



Post-earthquake Self-Reported Depressive Symptoms and Post-Traumatic Stress Disorder and their Correlates among College-Youths in Kathmandu, Nepal

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Abstract

Exposure to earthquake has previously been associated with adverse mental health outcomes, however, evidence is limited among youth in resource-limited settings. This study explored the association of retrospective extent of exposure on current day depressive symptoms and post-traumatic stress disorder (PTSD) symptoms among 125 youth attending a college in Kathmandu, Nepal. A self-administered survey including socio-demographic variables, scale for earthquake exposure and Nepali language validated standardized scales for depressive and PTSD symptoms was used. Prevalence estimates for depressive symptoms was 43.2% and PTSD symptoms was 19.2%. For each increasing unit of the extent of earthquake exposure, the odds of having depressive symptoms increased by a factor of 1.26 ($p=0.001$) and PTSD symptoms increased by a factor of 1.26 ($p=0.002$). Being in a complicated romantic relationship increased the odds of both depressive symptoms and PTSD symptoms. Exposure to earthquake is an important factor to consider while assessing depressive and PTSD symptoms among youth earthquake survivors in Kathmandu. It is important that programs or policies aimed at youth mental health concurrently address disaster exposures.

Keywords Earthquake exposure · Depressive symptoms · PTSD symptoms · Resilience · Youth

Introduction

Adverse mental health issues such as post-traumatic stress disorder (PTSD) and depression are common among survivors of natural disasters [1, 2]. Adolescent survivors are especially vulnerable to adverse mental health issues, both because of the ongoing mental and behavioral development [3] and the course of trajectory these exposures might trigger. Prior studies have indicated that adult mental disorders, such as depression [4], may first appear during adolescence [5] and exposure to traumatic events, such as natural disasters,

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during adolescence can have long-term impact. For instance, although mental health symptoms decrease over time during the post-disaster period [6–9], residual effects have been observed as long as 17 years after exposure to the disaster [8]. However, mental and behavioral health outcomes among adolescent disaster survivors continues to be understudied.

Furthermore, peer-reviewed manuscripts regarding adverse mental health outcomes among adolescents exposed to natural disasters in developing countries is limited. For example, in a review of 160 studies on post-disaster mental health published between 1981 and 2001, 27 (16.9%) included school-aged children and adolescents, among which, only three (11%) were conducted in developing countries [10]. Results of the same review also revealed that children and adolescents exposed to natural disasters in developing countries were more likely to have severe or very severe psychopathology rates ($p < 0.001$) [10], further indicating the need to assess mental and behavioral health outcomes among adolescent survivors in developing countries.

The 2015 earthquakes in Nepal caused massive mortality and morbidity [11], including among the young population [12]. Prior studies have indicated that there were 8151 deaths, and mortality was higher among females, ethnic minorities, children under 10 years of age and the elderly [13]. Post-earthquake mental health outcomes among adults have been reported [14, 15], but evidence regarding mental health impacts among youth is limited. Results of cross-sectional studies conducted in different districts among different population sub-groups of Nepal 4–20 months after the earthquakes estimate the prevalence of depression between 23 to 42% and the prevalence of PTSD between 5 and 51% [14–19]. Long-term post-earthquake prevalence of these conditions among youth survivors is not yet known.

The aim of this study was to describe the relationship between the extent of exposure to the 2015 Nepal earthquakes and current depressive and PTSD symptoms among youth (18–20 years) attending a college, four years later. Resilience is an important predictor for mental health outcomes among survivors of the earthquakes [20] and was also studied.

Methods

Study Setting

This study was conducted among college-attending youth in Kathmandu, one of the districts that was hard-hit by the 2015 earthquakes in Nepal. The participants were recruited from one college. The college was selected because it had a large enough student population to meet the sample size requirement, had students from both Kathmandu and other provinces, student body was diverse in terms of caste and ethnicity and the monthly fees of the college was close to local, government colleges, making it more accessible for students of different economic status to enroll. Some students lived on the college campus, especially those from outside Kathmandu.

Study Design

A cross-sectional study design was used in this study. Self-administered surveys, including Nepali-validated scales, were employed to elicit information regarding earthquake exposure and current depressive and PTSD symptoms.

Inclusion criteria included: 1) being a registered student; 2) provided written informed consent to participate in the study; and 3) resident of Kathmandu during the 2015 earthquakes. All research procedures were conducted in the Nepali language.

Sample Size

For high-exposure group, the average of available estimates of post-earthquake depressive symptoms (32.5%) was used [14–19]. For low-exposure group, pre-earthquake depression prevalence (11.7%) reported by previous research [21] was used. Setting power to 80% and alpha to 0.05, the sample size was estimated to be 122; no data about pre-earthquake PTSD rates was available at the time of data collection.

