

SOME PSYCHOLOGICAL, GASTROINTESTINAL AND CARDIOVASCULAR CONSEQUENCES OF EARTHQUAKES

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SUMMARY

In the last 40 years there has been a 6-fold increase in the number of earthquakes worldwide. Devastating earthquakes, 5.5 and 6.2 on Richter scale hit Croatia in 2020 during the brutal pandemic year. Our experience served us as our initial motivation for finding out all clinical outcomes after an earthquake. Previous research has shown increased rates of suicidal thoughts, susceptibility to PTSD and depressive symptomatology. Mental health action plans should be encouraged and well prepared in advance by leading organizations. Studies conducted to date have found that the number of patients with gastric and duodenal ulcers increased as an earthquake aftermath. Other gastrointestinal symptoms were abdominal pain, distension and constipation. Earthquakes provide a good example of how acute stress can trigger cardiovascular events, predominantly through sympathetic nervous activation. Studies conducted to date have found an increased incidence of acute myocardial infarction, stroke, arrhythmias and Takotsubo cardiomyopathy. This review reminds us of the importance of treating psychological and psychosomatic consequences of earthquakes.

Key words: earthquake – psychology - psychosomatic medicine – gastroenterology - cardiology

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INTRODUCTION

According to the U.S. Geological Survey (USGS), in the last 40 years there has been a 6-fold increase in the number of earthquakes worldwide. (Farooqui et al. 2017) During the same period, it was also detected that these disasters had been associated with increased incidence and prevalence of various psychiatric diseases amongst survivor groups, including acute stress disorder (ASD), posttraumatic stress disorder (PTSD), anxiety disorders, major depression, somatic complaints, and sleep disturbances (Karanci & Rüstemli 1995, Roberts et al. 2010). The studies on disaster aftermath indicate that many victims are likely to present a clinically significant symptomatic response as a consequence of exposure to stressful events, extent of loss, social disorganization and lack of community support (Kokai et al. 2004). In this review, we will present previous research on the psychological and psychosomatic consequences of earthquakes.

PSYCHOLOGICAL CONSEQUENCES OF EARTHQUAKES

Disastrous events have various effects on individuals, as some may be more susceptible to its adverse effects, while others may be more resistant or resilient (Čurković et al. 2020). Lived experiences acquire their psychological significance on the basis of the fantasy from which they are perceived (Kušević et al. 2020). Personality plays an important role in determining people's perception of their control over hazards (Zhang & Zhang 1991). Personality as one of the stable

psychological characteristics of an individual, can be changed by a vital event such as an earthquake disaster. Interestingly, differences in behaviour between different groups, i.e. between the uninjured and injured people, can be found. There is a positive correspondence between the degree of injury and psychological consequences for the survivors (Zhang & Zhang 1991). Geng et al. in a longitudinal study of recurrent earthquakes had found that over 50% of participants felt very much and moderately scared when the Ya'an earthquake happened and over 85% worried about the occurrence of another earthquake (Geng et al. 2018). The first reactions to an earthquake are emotional numbness, the loss of sense of reality, and an abnormal sense of time. Several days after the disaster, these responses are followed by anxiety and fear of aftershocks. Within a week, somatic signs appear, such as poor sleep and a few weeks later, depressive symptoms begin (Shinfuku 2002). Depression can dominate the whole mental life or it can color a disorder as a background mood (Kušević et al. 2020). Year after the earthquake, a wide variety of studies also suggests alcohol abuse, as potential disaster sequela (Kokai et al. 2004). Nightmares, excessive clinging to caregivers, separation anxiety, loss of previously acquired skills, hyperactivity, irritability, difficulty in concentration and panic attacks were reported in children and young survivors (Giannopoulou et al. 2006, Shiban et al. 2018). Of all natural disasters, earthquakes are associated with the highest rates of suicide. (Krug et al. 1998) After the Marmara earthquake in Turkey in 1999, the rate of suicidal tendency was 16.7%, and suicidal thoughts were 1.76 times higher (95% CI 1.40–2.22) in

