https://jos.unsoed.ac.id/index.php/jipa

ARTICLE REVIEW

The Impact of Natural Disasters on Psycho-neuroendocrine Dysregulation in Adult Survivors: A Systematic Review

Putri Amalia Fabiar[1*], Yuni Rizki Nurazizah[2], Hilma Paramita[3]

ABSTRACT

Background: Natural disasters constitute extreme stressors that can disrupt psychological functioning as well as the biological systems regulating stress responses. However, scientific evidence on the psycho- neuroendocrinological effects of natural disaster exposure remains fragmented and has not yet been systematically integrated. **Methods:** In order to identify studies published between 2015 and 2025, a systematic literature search was conducted using the PubMed and ScienceDirect databases. Observational studies assessing mental health outcomes and neuroendocrine or neurobiological markers among natural disaster survivors were included. The heterogeneity of study designs and outcome measures necessitated the extraction and narrative synthesis of data. **Results:** The inclusion criteria were met by a total of 29 studies. Exposure to natural disasters was consistently linked to post-traumatic stress disorder (PTSD), despondency, anxiety, and sleep disturbances, with the consequences of these conditions lasting for up to two decades after the disaster. In individuals with severe PTSD, the Hypothalamic–Pituitary–Adrenal (HPA) axis dysregulation was observed, which was characterized by reduced levels of Brain-Derived Neurotrophic factor (BDNF) and serotonin, as well as changes in brain structure and network connectivity, including a reduction in hippocampal volume. Additionally, these psycho-neuroendocrine effects were linked to an elevated risk of cardiovascular disease and other chronic conditions. **Conclusion:** Natural disasters exert complex and long-lasting psycho-neuroendocrinological effects through interactions among psychological, neural, and endocrine factors. Integrated and sustained post-disaster recovery approaches are essential to improve long-term health outcomes among survivors.

Keywords: natural disasters; psycho-neuroendocrinology; mental health; mental disorders

1. RSUD Pati, Indonesia
2. RSUD Kendal, Indonesia
3. RSUD Banyumas, Indonesia

* ✉ email: putrifabiar@gmail.com

INTRODUCTION

Natural disasters, including earthquakes, floods, storms, and typhoons, are extreme events that cause not only physical destruction and economic losses, but also significant and enduring effects on the mental health of the affected populations (Norris *et al*., 2002; Goldmann & Galea, 2014). A expanding body of evidence indicates that disaster survivors are at a substantially increased risk of developing mental health disorders, including Post-Traumatic Stress Disorder (PTSD), depression, anxiety, and maladaptive coping behaviors, including enhanced tobacco use (Galea *et al*., 2005; Tang *et al*., 2014). These adverse psychological outcomes may manifest acutely or persist for years after disaster exposure, contributing to chronic morbidity and reduced quality of life (Lowe *et al*., 2020). Over the past decades, research on disaster-related mental health has evolved from a predominantly psychological framework toward a more integrative psychoneuroendocrinological perspective. This approach emphasizes the complex bidirectional interactions between psychological stress, the central nervous system, and the endocrine system in response to extreme and prolonged stress exposure (McEwen, 2007). Sustained activation of the Hypothalamic–Pituitary–Adrenal (HPA) axis, dysregulation of key neurotransmitter systems, including serotonin and Brain-Derived Neurotrophic factor (BDNF), and changes in stress hormone regulation—particularly cortisol—have been identified as significant biological mechanisms that underlie post-disaster mental disorders (Yehuda *et al*., 2015; Daskalakis *et al*., 2013).

The accumulation of longitudinal and observational evidence further suggests that adverse psychological outcomes are not the solitary consequence of exposure to natural disasters, but also with measurable neuroendocrine and neurobiological alterations, cognitive impairment, and long-term physical health consequences (Van den Berg *et al*., 2010; Mulder *et al*., 2022). However, these findings remain fragmented across heterogeneous disaster contexts, populations, and study designs, limiting the ability to draw robust and comprehensive conclusions regarding patterns of psychoneuroendocrine dysregulation following natural disasters. (Bonanno *et al*., 2010).

Consequently, the objective of the present systematic review is to compile the scientific evidence that is currently available regarding the psychological, neurobiological, and endocrine outcomes of adult populations as a result of natural disasters. In particular, this review investigates the relationships between disaster exposure and mental health outcomes, changes in psycho-neuroendocrine biomarkers, and the factors that influence short- and long-term vulnerability and recovery. Through the integration of discoveries from various fields, this review seeks to advance understanding of the mechanisms underlying disaster-related health impacts and to inform the development of more comprehensive evidence-based mental health interventions and public health policies.

METHODS & MATERIALS

Study Design

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page *et al*., 2021). The objective of the review was to identify, critically evaluate, and synthesize empirical evidence regarding the influence of natural disasters on the psycho-neuroendocrine processes and psychological outcomes of adults aged 18 years and older.