Study Tools

A self-administered survey designed to collect data on socio-demographic characteristics, risk and resilience factors, extent of earthquake exposure, and mental health outcomes (i.e. depressive and PTSD symptoms) was administered to participants. Socio-demographic variables included age, gender (male, female), place of birth (Kathmandu Valley, outside Kathmandu Valley), place of residence (Kathmandu Valley, outside Kathmandu Valley), marital status (unmarried, married, other), romantic relationship status (in a romantic relationship, not in a romantic relationship, its complicated), employment status (employed full-time, employed part-time, self-employed, unemployed), living status (with family including both parents, with family including one parent, hostel or rent a room with friends, others), caste/ethnicity (Brahmin, Chhetri, Newar, Other) and religion (Hindu, Buddhist, Muslim, Christian, Other).

Mental health outcomes were measured using Nepali language-validated scales. For depressive symptoms, the Nepali version of the Hopkins Symptoms Checklist-25 (HSCL-25) [22, 23] was used. The conventional cutoff mean score of 1.75 was used for classifying subjects with/without depressive symptoms [22, 23]. The Nepali version of the PTSD Checklist-Civilian version (PCL-C) [23, 24] was also used. A cumulative score of 50 was used as a cut-off score (50 and above) to determine the presence of PTSD symptoms [25]. The same scales were used to assess pre- and post-earthquake mental health symptoms. Pre-earthquake mental health symptoms were retrospectively studied.

For resilience, the Nepali 10-item version of the Connor-Davidson Resilience Scale (CD-RISC 10 NP) was used [26, 27]. The summation score is the resilience score for each individual, and a higher score is indicative of greater resilience.

In the study sample, Cronbach's alpha was 0.90 for HSCL, 0.91 for PCL-C, and 0.91 for CD-RISC 10 NP. These results indicate high internal consistency.

Exposure to the earthquake was measured using a modified version of the 4-item instrument developed by Shi et al. [28]. Exposure via media or social media was added as a fifth item to the scale. Briefly, each item of the instrument (1. Causalities of family members; 2. House damage; 3. Property loss; 4. Witness of tragic scenes: non-media nor social media; and 5. witness of tragic scenes: via media or social media) was scored using a 5-point Likert scale (0 to 4). Then, a cumulative score was calculated. In the study sample, Cronbach's alpha was 0.80 for the exposure instrument. Questions were designed and revised per the advice of a community panel. This panel was comprised of a local psychologist, a bilingual Nepali community member, and a youth of the same age group as the study participants who was not attending the targeted recruitment college.

Data Analysis

Data entry, cleaning, and analysis was accomplished using SPSS version 25. Cronbach's alpha was calculated for standard instruments to measure internal consistency, to ascertain reliability, and to aid in interpretation of study results [29]. Bivariate associations followed by multivariable logistic regressions were used to assess the relationship between earthquake exposure and mental health outcomes. The differences between pre- and post-earthquake depressive symptoms and PTSD scores were calculated. Stepwise backward linear regression was used to assess the relationship between extent of earthquake exposure with the score difference.

Results

Socio-Demographic Characteristics

A total of 150 students were registered in the college and 127 students completed the survey (85% response rate). The other 23 students declined to participate. Two of the questionnaires had more than 80% of the survey left blank. These were considered incomplete questionnaires and were removed from the sample. Thus, the final sample size was 125.

The socio-demographic characteristics of the study participants are presented in Table 1. The mean age of the study participants was 18.3 ± 0.6 years. The majority of them were male, born in Kathmandu, currently living in Kathmandu with both parents, unmarried, not involved in a romantic relationship, and unemployed. The majority of the study participants self-identified as being Hindu, followed by Buddhists, Christians, Muslims, and Others. Regarding caste and ethnicity, most of the participants self-identified as Chhetri, followed by Other, Newar, and Brahmin.

Depressive Symptoms

The prevalence of depressive symptoms in the sample was 43.2%. The results of bivariate logistic regression estimating the odds of depressive symptoms after the earthquakes are shown in Table 2, Model 1. At the bivariate level, associations were found between depressive symptoms (i.e., being classified as having depressive symptoms) and two variables: 1) earthquake exposure; and, 2) having a “complicated” romantic relationship.

Table 2, Model 2 includes the results of a stepwise backward multivariable logistic regression with Likelihood Ratio estimation, where Model 2a shows the initial model and Model 2b represents the final model. In the initial model, there was significant association between depressive symptoms and three variables: 1) exposure to earthquakes; 2) place where they were born; and, 3) involvement in a ‘complicated’ romantic relationship. These associations remained significant in the final model. At the multivariable level, after controlling for other variables, for one unit increase in earthquake exposure, the odds of the dependent variable being positive (likely to have depressive symptoms) increased by a factor of 1.26 (95% CI: 1.09–1.45; $p=0.001$).

