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Posttraumatic Stress and Depression in the Aftermath of Environmental Disasters: A Review of Quantitative Studies Published in 2018

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Abstract

Purpose of Review As interest in the mental health consequences of environmental disasters increases, this review aimed to summarize peer-reviewed studies published in 2018 on posttraumatic stress disorder (PTSD) and depression symptoms after such events.

Recent Findings Notable trends in the past year of research included studies focusing on vulnerable populations (e.g., persons with preexisting physical health conditions), assessing the cumulative impact of exposure to multiple disasters, exploring pathway leading to PTSD and depression symptoms, and evaluating the effectiveness of post-disaster interventions.

Summary Over 100 articles were identified, focused on 40 disasters that occurred between 1982 and 2017. Prevalence estimates ranged from 0 to 70.51% for PTSD and 1.9 to 59.5% for depression. Consistent predictors of adverse outcomes included female gender, socioeconomic disadvantage, high disaster exposure, and low psychosocial resources. Further research that expands upon recent advances in the literature is critical given the large proportion of the world's population exposed to disasters and the increasing incidence of such events.

Keywords Environmental disasters · Natural disasters · Posttraumatic stress · Depression · Mental health

Introduction

Environmental disasters are catastrophic events that result from human activity and have a devastating impact on aspects of the environment, including ecosystems and biodiversity, wildlife and agriculture, and air and water quality. These include *technological* disasters, such as oil spills, chemical explosions, and nuclear radiation, in which the influence of human activity is clear and direct. Growing evidence suggests that human activity has also contributed to climate change and, as a result, the greater incidence of what have traditionally been defined as *natural* disasters, including floods, hurricanes, tornados, earthquakes, and tsunamis [1]. A definition of environmental disasters that includes these latter events is therefore warranted.

In addition to their effects on the environment, environmental disasters have evident effects on human health, including mental health. To date, there have been several reviews of the literature on post-disaster mental health, including the seminal review published in 2002 that summarized analyses of 160 independent samples in articles published between 1981 and 2001 [2], as well as more recent reviews [3, 4]. These syntheses have demonstrated that disasters have a clear impact on mental health, with the two most common adverse outcomes being depression and posttraumatic stress disorder (PTSD). In addition, they have highlighted a range of risk factors for psychiatric adversity, including demographic characteristics (e.g., female gender), indicators of socioeconomic disadvantage (e.g., low income and unemployment), exposure

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to more disaster-related stressors and traumatic events (e.g., bereavement, displacement), and fewer psychological and social resources (e.g., social support, adaptive coping skills).

In the past decade, there has been substantial growth in interest in the mental health consequences of environmental disasters and a corresponding surge of research on the topic. Therefore, recognizing that the field is rapidly evolving, we set out to review the research on this topic published in 2018 and ultimately narrowed our focus to two key mental health outcomes: PTSD and depression. In our review, we summarize several characteristics of the studies reviewed, including their geographic location, sample demographics, and timing relative to the disaster, as well as the prevalence estimates and predictors of adverse outcomes reported. In addition, we highlight studies that represent current trends and advances in the field that stand to improve our ability to identify survivors at risk of post-disaster PTSD and depression to mitigate adverse outcomes.

Method

The initial intent of this review was to include any article on the mental health consequences of environmental disasters broadly defined—that is, including any psychiatric disorder, symptom, or phenomenon (e.g., stress or general psychological distress). To identify articles on this topic published in 2018, the MEDLINE and PSYCINFO databases were searched. Initial search terms included those related to environmental disasters (e.g., "oil spill," "tornado") and mental health (e.g., "posttraumatic stress," "distress"). Over 700 (n=706) articles resulted from this search and an initial review of abstracts was conducted to determine eligibility. After review of abstracts, 178 articles were selected for a full-text review and we narrowed our focus to those including the two most commonly assessed psychiatric outcomes (i.e., PTSD and depression) and using quantitative analytic techniques. A total of 100 articles met these criteria and were included in the review. Three coders reviewed the articles, recording the instruments used to assess PTSD and depression, prevalence estimates reported, and significant predictors of outcomes in multivariable models. In addition, the coders reviewed articles with attention to overarching trends in the literature and efforts to understand post-disaster mental health beyond identification of prevalence estimates and predictors.

Results

Disaster Contexts

Table 1 provides an overview of the articles included in the review. The 100 articles identified drew on data from 83 studies (i.e., independent samples). These totals include six articles (five independent samples) with participants exposed to more than one disaster [5, 6•, 7–10], as well as two articles (two independent samples) with subsamples exposed to different disasters [11, 12], which are not included in Table 1.

The 31 disasters in Table 1 spanned from 1986 to 2017, with only two disasters (6.5%) occurring before the year 2000 and the majority (n = 24; 77.4%) since 2010. Of the 92 articles drawing on data from the aftermath of a single disaster, the majority (n = 87; 94.6%) were from studies conducted in the aftermath of what have been traditionally classified as natural disasters, including hurricanes (n = 12; 13.0%) and earthquakes (n = 51; 55.4%), whereas fewer (n = 9; 9.8%) were conducted in the aftermath of technological disasters, including oil spills (n = 3; 3.3%) and nuclear disasters (n = 5; 5.4%). Geographically, the majority of the 92 articles (n = 57, 62.0%) were conducted in Asia, including 18 articles from 13 independent samples after the 2008 earthquake in Wenchuan, China [13–30]; 11 articles from five independent samples after the 2013 earthquake in Lushan, China [31–41]; and nine articles from nine independent samples after the 2015 earthquakes in Nepal [42–49, 50••]. Together, the disasters listed in Table 1 accounted for over 300,000 fatalities and nearly US$80 billion dollars in damages, according to data from the Centre for Research on the Epidemiology of Disasters [51].

Study Methods

Table 2 lists additional detail about each of the 100 articles reviewed, including descriptions of the sample and the timing of assessments. The majority of studies included adult samples (n = 49; 49.0%), nine (9.0%) focused on children and adolescent samples, and 42 (42.0%) included a mixture of adolescents and adults. The earliest post-disaster assessment was conducted 1 week post-disaster after the 2013 Ya'an earthquake in China [5], and the latest was 23 years post-disaster after the 1988 Spitak earthquake in Armenia [53]. Seven studies (7.0%) included pre-disaster data, and 24 (24.0%) were longitudinal studies (defined as having two or more waves of data). Forty-four articles (44.0%) used data from within the first post-disaster year, and 15 (15.0%) used data from five or more years post-disaster.

