A survey of Post-Traumatic Stress Disorder, Anxiety and Depression among Flood Affected Populations in Kerala, India

Mohammad Asim¹, Brijesh Sathian².³, Edwin van Teijlingen³, Ahammed A Mekkodathil¹, M G Ramesh Babu⁴, Elayedath Rajesh⁵, Rajeev Kumar N⁵, Padam Simkhada⁶, Indrajit Banerjee⁷

Abstract:
Background: Globally, post traumatic stress disorder (PTSD) is one of the most common psychiatric illnesses following a disaster. We aimed to evaluate the relationship between the socio-economic and flood exposure factors with PTSD, depression and anxiety among the flood-affected populations in Kerala, India.

Methods: A cross-sectional household survey was conducted from November 2019 to January 2020 in Kozhikode district of Kerala, India. Adults (≥ 18 years), who were permanent residents and had been directly exposed to the flood, were invited to take part in the study. Individuals with a history of mental health issues and those who had other stressful situations in the past were excluded. The survey questionnaire was based on three screening tools: (1) PTSD Checklist for DSM-5 (PCL-5); (2) patient health questionnaire (PHQ-9); and (3) generalized anxiety disorder (GAD-7). Data included sociodemographic factors and flood exposure variables. The primary outcome variable was psychiatric morbidity (PTSD, anxiety and depression).

Results: A total of 276 respondents (150 males/126 females) participated in the study. A significant correlation was observed between total score on PCL-5 and GAD-7 (r=0.339, p=0.001) and PHQ-9 (r=0.262, p=0.001). Females had significantly higher total PTSD symptom severity scores (8.24±5.88 vs. 6.07±5.22; p=0.001), severity of symptoms of intrusion (4.66±3.60 vs. 3.69±3.20; p=0.04), increased level of anxiety (2.54±1.94 vs. 1.79±1.53; p=0.001) and depression (3.02±2.26 vs. 2.04±1.67; p=0.001) compared to males. However, the gender difference for PTSD symptoms disappeared when controlling for age.

Conclusion: The findings of this survey revealed that the vast majority of respondents (92 percent females and 87 percent males) still had subclinical psychiatric symptoms one year after the flood. Therefore, tailored psychological interventions are warranted to counter the long-lasting impact of flooding on the mental health of individuals.

Keywords: Flood, Post-Traumatic Stress Disorder, Anxiety, Depression

Correspondence: Dr. Brijesh Sathian, Deputy chair for research, Geriatrics and long-term care department, Rumailah Hospital, Hamad Medical Corporation, Doha, Qatar. Email: drsathian@gmail.com
Received 05 Jan 2022/Revised 02 Jun 2022/Accepted 06 Jun 2022
Citation: Asim M, Sathian B, van Teijlingen E, Mekkodathil AA, Babu MGR, Rajesh E, Kumar RN, Simkhada P, Banerjee I. A survey of Post-Traumatic Stress Disorder, Anxiety and Depression among Flood Affected Populations in Kerala, India. Nepal J Epidemiol. 2022;12(2): 1203-1214.
DOI: 10.3126/nje.v12i2.46334
This work is licensed under a Creative Commons Attribution 4.0 International License.
Introduction

Psychological disorders account for a significant amount of the world's disease burden, and are the primary cause of years spent living with a disability (Disability-Adjusted Life Years) [1]. This causes decreased productivity, and has a detrimental effect on the quality of life of the affected individuals and society as a whole [2]. Flooding has a variety of negative impacts on human health, including an increased risk of drowning, injuries, loss of property and long-lasting psychological illnesses [3]. Post-traumatic stress disorder (PTSD), depression, anxiety, and suicidal ideation are psychiatric morbidities that are often associated with flood exposure [4,5]. Notably, PTSD is the psychological illness that victims of flooding are most likely to develop [5]. Besides, sleep deprivation, emotional numbness, avoidance, and excessive arousal are the most common symptoms of PTSD which may develop and persist for longer duration following exposure to a disaster [6].

Floods are known to have a profound mental health impact, especially in poor people in low-income countries [7]. Most studies addressing the effects of flooding on mental disorders are from high-income countries, [8] whilst developing regions such as the Indian subcontinent, are less well researched. Ethnicity, frequency and extent of flooding, and social support are the key factors influencing the severity of mental illness in India [9]. Individuals who have experienced severe flooding or sudden natural disasters are most frequently diagnosed with PTSD, depression, and anxiety [10]. PTSD was reported in 30.6% children/adolescents after a natural disaster in Orissa, India [11]. According to an earlier cross-sectional study from Kashmir, having a strong support from family and friends minimizes the risk of developing symptoms of PTSD and depression after flood exposure [12]. A study conducted by Telles et al., among survivors of flood from Bihar, India demonstrated that elderly individuals are more susceptible to PTSD and depression after a natural disaster [13].

The 2015 floods in India affected 13.71 million people and inflicted enormous economic damages [14]. The Kerala flood in the year 2018 accounted for 453 deaths and around 140 people missing. The disaster displaced around 14.5 lakh people and requiring over 3000 relief camps [14]. Over one-sixth of the population of Kerala was directly affected by the flood and its aftermath. Notably, such natural disaster may have huge impact on the mental wellbeing of the victims and therefore, exploration of psychological effects on survivors is important to develop coping strategies. Though few studies have reported the prevalence of PTSD among adolescents [15] and adults [16] of 2018 flood victims in Kerala, there are no reports available on other associated psychological disorders such as depression and anxiety. Therefore, we assessed the relationship between the socio-economic and flood exposure factors with PTSD, depression and anxiety among the flood survivors in the Kozhikode district of Kerala, India.

Methodology

Study design and participants

A cross-sectional household survey was conducted from November 2019 to January 2020 in Kozhikode district of Kerala, India. Adults (≥ 18 years), who were permanent residents and had been directly exposed to the flood were invited to participate in the study. Individuals with a history of mental health issues and those who had other serious stressful situations in the past were excluded. A random sampling technique was chosen to select the most flood-affected wards in Kozhikode districts which was under the Kozhikode city corporation limit.