Table 1 Socio-demographic distribution of study participants

| Characteristics | Number (n = 125) | Percentage (%) |
|---|---------------------|----------------|
| Age (years) | | |
| 18 | 94 | 75.2 |
| 19 | 25 | 20.0 |
| 20 | 6 | 4.8 |
| Gender | | |
| Male | 66 | 52.8 |
| Female | 59 | 47.2 |
| Place of birth | | |
| Kathmandu Valley (includes Kathmandu, Bhaktapur and Lalitpur) | 72 | 58.1 |
| Outside Kathmandu Valley | 52 | 41.9 |
| Place of residence | | |
| Kathmandu Valley | 123 | 98.4 |
| Outside Kathmandu Valley | 2 | 1.6 |
| Marital status | | |
| Unmarried | 118 | 94.4 |
| Married | 5 | 4.0 |
| Other | 2 | 1.6 |
| Romantic relationship status | | |
| In a romantic relationship | 19 | 15.2 |
| Not in a romantic relationship | 93 | 74.4 |
| It's complicated | 13 | 10.4 |
| Employment status | | |
| Employed full-time | 5 | 4.0 |
| Employed part-time | 2 | 1.6 |
| Self-employment | 2 | 1.6 |
| Unemployed | 116 | 92.8 |
| Living status | | |
| Family (including both parents) | 95 | 76 |
| Family (including one parent) | 19 | 15.2 |
| Hostel or rent a room with friends | 6 | 4.8 |
| Others | 5 | 4 |
| Caste/ethnicity | | |
| Brahmin | 23 | 18.4 |
| Chhetri | 36 | 28.8 |
| Newar | 32 | 25.6 |
| Other | 34 | 27.2 |
| Religion | | |
| Hindu | 105 | 84.0 |
| Buddhist | 13 | 10.4 |
| Muslim | 1 | 0.8 |
| Christian | 5 | 4.0 |
| Other | 1 | 0.8 |

Table 2 Bivariate and multivariable logistic regression estimation of odds of having depressive symptoms by exposure to earthquakes, socio-demographic variables and other potential confounders

| Characteristics | Bivariate | | Multivariable | | | | | | |
|--|-----------|------------|--------------------------|------|------------------------|-------|------|------------|-------|
| | Model 1 | | Model 2a (Initial Model) | | Model 2b (Final Model) | | | | |
| | OR | 95%CI | p | aOR | 95% CI | p | aOR | 95%CI | p |
| Earthquake exposure (cumulative score) | 1.20 | 1.06–1.36 | 0.005 | 1.30 | 1.11–1.52 | 0.001 | 1.26 | 1.09–1.45 | 0.001 |
| Resilience | 1.02 | 0.98–1.06 | 0.350 | 1.00 | 0.95–1.06 | 0.926 | | | |
| Age (years) | | | | | | | | | |
| 18–20 (treated as numerical) | 1.16 | 0.64–2.13 | | 1.19 | 0.57–2.49 | 0.646 | | | |
| Gender | | | | | | | | | |
| Male | 1.07 | 0.52–2.17 | 0.860 | 1.08 | 0.45–2.63 | 0.864 | | | |
| Female (Ref) | | | | | | | | | |
| Place of birth | | | | | | | | | |
| Outside KV | 0.61 | 0.29–1.26 | 0.182 | 0.19 | 0.06–0.59 | 0.004 | 0.41 | 0.18–0.94 | 0.035 |
| In KV (Ref) | | | | | | | | | |
| Current marital status | | | | | | | | | |
| Married and Other | 0.99 | 0.21–4.60 | 0.985 | 1.44 | 0.19–10.84 | 0.722 | | | |
| Unmarried (Ref) | | | | | | | | | |
| Romantic relationship status | | | | | | | | | |
| In a romantic relationship | 0.35 | 0.11–1.15 | 0.083 | 0.33 | 0.09–1.23 | 0.099 | 0.41 | 0.12–1.37 | 0.405 |
| It's complicated | 4.42 | 1.14–17.10 | 0.032 | 8.41 | 1.81–39.08 | 0.007 | 5.93 | 1.42–24.84 | 0.015 |
| Not in a romantic relationship (Ref) | | | | | | | | | |
| Current employment status | | | | | | | | | |
| Employed | 0.64 | 0.15–2.67 | 0.538 | 0.39 | 0.05–3.00 | 0.366 | | | |
| Unemployed (Ref) | | | | | | | | | |
| Living status | | | | | | | | | |
| Family (including one parent) | 1.04 | 0.39–2.83 | 0.932 | 1.86 | 0.55–6.28 | 0.317 | | | |
| Other | 2.51 | 0.69–9.17 | 0.163 | 4.08 | 0.79–21.00 | 0.092 | | | |

Table 2 (continued)

| Characteristics | Bivariate | | Multivariable | | | | | | |
|---------------------------------------|-----------|-----------|--------------------------|------|-----------|------------------------|-----|-------|---|
| | Model 1 | | Model 2a (Initial Model) | | | Model 2b (Final Model) | | | |
| | OR | 95%CI | P | aOR | 95% CI | P | aOR | 95%CI | P |
| Family (including both parents) (Ref) | | | | | | | | | |
| Caste/ethnicity | | | | | | | | | |
| Chhetri | 1.11 | 0.38–3.23 | 0.847 | 1.73 | 0.45–6.62 | 0.422 | | | |
| Newar | 1.21 | 0.41–3.60 | 0.732 | 0.56 | 0.14–2.87 | 0.561 | | | |
| Other | 1.38 | 0.47–4.05 | 0.554 | 2.11 | 0.50–8.89 | 0.309 | | | |
| Brahmin (Ref) | | | | | | | | | |
| Religion | | | | | | | | | |
| Non-Hindu | 1.09 | 0.42–2.86 | 0.859 | 0.50 | 0.13–1.87 | 0.300 | | | |
| Hindu (Ref) | | | | | | | | | |

PTSD Symptoms

The prevalence of depressive symptoms in the sample was 19.2%. The results of the bivariate logistic regression estimating the odds of post-earthquakes PTSD symptoms are shown in Table 3, Model 3. At the bivariate level, significant associations were found between PTSD and earthquake exposure only.