injured students and in students whose relatives had injuries serious enough to require medical attention than in those without injured family members (Vehid et al. 2005). Although the consequences of any disaster may include a wide range of symptoms and psychopathologies, the most commonly present and most frequent psychopathology in the aftermath of natural disasters is PTSD (Neria et al. 2008, Tuggle 2016). Yiming et al. did the 10-year systematic review on posttraumatic stress disorder following the 2008 Wenchuan earthquake. One to two months after the earthquake, the prevalence rate in the hardest hit area was 86.2% while after three months it was 45.5%. One year later, several studies reported that PTSD prevalence estimates ranged from 21.5% to 41.0%. Three years later, prevalence rates of PTSD were reported by 10.3% of the respondents from two severely affected villages. Eight years later, prevalence of PTSD was reported by 11.8% of the respondents from two severely damaged townships. In summary, as time passed, the PTSD prevalence among survivors in the affected areas steadily dropped (Liang et al. 2019). For comparison purposes, Kušević et al. found that 4 years after the end of The Croatian War of Independence, prevalence of chronic PTSD in Croatian war veterans was 27% by using DSM IV and/or WHO diagnostic criteria in 1999. Diagnostic criteria were met entirely by 16,6% of the subjects, and 10,4% had only some elements of the disorder (Kušević et al. 1999). Garfin et al. examined interesting relationship between acute stress response to the 2013 Boston Marathon bombings and prior direct and media-based exposure to three collective traumatic events: the 9/11 terrorist attacks, Superstorm Sandy, and the Sandy Hook Elementary School shooting. The results indicated that people who experience multiple community-based traumas may be sensitized to the negative impact of subsequent events (Garfin et al. 2015). Consistent with the stress sensitization hypothesis Geng et al. found that adolescents with higher levels of Wenchuan earthquake experiences were prone to greater acute stress symptoms and PTSD symptoms after subsequent Ya'an earthquake. In contrast, the habituation hypothesis posits that previous trauma exposure may fortify a person for future traumatic or stressful events and reduce the risk of mental health problems in later life (Geng et al. 2018). Studies of older adults exposed to several serious floods in Kentucky and Israeli residents affected by ongoing terrorism reported minimal psychopathology despite recurrent trauma exposure and provided support for the habituation hypothesis (Norris & Murrell 1988, Bleich et al. 2003). We suggest that age might be crucial for that contrast. Adolescence is a rapid phase of biological, neurological, and psychological development. This may cause adolescents to be more vulnerable and to have more complex response patterns in face of recurrent traumatic events than adults (Geng et al. 2018).

Children aged 8–12 after 2015 Nepal earthquakes were found to have lower than expected scores for depressive symptomatology when compared to older adolescents (Schwind et al. 2018). This might be because older children tend to have excessive attention, pessimistic expectations, and negative cognitive perception on traumatic events (Sun et al. 2014). Sun et al. found that besides age, gender was also a major general factor that would influence psychosomatic conditions. In particular, compared with the boys, the girls had significantly higher scores on the states of anxiety and behavior, which may be resulted from their greater sensitivity to acute stress (Sun et al. 2014). Also, it has been shown that girls are more likely to develop PTSD after earthquake exposure than boys (Goenjian et al. 2005). Accordingly, Naeem et al. presented the possibility of women thinking more about the disaster and having more recalls about the incident made females more prone to development of PTSD than males (Naeem et al. 2011). Likewise, few studies have been conducted to assess the temporal association between PTSD and female reproductive health after earthquakes. They concluded that women with PTSD are a high-risk group for pregnancy complications (Patel et al. 2006, Seng et al. 2001). We must mention a study that found that individuals who live in highly devastated areas report less concern than those further from the epicentre. Li and colleagues suggested that these findings, referred to as the “Psychological Typhoon Eye”, are important to consider in planning of mental health interventions (Li et al. 2009). It is also noteworthy that Schwind et al. state that children from households identified as being from an upper caste or other ethnicity were found to have higher scores for depressive symptomatology compared to the Janajatis, Nepal's indigenous people (Schwind et al. 2018). In contrast, in a study conducted after the 2011 Wenchuan earthquake, lower socioeconomic status was found to be significantly related to development of psychological difficulties (Yuan et al. 2013). Differences in living conditions were also factors that influenced emergence of symptoms. Those residing in temporary houses were more prone to damage and to subsequent development of PTSD symptoms as compared to those who resided in original permanent houses (Yuan et al. 2013). It is also important to note that relocation after a disaster increases psychological distress, especially in females and in those who have experienced multiple relocations (Inaba et al. 2005). The negative impact of a disaster on health depends on many biopsychosocial components. As personality of a person; economic instability, political and economic corruption, and chronic lack of basic resources can hinder the ability of developing countries to respond to and recover from natural disasters (Escaleras et al. 2007). In a case control study, Blanc et al. compared the effectiveness of a specific psychosocial support and the prevalence of PTSD and depression in

two groups of schoolchildren one year after the 2010 earthquake in Haiti. The authors detected higher rates of PTSD and severe depression (68% and 40.9%, respectively) than in the counterpart control group of children with psychosocial support (50% and 20.5%) (Blanc et al. 2015). Therefore, adoption of comprehensive, yet rapid mental health and exposure assessments should be encouraged in short-term and long-term disaster response action plans, especially in areas with less-developed capacities for response (Schwind et al. 2018).