Sample size calculation

An earlier cross-sectional study reported the prevalence of PTSD to be 22% among 100 households affected by flooding in Kerala [16]. Considering a 22% prevalence of PTSD, we would need a total of 264 participants to estimate the predicted proportion with a 5% absolute precision and a 95% confidence level in our study. We were able to get an adequate sample size consisting of 276 respondents.

Data collection

A single team of nine members, with a team leader and four male and four female enumerators (health workers), collected the data. A pretested semi-structured questionnaire was used to collect the socio-demographic and flood exposure factors, and the screening for psychiatric illness was done by using PTSD Checklist for DSM-5 (PCL-5); a patient health questionnaire (PHQ-9); and generalized anxiety disorder (GAD-7).

The PTSD checklist for DSM-5 (PCL-5) questionnaire contains 20 items on a Likert-type scale with a five-point range (0–4) that evaluate the symptoms of PTSD. Its total score lies between 0 to 80 and the respondent has met the diagnosis for PTSD if their score is 33 or above [17]. The presence of PTSD-related symptoms that are elevated but do not fully satisfy the diagnostic criteria for PTSD (score<33) is known as subclinical PTSD. The patient health questionnaire (PHQ-9) was used to assess depression in order to identify both current and former depression, which also correlates to the diagnosis of major depressive disorder as defined by the DSM-IV [18]. A score of 1–4 indicated that the respondents had minimal depression, a score of 5–9 indicated mild depression, a score of 10–14 indicated moderate depression, a score of 15–19 indicated fairly severe depression, and a score of 20–27 indicated severe depression, respectively. Also, based on DSM-IV criteria, Generalized Anxiety Disorder (GAD-7) was used to measure
Respondents with scores of 5 to 9 were classified as having mild anxiety, 10 to 15 as having moderate anxiety, and 15 or more as having severe anxiety. To identify PTSD, anxiety, and depression in the respondents, these questionnaires were administered in English and was also translated in the local language Malayalam for better understanding. The trained enumerators, who were fluent in Malayalam and English, asked the survey questions face-to-face whilst strict privacy was maintained.

**Variables**

The study variables included sociodemographic factors such as age, gender, marital status, family structure, level of education, employment status, chronic illness, monthly income, and location. The flood exposure factors were water levels at homes during flooding, injury during flooding, loss of family member, loss of land or flood damage to property, and social support or financial help post event. The primary outcome variable was psychiatric morbidity (PTSD, anxiety and depression).

**Ethical considerations**

All study participants were explained about the study and their informed consent was obtained in English or Malayalam. Anonymous data were recorded on the questionnaire. Ethical approval was obtained from the Research Ethics Committee in the School of Behavioral Sciences, Mahatma Gandhi University, India.

**Statistical analysis**

Data were presented as proportions, medians (range), or mean (± standard deviation; SD) as appropriate. The variables of interest such as socio-demographic variables and the intensity of flood exposure were compared and analyzed according to the PTSD diagnosis, gender, PCL-5 subscale in patients with subclinical PTSD, level of anxiety and depression. Differences in categorical and continuous variables were analyzed using the χ2 test and students t-test, as appropriate. The Pearson correlation coefficient (r) was calculated to identify the linear relationship between the psychometric parameters. A significant difference was considered when the 2-tailed p-value was less than 0.05. A one-way multivariate analysis of covariance (MANCOVA) was performed to determine the effect of gender on the adjusted means of total score of PTSD, GAD-7 and PHQ-9 with age as covariate. Data were analyzed using the Statistical Package for Social Sciences version 21 (SPSS Inc., Chicago, IL).

**Results**

A total of 276 respondents (150 males and 126 females) agreed to participate, their mean age was 46.0±15.2 years and the majority were married (74%), belonged to nuclear families (93.5%) and lived in urban areas (83.3%). Table 1 displays the sociodemographic details of the study subjects. Seventy percent of respondents had reached primary/middle/high school education, while 24.6% were graduates or diploma holders. Nearly two-thirds (65.5%) of respondents had an average monthly household income ≤4,000 Indian Rupees (IR). Most had >2 feet water level at the home (82.4%) during the flood. Nearly half (n=120/ 43.5%) did not receive any financial help after the flood. Subclinical PTSD symptoms were identified in the majority of participants. Those with subclinical PTSD were six years older in age (46.7±15.3 vs. 40.3±12.2; p=0.03) and were more likely to be hailing from a rural area (97.8% vs. 2.2%; p=0.04). The two groups were comparable for gender, marital status, educational status and employment.

Table 2 shows the mean PCL-5 with subscale scores i.e. intrusion, arousal and negative cognition, hyperarousal subscales. The mean total score on PCL-5 was 7.89±5.37, and the mean scores for the symptom clusters was highest for intrusion 4.22±3.45, followed by arousal and reactivity (3.10±1.76), negative cognition and mood (2.67±1.46) and avoidance score (1.67±0.93). Those who developed subclinical PTSD had significantly higher levels of GAD-7 (p=0.001) and were more likely to develop mild and moderate anxiety compared to those who did not develop PTSD. Similarly, the score for depression was significantly higher among the subclinical PTSD group [2 (0-12) vs. 0 (0-4), p=0.001] than the non-PTSD group. The frequency of mild and moderate depression was higher in the PTSD group though the difference was not statistically significant.

Table 3 showed the comparison of gender with respect to the PTSD checklist for DSM-V, GAD-7 and PHQ-9 scores. Females had significantly higher total PTSD symptom severity score (8.24±5.88 vs. 6.07±5.22; p=0.001), higher severity of symptoms of intrusion (4.66±3.60 vs. 3.69±3.20; p=0.04), increased level of anxiety (2.54±1.94 vs. 1.79±1.53; p=0.001) and depression (3.02±2.26 vs. 2.04±1.67; p=0.001) as compared to males. Avoidance symptoms, negative thoughts, and mood, as well as arousal and reactivity, did not differ by gender.