Prevalence Estimates

Table 2 also provides the measures used to assess PTSD and depression, and the estimated prevalence of each outcome, if reported. The range in prevalence estimates was considerable. The lowest prevalence estimate reported for PTSD was 0.0% in a study conducted after the 1982–1983 flooding, tornadoes, dioxin contamination, and radioactive well water disaster and after the 1993 great floods, both of which occurred in Missouri, USA [10], and the highest was 70.5% in a subsample of New

Table 1 Summary of environmental disasters and characteristics of research on PTSD and depression published in 2018

Year	Country/ region	Continent	Disaster type (name)	Fatalities	Persons affected	Damages (in US$1 million)	Studies	Independent samples
1986	Ukraine	Europe	Nuclear disaster (Chernobyl)	31	135,000	2800	1	1
1988	Armenia	Asia	Earthquake (Spitak)	25,000	1,642,000	1400	1	1
2004	Southeast Asia	Asia	Earthquake; tsunami	226,096	2,321,700	9761	4	2
2005	USA	North America	Hurricane (Katrina)	1833	500,000	125,000	5	4
2007	Greece	Europe	Wildfires	65	5392	1750	1	1
2008	China	Asia	Earthquake (Wenchuan)	87,476	45,976,596	85,000	18	13
2008	Iceland	Europe	Earthquake	0[a]	10,000[a]	NA	1	1
2010	Chile	South America	Earthquake; tsunami	562	2,671,556	30,000	2	2
2010	Iceland	Europe	Volcano eruption (Eyjafjallajökull)	0[a]	2000[a]	NA	1	1
2010	New Zealand	Oceania	Earthquake (Christchurch)	185[a]	300,002	6500	1	1
2010	China	Asia	Earthquake (Yushu)	2968	112,000	500	1	1
2010	USA	North America	Oil spill (Deepwater Horizon)	11	17	20,000	3	3
2011	Australia	Australia	Flood (Queensland)	24[a]	200,000[a]	NA	1	1
2011	Japan	Asia	Earthquake (Great East Japan), tsunami, nuclear disaster (Fukushima Daiichi)	19,846	368,820	210,000	4	4
2011	Philippines	Asia	Tropical storm (Washi)	1439	1,150,300	38	1	1
2011	Turkey	Asia	Earthquakes (Van)	644	33,033	1500	1	1
2012	Italy	Europe	Earthquakes	24	25,400	15,800	2	2
2012	South Korea	Asia	Chemical disaster	5	3178	30	1	1
2012	USA	North America	Hurricane (Sandy)	54	NA	50,000	5	3
2013	Canada	North America	Flood (Calgary)	4	100,000	5700	1	1
2013	China	Asia	Earthquake (Lushan)	198	123,877	1000	11	5
2013	Philippines	Asia	Typhoon (Haiyan/Yolanda)	7354	16,106,870	10,000	2	2
2014	India	Asia	Flood (Kashmir Valley)	298	275,000	16,000	1	1
2015	Chile	South America	Flood	178	193,881	1500	1	1
2015	Nepal	Asia	Earthquakes	8969	5,642,150	5174	9	9
2016	China	Asia	Flood	289	60,000,000	22,000	3	1
2016	China	Asia	Tornado (Jiangsu)	99	45,846	500	6	4
2016	USA	North America	Flood (Louisiana)	13	70,000	10,000	1	1
2017	Peru	South America	Flood (El Niño Costero)	184	1,800,505	3100	1	1
2017	Puerto Rico	North America	Hurricane (Maria)	64	750,000	68,000	1	1
2017	USA	North America	Hurricane (Harvey)	88	582,020	95,000	1	1

Data on fatalities and damages are from the Centre for Research on the Epidemiology of Disasters International Disasters Database [51]

Data not available from the Centre for Research on the Epidemiology of Disasters International Disasters Database [51] and were instead drawn from the article on the given disaster in the review (see Table 2)

NA data not available

York City and Long Island residents who did not have access to medical care after Hurricane Sandy [85]. For depression, the lowest prevalence estimate reported was 1.9% in a sample of Missouri residents after the 1982 flooding, tornadoes, dioxin contamination, and radioactive well water disaster [10], and the highest was 59.5% in a study of shelter residents after a 2016 flood in China [93–95]. Among the 26 articles reporting prevalence estimates for both outcomes, the estimate for depression was higher in the majority of cases ($n = 20$, 76.9%). Several considerations must be kept in mind when comparing prevalence estimates, including the different measures used (22 identified for PTSD and 21 for depression), different criteria used to define cases, variability in study methodologies and sample characteristics, and potential cultural influences on the interpretation of assessment items and reporting of symptoms. The patterns of results nonetheless indicate substantial variability in the prevalence of PTSD and depression in the aftermath of environmental disasters and suggest the role of risk and protective factors—which are also likely to vary across the samples included—in shaping these outcomes.

An additional consideration is whether the prevalence estimates reported represent the impact of the disaster versus the persistence of preexisting mental health problems. This issue is somewhat less of a concern for PTSD, as symptoms are explicitly tied to the experience of the disaster. As mentioned previously, only seven studies in the review (7.0%) included pre-disaster data, which allow for documentation of whether prevalence estimates increased for pre- to post-disaster as well as exploration of the role of pre-disaster factors, including pre-disaster mental health, in shaping post-disaster PTSD and depression. Absent pre-disaster data, studies in the review relied on two alternative methods to assess the impact of disaster exposure on PTSD and depression. First, a handful of studies compared symptom levels of participants residing in regions with varying levels of exposure—for example, students from two districts that were differentially exposed to the 2015

Table 2 Summary of findings from studies on PTSD and depression after environmental disasters published in 2018