GASTROINTESTINAL CONSEQUENCES OF EARTHQUAKES

The 1995 Hanshin-Awaji earthquake of 7.2 on the Richter scale caused people in the devastated area to experience serious life-event stresses. Here we will present its effects on a human digestive tract. In 61 hospitals, a study was conducted the same year and it confirmed that emotional stress increases the risk of complications of peptic ulcer such as perforation or bleeding. For the control group they used 1994 data (Matsushima et al. 1999). Remarkably, bleeding from 46.8% of gastric and 36.4% of duodenal ulcers was reported in the first two weeks after the earthquake. For comparison with 1994, where the figures for the same period, the same area of Japan and the same ulcers were 10.7% and 2.9% (Matsushima et al. 1999). The authors pointed out that it is recommended to prescribe an antiulcer drug in case of similar natural disaster to those who have a medical history of peptic ulcer to prevent severity of peptic ulcer disease after the earthquake or similar stressor. Kanno et al. later studied the Great East Japan earthquake where the number of patients with duodenal ulcers increased 1.58 fold in 2011 as compared with 2010, and more prominently, those with gastric ulcers increased 2.68 fold (Kanno et al. 2013). A total of 257 patients with hemorrhagic ulcers were identified using upper GI endoscopy within the 3 months after the earthquake while a total of 119 patients were identified in the same period of 2010 and the proportion of patients who needed blood transfusion in 2011 was significantly higher than in the previous year (40.3% in 2010 vs. 59.1% in 2011, $p < 0.01$) (Kanno et al. 2013). Yamanaka et al. found that in the acute stress phase from 10 days to 1 month after the disaster the rate of multiple ulcers was significantly higher (88.9% vs 25%, $P < 0.005$). In conclusion, severe stress caused by an earthquake disaster may have affected the characteristics of hemorrhagic gastric or duodenal ulcers (Yamanaka et al. 2013), Li et al. decided to analyze the relationship between digestive tract symptoms and sleep disorders in residents in the disaster area after the Wenchuan earthquake. Results among the 956 affected residents, 459 (48.0%) had gastrointestinal symptoms. Among the 1021 residents in the control group, 78

(7.6%) had gastrointestinal symptoms (Li et al. 2010). The gastrointestinal symptoms of the affected residents within 2 weeks of the earthquake were mainly abdominal pain (14.0%), abdominal distension (12.1%), constipation (10.3%), heartburn (8.6%), and bowel disorders (8.3%). Among the 459 affected residents with gastrointestinal symptoms, 384 (83.7%) had sleep disorders, which was significantly higher than the 19 cases (24.4%) in the control group, $P < 0.05$. They concluded that the incidence of digestive tract symptoms is related to sleep disorders, and early waking with fatigue is the influencing factor of digestive tract symptoms (Li et al. 2010). In children's PTSD group stomach pain (63.2%), constipation, loose bowels, or diarrhea (32.9%), and nausea, gas, or indigestion (47.9%) were detected in the probable PTSD group, suggesting that gastrointestinal symptoms were common among child and adolescent survivors with PTSD after an earthquake (Zhang et al. 2015). Tsuboyama-Kasaoka et al. suggest that we also must take into consideration that evacuees live in shelters where preparing and having meals is a problem itself due to shortages of cooking utilities and food (Tsuboyama-Kasaoka et al. 2014). According to the results of an interesting study, the elderly survivors of the Azerbaijan earthquake in Iran believe that they disregarded the search for relief supplies after the earthquake for reasons such as maintaining dignity, despair, and resentment of unfair distribution of relief aids. They tried to stay away from distribution locations, in which there were competitive and abusive relationships (Ahmadi et al. 2018). All these data are indicators of how gastrointestinal clinical presentations can vary affected by many stressors after an earthquake.