Table 4 compares the socio-demographic characteristics based on symptom clusters in patients with subclinical PTSD. Elderly individuals (≥60 years) were more likely to have persistent intrusive memories, negative cognition, arousal and avoidance of stimuli than younger participants. Negative cognition, and avoidance of stimuli were more common among unmarried participants, intrusive memories were more frequent in divorced participants and arousal and reactivity was most prevalent among married individuals. All symptom clusters were more prevalent among the those who were living alone, illiterate, unemployed and those with a prior history of chronic illness. Those with persistent symptoms of avoidance of stimuli were more likely to develop higher level of anxiety (3.06±2.02) and depression (3.37±1.99).
Table 1: Socio-demographic characteristics of flood survivors by PTSD symptoms

| Variables                        | Overall (n=276) | No-PTSD (n=29) | Subclinical PTSD (n=247) | P value |
|----------------------------------|-----------------|---------------|--------------------------|---------|
| Age (mean±SD, years)             | 46.0±15.2       | 40.3±12.2     | 46.7±15.3                | 0.03**  |
| 18-34                            | 64 (23.2%)      | 10 (15.6%)    | 54 (84.4%)               | 0.08 for all |
| 35-44                            | 63 (22.8%)      | 7 (11.1%)     | 56 (88.9%)               |         |
| ≥60                              | 93 (33.7%)      | 11 (18.8%)    | 82 (88.2%)               |         |
| Males                            | 150 (54.3%)     | 19 (12.7%)    | 131 (87.3%)              | 0.20    |
| Marital status (n=274)           |                 |               |                          |         |
| Unmarried                        | 52 (19.0%)      | 9 (17.3%)     | 43 (82.7%)               |         |
| Married                          | 203 (74.0%)     | 18 (8.9%)     | 185 (91.1%)              |         |
| Divorced/widowed                 | 19 (7.0%)       | 2 (10.5%)     | 17 (89.5%)               |         |
| Family Type (n=275)              |                 |               |                          |         |
| Nuclear                          | 257 (93.5%)     | 28 (10.9%)    | 229 (89.1%)              | 0.71    |
| Joint                            | 14 (5.1%)       | 1 (7.1%)      | 13 (92.9%)               |         |
| Alone                            | 4 (1.5%)        | 0 (0.0%)      | 4 (100%)                 |         |
| Educational Status               |                 |               |                          |         |
| Graduate/Diploma                 | 68 (24.6%)      | 10 (14.7%)    | 58 (85.3%)               | 0.29    |
| Primary-to-high school           | 200 (72.5%)     | 19 (9.5%)     | 181 (90.5%)              |         |
| Illiterate                       | 8 (2.9%)        | 0 (0.0%)      | 8 (100%)                 |         |
| Unemployed/Retired               | 105 (38.0%)     | 8 (7.6%)      | 97 (92.4%)               | 0.22    |
| Employed                         | 171 (62.0%)     | 21 (12.3%)    | 150 (87.7%)              |         |
| Monthly Family Income (IR)       |                 |               |                          |         |
| 20,001–30,000                    | 2 (0.7%)        | 0 (0.0%)      | 2 (100%)                 | 0.03**  |
| 12,001–20,000                    | 10 (3.6%)       | 0 (0.0%)      | 10 (100%)                |         |
| 4,001–12,000                     | 82 (29.8%)      | 7 (8.8%)      | 75 (91.5%)               |         |
| ≤4,000                           | 180 (65.5%)     | 21 (11.7%)    | 159 (88.3%)              |         |
| Poor previous health status      | 19 (6.9%)       | 2 (10.5%)     | 17 (89.5%)               | 0.14    |
| Locality (n=275)                 |                 |               |                          |         |
| Urban                            | 229 (83.3%)     | 28 (12.2%)    | 201 (87.8%)              | 0.04**  |
| Rural                            | 46 (16.7%)      | 1 (2.2%)      | 45 (97.8%)               |         |
| Flood exposure factors           |                 |               |                          |         |
| Water level at the home (feet)   | 4 (1-6)         | 4 (2-5)       | 4 (1-6)                  | 0.03**  |
| ≤2                               | 48 (17.6%)      | 1 (2.1%)      | 47 (97.9%)               | 0.03**  |
| >2                               | 224 (82.4%)     | 28 (12.5%)    | 196 (87.5%)              |         |
| Injury due to flooding           | 3 (1.1%)        | 0 (0.0%)      | 3 (100%)                 | 0.55    |
| Loss of family member            | 2 (0.7%)        | 0 (0.0%)      | 2 (100%)                 | 0.62    |
| No financial help                | 120 (43.5%)     | 8 (6.7%)      | 112 (93.3%)              | 0.24    |

** statistically significant

Table 2: Psychometric parameters of PTSD symptoms (subscale scores), Anxiety & Depression scores

| Variables                          | Overall (n=276) | No-PTSD (n=29) | Subclinical PTSD (n=247) | P value |
|------------------------------------|-----------------|---------------|--------------------------|---------|
| PCL-5 total score                  | 7.89±5.37       | -             | 7.89±5.37                | -       |
| PCL-5 subscales                    |                 |               |                          |         |
| Intrusion                          | 4.22±3.45       | -             | 4.22±3.45                | -       |
| Avoidance                          | 1.67±0.93       | -             | 1.67±0.93                | -       |
| Negative cognition and mood        | 2.67±1.46       | -             | 2.67±1.46                | -       |
| Arousal and reactivity             | 3.10±1.76       | -             | 3.10±1.76                | -       |
| Generalized anxiety disorder (level of anxiety) | 2 (2-11) | 0 (0-2) | 2 (0-11) | 0.001** |

1206
| Variable                              | Females (n=126) | Males (n=150) | P value |
|---------------------------------------|-----------------|---------------|---------|
| **Patient health questionnaire 9**    |                 |               |         |
| None-minimal depression (0-4)         | 2 (0-12)        | 0 (0-4)       | 0.001** |
| Mild depression (5-9)                 | 245 (88.8%)     | 29 (100%)     | 0.12    |
| Moderate depression (10-14)           | 26 (9.4%)       | 20 (10.5%)    | 0.18    |
| Minimal (0-4)                         | 114 (90.5%)     | 144 (96.0%)   | 0.18    |
| Mild (5-9)                            | 10 (7.9%)       | 5 (3.3%)      |         |
| Moderate (10-15)                      | 2 (1.6%)        | 1 (0.7%)      |         |