Table 3 includes results of a stepwise backward multivariable logistic regression with Likelihood Ratio estimation, where Model 4 a shows the initial model and Model 4 b represents the final model. After controlling for other variables, for every unit increase in earthquake exposure, the odds of having PTSD symptoms increased by a factor of 1.26 (95% CI: 1.13–1.61; $p=0.002$).

Discussion

Our prevalence estimates for depressive symptoms (43.2%) and PTSD symptoms (19.2%) were comparable to other published studies among similar age population but these studies we conducted up to 20 months after the earthquake [14–19]. Additionally, our results confirm positive associations between the extent of exposure and both outcomes (depressive symptoms and PTSD symptoms) four years after the 2015 earthquakes among youth survivors in Kathmandu, Nepal. Prior studies analyzing mental health among children exposed to disaster-associated traumatic experiences in the U.S have argued that a dose–response relationship exists between the extent of exposure and severity of the outcomes [30, 31]. This study appears to be the first on this topic from Nepal. The positive association between exposure and depressive symptoms four years later contrasts with a study that found such association 6 months but not 30 months after the Wenchuan earthquake in China [28]. It is important to note that after the Wenchuan earthquake, a comprehensive reconstruction policy was formulated by the Government of China and the goals of reconstruction (for example, building stable housing for every family, providing job stability for at least one member of the family, etc.) were achieved within three years after the earthquake via multi-sectoral collaborations [32]. Similar efforts in scale and magnitude did not occur in Nepal [33]. The lack of comprehensive rehabilitation programs coupled with frequent aftershocks and lack of youth-friendly mental health services could be responsible for explaining some of the factors contributing to long-lasting depressive symptoms and PTSD symptoms in this study. The findings support the need for long-term support and treatment for survivors of earthquakes in such areas, specially where this association persists in the long term.

Being in a complicated romantic relationship emerged as one of the important correlates for depressive symptoms. The association of negative qualities of romantic relationships with depressive symptoms among adolescents has been established before [34]. However, to the best of our knowledge, our study was the first to include the option of “it’s complicated” to assess current romantic relationship status among young disaster survivors. To provide some context, the Nepali society generally frowns upon premarital romantic relationships, often equating it with a premarital sexual relationship [35]. Being romantically involved can be taken as having a “bad character”, especially in the case of unmarried girls and thus is stigmatized [36]. Another plausible explanation leading to “it’s complicated” could be romantic involvement with someone from a different caste or ethnicity. The illegal caste-system is still socially prevalent across different ethnic groups in the country and predisposes people to stigma if involved in a romantic relationship with someone from

Table 3 Bivariate and multivariable logistic regression estimation of odds of having PTSD symptoms by exposure to earthquakes, socio-demographic variables and other potential confounders

| Characteristics | Bivariate | | | Multivariable | | | | | |
|---------------------------------------|-----------|------------|-------|--------------------------|------------|-------|------------------------|-----------|-------|
| | Model 3 | | | Model 4a (Initial Model) | | | Model 4b (Final Model) | | |
| | OR | 95%CI | p | aOR | 95% CI | p | aOR | 95% CI | p |
| Earthquake exposure | 1.25 | 1.09–1.44 | 0.002 | 1.25 | 1.06–1.49 | 0.010 | 1.26 | 1.08–1.45 | 0.002 |
| Resilience | 1.01 | 0.97–1.06 | | 1.01 | 0.95–1.07 | 0.814 | | | |
| Age (years) | | | | 1.03 | 0.40–2.62 | 0.954 | | | |
| Gender | | | | | | | | | |
| Male | 1.64 | 0.70–3.83 | | 1.27 | 0.45–3.56 | 0.655 | | | |
| Female (Ref) | | | | | | | | | |
| Place of birth | | | | | | | | | |
| Outside KV | 2.02 | 0.87–4.68 | | 1.17 | 0.35–3.90 | 0.800 | | | |
| In KV (Ref) | | | | | | | | | |
| Marital status | | | | | | | | | |
| Married and Other | 0.54 | 0.06–4.64 | | 1.37 | 0.11–16.67 | 0.803 | | | |
| Unmarried (Ref) | | | | | | | | | |
| Romantic relationship status | | | | | | | | | |
| In a romantic relationship | 0.17 | 0.02–1.34 | | 0.18 | 0.02–1.57 | 0.120 | 0.20 | 0.03–1.66 | 0.137 |
| It's complicated | 1.90 | 0.57–6.40 | | 2.73 | 0.63–11.83 | 0.179 | 2.36 | 0.66–8.44 | 0.187 |
| Not in a romantic relationship (Ref) | | | | | | | | | |
| Employment status | | | | | | | | | |
| Employed | 0.94 | 0.19–4.80 | | 0.68 | 0.06–7.33 | 0.749 | | | |
| Unemployed (Ref) | | | | | | | | | |
| Living status | | | | | | | | | |
| Family (including one parent) | 1.97 | 0.66–5.90 | | 2.29 | 0.58–9.04 | 0.237 | | | |
| Other | 3.57 | 0.98–12.99 | | 2.25 | 0.41–12.19 | 0.348 | | | |
| Family (including both parents) (Ref) | | | | | | | | | |
| Caste/ethnicity | | | | | | | | | |
| Chhetri | 1.61 | 0.37–6.98 | | 1.52 | 0.27–8.46 | 0.633 | | | |
| Newar | 2.22 | 0.52–9.51 | | 1.93 | 0.32–11.72 | 0.475 | | | |
| Other | 3.19 | 0.78–13.06 | | 5.45 | 0.96–30.96 | 0.056 | | | |
| Brahmin (Ref) | | | | | | | | | |
| Religion | | | | | | | | | |
| Non-Hindu | 0.80 | 0.25–2.61 | | 0.26 | 0.06–1.21 | 0.086 | | | |
| Hindu (Ref) | | | | | | | | | |