Literature Search Strategy

The electronic databases PubMed

and ScienceDirect were employed to conduct a thorough and systematic literature search. Articles that were peer-reviewed and published between January 2015 and December 2025 were deemed eligible. The search strategy employed predefined keywords combined with Boolean operators as follows: ("natural disaster" OR earthquake OR flood OR typhoon OR tsunami OR climate-related disaster) AND (psychological stress OR PTSD OR depression OR anxiety), ("natural disaster" OR earthquake OR flood OR typhoon OR tsunami OR climate-related disaster) AND (immune dysregulation OR inflammation OR cytokines OR CRP), ("natural disaster" OR earthquake OR flood OR typhoon OR tsunami OR climate-related disaster) AND (neuroendocrine OR HPA axis OR cortisol OR stress hormones). In addition, In order to identify supplementary eligible studies that were not identified through database searches, a manual sifting of reference lists from pertinent articles was implemented (Liberati *et al*., 2009). The final literature search was completed on 28 December 2025.

Eligibility Criteria

The following criteria were satisfied by the studies that were included: (1) observational or longitudinal study design; (2) inclusion of adult participants (≥18 years); (3) assessment of the influence of natural disasters on psycho-neuroendocrine biomarkers and mental health outcomes;
(4) publication in English; and (5) publication between 2015 and 2025. Studies were excluded if they were: (1) narrative reviews, editorials, commentaries, or case reports; (2) exclusively involved children or adolescents; (3) did not clearly report mental health outcomes; (4) focused on highly specific or non-representative populations (e.g., intensive care unit patients, autoimmune diseases, malignancies); and (5) examined non-natural disasters or trauma unrelated to disaster exposure.

Study Selection

Study selection was independently performed by two reviewers using the Rayyan web-based application. The selection process consisted of two stages. First, titles and abstracts were screened for relevance. Second, full-text articles meeting the initial criteria were reviewed to determine final eligibility. Discrepancies between reviewers were resolved through discussion and consensus.

Data Extraction

The data was extracted using a standardized extraction form. Extracted variables included: author(s) and year of publication, article title, type and location of disaster, study design, participant characteristics (sample size and age range), assessment instruments, primary mental health outcomes, psycho-neuroendocrine biomarkers assessed and measurement methods, and conclusions regarding risk of bias.

Risk of Bias Assessment

Validated methods that were suitable for the study design were employed to evaluate the methodological quality and risk of bias. The Newcastle–Ottawa Scale was employed to evaluate cohort and case-control studies, while criteria from the Journal of Interdisciplinary Biosciences were employed to evaluate cross-sectional studies. These assessments informed interpretation of evidence strength and are summarized in **Table 1**.

Data Synthesis

There was no possibility of conducting a quantitative meta-analysis due to the substantial heterogeneity in study designs, disaster categories, and reported outcomes. Therefore, findings were synthesized narratively. Results were organized by disaster type and outcome domain (psychological, neurobiological, and endocrine) to identify consistent patterns, key risk factors, and plausible mechanisms underlying psychoneuroendocrine dysregulation following natural disasters.

REVIEWS

Study Selection

The study selection procedure is illustrated in **Figure 1** (PRISMA flow diagram). After the removal of duplicate records, 15,197 articles were identified for title and abstract screening. Out of these, 15,083 articles were excluded during the initial inspection. A total of 114 full-text articles were evaluated for eligibility. Twenty-eight articles could not be retrieved through institutional library services, and the authors did not respond to requests for full texts. Additionally, 57 articles were excluded as a result of an inadequacy in the population, outcomes, study design, or language. In the final synthesis, these 29 studies were incorporated due to their compliance with all of the inclusion criteria.

Study Characteristics

Characteristics of the 29 included studies are summarized in **Table 1**. Of these, 22 studies primarily examined mental health outcomes, five focused on neurological outcomes, and two investigated endocrine outcomes. Study designs were predominantly cross-sectional and cohort studies. The study populations comprised adult survivors of various natural disasters, most commonly earthquakes, floods, tsunamis, cyclones/typhoons, and wildfires, with ages ranging from young adulthood to older age.