** statistically significant

### Table 4: Symptom clusters in patients with subclinical PTSD (n=247) by demographics

| Variables                          | Intrusion (n=202) | Avoidance (n=108) | Negative cognition and mood (n=162) | Arousal and reactivity (n=156) |
|------------------------------------|-------------------|-------------------|-------------------------------------|-------------------------------|
| **Age (mean±SD, years)**           |                   |                   |                                     |                               |
| 18-34                              | 47.1±16.1         | 48.7±17.3         | 47.5±16.5                           | 47.3±15.6                     |
| 35-44                              | 45 (70.3%)        | 23 (35.9%)        | 37 (57.8%)                          | 33 (51.6%)                    |
| ≥60                                | 62 (66.7%)        | 31 (33.3%)        | 50 (53.8%)                          | 50 (53.8%)                    |
| Females                            | 111 (88.1%)       | 57 (45.2%)        | 84 (66.7%)                          | 55 (43.7%)                    |
| Males                              | 91 (60.7%)        | 51 (34.0%)        | 78 (51.9%)                          | 101 (67.3%)                   |
| **Marital status (n=274)**         |                   |                   |                                     |                               |
| Unmarried                          | 39 (75.0%)        | 26 (50.0%)        | 33 (63.5%)                          | 29 (55.8%)                    |
| Married                            | 146 (71.9%)       | 73 (36.0%)        | 118 (58.1%)                         | 119 (58.6%)                   |
| Divorced/widowed                   | 15 (78.9%)        | 8 (42.1%)         | 10 (52.6%)                          | 8 (42.1%)                     |
| **Family Type (n=275)**            |                   |                   |                                     |                               |
| Nuclear                            | 186 (72.4%)       | 102 (39.7%)       | 150 (58.4%)                         | 145 (56.4%)                   |
| Joint                              | 11 (78.6%)        | 2 (14.3%)         | 7 (50.0%)                           | 7 (50.0%)                     |
| Alone                              | 4 (100%)          | 4 (100%)          | 4 (100%)                            | 4 (100%)                      |

Educational Status
### Table 5: Comparison of socio-demographic characteristics based on level of Anxiety

| Variables                        | Minimal Anxiety (n=258) | Mild Anxiety (n=15) | Moderate Anxiety (n=3) | P value |
|----------------------------------|-------------------------|---------------------|------------------------|---------|
| **Age (mean±SD) years**          | 45.3±14.9               | 53.5±13.7           | 68.7±12.5              | 0.004** |
| **18-34**                        | 63 (98.4%)              | 1 (1.6%)            | 0 (0.0%)               | 0.006** |
| **35-44**                        | 61 (96.8%)              | 2 (3.2%)            | 0 (0.0%)               |         |
| **45-59**                        | 87 (93.5%)              | 6 (6.5%)            | 0 (0.0%)               |         |
| **≥60**                          | 47 (83.9%)              | 6 (10.7%)           | 3 (5.4%)               | 0.18    |
| **Males**                        | 144 (96.0%)             | 5 (3.3%)            | 1 (0.7%)               |         |
| **Females**                      | 114 (90.5%)             | 10 (7.9%)           | 2 (1.6%)               |         |
| **Marital status (n=274)**       |                         |                     |                        |         |
| Unmarried                        | 47 (90.4%)              | 3 (5.8%)            | 2 (3.8%)               | 0.06**  |
| Married                          | 193 (95.1%)             | 9 (4.4%)            | 1 (0.5%)               |         |
| Divorced/widowed                 | 16 (84.2%)              | 3 (15.8%)           | 0 (0.0%)               |         |
| **Family Type (n=275)**          |                         |                     |                        |         |
| Nuclear                          | 244 (94.9%)             | 11 (4.3%)           | 2 (0.8%)               | 0.001** |
| Joint                            | 12 (85.7%)              | 1 (7.1%)            | 1 (7.1%)               |         |
| Alone                            | 2 (50.0%)               | 2 (50.0%)           | 0 (0.0%)               |         |
| **Educational Status**           |                         |                     |                        |         |
| Graduate/Diploma                 | 66 (97.1%)              | 2 (2.9%)            | 0 (0.0%)               | 0.001** |
| Primary/middle/high school degree| 187 (93.5%)             | 12 (6.0%)           | 1 (0.5%)               |         |
| Illiterate                       | 5 (62.5%)               | 1 (12.5%)           | 2 (25.0%)              |         |
| Unemployed/Retired               | 93 (88.6%)              | 9 (8.6%)            | 3 (2.9%)               | 0.01**  |
| Employed                         | 165 (96.5%)             | 6 (3.5%)            | 0 (0.0%)               |         |
| **Monthly Family Income (IR)**   |                         |                     |                        |         |
| 20,001–30,000                    | 2 (100%)                | 0 (0.0%)            | 0 (0.0%)               | 0.48    |
| 12,001–20,000                    | 8 (80.0%)               | 2 (20.0%)           | 0 (0.0%)               |         |
| 4,001–12,000                     | 80 (97.6%)              | 2 (2.4%)            | 0 (0.0%)               |         |
| Variables                          | Minimal depression (n=245) | Mild depression (n=26) | Moderate depression (n=5) | P value |
|-----------------------------------|---------------------------|-----------------------|--------------------------|---------|
| Age (mean±SD, years)              | 45.0±14.5                 | 53.3±17.4             | 58.6±16.3                | 0.005** |
| 18-34                             | 59 (92.2%)                | 5 (7.8%)              | 0 (0.0%)                 | 0.001** |
| 35-44                             | 61 (96.8%)                | 1 (1.6%)              | 1 (1.6%)                 |         |
| 45-59                             | 85 (91.4%)                | 7 (7.5%)              | 1 (1.1%)                 |         |
| ≥60                               | 40 (71.4%)                | 13 (23.2%)            | 3 (5.4%)                 |         |
| Males                             | 139 (92.7%)               | 10 (6.7%)             | 1 (0.7%)                 | 0.06    |
| Females                           | 106 (84.1%)               | 16 (12.7%)            | 4 (3.2%)                 |         |
| Marital status (n=274)            |                           |                       |                          |         |
| Unmarried                         | 39 (75.0%)                | 11 (21.2%)            | 2 (3.8%)                 | 0.001** |
| Married                           | 192 (94.6%)               | 9 (4.4%)              | 2 (1.0%)                 |         |
| Divorced/widowed                  | 12 (63.2%)                | 6 (31.6%)             | 1 (5.3%)                 |         |
| Family Type (n=275)               |                           |                       |                          |         |
| Nuclear                           | 229 (89.1%)               | 24 (9.3%)             | 4 (1.6%)                 | 0.02**  |
| Joint                             | 13 (92.9%)                | 0 (0.0%)              | 1 (7.1%)                 |         |
| Alone                             | 2 (50.0%)                 | 2 (50.0%)             | 0 (0.0%)                 |         |
| Educational Status                |                           |                       |                          |         |
| Graduate/Diploma                  | 63 (92.6%)                | 5 (7.4%)              | 0 (0.0%)                 | 1.00    |
| Primary- to-high school           | 175 (87.5%)               | 21 (10.5%)            | 4 (2.0%)                 |         |
| Illiterate                        | 7 (87.5%)                 | 0 (0.0%)              | 1 (12.5%)                |         |
| Unemployed/Retired                | 85 (81.0%)                | 15 (14.3%)            | 5 (4.8%)                 | 0.001** |
| Employed                          | 160 (93.6%)               | 11 (6.4%)             | 0 (0.0%)                 |         |
| Monthly Family Income (IR)        |                           |                       |                          |         |
| 20,001 – 30,000                   | 2 (100%)                  | 0 (0.0%)              | 0 (0.0%)                 | 0.46    |
| 12,001 – 20,000                   | 10 (100%)                 | 0 (0.0%)              | 0 (0.0%)                 |         |
| 4,001 – 12,000                    | 78 (95.1%)                | 3 (3.7%)              | 1 (1.2%)                 |         |
| ≤ 4,000                           | 153 (85.0%)               | 23 (12.8%)            | 4 (2.2%)                 |         |
| Chronic illness                   | 15 (78.9%)                | 2 (10.5%)             | 2 (10.5%)                | 0.02**  |
| Water level at the home (feet)    |                           |                       |                          |         |
| ≤2                                | 43 (89.6%)                | 4 (8.3%)              | 1 (2.1%)                 | 0.94    |
| >2                                | 198 (88.4%)               | 22 (9.8%)             | 4 (1.8%)                 |         |