a different caste/ethnicity [37]. This could add to the perception of complication in the relationship.

Another important correlate of depressive symptoms was place of birth. Participants who had been born outside Kathmandu had lower odds of having depressive symptoms after the earthquakes as compared to participants born in Kathmandu. This might have

been because if they were born outside Kathmandu, they still likely had relatives in the village and could travel there after the earthquakes to “get away” from Kathmandu. Approximately 300,000 people were estimated to have left Kathmandu to their villages after the earthquakes [38]. This might have helped them in recuperating and coping with the aftermath of the earthquakes. They might not have faced other challenges that the ones who had to stay back had to face, for example, living in tents, or continuing to see the destruction around them, which could have aggravated depressive symptoms. For example, findings of a study conducted in Pakistan 18 months after an earthquake in 2005 indicated that living in a tent was associated with general psychiatric morbidity among the participants [39]. Thus, avoidance of potentially difficult situations by temporarily emigrating to the villages they were born in could have worked as a protective factor against depressive symptoms after the earthquake among the study population.

The absence of association between resilience and either of the adverse mental health outcomes at the bivariate and multivariable level is noteworthy. This was in contrast with findings of another study where the authors found a significant negative association ($r = -0.5$, $p < 0.001$) between resilience (measured using CD-RISC 25) and depressive mood (measured using Patient Health Questionnaire-9) among survivors of the Nepal earthquakes who had suffered from spinal cord injury (SCI) due to the earthquakes [40]. This could have been because the Connor-Davidson scale was developed to measure resilience in patients living with chronic pain [26] and thus, the validation of the scale in Nepali language was also conducted among individuals living with chronic pain [27]. Despite the fact that participants from both studies were exposed to earthquakes, the factors that lead to resilience in chronic pain might not be the same as those that lead to resilience in people with depressive symptoms or PTSD symptoms. In addition, the mean age of participants in the SCI study (34.8 ± 11.38 years) was higher than in the present study (18.3 ± 0.6 years). Lack of association could be indicative of uniqueness in resilience among youth who faced earthquakes during their adolescence, the character of which needs further in-depth analysis.

Some of the strengths of this study are that it is the first of its kind to explore the association between the extent of earthquake exposure and depressive and PTSD symptoms among youth survivors of earthquakes in Nepal. This is also the first study to measure resilience among youth earthquake survivors in Nepal using a validated scale. Data collection occurred approximately four years after the earthquakes, adding to the literature on long-term effects of earthquake exposure in the Nepali population.

There are also some limitations in the study. First, there was lack of baseline data on depressive and PTSD symptoms in the population, thus, making it difficult to ascertain the negative mental health outcomes are attributed to the earthquakes. In absence of baseline data from before the earthquakes, disentangling adverse mental health outcomes as they relate to other life events can be challenging. Second, the study was conducted in one management college of Kathmandu. Thus, the results might not be generalizable to the youth earthquake survivors in the region. Third, while a significant association was found between relationship status and adverse mental health outcomes, the confidence intervals were wide. In future studies, a larger sample size might result in better estimates. Fourth, the pool of participants might have been cognitively higher-functioning individuals as compared to others who underwent severe trauma and did not continue their education or dropped-out of school. Individuals who had extreme scores in the depressive and PTSD symptoms scales might not have chosen to participate in the study. Efforts were made to negate this possibility by the following efforts: 1) avoiding

the use of the words ‘depression’, ‘PTSD’, or ‘mental health’ in the study title; 2) presenting the study as an opportunity to explore the overall well-being of youth in Kathmandu after the earthquake; and 3) presenting the study as a study of youth in Kathmandu after the earthquake rather than of youth earthquake survivors, hence putting emphasis on the event rather than the people.