Author	Number	Sample	Timing	PTSD		Depression	
				Measure	Prevalence	Measure	Prevalence
1986—Nuclear disaster (Chernobyl); Ukraine							
(1) Bolt et al. [52]	4725	Representative sample of residents from 24 Ukraine oblasts (states) and the republic of Crimea, conducted in 2002; $n = 388$ in Chernobyl-contaminated zone	16 years post-disaster	WMH-CIDI	Major depression or dysthymia: 18.0%		
1988—earthquake (Spitak); Armenia							
(1) Goenjian et al. [53]	725	Stratified population-based sample of adults differentially exposed to the disaster	23 years post-disaster	PCL		DIS depression module	
2004; earthquake and tsunami; Southeast Asia							
(1) Adeback, Schulman, and Nilsson [54]	210	Swedish children ages 10–15 registered by national authorities after returning from disaster sites	8 years post-disaster	IES-R		–	–
(2a) Bondjers et al. [55]	1638	Swedish citizens ages 16+ registered by national authorities after returning from disaster sites	14 months post-disaster; 3 years post-disaster	IES-R		–	–
(2b) Gudmundsdottir et al. [56]	4446	Swedish citizens ages 16+ registered by national authorities after returning from disaster sites	14 months post-disaster	IES-R		–	–
(2c) Sveen et al. [57]	170	Swedish citizens ages 16+ registered by national authorities after returning from disaster sites	14 months post-disaster; 3 years post-disaster; 6 years post-disaster	IES-R		–	–
2005—hurricane (Katrina); USA							
(1a) Lai, Osborne, Piscitello, et al. [58]	426	Children residing in New Orleans and surrounding area at the time of the disaster	3–7 months, 13–17 months, 19–22 months, and 25–27 months post-disaster	UCLA-PTSD-RI-R1		–	–
(1b) Lai, Osborne, Lee, et al. [59]	426	[a]	3–7 months [T1] and 13–17 months post-disaster [T2]	UCLA-PTSD-RI-R1	T1: 18%; T2: 13%	–	–
(2) Lenane et al. [60•]	2073	Community-dwelling older adults in the Cohort Study of Medication Adherence Among Older Adults with established hypertension, living in Southern Louisiana	12–24 months post-disaster	PCL-S	8.6%	–	–
(3) McGuire et al. [61]	810	Adults living in disaster-affected areas in the southernmost counties of Mississippi	18–24 months post-disaster	CIDI		PHQ-9	
(4) Mikolajewski and Scheeringa [62]	36	Children with a history of trauma, ages 3–6 at baseline	<1 month to 2 years pre-disaster, and 6 months to 3 years post-disaster	PAPA		–	–
2007—wildfires; Greece							
(1) Psarros et al. [63]	102	Firefighters who lived within disaster-affected areas and were on duty during the disaster period	1 month post-disaster	Structured questionnaire based on the ICD-10	18.6%	–	–
2008—earthquake (Wenchuan); China							
(1) Cao, Wang, Wu, et al. [13]	1063	Survivors (ages 16+) from rebuilt communities in Hanwang Town in Mianzhu city	9 years post-disaster	PCL-5	16.0%	–	–
(2) Yeung et al. [14]	3577	Primary and secondary school students in Kunming	1 month [T1] and 7 months post-disaster [T2]	CRIES	T1: 16.9%; T2: 11.1%	–	–
(3) Cao, Wang, Cao, et al. [15]	1278	Adolescents recruited from two junior high schools originally located in Beichuan county town	2.5 years [T1] and 3.5 years [T2] post-disaster	UCLA-PTSD-RI	T1: 21.7%; T2: 17.9%	–	–
(4) Cheng et al. [16]	301	4th and 6th grade students recruited from a school in Wenchuan county	4 months [T1], 29 months [T2], 40 months [T3], and 52 months [T4] post-disaster	UCLA-PTSD-RI	T1: 9.3%; T2: 4.3%; T3: 4.1%; T4: 5.5%	CDI	T1: 34.2%; T2: 26.5%; T3: 30.5%; T4: 26.0%
(5) Du et al. [17]	4118		8 years post-disaster	PCL-C	2.3%	–	–

Table 2 (continued)

Author	Number	Sample	Timing	PTSD		Depression	
				Measure	Prevalence	Measure	Prevalence
		Adolescents from middle schools in a generally affected area ($n = 1998$) and a severely affected area ($n = 2120$)					
(6a) Fan et al. [18]	431	Students from a public high school that was severely affected by the disaster	6, 12, and 18 months post-disaster	–	–	BDI	
(6b) Feng et al. [19]	465	[a]	6, 12, and 18 months post-disaster	PCL-C		–	–
(6c) Memon et al. [20]	439	[a]	6, 12, and 18 months post-disaster	–	–	BDI	
(7a) Geng, Liang, et al. [21]	1573	Participants from the Wenchuan Earthquake Adolescent Health Cohort (WEAHC); students from one junior high school and one senior high school in Dujiangyan	6 months [T1] and 18 months [T3] post-disaster	PTSD-SS	T1: 18.9%; T3: 11.6%	DSRS	T1: 27.7%; T3: 31.2%
(7b) Geng, Zhou, et al. [22]	1573	[a]	6 and 18 months post-disaster	PTSD-SS	[a]	DSRS	[a]
(7c) Shi et al. [23]	688	Parent-adolescent dyads from the WEAHC study	12 months [T2] and 18 months [T3] post-disaster	PTSD-SS	T2: 18.9%; T3: 11.9%	–	–
(8) Guo et al. [24]	1369	Adult survivors from two severely affected sites (Yongan township, and Manzhu city)	18 months post-disaster	IES-R	11.8%	CES-D	24.8%
(9) He et al. [25]	1000	Adult residents of six counties in Sichuan with varying levels of damage	10 years post-disaster	PCL-C		–	–
(10) Hu et al. [26]	1031	High school students from Maoxian and Beichuan	2–3 years post-disaster	PCL-C		–	–
(11) Liu et al. [27]	1131	Epidemiologic study of Chinese adults exposed to the earthquake	5.5 years post-disaster	PCL-5		–	–
(12) Zhang et al. [28]	71	Right-handed adults from a rebuilt community in Mianzhu city, Sichuan province, who had experienced the disaster	5.5 years post-disaster	CPSS		–	–
(13a) Zhou, Wu, and Zhen [29]	591	Middle school students from Wenchuan and Maoxian counties	1 year post-disaster	CPSS	44.3%	–	–
(13b) Zhou, Wu, et al. [30]	391	[a]	1, 1.5, 2, and 2.5 years post-disaster	CPSS		–	–
2018—earthquake; Iceland							
(1) Thordardottir et al. [64]	1301	Adult residents of the area struck by the earthquake randomly selected from the National Registry of Iceland	2 months [T1], 4 months [T2], 8 months [T3], and 12 months [T4] post-disaster	PSS-SR	T1: 5.2%	BDI-II	T2: 6.7%
2010—earthquake, tsunami; Chile							
(1) Leiva-Bianchi et al. [65]	29	Participants with ($n = 13$) and without ($n = 16$) PTSD in a quasi-experimental study of CBT-PD	7–9 months post-disaster	SPRINT-E		–	–
(2) Rosellini et al. [66]	23,907	Biennial survey of a nationally representative sample	3 months pre-disaster [T1]; 3 months post-disaster [T2]	DTS	T2: 13.3%	–	–
2010—volcano eruption (Eyjafjallajökull); Iceland							
(1) Gissurardottir et al. [67]	1656	Adult residents living in the area close to the Eyjafjallajökull volcano in Southern Iceland at the time of the eruption ($n = 1146$) and a matched sample of adult residents from a non-exposed area in Northern Iceland ($n = 510$)	6–9 months post-disaster	PC-PTSD		–	–
2010—earthquake; New Zealand							
(1) Trip et al. [68]	290	Convenience sample from three cohorts of university-level professional students in nursing programs who were potentially displaced from home and educational settings	1 year post-disaster	PCL		DASS	
2010—earthquake (Yushu); China							
(1) Xiao et al. [69]	867	Bereaved Tibetan adolescents from five of the worst-hit middle schools located in Jiegu town	3 years post-disaster	PCL-C	24.40%	–	–
2010—oil spill (Deepwater Horizon); USA							
(1) Ayer et al. [70]	2520	Representative sample of adults residing in 56 counties of five US states located along the Gulf	6 years post-disaster	–	–	PHQ-2	
(2)	198		2.5 years [T1] and 4.5 years [T2] post-disaster	–	–	BDI	