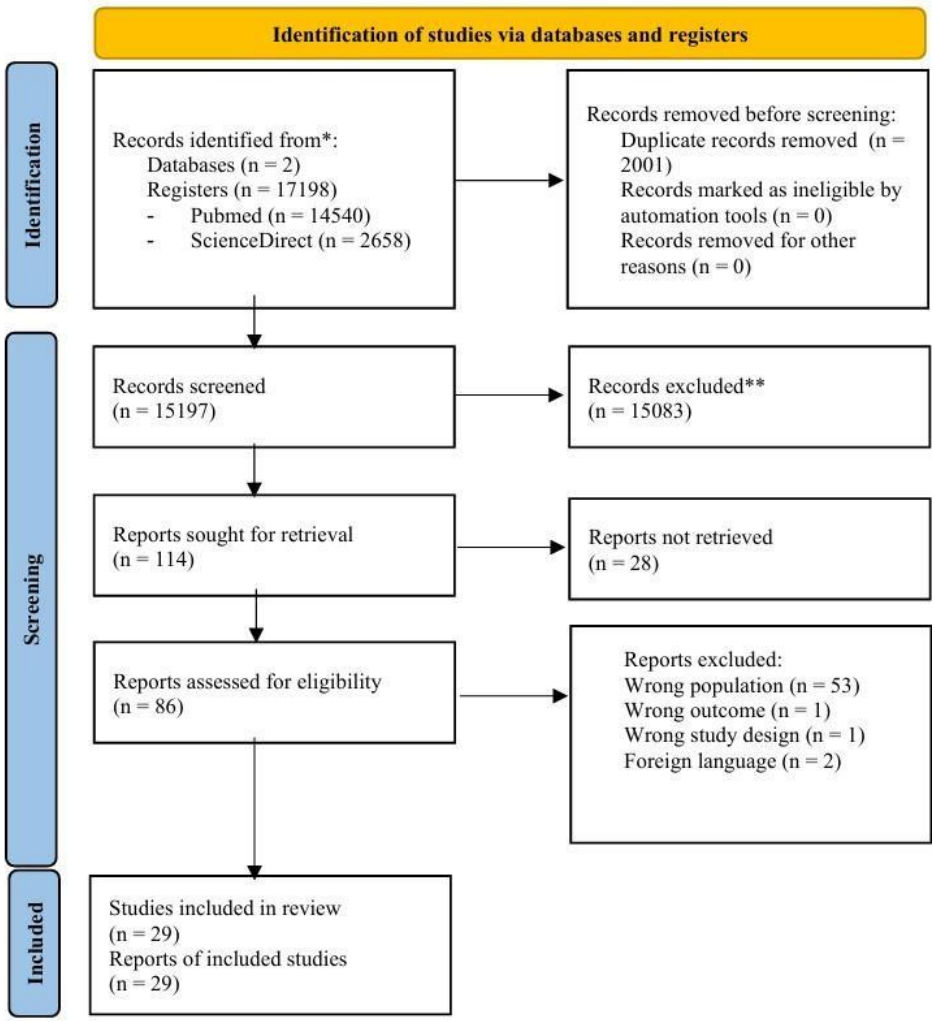

Figure 1. PRISMA flow diagram

Table 1. Included Studies

Author	Article Title	Study Design	Population	Outcomes	Measurement Instruments	Main Findings	Risk of Bias
Lamond et al., 2015	An exploration of factors affecting the long term psychological impact and deterioration of mental health in flooded households	cross sectional	Flood survivors in England 2000–2010; (aged ≥18 years; n = 1,024)	Long-term mental health deterioration (psychological distress, reduced mental well-being)	Self-reported mental health status and standardized mental health questionnaires	Flood exposure was associated with long-term psychological impacts influenced by interactions between material losses, economic stress, and psychosocial factors.	Moderate
Huang et al., 2025	Increase in short-term and long-term stress-associated mental illness after Jiji earthquake in Taiwan: A twenty-year longitudinal population-based cohort study (1999–2019)	cohort	Survivors of the 1999 Jiji earthquake, Taiwan; (age groups 19–39, 40–64, ≥65 years; n = 468,804)	PTSD, sleep disorders, anxiety, depression, short-term (<1 years post-earthquake) & long-term (until 20 years post-earthquake)	Nationwide health databases, ICD-9-CM and ICD-10-CM diagnoses	Earthquake exposure significantly increased the risk of stress-related mental disorders for up to 5–10 years post-disaster.	Low
Gölbaşı et al., 2025	Investigation of the factors affecting post-traumatic stress disorder in survivors of the 2023 Kahramanmaraş earthquakes	cross sectional	University student survivors of the 2023 Kahramanmaraş earthquakes, Turkey; (aged ≥18 years; n = 160)	PTSD	PTSD Checklist for DSM-5 (PCL-5)	High PTSD prevalence was associated with female sex, severity of building damage, economic hardship, and participation in search-and-rescue activities.	Low
Bastami et al., 2024	Prevalence of post-traumatic stress disorder and its relationship with coping strategies among flood victims: Evidence from Iran	cross sectional	Flood survivors in Poledokhtar and Mamoulan, Iran 2019; (aged ≥18 years; n = 374)	PTSD, coping strategies	PTSD Checklist (DSM-5 PCL-5), Coping Responses Inventory (CRI) questionnaire	PTSD prevalence was significantly higher among women, individuals aged ≥35 years, those with lower education and income levels, and widowed participants. Passive and social coping	Low

Author	Article Title	Study Design	Population	Outcomes	Measurement Instruments	Main Findings	Risk of Bias
						strategies were associated with higher PTSD severity.	
Guo et al., 2016	Post-traumatic stress disorder after typhoon disaster and its correlation with platelet 5-HT concentrations	cross sectional	Survivors of Typhoon Rammasun, Hainan Province, China; (aged ≥18 years; n = 5,114)	Psychological stress symptoms, PTSD, platelet serotonin levels	General condition questionnaire, PTSD CheckList – Civilian Version (PCL-C), High Performance Liquid Chromatography (HPLC)	Middle-aged adults exhibited the highest PTSD symptom severity. Platelet serotonin levels were significantly lower in individuals with PTSD.	Moderate
Varela et al., 2025	Long-term psychological sequelae in flood survivors of the 2017 Eurydice flood: PTSD, dissociation, depression and the role of personality	cross sectional	Survivors of the 2017 Eurydice flash flood seeking healthcare services; (adults aged 19–85 years; n = 98)	Long-term PTSD, depression, dissociation, psychological symptoms	Davidson Trauma Scale (DTS), Zung Self-Rating Depression Scale (ZSDS), SCL-90-R, Cambridge Depersonalization Scale (CDS), Eysenck Personality Questionnaire (EPQ)	Significant long-term psychological effects, including PTSD and depression, persisted for up to two years post-disaster.	Moderate
Li et al., 2023	Vulnerability and recovery: Long-term mental and physical health trajectories following climate-related disasters	cohort	Survivors of climate-related disasters in Australia 2010–2019; (aged ≥18 years; n = 1,357)	PTSD symptoms, depression, psychological distress, long-term physical health outcomes	Self-reported questionnaires	Direct disaster exposure, low socioeconomic status, and pre-existing chronic conditions significantly increased the likelihood of poor long-term health outcomes.	Low
Kanehara et al., 2016	Trends in psychological distress and alcoholism after The Great East Japan Earthquake of 2011	cohort	Survivors of the 2011 earthquake and tsunami in Higashi-Matsushima, Japan; (aged ≥19 years; n = 7,636)	Psychological distress, alcohol-related problems	Kessler Psychological Distress Scale (K6), CAGE questionnaire	Psychological distress was more prevalent among women, whereas increased alcohol consumption was more common among men.	Low