While the study had notable limitations, the results have implications for behavioral health of youth survivors who were exposed to the 2015 earthquakes. Prior studies conducted among medical students in Nepal have indicated high prevalence of adverse mental health outcomes [41], including depression [42–44]. So, the results of this study reaffirms the conclusions from prior studies that youth mental health needs additional attention, be it in terms of research, services or policies. Positive association between earthquake exposure and both outcomes- depressive symptoms and PTSD, even after 4 years of exposure points to the need for youth-friendly mental health related services that integrates assessment and addressing of earthquake exposure vulnerabilities.

Globally, experiencing the current ongoing COVID-19 pandemic, which has been no short of a disaster, has laid bare the potential short and long-term impacts on the mental health of youths. Additionally, relevant findings could help identify mental health research and services in other countries, where natural disasters such as earthquakes, hurricanes, and severe winter storms, including catastrophic flooding have occurred. For example, results of a cross-sectional study including youth survivors of hurricane Katrina indicated that post-traumatic stress and depressive symptoms remained elevated as compared to pre-hurricane among exposed youths even after two years [45]. Some of the initiatives could include assessing exposure to natural disasters in screening questionnaires in mental and behavioral health service centers and conducting studies to assess association between these exposures and mental and behavioral health outcomes in long-term.

In conclusion, in this study of youth who were exposed to earthquakes during their adolescence, positive associations were found between the extent of earthquake exposure and current depressive and PTSD symptoms four years after the events, addressing a significant gap in knowledge. Undiagnosed and untreated adverse mental health conditions are detrimental to functioning and the quality of life of all youths. Results of the study indicate that exposure to earthquake needs to be considered to further identify the need of mental health services in this population. The findings suggest the need for long-term, youth-friendly mental health services and support system mechanisms for earthquake survivors. Similarly, for preparedness and preventive purposes, it is essential for future disaster survivors to have access to mental health services immediately following the disasters. Availability of longitudinal data that covers both risk and protective factors is essential for evidence-based planning and programming for youth populations. The present study opens a path for future studies to take a step further and assess possible explanatory pathways between the extent of earthquake exposure and adverse mental health outcomes. It also calls for exploring the meaning of resilience in youth who were exposed to earthquakes during their adolescence.

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Declarations

Ethics Approval Written informed consent was obtained from all study participants. The study was approved by the University of South Florida IRB (Pro 00037101) and the Nepal Health Research Council (NHRC) (Reg. number 738/2018). Authorization to use the Nepali language-validated versions of the scales was also obtained.

Conflicts of Interest The authors declare that they have no conflict of interest.

References

- Galea S, Nandi A, Vlahov D. The epidemiology of post-traumatic stress disorder after disasters. *Epidemiol Rev*. 2005;27(1):78–91. <https://doi.org/10.1093/epirev/mxi003>.
- Xie Z, Xu J, Wu Z. Mental health problems among survivors in hard-hit areas of the 5.12 Wenchuan and 4.20 Lushan earthquakes. *J Ment Health*. 2017;26(1):43–9. <https://doi.org/10.1080/09638237.2016.1276525>.
- Catalano RF, Fagan AA, Gavin LE, Greenberg MT, et al. Worldwide application of prevention science in adolescent health. *Lancet*. 2012;379(9826):1653–64. [https://doi.org/10.1016/s0140-6736\(12\)60238-4](https://doi.org/10.1016/s0140-6736(12)60238-4).
- Pine DS, Cohen E, Cohen P, et al. Adolescent depressive symptoms as predictors of adult depression: moodiness or mood disorder? *Am J Psychiatry*. 1999;156(1):133–5. <https://doi.org/10.1176/ajp.156.1.133>.
- Kessler RC, Angermeyer M, Anthony JC, et al. Lifetime prevalence and age-of-onset distributions of mental disorders in the World Health Organization's World Mental Health Survey Initiative. *World Psychiatry*. 2007;6(3):168–76. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2174588/>. Accessed 12 Feb 2021.
- Norris FH, Friedman MJ, Watson PJ. 60,000 disaster victims speak: Part II. Summary and implications of the disaster mental health research. *Psychiatry: Interpersonal and Biological Processes*. 2002;65(3):240–60. <https://doi.org/10.1521/psyc.65.3.240.20169>.
- Asarnow J, Glynn S, Pynoos RS, Nahum J, Guthrie D, Cantwell DP, Franklin B. When the earth stops shaking: Earthquake sequelae among children diagnosed for pre-earthquake psychopathology. *J Am Acad Child Adolesc Psychiatry*. 1999;38(8):1016–23. <https://doi.org/10.1097/00004583-199908000-00018>.
- Green BL, Grace MC, Vary MG, Kramer TL, Gleser GC, Leonard AC. Children of disaster in the second decade: A 17-year follow-up of Buffalo Creek survivors. *J Am Acad Child Adolesc Psychiatry*. 1994;33(1):71–9. <https://doi.org/10.1097/00004583-199401000-00011>.
- Gleser G, Green B, Winget C. Buffalo Creek revisited: Prolonged psychosocial effects of disaster. 1st ed. New York, NY: Simon & Schuster; 1981.
- Norris FH, Friedman MJ, Watson PJ, et al. 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981–2001. *Psychiatry: Interpersonal and Biological Processes*. 2002;65(3):207–39. <https://doi.org/10.1521/psyc.65.3.207.20173>.
- Simkhada P, van Teijlingen E, Pant PR, et al. Public health, prevention and health promotion in post-earthquake Nepal. *Nepal J Epidemiol*. 2015;5(2):462. <https://doi.org/10.3126/nje.v5i2.12826>.
- Thapa K. Mental health in post-earthquake Nepal. *Nepal J Epidemiol*. 2015;5(4):520–1. <https://doi.org/10.3126/nje.v5i4.14261>.
- Adhikari B, Bhandari PM, Neupane D, et al. A retrospective analysis of mortality from 2015 Gorkha Earthquakes of Nepal: evidence and future recommendations. *Disaster Med Public Health Prep*. 2020;26:1–7. <https://doi.org/10.1017/dmp.2020.12>.
- Schwind JS, Norman SA, Brown R, Frances RH, Koss E, Karmacharya D, Santangelo SL. Association between earthquake exposures and mental health outcomes in Phulpingdanda Village after the