CARDIOVASCULAR CONSEQUENCES OF EARTHQUAKES

There is growing evidence that extremely stressful experiences contribute to cardiovascular disease. Earthquakes provide a good example of how acute stress can trigger cardiovascular events, predominantly through sympathetic nervous activation and potentiation of acute risk factors with blood pressure increase, endothelial cell dysfunction, increased blood viscosity, and platelet activation and hemostasis (Kario et al. 2003). One of the events that shows this is Hanshin-Awaji earthquake which in addition to gastrointestinal caused numerous effects on the human cardiovascular system (Suzuki et al. 1997). The number of patients with acute myocardial infarction during the first 4 weeks after this earthquake was increased by about 3.5-fold in people living near the epicenter (Suzuki et al. 1997). The increase was significantly higher in women than in men (Kario et al. 2003). Also, the incidence of stroke in the same period increased almost twice (Kario & Ohashi 1998). An increase in blood pressure was also recorded after the

earthquake. Increases of approximately 18 mmHg in systolic BP and 8 mmHg in diastolic BP were found during the period 2 weeks after the earthquake, when compared with the BP levels before the earthquake (Kario et al. 1997). In most patients, this increase was transient, and returned to the pre-earthquake baseline level within 4 weeks (Kario et al. 2003). It is important to note that 97% of cardiovascular deaths caused by the Hanshin-Awaji earthquake occurred in persons aged 60 years or older (Kario & Ohashi 1997). This age distribution indicates that older age is a risk factor for stress-induced cardiovascular disease. Zhang et al. studied the incidence of cardiac arrhythmias in hospitalized patients with heart disease after the 2008 Wenchuan earthquake (Zhang et al. 2007). They noted that the number of hemodynamically unstable ventricular arrhythmias increased from an initial 7-14 per 10,000 individuals to 67 per 10,000 individuals per day. Also, hypokalemia, acute myocardial ischemia, and heart failure have been shown to be associated with the onset of this type of arrhythmia during the earthquake period (Zhang et al. 2007). A major earthquake measuring 6.8 on the Richter scale occurred in Niigata, Japan (Sato et al. 2006). Emotional stress was the trigger for Takotsubo cardiomyopathy, a pathological condition characterized by transient akinesia of the apical and middle left ventricles (Bybee et al. 2004, Sharkey et al. 2005). Takotsubo cardiomyopathy was diagnosed in 16 patients (1 male, 15 female, mean age 71.5 years) within 1 month after the earthquake. None of the patients had ischemic heart disease in the past. The incidence of this type of cardiomyopathy one month after the earthquake was approximately 24 times higher near the epicenter than before the earthquake (Sato et al. 2006). The symptoms (chest pain, shortness of breath) and electrocardiographic changes of cardiomyopathy are similar to those of acute coronary syndrome (ACS) (Kurusu et al. 2004). It is important to distinguish these two diseases because transvenous thrombolytic therapy is not only unnecessary in Takotsubo cardiomyopathy, but can also be dangerous. Therefore, when ACS is suspected during major earthquakes, Takotsubo cardiomyopathy must be considered, especially in older women whose symptoms develop on the day of the earthquake (Sato et al. 2006).

CONCLUSIONS

Our review article provides practical information for disasters which can occur anywhere and anytime. The consequences of earthquakes can sometimes be overwhelming and uncontrollable, even if all preventive measures are taken. However, strong social support is one major coping skill mechanism that can be utilized to minimize mental health symptoms (Farooqui et al. 2017). We must mention how devastating earthquakes,

5.5 and 6.2 on Richter scale hit Croatia in 2020, during the brutal pandemic year. Most natural and protective responses to such a disaster, such as seeking comfort from the closest ones, were forestalled as they could potentiate infectious COVID19 transmission (Čurković et al. 2020). Our experience served us as our initial motivation for finding out all clinical outcomes after an earthquake. This review is a reminder that the medical aftermaths of earthquakes are not limited to physical injury or emotional distress, and that effects may present in cardiovascular and gastrointestinal emergency as well.

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Contribution of individual authors:

Zorana Kušević developed the original idea, wrote and revised the first draft, collected and analyzed data, and supervised all phases of reporting.

Kristina Krstanović wrote the first draft of the article, performed a literature search, collected and analyzed data, and was in charge of correspondence.

Karla Kroflin wrote the first draft of the article and performed a literature search, collection, and analysis of data.

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