Author	Article Title	Study Design	Population	Outcomes	Measurement Instruments	Main Findings	Risk of Bias
Kar et al., 2022	Anxiety, Depression, and Post-traumatic Stress a month after 2019 Cyclone Fani in Odisha, India	cross sectional	Survivors of Cyclone Fani, India; (aged ≥18 years; n = 80)	PTSD symptoms, anxiety, depression, suicidal ideation, comorbidity	Primary Care PTSD Screen for DSM-5 (PC-PTSD-5), Generalized Anxiety Disorder-7 (GAD-7), Patient Health Questionnaire-9 (PHQ-9), Specific item of PHQ-9	High prevalence of PTSD, severe anxiety, and moderate-to-severe depression with psychiatric comorbidity within one month post-cyclone.	Moderate
Arcaya et al., 2017	Association of posttraumatic stress disorder symptoms with migraine and headache after a natural disaster	cohort	Survivors of Hurricane Katrina; (adults aged 18–34 years; n = 1,019)	PTSD symptoms, frequent headache or migraine	Impact of Event Scale–Revised (IES-R), migraine = self-reported	PTSD symptoms following disaster exposure were significantly associated with an increased risk of frequent headache or migraine.	Low
Kim et al., 2021	Association between change in sleep duration and posttraumatic stress symptoms in natural disaster victims: the mediating role of resilience	cross sectional	Survivors of natural disasters in Korea 2015–2017 (mean age 54.85 ± 18.35 years and 60.34 ± 15.07 years, n = 2,707)	PTSD	Impact of Event Scale–Revised (IES-R) = PTSD, sleep duration = self reported	Reduced sleep duration after disaster exposure was significantly associated with increased PTSD symptom severity.	Low
Labarda, C. E., Chan, C. S., 2018	Sleep disturbances, posttraumatic stress, and psychological distress among survivors of the 2013 Super Typhoon Haiyan.	cross sectional	Survivors of Super Typhoon Haiyan 2013, Philippines; (aged ≥18 years; n = 361)	Insomnia, PTSD; GPD = general psychological distress.	Insomnia Severity Index (ISI), Pittsburgh Sleep Quality Index (PSQI), PTSD Checklist-Specific (PCL-S), PTSD Checklist for DSM5 (PCL-5), K6 = Kessler Psychological Distress Scale	Insomnia was significantly associated with PTSD symptoms and psychological distress up to 30 months post-disaster.	Moderate

Author	Article Title	Study Design	Population	Outcomes	Measurement Instruments	Main Findings	Risk of Bias
Li X et al., 2019	Association of Postdisaster Depression and Posttraumatic Stress Disorder With Mortality Among Older Disaster Survivors of the 2011 Great East Japan Earthquake and Tsunami	cohort	Survivors of the 2011 earthquake and tsunami in Japan (aged ≥65 years; n = 2,965)	Depression, PTSD	Depression : Geriatric Depression Scale – Short Form (GDS-SF ≥5), PTSD: Screening Questionnaire for Disaster-Related Mental Health (SQD-P)	Post-disaster depression was associated with increased mortality risk, whereas PTSD was not significantly associated with mortality.	Low
Maya-Mondra et al., 2019	Prevalence of Post-traumatic Stress Disorder and Depression After the September 19(th), 2017 Earthquake in Mexico	cross sectional	Survivors of the 2017 earthquake in Mexico (aged ≥ 18 years; n = 44,855)	PTSD, depression	Screening Questionnaire for Disaster Mental Health (SQD)	Severe PTSD and depression were more prevalent in severely affected areas until 1-2 months post-earthquake, with higher risk among women.	Low
Cowlishaw et al., 2021	Anger Dimensions and Mental Health Following a Disaster: Distribution and Implications After a Major Bushfire	cross sectional	Survivors of the 2009 Black Saturday bushfires, Australia; (adults aged 18–≥65 years; n = 736)	Mental health, anger, suicidal ideation, aggression	DAR-5, PCL-4; PHQ-9; K6	Individuals in severely affected areas had more than a threefold increased risk of anger-related problems.	Moderate
Li et al., 2024	Association between electrocardiographic abnormalities and flood exposure among middle-aged and elderly people: A national longitudinal study in China	cohort	Flood survivors in China (2013–2018); (aged >40 years; n = 38,375)	ECG abnormalities (atrial fibrillation, ST depression, left ventricle hypertrophy)	Standard 12-lead electrocardiography	Flood exposure was associated with increased risk of atrial fibrillation and ST-segment depression	Low
Nygaard et al., 2016	General self-efficacy and posttraumatic stress after a natural	cohort	Norwegian survivors of the 2004 Southeast	Post-traumatic	Impact of event scale-revised (IES-R)	Low general self-efficacy nearly doubled the risk of	Moderate