- 2015 Nepal earthquakes. *Community Ment Health J.* 2019;55(7):1103–13. <https://doi.org/10.1007/s10597-019-00404-w>.
15. Kvestad I, Ranjitkar S, Ulak M, et al. Earthquake exposure and post-traumatic stress among Nepalese mothers after the 2015 earthquakes. *Front Psychol.* 2019;10:734. <https://doi.org/10.3389/fpsyg.2019.00734>.
 16. Kane JC, Luitel NP, Jordans MJ, et al. Mental health and psychosocial problems in the aftermath of the Nepal earthquakes: findings from a representative cluster sample survey. *Epidemiol Psychiatr Sci.* 2018;27(3):301. <https://doi.org/10.1017/S2045796016001104>.
 17. Silwal S, Dybdahl R, Chudal R, Sourander A, Lien L. Psychiatric symptoms experienced by adolescents in Nepal following the 2015 earthquakes. *J Affect Disord.* 2018;234:239–46. <https://doi.org/10.1016/j.jad.2018.03.002>.
 18. Acharya S, Bhatta DN, Assannangkornchai S. Post-traumatic stress disorder symptoms among children of Kathmandu 1 year after the 2015 earthquake in Nepal. *Disaster Med Public Health Prep.* 2018;12(4):486–92. <https://doi.org/10.1017/dmp.2017.100>.
 19. Sharma A, Kar N. Posttraumatic stress, depression, and coping following the 2015 Nepal earthquake: a study on adolescents. *Disaster Med Public Health Prep.* 2019;13(2):236–42. <https://doi.org/10.1017/dmp.2018.37>.
 20. Kukihara H, Yamawaki N, Uchiyama K, et al. Trauma, depression, and resilience of earthquake/tsunami/nuclear disaster survivors of Hiroo, Fukushima Japan. *Psychiatry Clin Neurosci.* 2014;68(7):524–33. <https://doi.org/10.1111/pcn.12159>.
 21. Risal A, Manandhar K, Linde M, et al. Anxiety and depression in Nepal: Prevalence, comorbidity and associations. *BMC Psychiatry.* 2016;16(1):1–9. <https://bmcp psychiatry.biomedcentral.com/articles/10.1186/s12888-016-0810-0>. Accessed 12 Feb 2021.
 22. Lipman RS, Covi L, Shapiro AK. The Hopkins Symptom Checklist (HSCL): Factors derived from the HSCL-90. *J Affect Disord.* 1979;1(1):9–24. [https://doi.org/10.1016/0165-0327\(79\)90021-1](https://doi.org/10.1016/0165-0327(79)90021-1).
 23. Thapa SB, Hauff E. Psychological distress among displaced persons during an armed conflict in Nepal. *Soc Psychiatry Psychiatr Epidemiol.* 2005;40(8):672–9. <https://doi.org/10.1007/s00127-005-0943-9>.
 24. Weathers FW, Litz BT, Herman D, Huska J, Keane T. The PTSD checklist-civilian version (PCL-C). Boston, MA: National Center for PTSD. 1994;10. <https://www.ptsd.va.gov/professional/assessment/documents/APCLC.pdf>. Accessed 12 Feb 2021.
 25. Saxon AJ, Davis TM, Sloan KL, et al. Trauma, symptoms of posttraumatic stress disorder, and associated problems among incarcerated veterans. *Psychiatr Serv.* 2001;52(7):959–64. <https://doi.org/10.1176/appi.ps.52.7.959>.
 26. Connor KM, Davidson JR. Development of a new resilience scale: The Connor-Davidson resilience scale (CD-RISC). *Depress Anxiety.* 2003;18(2):76–82. <https://doi.org/10.1002/da.10113>.
 27. Sharma S, Pathak A, Abbott JH, Jensen MP. Measurement properties of the Nepali version of the Connor Davidson resilience scales in individuals with chronic pain. *Health Qual Life Outcomes.* 2018;16(1):1–1. <https://hqlq.biomedcentral.com/articles/10.1186/s12955-018-0884-0>. Accessed 12 Feb 2021.
 28. Shi X, Yu NX, Zhou Y, et al. Depressive symptoms and associated psychosocial factors among adolescent survivors 30 months after 2008 Wenchuan earthquake: a follow-up study. *Front Psychol.* 2016;7:467. <https://doi.org/10.3389/fpsyg.2016.00467>.
 29. Tavakol M, Dennick R. Making sense of Cronbach's alpha. *Int J Med Educ.* 2011;2:53. <https://doi.org/10.5116/ijme.4dfb.8dfd>.
 30. Pina AA, Villalta IK, Ortiz CD, et al. Social support, discrimination, and coping as predictors of post-traumatic stress reactions in youth survivors of Hurricane Katrina. *J Clin Child Adolesc Psychol.* 2008;37(3):564–74. <https://doi.org/10.1080/15374410802148228>.
 31. La Greca AM, Silverman WK, Vernberg EM, et al. Symptoms of posttraumatic stress in children after Hurricane Andrew: a prospective study. *J Consult Clin Psychol.* 1996;64(4):712. <https://doi.org/10.1037/0022-006x.64.4.712>.
 32. Xu P, Lu X, Zuo K, et al. Post-Wenchuan earthquake reconstruction and development in China. In *Disaster and Development 2014* (pp. 427–445). Springer, Cham.
 33. Daly P, Ninglekhu S, Hollenbach P, et al. Situating local stakeholders within national disaster governance structures: rebuilding urban neighbourhoods following the 2015 Nepal earthquake. *Environ Urban.* 2017;29(2):403–24. <https://doi.org/10.1177/0956247817721403>.
 34. La Greca AM, Harrison HM. Adolescent peer relations, friendships, and romantic relationships: Do they predict social anxiety and depression? *J Clin Child Adolesc Psychol.* 2005;34(1):49–61. https://doi.org/10.1207/s15374424jccp3401_5.
 35. Regmi PR, Van Teijlingen E, Simkhada P, Acharya DR. Barriers to sexual health services for young people in Nepal. *J Health Popul Nutr.* 2010;28(6):619. <https://doi.org/10.3329/jhpn.v28i6.6611>.