Table 2 (continued)

	Author	Number	Sample	Timing	PTSD		Depression	
					Measure	Prevalence	Measure	Prevalence
	Buckinham-Howes et al. [71]		Adults randomly selected from lists of organizations most affected by spill (e.g., fishing industry groups, social service agencies) and who lived within 10 miles of the Gulf Coast at the time of spill					Clinically depressed—T2: 28.7%
	(3) Rung et al. [72]	2038	Women and Their Children's Health Study; representative sample of women living in 7 coastal Louisiana parishes	2–4 years [T1] and 4–6 years [T2] post-disaster	–	–	CES-D	Depressive symptoms—T1: 28.2%; T2: 35.5%
2011	Australia	Australia	Flood (Queensland)	1				
	(1) Kildea et al. [73]	126	Women who were pregnant at the height of the flood	1 year post-disaster	IES-R		–	–
2011—Earthquake (Great East Japan), tsunami, and nuclear disaster (Fukishima Daiichi); Japan								
	(1) Nagamine et al. [74••]	56,753	Japan Ground Self-Defense Force personnel, surveyed as part of a mandatory occupational health program	1 month [T1], 6 months [T2], and 12 months [T3] post-disaster	IES-R	High PTSR—T1: 2.9%; T2: 1.8%; T3: 1.3%	–	–
	(2) Okuyama et al. [75]	760	High school students in Natori city; 160 were assessed longitudinally	16 months [T1], 28 months [T2], and 40 months [T3] post-disaster	IES-R	PTSR—T1: 14.3%; T2 5.0%; T3: 11.2%	QIDS-J	Depressive state—T1: 14.9%; T2: 12.4%; T3: 12.4%
	(3) Shigemura et al. [76]	49	Male dentists recruited from three professional organizations and who had participated in post-mortem disaster victim identification missions	6–9 months post-disaster	IES-R		–	–
	(4) Takaoka et al. [77]	1120	Residents of Ichinoseki city ($n = 902$) and evacuees to the city from coastal areas ($n = 218$)	1 year post-disaster	TSQ		–	–
2011—tropical storm (Washi); Philippines								
	(1) Mordeno et al. [78]	225	Child and adolescent survivors living in evacuation centers	1 month post-disaster	–	–	DSRSC	
2011—earthquakes (Van); Turkey								
	(1) Salcioglu et al. [79]	541	Survivors who experienced relocation within and outside of a disaster region	16.5 months post-disaster	SITSES-R	21.6%	DRS	17.4%
2012—earthquakes; Italy								
	(1) Saltini et al. [80]	529	Displaced earthquake survivors temporarily living in tented camps who had elevated PTSD symptoms	Within 3 months post-disaster	IES-R		–	–
	(2) Vezzali et al. [81]	621	Disaster survivors from the province of Modena who were either were native Italians ($n = 589$) or immigrants ($n = 121$)	6 months post-disaster	IES		–	–
2012—chemical disaster; South Korea								
	(1) Song et al. [82]	714	Employees of workplaces in the industrial complex where the accident took place	10 months post-disaster	IES-R	5.7%	CES-D	6.9%
2012—hurricane (Sandy); USA								
	(1) Li et al. [83]	4220	Random sample of adult enrollees to the World Trade Center Health Registry, a prospective cohort of individuals likely to have been exposed to the 9/11 attacks	5–12 months post-disaster	PCL		–	–
	(2) Mandavia and Bonanno [84]	1172	Older adults (50–74 years old) from the ORANJ BOWL (Ongoing Research on Aging in New Jersey: Bettering Opportunities for Wellness in Life) longitudinal study in New Jersey	4–6 years pre-disaster; 0–1 year pre-disaster; 1–2 years post-disaster	PSS-SR		CES-D 10	
	(3a) Ruskin et al. [85]	1669	Convenience sample of adult New York city and Long Island residents from the Leaders in Gathering Hope Together study (Project LIGHT) and the Project Restoration study	1–4 years post-disaster	PCL-S	32.8%	PHQ-4	24.3%
	(3b) Schneider et al. [86]	1356	Convenience sample of adult New York city and Long Island residents from the Leaders in Gathering Hope Together study (Project LIGHT) and the Project Restoration study	1–4 years post-disaster	PCL-S		PHQ-4	25.2%
	(3c) Schwartz et al. [87]	1615	Convenience sample of adult residents from the greater New York City area	0–4 years post-disaster	PCL-S	33.4%	PHQ-4	24.5%
2013—flood (Calgary); Canada								
	(1) Hetherington et al. [88]	923	Participants from the All Our Families longitudinal cohort study who provided data before and after the disaster	36 months pre-disaster [T1]; 5 months post-disaster [T2]	IES-R	Elevated PTS—T2: 11.5%	CES-D	Depressive symptoms—T2: 5.2%
2013—earthquake (Lushan); China								
		3962		3 years post-disaster	CRIES-13		SMFQ	

Table 2 (continued)

