consulted medical practitioners due to injury or illness reported significantly lower mental health outcomes compared to those women who had not visited medical practitioners. These findings suggest that mental health symptoms are not necessarily influenced by accessing medical practitioners or may indicate the severity of symptoms experienced by those women who do seek medical attention. Instead, the higher levels of poor mental health scores reported by women who visited medical practitioners may be related to other socio-demographic structures (e.g., financial incapacity to continue the medication or do follow-up treatment), or health services (e.g., inadequate healthcare facilities). However, the reason for these findings requires further empirical investigation as the association between visiting medical practitioners and mental health has been found to be complex. For example, research showed health professionals play a vital role in the mental health recovery of disaster victims (Coffey et al. 2021; Hugelius et al. 2017; Schafer et al. 2020).

As predicted in hypothesis 3, the results indicate that women who have witnessed casualties during disasters reported poorer physical and mental health outcomes. Also, noteworthy is the finding that a large proportion of participants in this study reported witnessing casualties during a recent disaster. Such experiences can have traumatic and long-term mental health impacts (Brooks et al. 2020; Naushad et al. 2019). The significant difference between groups on both physical and mental health scores is consistent with research in different populations, which has found relationships between adverse mental health and witnessing casualties (Naushad et al. 2019; Smith et al. 2022). Two different systematic reviews by Naushad et al. (2019) and Fatema et al. (2021) have explained that witnessing the casualties and injuries of others increases the risk of development of severe anxiety, depression, and other mental health problems. Moreover, in the past Liang and Cao (2014) revealed that when mental health symptoms of female disaster victims were resolved, the physical health problems were gradually highlighted. That is, as the mental health issues

improved, the women became more aware of physical issues. Similar results were, respectively, evident among earthquakes and tsunami-exposed women in Nepal and Sri Lanka (Schwind et al. 2019; Wickrama and Ketring 2012). However, previous studies found physical and mental health complications are positively associated among female disaster victims (Fatema et al. 2021; Zhang et al. 2021). The present study confirmed physical health and mental health outcomes are associated positively, or in other words, affect each other.

As predicted in the fourth hypothesis, losing family members or relatives during a disaster is a predictor of worse physical and mental health outcomes. Thus, there is a statistically significant difference in physical and mental health scores between groups who have lost families and those who did not. These findings are similar to those of previous research on specific mental health outcomes in the context of disasters (Morganstein and Ursano 2020; Naushad et al. 2019; Schwind et al. 2019).

In support of the fifth hypothesis, this study found differences in physical and mental health outcomes between the women who moved to shelters because of disasters and those who did not move to shelters. Women who moved to shelters during a disaster scored significantly poorer on physical and mental health outcomes. The results show more than one-third of the participants did not move to shelters during a disaster, and for those who moved to shelters almost half of them felt insecure. The important reasons for women's refusal to move to a shelter were feeling emotional about leaving home, concerns about perceived lack of safety, and previous negative experiences. Additionally, previous research suggests that shelters are overcrowded and have poor environmental conditions including poor ventilation (Ayeb-Karlsson 2020; Juran and Trivedi 2015). These findings support women's unwillingness to move to a shelter during disasters. It is essential that future research includes women's exposure to shelters and identifies the shelter-associated risk factors to help overcome the high female mortality during disasters (Juran and Trivedi 2015; Neumayer and Plümper 2007). As previous research highlights the poorer physical and mental health related to those who move to shelters, Bangladesh and similarly affected countries need to look toward improving the conditions in shelters (Ayeb-Karlsson 2020; Thapa and Acharya 2017).

Furthermore, this study found that women who have sacrificed their food for the family during disasters reported significantly poorer physical and mental health than those who did not sacrifice food during a disaster, thus, supporting the final hypothesis. Notably, this study found that more than three quarters of the respondents reported sacrificing their food for other family members during a disaster. More specifically, these findings indicate the poor socio-economic conditions of women in rural Bangladesh, which is like the findings of previous studies of resource-poor countries (Ayeb-Karlsson 2020; Kabir et al. 2019; Thapa and Acharya 2017). These results highlight the potential health risk for women in Bangladesh living in disaster-prone areas or emergency situations.

Finally, this research has some limitations. There may have been some cultural differences in understanding the measure, a psychometric evaluation of the translated health measures may validate the Bangla version of the measures. In Bangladesh, aside from these two disaster-prone environmentally vulnerable areas, there are more disaster-prone areas. Future research could be extended to explore the health status of disaster victims in those areas. Moreover, other determinants that were missed in the analysis include access to healthcare services and information about available healthcare services, all of which have previously been associated with poor physical and mental health outcomes. The strengths of the study include data collected from a large sample of residents from disaster-affected areas, and widely used, and the use of respected measures of health in the context of disasters. The current study was not limited to investigating the association of

demographic variables such as age, gender, and income, all of which were well established as physical and mental health impacts of disaster victims in previous research (Karaye et al. 2019; Liang and Cao 2014). Rather the study explored other risk factors in the cultural context of Bangladesh.

4.1 Recommendation

Women, as a large vulnerable group, need attention and support in the context of disaster-prone and resource-poor countries. Given the high prevalence of poorer physical and mental health effects that have been found in this study, intervention is warranted to improve the health status of the women where the identified health vulnerabilities could be reduced. Interventions should be offered during the recovery period and post-disaster phase to help women who were injured and lost their families or relatives. Interventions need to be culturally appropriate and developed with input from local communities, groups, and health care providers. Special attention should be given to lobbying the government to ensure these recommendations are considered and included in future government policies.

5 Conclusion

The main aims of this study were to establish the health outcomes of women in disaster-prone areas. The findings of this study support the growing concern of the disasters-inclined health threats to women in Bangladesh and women across the globe. This research provides an important, initial platform to explore the physical and mental health outcomes of disaster-affected women in Bangladesh. Given the physical and mental health status and associated factors of participants reported in this research, and the increasing frequency of disasters for people in this region, further research in this area is essential.

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Data availability The data sets for this study are not open access but can be made available on reasonable request to the Principle Investigator and after consideration of ethical approval.

Declarations

Conflict of interests There is no potential conflict of interest with respect to the research, authorship, and/or publication of this article.







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