36. Regmi P, Simkhada P, Van Teijlingen E. “Boys Remain Prestigious, Girls Become Prostitutes”: Socio-Cultural Context of Relationships and Sex among Young People in Nepal. *Global J Health Sci.* 2010;2(1):60–72. <https://doi.org/10.5539/gjhs.v2n1p60>.
37. Atreya A, Shrestha M, Acharya J. Inter-caste lovers’ suicide pact—Case report from Nepal. *Med Leg J.* 2018;86(2):103–6. <https://doi.org/10.1177/0025817217730993>.
38. Khazai B, Anhorn J, Girard T, et al. Shelter response and vulnerability of displaced populations in the April 25, 2015 Nepal Earthquake. Center for Disaster Management and Risk Reduction Technology of the Karlsruhe Institute of Technology, and the South Asia Institute, Heidelberg University. 2015 May 5;5:2015. https://www.cedim.kit.edu/download/CEDIM_FDA_NepalEarthquake_Report2Shelter.pdf. Accessed 12 Feb 2021.
39. Naeem F, Ayub M, Masood K, et al. Prevalence and psychosocial risk factors of PTSD: 18 months after Kashmir earthquake in Pakistan. *J Affect Disord.* 2011;130(1–2):268–74. <https://doi.org/10.1016/j.jad.2010.10.035>.
40. Bhattarai M, Maneewat K, Sae-Sia W. Psychosocial factors affecting resilience in Nepalese individuals with earthquake-related spinal cord injury: a cross-sectional study. *BMC Psychiatry.* 2018;18(1):1–8. <https://doi.org/10.1186/s12888-018-1640-z>.
41. Adhikari A, Dutta A, Sapkota S, et al. Prevalence of poor mental health among medical students in Nepal: a cross-sectional study. *BMC Med Educ.* 2017;17(1):1–7. <https://doi.org/10.1186/s12909-017-1083-0>.
42. Pokhrel NB, Khadayat R, Tulachan P. Depression, anxiety, and burnout among medical students and residents of a medical school in Nepal: a cross-sectional study. *BMC Psychiatry.* 2020;20(1):1–8. <https://doi.org/10.1186/s12888-020-02645-6>.
43. Kunwar D, Risal A, Koirala S. Study of depression, anxiety and stress among the medical students in two medical colleges of Nepal. *Kathmandu Univ Med J.* 2016;53(1):22–6. <http://www.kumj.com.np/issue/53/22-26.pdf>. Accessed 12 Feb 2021.
44. Basnet B, Jaiswal M, Adhikari B, et al. Depression among undergraduate medical students. *Kathmandu Univ Med J.* 2012;10(3):56–9. <https://doi.org/10.3126/kumj.v10i3.8021>.
45. Roberts YH, Mitchell MJ, Witman M, Taffaro C. Mental health symptoms in youth affected by Hurricane Katrina. *Prof Psychol Res Pract.* 2010;41(1):10. <https://doi.org/10.1037/a0018339>.

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