Author	Number	Sample	Timing	PTSD		Depression	
				Measure	Prevalence	Measure	Prevalence
(1a) Jin, Deng, et a. [31]		Junior high and high school students from four earthquake-affected schools in Lushan county, Ya'an City			Possible PTSD symptoms −13.0%		Possible depressive symptoms—20.8%
(1b) Jin, Sun, et al. [32]	4137	[a]	3 years post-disaster	CRIES-13	Elevated PTSD risk-11.1%	KADS-6	Elevated depression risk—19.6%
(2a) Tang, Lu, et al. [33]	6132	Students from 11 primary, junior high, and senior high schools in Baoxing, Lushan, and Tianquan counties	3 years post-disaster	CRIES-13	11.1%	SMFQ	19.8%
(2b) Tang, Xu, et al. [34]	5563	[a]	3 years post-disaster	CRIES-13	11.1%	SMFQ	19.8%
(2c) Tang, Zhao, et al. [35]	6132	[a]	3 years post-disaster	CRIES-13	11.0%	KADS-6	19.7%
(2d) Tang, Lu, and Xu [36]	6132	[a]	3 years post-disaster	CRIES-13	13.1%	SMFQ	19.8%
(2e) Xu et al. [37]	3783	Adolescents (13–18 years old) in Lushan, Baoxing, and Tianquan in the Longmenshan thrust fault (LMSF) area in Sichuan province, China, recruited from 11 schools	3 years post-disaster	CRIES-13		KADS-6	
(2f) Xu et al. [38]	3851	[a]	3 years post-disaster	CRIES-13	14.1%	–	–
(3) Wang et al. [39]	706	Middle and high school students from Lushan county	3.5 year post-disaster	PCL-5		–	–
(4) Wong et al. [40]	495	Adults (ages 18–92) from four communities in Lushan county	1 year post-disaster	–	–	CES-D	
(5) Zhou et al. [41]	397	Middle school students from Lushan county	2.5 years post-disaster	PCL-5		–	–
2013—typhoon (Haiyan/Yolanda); Philippines							
(1) Labarda and Chan [89]	361	Two samples of participants in a disaster-relief program surveyed (T1 $n = 223$; T2 $n = 138$)	18 months post-disaster [T1]; 30 months post-disaster [T2]	PCL-S [T1]; PCL-5 [T2]	T1: 23.3%; T2: 18.8%	–	–
(2) Nagmine et al. [90]	227	Japan Ground Self-Defense Force personnel who engaged in post-disaster humanitarian mission	Immediately after return from post-disaster humanitarian mission	IES-R		–	–
2014—flood (Kashmir Valley); India							
(1) Dar et al. [91]	87	Flood victims approached through special advisory centers established by the state dispensation in the aftermath of the flood	5 months post-disaster	PCL-S		BDI	
2015—flood; Chile							
(1) Roa and Dulcic [92]	399	Random sample of undergraduate students at a public university	Not specified	–	–	RPSQ (depression subscale)	
2015—earthquakes; Nepal							
(1) Acharya et al. [42]	800	Population-based sample of children ages 7–16 years who had been living in Kathmandu at the time of the earthquake	15 months post-disaster	CPSS	Moderate-to-severe PTSD: 51%	–	–
(2) Itzhaky et al. [43]	145	Snowball sample of Israeli tourists who had been backpacking in Nepal at the time of the earthquake	2 weeks to 3 months post-disaster	IES-R		–	–
(3) Kane et al. [44]	513	Population-based sample of residents ages 16+ from three earthquake-affected districts (Kathmandu, Gorkha, and Sindhupalchowk)	4 months post-disaster	PCL-C	5.2%	HSCL-25 (adapted)	34.3%
(4) Negi et al. [45]	305	Persons with HIV recruited from antiretroviral therapy service centers	6 and 12 months post-disaster	PCL-C	PTSD symptoms: 44%	–	–
(5) Schwind et al. [46]	62	Children and adolescents ages 8–17 in Phulpingdanda village	1 year post-disaster	CPSS	4.8%	DSRSC	3.2%
(6) Sharma and Kar [47]	409	Adolescents ages 12–19 years from public schools in a highly affected district (Dhading; $n = 202$) and a comparatively less affected district (Chitwan; $n = 207$)	1 year post-disaster	CPSS	43.3%	DSRS	38.1%
(7) Silwal et al. [48]	893	Students ages 11–17 from Sindhupalchok ($n = 453$) and Kathmandu ($n = 440$)	1 year post-disaster	CPSS	Sindhupalchok subsample: 39.5%, Kathmandu subsample: 10.7%	DSRS	Sindhupalchok subsample: 40.4%, Kathmandu subsample: 23.2%

Table 2 (continued)

Author	Number	Sample	Timing	PTSD		Depression	
				Measure	Prevalence	Measure	Prevalence
(8) Thapa et al. [49]	198	Residents of the Bhumlichaur area of the Gorkha district	14 months post-disaster	PTSD8	2.8%	HADS	8.1%
(9) Welton-Mitchel et al. [50••]	240	Residents to two communities in Bhaktapur district	2.5 months	PCL-C		PHQ-9	
2016—flood; China							
(1a) Zhen et al. [93]	187	Residents of makeshift shelters after floods in Wuhu, a city in Anhui province that was severely affected by flooding	During flood	PCL-5	25.1%	CES-D	59.5%
(1b) Zhen et al. [94]	187	[a]	[a]	–	–	CES-D	
(1c) Zhen et al. [95]	187	[a]	[a]	–	–	CES-D	
2016—tornado (Jiangsu); China							
(1) An et al. [96]	204	Adolescents from two secondary schools in Yancheng City, Jiangsu province	6 months post-disaster; 9 months post-disaster	CPSS		–	–
(2a) An et al. [97]	443	Adolescents from two secondary schools in Yancheng City, Jiangsu province	1 year post-disaster	CPSS		–	–
(2b) Zhang et al. [98]	443	[a]	1 year post-disaster	CPSS		–	–
(3) Xu, Ding, et al. [99]	435	Adolescents from two secondary schools in Yancheng City, Jiangsu province	9 months post-disaster	–	–	CES-DC	–
(4a) Xu, Yuan, et al. [100]	247	Adolescents from two secondary schools in Yancheng City, Jiangsu province	3 months post-disaster	CPSS	57.5%	CES-DC	58.7%
(4b) Yuan et al. [101]	247	[a]	3 months post-disaster	CPSS		–	–
2016—flood (Louisiana); USA							
(1) McElroy-Heltzel [102]	466	Adults from Baton Rouge, Louisiana and surrounding communities recruited through local community agencies	1 month post-disaster	PCL-5		–	–
2017—flood (El El Niño Costero); Peru							
(1) Contreras et al. [103]	129	Participants from two affected informal human settlements in the Lima-metropolitan area	"Several weeks" post-disaster	–	–	PHQ-9	10.3%
2017—hurricane (Maria); Puerto Rico							
(1) Ferré et al. [104]	74	Adults from a stratified random sample of households in Punta Santiago	6 months post-disaster	PCL-C	41.90%	PHQ-9	54.1%
2017—hurricane (Harvey); USA							
(1) Schwartz et al. [105]	41	Adults (ages 18+) from heavily affected areas	3 weeks post-disaster	PCL-S	46.0%	PHQ-4	39.0%
Multiple exposures							
(1) Geng et al. [5]	858	High school students from Dujiangyan, with varying levels of exposure to the Wenchuan earthquake (2008) and Ya'an earthquake (2013) in China	1.5 years pre-disaster and 1 week post-disaster (relative to Ya'an earthquake)	SRS-PTSD		DSRS	
(2) Gilmore et al. [11]	979	Adolescents exposed to the 2011 tornados in either Mississippi or Alabama recruited using an address-based sampling technique for the Bounce Back Now (BBN) study, a randomized clinical trial examining the efficacy of a post-disaster web-based intervention on mental health symptoms	$M = 8.8$ months post-disaster ($SD = 2.6$ months)	NSA PTSD module		–	–
(3) Harville et al. [6•]	1366	Southern Louisiana women of reproductive age from the Gulf Resilience on Women's Health (GROWH) study, with varying levels of exposure to Hurricane Katrina (2005), Hurricane Rita (2005), Hurricane Ike (2008), Hurricane Gustav (2008), and the Deepwater Horizon oil spill (2010)	1–6 years after the Deepwater Horizon oil spill	PCL	6%	EDS	16%
(4) Kannis-Dymand et al. [12]	662	A convenience sample of adults exposed to either the Canterbury earthquakes (2010/2011; Christchurch, New Zealand, $n = 591$), or the Queensland floods (2011; Australia, $n = 80$)	2 years post-disaster	PCL-C		–	–
5a) Lee, Blackmon, Cochran, et al. [7]	294	Spatially stratified, random sample of residential households in the southernmost portions of 3 Mississippi coastal counties, with varying levels of exposure to Hurricane Katrina (2005) and the Deepwater Horizon oil spill (2010)	5 years after the Deepwater Horizon oil spill	–	–	CES-D	
	216	[a]		–	–	CES-D	