Author	Article Title	Study Design	Population	Outcomes	Measurement Instruments	Main Findings	Risk of Bias
	disaster: a longitudinal study		Asia tsunami; (adults aged ≥18 years; n = 617)	stress reaction		developing PTSD symptoms following disaster exposure.	
Nagashima et al., 2018	Changes in pulmonary function of residents in Sanriku Seacoast following the tsunami disaster from the Great East Japan Earthquake	cohort	Survivors of the 2011 earthquake and tsunami in eastern Japan; (aged ≥18 years; n = 9,074)	Pulmonary function, smoking prevalence	CHESTAC-8800 spirometer	Pulmonary function improved significantly one year after the disaster, influenced by smoking behavior.	Low
Ahmadi et al., 2024	Modeling the structural relationships between trauma exposure with substance use tendency, depression symptoms, and suicidal thoughts in individuals with earthquake trauma experience: the mediatory role of peritraumatic dissociation and experiential avoidance.	cross sectional	Survivors of the 2017 Kermanshah earthquake, Iran; (adults aged 18–50 years; n = 324)	Substance use tendency, depression, suicidal ideation	Traumatic Exposure Severity Scale (TESS), Peritraumatic Dissociative Experiences Questionnaire (PDEQ), Acceptance and Action Questionnaire-II (AAQ-II), Iranian Addiction Potential Scale (IAPS), Beck Depression Inventory-II (BDI-II), Beck Suicidal Thoughts Scale (BSTS)	Earthquake-related trauma indirectly increased depressive symptoms and substance use through experiential avoidance.	Moderate
Makwana et al., 2024	Long-term mental health outcomes following natural disasters: A systematic review and meta-analysis	systematic review	Survivors of various natural disasters globally (multiple studies)	PTSD, depression, anxiety, long-term psychological outcomes	Multiple validated instruments across included studies	Natural disasters were associated with long-term increases in PTSD, depression, and anxiety, with some effects persisting for years post-disaster.	Low

Post-Traumatic Stress DIsorder (PTSD) and Related Symptoms

The vast majority of research studies demonstrated a significant correlation between natural disasters and an increase in Post-Traumatic Stress Disorder (PTSD) symptoms among survivors. The prevalence and severity of PTSD were influenced by disaster type and intensity, individual characteristics, and socioeconomic factors. According to Lamond *et al*. (2015), approximately 20.1% of respondents reported persistent deterioration in mental health up to 2–3 years following flooding. Severe housing damage significantly increased the risk of mental health disorders (OR = 1.92; 95% CI: 1.38–2.67), while flood-related income loss was also significantly associated with poor psychological outcomes (OR = 1.81; 95% CI: 1.29–2.54). Psychosocial factors such as lack of social support (OR = 2.04; 95% CI: 1.47–2.83) and a prior history of mental health problems (OR = 2.50; 95% CI: 1.72–3.64) further amplified the negative impact of flooding on mental health.

Cross-sectional and cohort studies consistently showed that PTSD may emerge shortly after disaster exposure or persist long-term, even beyond a decade post-disaster (Huang *et al*., 2025; Kino *et al*., 2020; Kanehara *et al*., 2016). Among survivors of climate-related disasters in Australia, approximately 23% of 1,357 respondents followed a persistent or worsening mental health trajectory up to three years post-disaster (Li *et al*., 2023).

Depression, Anxiety, and Psychological Distress

Post-traumatic stress disorder (PTSD), melancholy, and anxiety were the most frequently reported psychological consequences of natural disasters. A study of 98 flood survivors affected by Storm Eurydice (2017) in the United Kingdom demonstrated significant long-term psychological impacts persisting up to two years post-disaster, with 18% reporting depressive symptoms and 15% reporting anxiety (Varela *et al*., 2025). Among survivors of Cyclone Fani (2019), 36.7% experienced severe anxiety, approximately 20% had moderate-to-severe depression, 3.8% had severe depression, and suicidal ideation increased by 14% (Kar *et al*., 2022).

Low socioeconomic status, relocation, and repeated disaster exposure contributed to the persistence of depression, anxiety, and psychological distress, whereas disaster assistance and community support were associated with symptom reduction (Perdana *et al*., 2025; Li *et al*., 2023). Individuals experiencing severe housing damage, loss of family members, and post-disaster economic hardship were at higher risk of psychological distress and alcoholism, suggesting a shift from emotional distress toward maladaptive coping during the recovery phase (Kanehara *et al*., 2016).

Sleep Disturbances and Insomnia

Sleep disturbances — particularly insomnia and reduced sleep duration—were consistently reported among disaster survivors. Post-disaster sleep reduction significantly increased the risk of PTSD symptoms (OR = 2.89; 95% CI: 2.31–3.62; $p < 0.001$), with actin that is resilient. Musculoskeletal discomfort was linked to new-onset psychological distress, as demonstrated by cohort studies, with a dose–response pattern according to the number of pain sites (Yabe *et al*., 2019). Flood exposure was also associated with increased risk of electrocardiographic abnormalities, particularly ST depression and atrial fibrillation (Li *et al*., 2024). Among older adults, post-disaster depression was associated with increased mortality risk, whereas PTSD was not (Li X *et al*., 2019), highlighting complex interactions between mental and physical health outcomes. Longitudinal studies further demonstrated changes in pulmonary function following the Great East Japan Earthquake and tsunami, influenced by post-disaster smoking behavior and recovery dynamics rather than anthropometric changes alone (Nagashima *et*

al., 2018).