** statistically significant

Table 6: Comparison of socio-demographic characteristics based on severity of depression
No financial help | 112 (93.3%) | 6 (5.0%) | 2 (1.7%) | 0.19
---|---|---|---|---
Generalized anxiety disorder | 1.89±1.51 | 3.96±2.12 | 5.60±4.98 | 0.001**
Minimal (0-4) | 236 (91.5%) | 19 (7.4%) | 3 (1.2%) | 0.001**
Mild anxiety (5-9) | 8 (53.3%) | 7 (46.7%) | 0 (0.0%) | ---
Moderate anxiety (10-15) | 1 (33.3%) | 0 (0.0%) | 2 (66.7%) | ---
PCL-5 total score | 6.72±5.54 | 9.15±5.18 | 13.0±7.51 | 0.006**
PCL-5 subscales
Intrusion (Q1-Q5) | 4.29±3.58 | 3.23±1.86 | 7.75±3.40 | 0.04**
Avoidance (Q6-Q7) | 1.64±0.95 | 1.79±0.91 | 1.67±0.57 | 0.82
Cognition and mood (Q8-Q14) | 2.64±1.42 | 2.48±1.31 | 4.40±2.19 | 0.02**
Arousal and reactivity (Q15-Q20) | 3.06±1.75 | 3.50±1.75 | 2.33±2.30 | 0.46

** statistically significant

Table 7: Bivariate correlation between psychometric parameters

| Variables | PTSD total score | GAD-7 total score | PHQ-9 total score |
|---|---|---|---|
| PTSD total score | Pearson Correlation | 1 | 0.339** | 0.262** |
| | Sig. (2-tailed) | | 0.001 | 0.001 |
| GAD-7 total score | Pearson Correlation | 0.339** | 1 | 0.568** |
| | Sig. (2-tailed) | | 0.001 | 0.001 |
| PHQ-9 total score | Pearson Correlation | 0.262** | 0.568** | 1 |
| | Sig. (2-tailed) | | 0.001 | 0.001 |

** statistically significant

Table 5 compares levels of anxiety for different socio-demographic characteristics. Moderate level of anxiety was significantly associated with advanced age (68.7±12.5 years; p=0.001) and being illiterate. Whereas, individuals who were unemployed and lived alone were more likely to develop minimal level of anxiety. Moreover, there was a significant relationship between moderate level of anxiety with PTSD (20.67±2.08; p=0.001) and depression (7.33±5.50; p=0.001).

Table 6 compares the socio-demographic characteristics based on severity of depression. Moderate levels of depression were significantly associated with advanced age (58.6±16.3 years; p=0.005), higher PTSD score (13.0±7.51; p=0.006) and level of anxiety (5.40±4.72; p=0.001). On the other hand, mild level of depression was more likely to be observed in those who were unmarried or divorced, living alone, or were unemployed.

Table 7 shows bivariate correlation between psychometric parameters. A significant correlation was observed between total score on PCL-5 and GAD-7 (r=0.339, p=0.001) and PHQ-9 (r=0.262, p=0.001). The one-way MANCOVA showed no statistically significant difference between the gender on the adjusted means of total scores of PTSD, GAD-7 and PHQ-9 after controlling for age.