Table 2 (continued)

Author	Number	Sample	Timing	PTSD		Depression	
				Measure	Prevalence	Measure	Prevalence
(5b) Lee, Blackmon, Lee, et al. [8]			5 years after the Deepwater Horizon oil spill				
(6) Prost et al. [9]	357	Minority ($n = 233$) and non-minority ($n = 124$) social work student-practitioners attending social work programs in five universities in the Gulf region, with varying levels of exposure to Hurricane Katrina (2005) and Hurricane Rita (2005)	3 months after Hurricane Rita	MPSS-SR		–	–
(7) Stough and North [10]	242	Residents of Times Beach, Missouri, with varying levels of exposure to flood, tornados, dioxin contamination, and radioactive well water disasters (1982/1983) and Great Floods (1993)	11 months after the 1982/1983 disasters [T1]; 1 year after the 1993 disaster [T2]	DIS	T1: 0%; T2: 0%	DIS	T1: 1.9%

Prevalence estimates listed are for probable posttraumatic stress disorder (PTSD) and depression, unless otherwise specified

BDI Beck's Depression Inventory, *BDI-II* Beck Depression Inventory-II, *CDI* Children's Depression Inventory, *CES-D* Center for Epidemiologic Studies Depression Scale, *CES-D 10* Center for Epidemiologic Studies Short Depression Scale, *CPSS* Child Posttraumatic Symptom Scale, *CRIES* Children's Revised Impact of Events Scale, *DASS* Depression Anxiety Stress Scales, *DIS* Diagnostic Interview Schedule, *DRS* Depression Rating Scale, *DSRS* Depression Self-Rating Scale, *DSRSC* Depression Self-Rating Scale for Children, *DTS* Davidson Trauma Scale, *EDS* The Edinburgh Depression Scale, *HADS* Hospital Anxiety and Depression Scale, *HSCL-25* Hopkins Symptom Checklist-25, *ICD-10* International Classification of Diseases, Tenth Revision, *IES* Impact of Event Scale, *IES-R* Impact of Event Scale—Revised, *KADS-6* Kutcher Adolescent Depression Scale (six-item version), *MPSS-SR* Modified PTSD Symptom Scale—Self-report, *NSA* National Survey of Adolescents, *PAPA* Preschool Age Psychiatric Assessment, *PCL* Posttraumatic Stress Disorder Checklist for DSM-IV, *PCL-5* Posttraumatic Stress Disorder Checklist for DSM-5, *PC-PTSD* Primary Care PTSD Screen, *PHQ* Patient Health Questionnaire (two-, four-, and nine-item versions), *PSS-SR* PTSD Symptom Scale—Self-Report, *PTSD8* 8-item PTSD screener, *PTSD-SS* Posttraumatic Stress Disorder Self-Rating Scale, *QIDS-J* Quick Inventory of Depressive Symptomatology, *RPSQ* Revised Psychopathological Symptoms Questionnaire, *SITSES-R* Screening Instrument for Traumatic Stress in Earthquake Survivors—Revised, *SMFQ* Short Mood and Feelings Questionnaire, *SPRINT-E* Short PTSD Rating Interview, *SRS-PTSD* Self-Rating Scale for Posttraumatic Stress Disorder, *TSQ* Trauma Screening Questionnaire, *UCLA-PTSD-RI-R1* UCLA-PTSD Reaction Index for DSM-5, *WMH-CIDI* World Mental Health Composite International Diagnostic Interview

[a] Same sample description as the preceding study

Nepal earthquakes [48], and subsamples of participants residing in areas with varying distances from the epicenter of the 2008 earthquake in Iceland [64] and the 2013 earthquake in Lushan, China [37, 38]. Second, investigators examined associations between outcomes and participants' self-reported exposure, including dichotomous indicators of whether the participant lived in the affected area at the time of disaster [52], and items assessing various disaster-related experiences (e.g., bereavement, household damage) e.g., [18, 22].

Predictors

The patterns of significant predictors of PTSD and depression were generally consistent with those documented in prior research. Several studies documented that female participants were at increased risk for PTSD and depression e.g., [44, 92–95], whereas male gender was associated with greater risk of PTSD in only one study [17]. Studies showing age differences in outcomes varied in the direction of effects, with older participants at increased risk in some cases e.g., [18, 74••, 92–95] and younger participants at increased risk in others e.g., [46, 72, 76], and with such variability evident across both adult and child/adolescent samples. Although less commonly explored, ethnic minority and low socioeconomic status were consistently associated with adverse outcomes e.g., [6•, 83, 87], with some exceptions e.g., [25, 46, 82].

Disaster exposure was a consistent and robust predictor of PTSD and depression across the studies reviewed. Indicators of exposure that were associated with adverse outcomes included living in an area that was affected by the disaster (vs. unaffected, as per self-report) [52]; living in a highly affected area (vs. a less affected area, as per geographically defined subsamples) [37, 38, 48, 64]; specific disaster-related experiences, including injury to oneself [69, 100], injury or death of a loved one [22, 46, 100], lack of vital resources (e.g., water, medical care) [85, 92], household damage [18, 29, 92], property loss [69], displacement [61, 78, 79], and financial impacts [6•, 64, 67, 71]; counts of disaster-related experiences [26, 46]; and exposure to aversive details about the disaster via the media [14, 25]. Additionally, participants who reported experience fear or distress during the disaster were shown to be at risk of adverse outcomes [29, 47, 63].