Psychosocial Risk and Protective Factors

Overall, evidence indicates that socioeconomic vulnerability, severe disaster exposure, older age, female sex, and maladaptive coping strategies are major risk factors for post-disaster psychological disorders (Bastami *et al*., 2024; Gölbaşı *et al*., 2025; Ahmadi *et al*., 2024). Passive and religious coping strategies were most commonly reported, with passive and social coping showing significant positive correlations with PTSD severity (Bastami *et al*., 2024).

Conversely, social support, resilience, self-efficacy, and certain personality traits such as extraversion functioned as protective factors, reducing both risk and severity of mental disorders (Nygaard *et al*., 2016; Varela *et al*., 2025). In a study of 454 survivors of the L'Aquila earthquake, individuals with low self-efficacy had nearly twice the risk of clinical PTSD compared with those with high self-efficacy (OR = 1.94; 95% CI: 1.28–2.94; p = 0.002), underscoring general self-efficacy as a critical protective factor in post-disaster mental health (Nygaard *et al*., 2016).

DISCUSSION

This systematic review underscores that natural disasters constitute extreme stressors capable of triggering complex responses across psychological, neurobiological, and endocrine levels, with consequences that frequently exist beyond the disaster's acute phase. The emergence of post- traumatic stress disorder (PTSD), melancholy, anxiety, and psychological distress is consistently linked to exposure to natural disasters at the psychological level. These conditions may initially represent adaptive responses to extreme threat, loss, and uncertainty; however, in a substantial proportion of individuals, they evolve into persistent and maladaptive disorders (Kar *et al*., 2022; Kanehara *et al*., 2016).

Psychosocial factors such as housing damage, displacement, and socioeconomic vulnerability appear to exacerbate these psychological responses, whereas social support and self-efficacy mitigate symptom severity. This pattern is consistent with the stress–diathesis model, in which traumatic exposure interacts with individual psychological resources to determine recovery trajectories or the chronicity of mental disorders (Nygaard *et al*., 2016; Li *et al*., 2023).

At the neurobiological level, findings from this review demonstrate that disaster-related trauma is associated with structural and functional brain alterations, particularly in regions involved in emotion regulation, memory processing, and stress responsiveness. Changes affecting the hippocampus, limbic circuitry, and large-scale brain network connectivity support the view that

PTSD and related conditions are not purely psychological phenomena but represent measurable neurobiological disorders (Bayar-Kapıcı *et al*., 2025; Qi *et al*., 2018). Reported cognitive impairments—most notably in working memory and verbal episodic memory—may be understood as consequences of disrupted neural circuits responsible for processing and consolidating traumatic experiences. (Walling *et al*., 2020; Li *et al*., 2020).

The current body of evidence indicates that disaster-related trauma can result in the long-term dysregulation of stress response systems, particularly the hypothalamic–pituitary–adrenal (HPA) axis, at the endocrine level. Findings of blunted cortisol responses and altered cortisol awakening response patterns years after disaster exposure support the concept of HPA-axis "burnout" resulting from chronic stress activation (Lawton *et al*., 2023).

In addition, alterations in biomarkers such as reduced brain-derived neurotrophic factor (BDNF) levels suggest impaired neuroplasticity mechanisms essential for neural recovery following severe stress. The

association between lower BDNF levels and PTSD severity further reinforces the hypothesis that endocrine dysregulation contributes to the maintenance of long-term neurobiological changes and persistent psychological symptoms (Stratta *et al*., 2016).

Chronic activation of the HPA axis in response to prolonged traumatic stress contributes to hippocampal volume reduction and disrupted neural connectivity which in turn exacerbate psychological symptoms including PTSD, depression, and sleep disturbances. The reciprocal interactions among psychological, neurobiological, and endocrine domains help explain why some survivors achieve recovery, whereas others develop chronic mental health conditions. Protective factors such as social support, resilience, and self-efficacy likely operate by attenuating chronic stress activation and facilitating recovery of stress-regulatory systems (Nygaard *et al*., 2016; Bastami *et al*., 2024).

The implications of a psycho-neuroendocrinological framework for comprehending the effects of natural disasters are significant for both clinical practice and public health policy. Post-disaster interventions should not solely concentrate on overt psychological symptoms; they should also take into account the underlying neurobiological and endocrine disturbances. Early interventions targeting sleep disturbances, chronic stress, and psychosocial support may help prevent the progression toward long- term stress system dysregulation.

In order to gain a more comprehensive understanding of recovery trajectories following disaster exposure, future research should incorporate psychological assessments, biological biomarkers, and neuroimaging measures. Longitudinal approaches that incorporate these three domains will be essential for identifying effective intervention targets and improving long-term outcomes for disaster survivors.

CONCLUSION

This systematic review demonstrates that natural disasters exert significant and multidimensional effects on survivors' mental, neurobiological, and physical health, with a substantial proportion of these effects persisting over the long term. Depression, anxiety disorders, insomnia, sleep disturbances, and psychological distress are among the mental health outcomes that are linked to disaster exposure, in addition to post-traumatic stress disorder (PTSD), substance use disorders (particularly alcohol misuse), suicidal ideation, cognitive impairment, and trauma-related emotional dysregulation. These mental health consequences often co-occur and interact with neurobiological alterations and physical health conditions, further compounding long-term morbidity. Accordingly, post-disaster response strategies should adopt a comprehensive, sustained, and risk- and resilience-oriented approach, addressing both psychosocial vulnerabilities and protective factors to support optimal recovery among survivors.