Discussion
This study attempted to find the psychological impact of flood and possible factors associated with it in adults in Kerala 2018 flood victims. This is one of the few studies exploring long-term sequelae of flood on the psychological well-being, including PTSD, anxiety and depression.

Long-term sequelae of mental health illness
We found that flooding has a negative influence on mental health that lasted at least a year after the flooding, accompanied with a higher prevalence of psychological morbidity, notably anxiety, depression, and PTSD, which is in agreement with findings of earlier studies [20, 21].

In our study, female flood survivors had higher score of PTSD, anxiety, and depression than males as reported elsewhere [22-24]. Moreover, we also observed symptom clusters in patients with subclinical PTSD which are significantly associated with depression and anxiety. Flood exposure may trigger PTSD and the victims are likely to experience symptoms related to intrusion, avoidance, negative cognition and mood, and arousal and reactivity. Additionally, these emotions may result in a vicious cycle of thinking among the victims, which in turn could lead to higher levels of depression and anxiety. Together, our findings suggest that PTSD symptoms, rather than depression and anxiety, are more closely associated with flood exposure [12]. Following disasters, it is also common to record cases of
depression, anxiety disorders, and substance misuse problems, which are frequent co-morbidities of PTSD [25]. Exposure to flooding has been reported as linked to PTSD, anxiety, and depressive symptoms [26,27]. It has been reported that flood victims exhibit profound depressive symptoms, anxiety, stress, and emotional distress than those who were not exposed to flood [28,29]. Our study also found an association between selected PTSD symptoms and various demographic factors, such as age, gender, marital status and education levels. We found that females had significantly higher total PTSD symptom severity scores, higher severity of symptoms of intrusion, increased level of anxiety and depression than males. However, the gender difference for PTSD symptoms disappeared when controlling for age. Consistent with our findings, a previous study showed a high mean score for all subscales of PTSD i.e. intrusion, avoidance, and hyperarousal among females than those in the males [30].

According to a previous meta-analysis, PTSD was strongly predicted by the severity of the trauma, a lack of social support, and additional life stressors [31]. Therefore, the use of more precise and impartial measures of psychiatric illness would help to mitigate the long-term impact of flooding. The severity of the flood and the length of the follow-up period could have had a significant impact on the variations in prevalence [32]. After a traumatic event, it is well known that the prevalence of PTSD and anxiety declines over time [33].

A relationship between depression, anxiety and PTSD among those who have experienced natural disasters has been reported with higher probable depression (aOR: 7.77), anxiety (aOR: 4.16), and PTSD (aOR: 14.41) [34]. The present study demonstrated a significant correlation between total score on PTSD with anxiety (r=0.339) and depression (r=0.262).

**Psychosocial post disaster care**

Those affected by flood or other disasters are vulnerable to a sudden stress reaction, which can result in the development of PTSD. An earlier study on PTSD in flood survivors of Kerala flood 2018 highlighted the need to carry out post-disaster mental health screening because of the high prevalence of PTSD following the floods [16]. Similarly, another study revealed that even eight months post disaster, a sizable percentage of adolescents were still experiencing stress-related disorders [15]. The health department of Kerala trained close to 1000 volunteers to help affected flood victims. Many qualified psychiatrists from various hospitals went to camps to provide flood survivors with psychosocial support, whilst helplines were also opened. As Kerala is the only Indian state with a District Mental Health Program (DMHP) that is accessible in every district, this was made possible [35]. Utilizing 122 intervention teams, the Mental Health Disaster Management team visited 1.23 lakh homes and 706 camps in flood-affected districts. Psychosocial intervention was given to 2.04 lakh individuals and 1543 individuals received pharmacotherapy [36]. Accredited social health activist (ASHA) workers were mobilized, trained, and then sent to multiple relief camps to assist flood victims. Since small health units’ emergency plans heavily rely on the concept of hospital networking, these units expanded and used their existing capabilities to assist damaged hospitals. In view of this, there is a need to transform healthcare facility infrastructure and revamp its operational preparedness to mitigate climate change threats following stressful climate events [37]. Identifying issues and gaps in climate preparedness for efficient health delivery, including pre-planning and post disaster response is the key to climate change risk mitigation.

**Strengths and limitations of this study**

Our study further adds to the existing knowledge and has addressed gaps about the effects of floods on mental health in Kerala, India. Utilizing standardized tools, the three main mental health outcomes i.e. depression, anxiety, and PTSD were evaluated. The following limitations need to be taken into account, first as a cross-sectional study, it is impossible to draw inferences about cause-and-effect relationships. Therefore, longitudinal studies that could indicate effects in both directions are more appropriate. Future studies that incorporate data from behavioural assessments may provide further insights. Although, we calculated the sample size, our fairly small sample may have resulted in less precise estimations in our population. Therefore, further research with larger samples would be required to offer more generalisable findings. Despite these limitations, the current study advances our knowledge of the post-flood related psychological consequences and adds to the body of literature in several ways. The psychological well-being of flood victims might be improved by efforts to train medical practitioners to deliver psychotherapy interventions given the possibility of adverse mental health outcomes, such as symptoms of PTSD and depression following floods.

**Conclusion**

Our findings highlighted that the vast majority of respondents experienced symptoms of subclinical psychiatric illness that persisted even one year post-flood. Within this population we found differences for selected PTSD symptoms by gender, age, marital status and education levels. Hence, we conclude that tailored psychological interventions are warranted to counter the long-lasting impact of flooding on the mental health of individuals.

**Future scope of the study**

A larger prospective study is needed for tailored psychological interventions to counter the long-lasting impact of flooding on the mental health of individuals.
What is already known on this topic?
The prevalence and risk factors of PTSD has been reported among the flood affected population has been reported in some studies from India.

What this study adds:
The present study highlighted that even a year after the disaster, a considerable proportion of flood survivors suffered from psychiatric morbidity.

Acknowledgement
None.

Authors' contribution
MA, BS and EvanT drafted the whole manuscript, MAA, ER, RNK contributed with data processing and interpretation, PS and IB actively participated of reviewing literature and helped in writing the manuscript, and BR, BS provided experience in statistics. All authors approved the final version of the manuscript.