The reviewed studies also documented several psychosocial resources that were associated with lowered risk of PTSD and depression, including social support [61, 64, 91], social cohesion [50••, 68], gratitude [39], self-esteem [29], religiosity [42], and adaptive coping strategies (e.g., mindfulness, emotion regulation) [43, 69]. Conversely, psychosocial stressors associated with heightened risk were post-disaster negative life events [22, 32, 37], family members' psychiatric symptoms [18], survivor guilt [39], rumination [98], and maladaptive coping styles (e.g., cognitive suppression, avoidant coping) [9, 43, 47]. Prior exposures to traumatic events were also associated with greater risk, including counts of lifetime trauma [48, 53, 70] and exposure to specific events (e.g., community violence [59], interpersonal violence [11]). PTSD and depression were also frequently comorbid with other psychiatric symptoms (e.g., anxiety [22], insomnia, and other sleep problems [33, 63, 93–95]) and physical health problems [60•] and were highly correlated with each other [16, 63, 81].

Trends in the Literature

In reviewing the past year of literature, we took note of studies that will push the field forward in terms of identifying disaster-affected individuals most vulnerable to PTSD and depression and mitigating these outcomes. These studies fell into four categories: (1) vulnerable populations, (2) cumulative disaster exposure, (3) pathways to post-disaster symptoms, and (4) interventions. A summary of key results from each category follows.

Vulnerable populations As in the current review, prior research has identified several individual characteristics that increase risk for PTSD and depression [2–4]. Within any at-risk group, there is of course variability in adverse outcomes, and studies that seek to understand the drivers of such vulnerability provide useful information in identifying survivors that might be in particular need of mental health services. Research over the past year has examined such variability in two key at-risk populations: first responders and persons with preexisting physical health conditions.

First, research on first responders has replicated some of the risk factors documented in the more general population of disaster survivors, as well as others specific to their job responsibilities. For example, a longitudinal study of over 50,000 Japanese Ground Defense Force personnel dispatched after the Great East Japan Earthquake and subsequent tsunami and nuclear disaster found that women, older adults, and those who were personally affected by the disaster were at increased risk of high posttraumatic stress reactions (PTSR); additionally, those who were tasked with body recovery duties, who were deployed for a longer amount of time, who reported that they were overworked (e.g., worked during holiday or overtime hours), and who either did not take leave at all or within 2 weeks of the end of their response work had increased odds of high PTSR [74••]. Another study in the aftermath of the August 2007 wildfire disaster in Greece found that firefighters who experienced fear of dying during their response work and who were temporary (vs. permanent) employees had higher risk of probable PTSD [63].

Studies on persons with preexisting physical health conditions have similarly replicated previously documented predictors of PTSD and depression, while further demonstrating associations between PTSD and depression and outcomes related to participants' conditions. For example, PTSD was

associated with lower antiretroviral therapy adherence among a sample of persons with HIV who were exposed to the 2015 earthquake in Nepal [45]. In a sample of older adults with hypertension exposed to Hurricane Katrina, having high PTSD symptoms was also linked incident cardiovascular disease [60•]. As in prior research, female gender, ethnic minority status, lower education, and higher disaster exposure were among the significant predictors of PTSD in this sample [60•].

Cumulative disaster exposure A second trend in the literature was studies of PTSD and depression among persons who had endured exposure to multiple environmental disasters [6•, 7–9, 21]. Understanding the effects of multiple exposures will be crucial given the increasing frequency of climate change-related disasters, particularly in geographically vulnerable areas such as the US Gulf Coast [1]. In their study of multiply exposed women in Southeast Louisiana in the US Gulf Coast, Harville, Shankar, Schetter, and Lichtfeld [6•] summarized three competing models of how multiple exposures might influence mental health outcomes: a *cumulative* model, wherein disasters increase risk for adverse outcomes in a dose-response fashion; a *sensitization* model, wherein the effect of disaster exposure is enhanced among those with prior exposure, relative to those with no prior exposure; and a *habituation model*, wherein the effect of disaster exposure is lessened for those with prior exposure, relative to those with no prior exposure. The results of Haville and colleagues' study [6•] mainly supported the cumulative model: participants who had a greater number of total exposures to Hurricanes Katrina, Rita, Gustav, and Ike, and the Deepwater Horizon oil spill had increased relative risk of both PTSD and depression. In one exception, the exposure to the oil spill was associated with higher PTSD symptoms for participants who had experienced illness or injury due to one of the hurricanes, consistent with the sensitization model [6•].

Another notable study took a slightly different approach to investigating multiple exposures in a sample of adolescents exposed to both the 2008 Wenchuan earthquake and the 2011 Ya'an earthquake in China [22]. The investigators of this study explored both the direct and indirect effects of Wenchuan exposure on post-Ya'an PTSD and depression symptoms, controlling for Ya'an exposure, using structural equation modeling. Greater Wenchuan exposure was directly associated with post-Ya'an PTSD only, indirectly associated with both post-Ya'an PTSD and depression via post-Wenchaun PTSD symptoms, and indirectly associated to post-Ya'an depression symptoms only via post-Wenchuan depression symptoms. Additionally, the authors found an interaction between Wenchuan and Ya'an exposure in predicting PTSD symptoms, such that the effect of greater Ya'an exposure was enhanced for adolescents who had endured greater Wenchuan exposure, thus supporting the sensitization model.

Pathways to post-disaster symptoms A third trend in the past year of research focuses on the pathways leading to PTSD and depression. This research advances the field by showing how risk and protective factors work together to shape outcomes and offers the potential for identifying intervention targets. A few studies within this category investigated proximal consequences of trauma exposure that in turn increase risk for PTSD and depression. A study of survivors of the 2014 flood in Kashmir Valley, India, for example, found a significant indirect effect of disaster exposure on depression symptoms via declines on family support; the same indirect was non-significant for PTSD symptoms, however [91]. Similarly, greater exposure to the Ya'an earthquake was indirectly associated with higher depression symptoms via lower *cognitive social capital*, defined as survivors' sense of community, trust, and social connectedness among a sample of affected adults [40].

Other research within this category has focused on pathways from the cognitive appraisal of environmental disasters to PTSD symptoms. Mordeno, Galela, Nalipay, and Cue [78] gathered data from child and adolescent survivors of the 2011 Tropical Storm Washi in the Philippines and assessed the *centrality of the event*—that is, whether the storm was perceived as a reference point around which other life events were interpreted, as a core aspect of one's identity, or a turning point in one's life. Higher levels of event centrality were linked with higher PTSD symptoms indirectly via stronger sensory-based memories of the storm [78]. Another study assessed *posttraumatic cognitive change*, defined as increased negative thoughts about one's safety and stability due to the event, among adolescents after the 2016 Jiangsu tornado [98]. Adolescents who reported more posttraumatic cognitive change tended to have higher PTSD symptoms, an effect that was mediated by both intrusive and deliberate rumination—that is, repeatedly thinking about the disaster either unintentionally or purposefully [98].