ACKNOWLEDGEMENTS

The authors would like to acknowledge all researchers and institutions whose work contributed to this systematic review. We also thank the developers and administrators of the PubMed and ScienceDirect databases for providing access to relevant scientific literature. No specific funding was received for the conduct of this study.

REFERENCES

Ahmadi, M., Hosseini, S. H., Karami, M., & Moradi, A. (2024). Modeling the Structural Relationships Between Trauma Exposure With Substance Use Tendency, Depression Symptoms, and Suicidal Thoughts in Individuals With Earthquake Trauma Experience: The Mediatory Role of Peritraumatic Dissociation and Experiential

Avoidance. Journal of Affective Disorders, 344, 180– 189.

Arcaya, M. C., Glymour, M. M., Christakis, N. A., Kawachi, I., & Subramanian, S. V. (2017). Association of Posttraumatic Stress Disorder Symptoms With Migraine and Headache After a Natural Disaster. JAMA Network Open, 177(6), 799–807.

Bastami, F., Akbari, M., Khankeh, H. R., & Ahmadi, S. (2024). Prevalence of Post-Traumatic Stress Disorder and Its Relationship With Coping Strategies Among Flood Victims: Evidence From Iran. BMC Psychiatry, 24, 112.

Bayar-Kapıcı, G., Aydın, O., Yıldırım, E., & Çetin, M. (2025). Hippocampus Alterations in Post-Traumatic Stress Disorder Among Survivors of the Consecutive Kahramanmaraş Earthquakes on February 6, 2023: Earthquake Brain at the End of the First Year. European Archives of Psychiatry and Clinical Neuroscience, 275, 145–156.

Bonanno, G. A., Brewin, C. R., Kaniasty, K., & La Greca, A. M. (2010). Weighing the Costs of Disaster: Consequences, Risks, and Resilience in Individuals, Families, and Communities. Psychological Science in the Public Interest, 11(1), 1–49.

Cowlishaw, S., Metcalf, O., Varker, T., Stone, C., Molyneaux, R., Gibbs, L., & Forbes, D. (2021). Anger Dimensions and Mental Health Following a Disaster: Distribution and Implications After a Major Bushfire. Journal of Affective Disorders, 278, 160–168.

Daskalakis, N. P., Lehrner, A., & Yehuda, R. (2013). Endocrine Aspects of Post-Traumatic Stress Disorder and Implications for Diagnosis and Treatment. Endocrinology and Metabolism Clinics of North America, 42(3), 503–513.

Galea, S., Nandi, A., & Vlahov, D. (2005). The Epidemiology of Post-Traumatic Stress Disorder After Disasters. Epidemiologic Reviews, 27(1), 78–91.

Goldmann, E., & Galea, S. (2014). Mental Health Consequences of Disasters. Annual Review of Public Health, 35, 169–183.

Gölbaşı, Z., Arslan, S., & Yıldırım, A. (2025). Investigation of the Factors Affecting Post- Traumatic Stress Disorder in Survivors of the 2023 Kahramanmaraş Earthquakes. Archives of Psychiatric Nursing, 39, 1–8.

Guo, J., Li, J., Chen, Y., Wang, X., & Zhang, H. (2016). Post-Traumatic Stress Disorder After Typhoon Disaster and Its Correlation With Platelet 5-HT Concentrations. Psychiatry Research, 239, 206–210.

Huang, Y. T., Lin, H. C., Chen, C. S., & Lee, H. C. (2025). Increase in Short-Term and Long- Term Stress-Associated Mental Illness After the Jiji Earthquake in Taiwan: A Twenty-Year Longitudinal Population-Based Cohort Study (1999–2019). Social Psychiatry and Psychiatric Epidemiology, 60, 321–333.

Kanehara, A., Umeda, M., Kawakami, N., & Sasaki, Y. (2016). Trends in Psychological Distress and Alcoholism After the Great East Japan Earthquake of 2011. Psychiatry and Clinical Neurosciences, 70(7), 303–312.

Kar, N., Kar, B., & Kar, S. (2022). Anxiety, Depression, and Post-Traumatic Stress One Month After Cyclone Fani (2019) in Odisha, India. Asian Journal of Psychiatry, 68, 102964.

Kim, J. H., Kim, K. R., Lee, S. H., & Kim, H. J. (2021). Association Between Change in Sleep Duration and Post-Traumatic Stress Symptoms in Natural Disaster Victims: The Mediating Role of Resilience. Sleep Medicine, 81, 15–22.

Kino, S., Aida, J., Kondo, K., Kawachi, I., & Tsakos, G. (2020). Long-Term Trends in Mental Health Disorders After the 2011 Great East Japan Earthquake and

Tsunami. Social Science & Medicine, 257, 113032.

Labarda, C. E., & Chan, C. S. (2018). Sleep Disturbances, Post-Traumatic Stress, and Psychological Distress Among Survivors of the 2013 Super Typhoon Haiyan. Journal of Traumatic Stress, 31(2), 215–223.