Competing interests
The authors declared no potential conflicts of interest with respect to the authorship, and/or publication of this article.

Source of Support:
The author received no financial support for the authorship, and/or publication of this article.

Authors' affiliations:
1 Clinical Research, Trauma and Vascular Surgery, Surgery Department, Hamad General Hospital, Doha, Qatar.
2 Geriatrics and long term care department, Rumailah Hospital, Hamad Medical Corporation, Doha, Qatar.
3 Centre for Midwifery, Maternal and Perinatal Health, Bournemouth University, Bournemouth, UK.
4 Division of Physiology, Department of Basic Medical Sciences, Manipal Academy of Higher Education [MAHE], Manipal, India.
5 School of Behavioural Sciences, Mahatma Gandhi University, Kerala, India.
6 School of Human and Health Sciences, University of Huddersfield, Huddersfield HD1 3DH, UK.
7 Department of Pharmacology, SSR Medical College, Belle Rive, Mauritius.

References
1. Whiteford HA, Ferrari AJ, Degenhardt L, et al. The global burden of mental, neurological and substance use disorders: an analysis from the Global Burden of Disease Study 2010. PLoS One 2015;10:e0116820.
https://doi.org/10.1371/journal.pone.0116820
PMid:25658103 PMCid:PMC4320057
2. World Federation for Mental Health. Dignity in mental health. Ocaquaan, Virginia: World Federation for Mental Health, 2015.
3. Hajat S, Ebi KL, Kovats RS, Menne B, Edwards S, Haines A. The human health consequences of flooding in Europe: a review. In: Kirch, W., Bertollini, R., Menne, B. (eds), Extreme weather events and public health responses, Berlin: Springer, 2005: 185-196.
https://doi.org/10.1007/3-540-28862-7_18
4. Ahern M, Kovats RS, Wilkinson P, Few R, Matthys F. Global health impacts of floods: epidemiologic evidence. Epidemiol Rev. 2005;27:36-46.
https://doi.org/10.1093/epirev/mx004
PMid:15958425
5. Mason V, Andrews H, Upton D. The psychological impact of exposure to floods. Psychol Health Med. 2010 Jan;15(1):61-73. https://doi.org/10.1080/13548500903483478
PMid:20391225
6. Verger P, Rotily M, Hunault C, Brenot J, Baruffol E, Bard D. Assessment of exposure to a flood disaster in a mental-health study. J Expo Anal Environ Epidemiol. 2003 Nov;13(6):436-42.
https://doi.org/10.1038/sj.jea.7500290
PMid:14603344
7. WHO: The world health report 2001-mental health: new understanding, new hope (2001). Retrieved from: http://www.who.int/whr/2001/en/whr01_en.pdf.
8. Stanke C, Murray V, Amlôt R, Nurse J, Williams R. The effects of flooding on mental health: Outcomes and recommendations from a review of the literature. PLoS Curr. 2012 May 30:4:e49f1fa9c3cae.
https://doi.org/10.1371/49f1fa9c3cae
PMid:23066515 PMCid:PMC3461973
9. Asim M, Mekkodathil A, Sathian B, Elayedath R, N RK, Simkhada P, van Teijlingen E. Post-Traumatic Stress Disorder among the Flood Affected Population in Indian Subcontinent. Nepal J Epidemiol. 2019 Mar;7(1):755-758.
https://doi.org/10.3126/nje.v9i1.24003
PMid:31209977 PMCid:PMC6546152
10. Makwana N. Disaster and its impact on mental health: A narrative review. J Family Med Prim Care. 2019 Oct 31;8(10):3090-3095.
https://doi.org/10.4103/jfmpc.jfmpc_893_19
PMid:31742125 PMCid:PMC6857396
11. Kar N, Mohapatra PK, Nayak KC, Pattnaik P, Swain SP, Kar HC. Post-traumatic stress disorder in children and adolescents one year after a super-cyclone in Orissa, India: exploring cross-cultural validity and vulnerability factors. BMC Psychiatry. 2007;7:8.
https://doi.org/10.1186/1471-244X-7-8
PMid:17300713 PMCid:PMC1808457
12. Dar KA, Iqbal N, Prakash A, Paul MA. PTSD and depression in adult survivors of flood fury in Kashmir: The payoffs of social support. Psychiatry Res. 2018;261:449-455. https://doi.org/10.1016/j.psychres.2018.01.023 PMid:29353771
13. Telles S, Singh N, Joshi M. Risk of posttraumatic stress disorder and depression in survivors of the floods in Bihar, India. Indian J Med Sci. 2009;63:330-4. https://doi.org/10.4103/0019-5359.55883 PMid:19770523
14. Kerala rains: Toll reaches 125, 17 still missing. The Hindu. Thiruvananthapuram. 2019 Aug 21. Available from: https://www.thehindu.com/news/national/kerala/kerala-rains-toll-reaches-125-17-still-missing/article29212558.ece
15. Mathew G, Varghese AD, Sabu AM, Joseph A. Screening for post-traumatic stress disorder among adolescents following floods- a comparative study from private and public schools in Kerala, India. BMC Pediatr. 2021 Oct 20;21(1):462. https://doi.org/10.1186/s12877-021-02933-4 PMid:34670533 PMCid:PMC8527689
16. Cherian V, Philip J, John A. Prevalence and factors associated with post-traumatic stress disorder among flood-affected adults in a panchayat in Ernakulam district in Kerala. Kerala J Psy 2020, 33(2). https://doi.org/10.30834/KJP.33.2.2020.222
17. Weathers FW, Litz BT, Keane TM, Palmieri PA, Marx BP, Schnurr PP. The PTSD Checklist for DSM-5 (PCL-5). [Internet]. 2013. Available from: https://www.ptsd.va.gov/professional/assessment/adult-sr/ptsd-checklist.asp
18. Anastario MP, Larrance R, Lawry L. Using mental health indicators to identify postdisaster gender-based violence among women displaced by Hurricane Katrina. J Womens Health (Larchmt). 2008 Nov;17(9):1437-44. https://doi.org/10.1089/jwh.2007.0694 PMid:18945206