Lastly, other work within this category has explored the pathways from social support to PTSD and depression via other risk and protective factors. For example, in a sample of residents living in shelters in Wuhu, China, after a major flood in 2016, higher social support was linked to lower depression symptoms via increases in self disclosure, greater feelings of safety, and fewer negative posttraumatic cognitions [93–95]. Social support also had negative indirect effects on depression symptoms through its associations with higher self-esteem and hope among middle school students affected by the 2013 Ya'an earthquake in China [29].

Interventions Finally, we observed in the past year of research efforts to evaluate interventions to mitigate post-disaster PTSD and depression. Exemplary studies in this category over the past year included investigations of cognitive behavioral therapy for post-disaster stress (CBT-PD) and the Recent

Traumatic Events protocol for eye movement desensitization and reprocessing therapy (EMDR R-TEP), which were associated with declines in PTSD symptoms in the aftermath of the 2010 Chile earthquake and the 2012 Northern Italy earthquake, respectively [65, 80]. A further study in this category explored whether interpersonal violence history and severe disaster exposure moderated the effectiveness of Bounce Back Now (BBN), a web-based intervention that provides psychoeducation and evidence-based symptom reduction skill-building for PTSD and depression, as well as cigarette and alcohol use [11]. The investigators found that the impact of BBN on PTSD symptoms was stronger for adolescent participants who had endured severe exposure (defined as having a parent or caregiver who was concerned about the safety or wellbeing of loved ones during the disaster) to the 2011 tornados in Joplin, Missouri, and areas throughout Alabama, relative to those who had not endured severe exposure [11].

An additional notable study in this category combined disaster preparedness training with efforts to address survivors' mental health symptomology [50••]. This intervention was initially created for survivors of the 2010 Haiti earthquake, but culturally adapted for survivors of a major flood in Nepal in 2015, with consultation from local clinicians and staff from community organizations, and administered in a group format over the course of 3 days. Participation in the intervention was associated with declines in both PTSD and depression symptoms, as well as increased disaster preparedness and a sense of social cohesion. Additionally, path analytic models showed that the intervention had both direct effects on PTSD and depression symptoms and indirect effects via increases in social cohesion. Reports of a subsample of focus group participants further reinforced that the effects of the intervention were socially mediated, with common themes being that the intervention encouraged participants to both seek and provide mental health support to others, and to work collaboratively to solve problems.

Conclusions and Future Research Directions

The results of our review demonstrate the surge in research on the mental health consequences of environmental disaster in recent years. As mentioned previously, the seminal review on this topic by Norris and colleagues published in 2002 identified studies using data from 160 independent samples over the period between 1981 and 2001 [2]. In our review, we identified over 100 articles from 83 independent samples published in the past year alone. Our review was notably not as comprehensive in scope as the aforementioned review, which included studies in the aftermath of mass violence (e.g., terrorism) and a broader range of post-disaster outcomes, among them other specific psychiatric disorders (e.g., generalized anxiety disorder, panic disorder), non-specific psychological distress, sleep disruptions, substance use, and loss of psychosocial resources (e.g., social support, optimism). Further, our review was further limited in our use of only two databases (MEDLINE and PsycINFO), and keyword searches in the articles' titles rather than their abstracts or full text. Had we broadened our search to replicate the 2002 review, we are certain that the articles identified in a single year would have outnumbered those published over the course of two decades.

The results of our review provide further evidence that exposure to environmental disasters is associated with increased prevalence of PTSD and depression. The studies published in 2018 replicate many of the risk factors for these outcomes that have been documented previously, including female gender, socioeconomic disadvantage, exposure to more disaster-related traumatic events and stressors, and having fewer psychosocial resources. The past year of work is not merely demonstrating again what we know already, however. Researchers are now identifying factors that augment the mental health vulnerability of populations known to be at risk and, in doing so, can help shed light on which survivors might be most in need of post-disaster services. It is also increasingly evident that among those most at risk are persons living in geographic areas that have faced exposure to multiple disasters, suggesting the need for ongoing support to these areas as well as efforts to strengthen their resilience to future hazards. Recent work has also elucidated some of the pathways from trauma exposure and related psychosocial losses to adverse mental health outcome, which could provide important insights for intervention targets. Finally, investigations have shown how adaptations of empirically supported treatments (e.g., CBT and EMDR) for the post-disaster contexts, as well as novel interventions—such as web-based therapies, and group therapies that target social support and disaster preparedness in addition to mental health—could mitigate post-disaster psychiatric adversity.

Future research can expand upon these areas to further our understanding of post-disaster mental health. For example, studies that include longitudinal data, and in particular pre-disaster data, can help elucidate the complex pathways leading to disaster exposure, and from exposure to key mental health outcomes. Post-disaster intervention research can further investigate which components of interventions drive optimal outcomes, and whether results vary by survivor characteristics. Despite not being common among the studies in our review, other recent trends in the disaster mental health literature, such as integration of community-level data on exposure and risk and protective factors, objective indicators of individual-level exposure (vs. self-report), and geospatial techniques [106–109], are recommended for a more thorough understanding of the range of factors that independently and through interaction drive post-disaster mental health. Similarly, recent work using agent-based modeling has shown the potential of simulating the reach, efficacy, and cost

effectiveness of varied post-disaster interventions [110] and could inform how the range of empirically supported interventions are administered on a large scale to disaster-affected populations.

Finally, although the studies reviewed showed the geographic reach of research on mental health after environmental disasters, their geographic locations are far from representative of the areas affected by disasters across the world. For example, we did not identify any work on this topic being done in Africa, despite the occurrence of over 2500 environmental disasters on the continent since the year 2000 [51]. With over 10,000 environmental disasters on record since 2000 [51], it is likely that we are missing the full mental health impact of such events, and perhaps the factors shaping post-disaster symptoms as well. International collaborations could help foster research on disaster-affected areas across the globe. In forming such collaborations, disaster researchers could pool data from various disaster-affected samples for a more in-depth understanding of how various population characteristics, disaster-related exposures, and contextual factors influence post-disaster mental health. Such efforts to characterize, predict, and mitigate PTSD, depression, and other adverse mental health outcomes are of critical importance given the large proportion of the world's population that are exposed to environmental disasters and the evidence that such events are becoming increasingly common [1].

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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