Lawton, R., Henningsen, K. H., & Lundberg, U. (2023). Exposure to the Indian Ocean Tsunami Shapes the HPA Axis Resulting in HPA "Burnout" Fourteen Years Later. Psychoneuroendocrinology, 149, 105982.

Li, H., Wu, Y., Wang, J., & Zhang, Z. (2020). Exploring Memory Function in Earthquake Trauma Survivors Using Resting-State fMRI and Machine Learning. NeuroImage: Clinical, 27, 102307.

Li, J., Li, X., Wang, Y., & Chen, S. (2023). Vulnerability and Recovery: Long-Term Mental and Physical Health Trajectories Following Climate-Related Disasters. Environmental Research, 216, 114574.

Li, X., Hikichi, H., Aida, J., Kondo, K., & Kawachi, I. (2019). Association of Postdisaster Depression and Post-Traumatic Stress Disorder With Mortality Among Older Disaster Survivors of the 2011 Great East Japan Earthquake and Tsunami. JAMA Network Open, 2(11), e1917550.

Li, Y., Zhang, L., Wang, X., & Chen, H. (2024). Association Between Electrocardiographic Abnormalities and Flood Exposure Among Middle-Aged and Elderly People: A National Longitudinal Study in China. Environmental Health Perspectives, 132(4), 047002.

Lowe, S. R., Sampson, L., Gruebner, O., & Galea, S. (2020). Psychological Resilience After Hurricane Sandy: The Influence of Individual- and Community-Level Factors on Mental Health After a Large-Scale Natural Disaster. PLoS ONE, 15(5), e0233598.

McEwen, B. S. (2007). Physiology and Neurobiology of Stress and Adaptation: Central Role of the Brain. Physiological Reviews, 87(3), 873–904.

Mulder, R., Boden, J. M., Carter, K., Fergusson, D. M., & Horwood, L. J. (2022). The Long- Term Health Consequences of Natural Disasters: A Systematic Review. Journal of Affective Disorders, 296, 50–61.

Norris, F. H., Friedman, M. J., Watson, P. J., Byrne, C. M., Diaz, E., & Kaniasty, K. (2002). 60,000 Disaster Victims Speak: Part I. An Empirical Review of the Empirical Literature, 1981–2001. Psychiatry, 65(3), 207–239.

Nygaard, E., Heir, T., & Bonanno, G. A. (2016). General Self-Efficacy and Post-Traumatic Stress After a Natural Disaster: A Longitudinal Study. BMC Psychology, 4, 15.

Perdana, A., Suryani, D., & Prasetyo, A. (2025). Shattered Ground, Shaken Minds: Mental Health Consequences of Earthquakes. International Journal of Disaster Risk Reduction, 98, 104231.

Qi, S., Mu, Y. F., Cui, L. B., & Zhang, J. (2018). Anomalous Gray Matter Structural Networks in Recent-Onset Post-Traumatic Stress Disorder. Human Brain Mapping, 39(5), 2034–2046.

Stratta, P., Rossi, A., Santarelli, V., & De Cataldo, S. (2016). Clinical Correlates of Plasma Brain-Derived Neurotrophic Factor in the Post-Traumatic Stress Disorder Spectrum After a Natural Disaster. Psychiatry Research, 239, 243–249.

Tang, B., Liu, X., Liu, Y., Xue, C., & Zhang, L. (2014). A Meta-Analysis of Risk Factors for

Depression in Adults and Children After Natural Disasters. BMC Public Health, 14, 623.

Van den Berg, B., Grievink, L., Stellato, R. K., Yzermans, C. J., & Lebret, E. (2010).

Symptoms of Post-Traumatic Stress Disorder in Residents Near a Major Industrial Disaster: The Role of Risk Perception and Media Exposure. Journal of Traumatic Stress, 23(3), 346–354.

Varela, A., Santos, J. L., & González, M. (2025). Long-Term Psychological Sequelae in Flood Survivors of the 2017 Eurydice Flood: PTSD, Dissociation, Depression, and the Role of Personality. Journal of Affective Disorders, 356, 412–421.

Walling, S. M., Simmons, J. L., & Smith, R. D. (2020). Neuropsychological Outcomes of Exposure to Hurricane Katrina and Relocation. Neuropsychology, 34(6), 648–659.

Yang, X., Liu, Y., Chen, S., & Zhao, J. (2025). Disaster Exposure and Insomnia Severity During the 7·20 Flood in Henan: The Moderated Mediation Model. Journal of Sleep Research, 34(2), e13985.

Yabe, Y., Hori, A., Fujiwara, T., & Kawachi, I. (2019). Musculoskeletal Pain Is Associated With New-Onset Psychological Distress in Survivors of the Great East Japan Earthquake. Journal of Psychosomatic Research, 116, 41–48.

Yehuda, R., Daskalakis, N. P., Desarnaud, F., Makotkine, I., Lehrner, A., Koch, E., Flory, J. D., Buxbaum, J. D., & Meaney, M. J. (2015). Epigenetic Biomarkers as Predictors and Correlates of Symptom Improvement Following Psychotherapy in Combat Veterans With PTSD. Frontiers in Psychiatry, 6, 118.

Zhu, H., Zhang, Y., Wang, X., & Li, L. (2020). Multivariate Classification of Earthquake Survivors With Post-Traumatic Stress Disorder Based on Large-Scale Brain Networks. NeuroImage: Clinical, 26, 102233.