19. Löwe B, Decker O, Müller S, Brähler E, Schellberg D, Herzog W, Herzberg PY. Validation and standardization of the Generalized Anxiety Disorder Screener (GAD-7) in the general population. Med Care. 2008 Mar;46(3):266-74. https://doi.org/10.1097/MLR.0b013e318160d093 PMid:18388841
20. Fernandez A, Black J, Jones M, et al. Flooding and mental health: a systematic mapping review. PLoS One. 2015;10(4):1-20. https://doi.org/10.1371/journal.pone.0119929 PMid:25860572 PMCid:PMC4393088
21. Zhong S, Yang L, Toloo S, et al. The long-term physical and psychological health impacts of flooding: a systematic mapping. Sci Total Environ. 2018; 626:165-94. https://doi.org/10.1016/j.scitotenv.2018.01.041 PMid:29339262
22. Perrin M., Vandeleur C.L., Castelao E., Rothen S., Glaus J., Vollenweider P., et al: Determinants of the development of post-traumatic stress disorder, in the general population. Soc Psychiatry Psychiatr. Epidemiol. 2014; 49: 447-457. https://doi.org/10.1007/s00127-013-0762-3 PMid:24022753
23. La Greca A.M., Silverman W.K., Lai B., and Jaccard J.: Hurricane-related exposure experiences and stressors, other life events, and social support: current and prospective impact on children's persistent posttraumatic stress symptoms. J Consult Clin Psychol. 2010;78: 794-805. https://doi.org/10.1037/a0020775 PMid:20939624
24. Weems C.F., Pina A.A., Costa N.M., Watts S.E., Taylor L.K., and Cannon M.F.: Pre-disaster trait anxiety and negative affect predict posttraumatic stress in youth after Hurricane Katrina. J Consult Clin Psychol. 2007;75: 154-159. https://doi.org/10.1037/0022-006X.75.1.154 PMid:17295574
25. Norris F.H., Friedman M.J., Watson P.J., Byrne C.M., Diaz E., and Kaniasty K.: 60,000 disaster victims speak: part I. An empirical review of the empirical literature, 1981-2001. Psychiatry 2002; 65: 20-239 https://doi.org/10.1521/psyc.65.3.207.2173 PMid:12405079
26. La Greca A.M., Silverman W.K., Vernberg E.M., and Prinstein M.J.: Symptoms of posttraumatic stress in children after Hurricane Andrew: a prospective study. J Consult Clin Psychol. 1996;64: 712-723. https://doi.org/10.1037/0022-006X.64.4.712 PMid:8803361
27. Roberts Y.H., Mitchell M.J., Witman M., and Taffaro C.: Mental health symptoms in youth affected by Hurricane Katrina. Prof. Psychol Res Pract. 2010; 41: 10-18. https://doi.org/10.1037/a0018339
28. McMillen C., North C.S., Mosley M., and Smith E.M.: Untangling the psychiatric comorbidity of posttraumatic stress disorder in a sample of flood survivors. Compr Psychiatry 2002; 43: 478-485. https://doi.org/10.1053/comp.2002.34632 PMid:12439837
29. Powell B.J., and Penick E.C.: Psychological distress following a natural disaster: a one-year follow-up of 98 flood victims. J Community Psychol. 1983; 11: 269-276. https://doi.org/10.1002/1520-6629(198307)11:3<269::AID-JCOP2290110311>3.0.CO;2-5
30. Othman AZ, Dahlan A, Borhani SN, Rusdi H. Posttraumatic Stress Disorder and Quality of Life Among Flood Disaster Victims. Procedia - Social Behav Sci 2016; 234:125-134. https://doi.org/10.1016/j.sbspro.2016.10.227
31. Brewin C, Andrews B, Valentine J. Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. J Consult Clin Psychol 2000;68:748e66. https://doi.org/10.1037/0022-006X.68.5.748 PMid:11068961
32. Dai W, Kaminga AC, Tan H, Wang J, Lai Z, Wu X, Liu A. Long-term psychological outcomes of flood survivors of hard-hit areas of the 1998 Dongting Lake flood in China: Prevalence and risk factors. PLoS One. 2017 Feb 7;12(2):e0171557. https://doi.org/10.1371/journal.pone.0171557 PMid:28170427 PMCid:PMC5295691
33. Wang CH, Tsay SL, Bond AE. Post-traumatic stress disorder, depression, anxiety and quality of life in patients with traffic-related injuries. J Adv Nurs. 2005;52(1):22-30. Epub 2005/09/10. https://doi.org/10.1111/j.1365-2648.2005.03560.x PMid:16149977
34. French CE, Waite TD, Armstrong B, Rubin GJ; English National Study of Flooding and Health Study Group, Beck CR, Oliver I. Impact of repeat flooding on mental health and health-related quality of life: A cross-sectional analysis of the English National Study of Flooding and Health. BMJ Open. 2019 Nov 2;9(11):e031562. https://doi.org/10.1136/bmjopen-2019-031562 PMid:31678948 PMCid:PMC6830640
35. Kerala offers psychosocial support to tide over flood trauma. Retrieved from https://www.thehindu.com/news/national/kerala/psychosocial-support-to-tide-over-flood-trauma/article61581854.ece accessed on June 5, 2022.
36. Gupta, A.K., Barwal, A., Madan, A. and Sood, A. (eds.) Health Adaptation and Resilience to Climate Change and Related Disasters - A Compendium of Case Studies. National Institute of Disaster Management, New Delhi, 2021, pp 327. Retrieved from file:///C:/Users/masim1/Downloads/CompendiumofCaseStudiesHER-CAP.pdf . Accessed on June 8, 2022.
37. Kerala state action plan on climate change. Department of environment and climate change. August 2014. Retrieved from https://envt.kerala.gov.in/wp-content/uploads/2019/10/Kerala-State-Action-Plan-on-Climate-Change-KSAPCC-2014-August.pdf Accessed on June 10, 2022.