



Mental Health Among Children Older than 10 Years Exposed to the Haiti 2010 Earthquake: a Critical Review

Judite Blanc¹ · Dominique Eugene^{2,3} · Elizabeth Farrah Louis⁴ · Jeff Matherson Cadichon⁵ · Jolette Joseph⁵ · Anderson Pierre⁵ · Roudly Laine⁵ · Margarett Alexandre⁶ · Keng-Yen Huang⁷

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Abstract

Purpose of Review There is evidence that the exposure to a major natural disaster such as the 2010 earthquake in Haiti may have devastating short- and long-term effects on children's mental health and overall development. This review summarizes what has been reported in the past 3 years (2017–2020) regarding emotional, psychological, and behavioral effects of exposure to this particular earthquake on children 10 years and older.

Recent Findings Twenty-six articles were screened, of which twenty-one were selected for final analysis. The main themes addressed in the literature over the 3 years concerned prevalence of post-traumatic stress disorder (PTSD), depression, determinants of resilience factors, prevalence of sexual violence as well as prenatal exposure, and subsequent autism behaviors/symptoms.

Summary The majority of the findings analyzed in this review on mental health in young Haitian survivors of the 2010 earthquake came from cross-sectional studies conducted in West region of Haiti, specifically Port-au-Prince. There was a paucity of longitudinal and translational data available. The results of this critical review can be used to inform disaster preparedness programs with the aim of protecting children's development and mental health, which are much needed on this disaster-prone island.

Keywords Haiti 2010 earthquake · Psychological · Emotional · Behavioral impairments · Children

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✉ Judite Blanc
Judite.Blanc@nyulangone.org

¹ Division of Health and Behavior, Department of Population Health, Center for Healthful Behavior Change, New York University Grossman School of Medicine, 180 Madison Avenue, New York, NY 10016, USA

² Fogarty International Center and National Institute of Mental Health of the National Institutes of Health, Harvard University, Cambridge, USA

³ Children's System of Care, Monterey County Behavioral Health Bureau, Salinas, CA, USA

⁴ Fogarty International Center and National Institute of Mental Health of the National Institutes of Health, Harvard University, Cambridge, USA

⁵ Université d'État d'Haïti, Port-au-Prince, Haiti

⁶ Department of Nursing, York College City University of New York, New York, USA

⁷ Population Health and Child and Adolescent Psychiatry Center for Early Childhood Health & Development (CEHD), Department of Population Health, New York University Grossman School of Medicine, New York, USA

Introduction

Exposure to chronic stress fueled by poverty, violence, and political instability is known to be important risk factor for adverse physical and mental outcomes. Similar to other nations affected by historical traumas of race-based slavery, Haiti has been prone to both man-made and natural disasters since its declaration of independence in 1804. The Haitian economy is the least developed in Latin America and the Caribbean. Out of 189 countries, Haiti ranks 169th in the Human Development Index [1•]. In 2018, Haitian life expectancy was 63.5 years. Studies on the effect of chronic and traumatic stress from centuries of socio-political crises and its relationship to the well-being of the Haitian population are scarce.

The review of the disaster literature demonstrates that natural disasters do not impact individuals the same way. Given their dependency on adults, children are considered to be the most vulnerable group during a disaster alongside women, the elderly, and persons with disabilities. There is evidence that the exposure to a major natural disaster such as the 2010

earthquake in Haiti may have devastating effects on children's mental health and psychological development [2•]. Most research conducted about the impact of disasters focused on immediate post-disaster, and less on long-term impacts. This review aims to address this gap by evaluating literature published in the last 3 years.

We analyzed recently published articles stemming from 2017 to 2020 regarding emotional, psychological, and behavioral effects of the exposure to this particular earthquake on children older than 10 years. Utilization of a medical librarian provided an extensive database search on concepts that included *Haiti, earthquake, emotions, behavioral symptoms, child, children, affective symptoms*. Databases included: PsycINFO, Embase, PubMed, Web of Science (all databases), Cochrane Library, and Google Scholar (Fig. 1). The search was not limited to English publications, thereby providing a thorough review of information from 2017 through 2020. Twenty-six articles were screened, of which twenty-one were selected for the final analysis. Table 1 provides a brief summary for each article included in this review. Overall, three research themes emerged from the 21 reviewed articles:

1. Psychiatric epidemiological research: (e.g., reporting the prevalence of PTSD and other mental disorders several years post-disaster), studying resilience and risk determinants for mental disorders.
2. Post-disaster violence research: (e.g., gender-based violence, abuse, child labor) in the context of post-disaster.
3. Post-disaster research with street children and special populations: (e.g., 4 articles reporting post-disaster street children's mental health and 1 article for children with autism spectrum disorder).

Psychiatric Epidemiological Research

According to the literature on post-traumatic psychiatric disorders, children's responses to disasters are usually associated with developmental factors such as age, individual characteristics, and family and social supports, along with considerations of the origin, severity, and duration of the traumatic event [2•, 3]. One of the most prevalent psychological disorders that has been documented among adults and children within the natural disaster literature is post-traumatic stress disorder (PTSD). Results show high prevalence of PTSD and mental disorders in Haiti. The prevalence of PTSD and other mental disorders exists several years post-disaster necessitating ongoing research on resilience and risk determinants for mental disorders [2•, 5•, 6•, 7•, 8•, 9•, 10•, 11, 12]. In the Haitian 2010 post-earthquake context, there is no clear

evidence to compare pre and post-disaster differences, given lack of longitudinal study designs.

The Burden of Post-traumatic Stress Disorder in Children in the Aftermath of the Disaster

The criteria for PTSD include exposure to actual or threatened death, serious injury, or sexual violence; presence of one or more intrusion symptoms; persistent avoidance of stimuli associated with the traumatic event(s); negative alterations in cognitions and mood; and marked alterations in arousal and reactivity all associated with the traumatic event(s), beginning after the traumatic event(s) [13]. Besides other psychosocial and behavioral issues (e.g., anxiety, depression, nightmares, and sleep disorders) that children present with in the aftermath of a traumatic event, PTSD is the most studied trauma-related disorder in children in Haiti [2•, 6•, 14•].

According to Dube et al. [15•], it was estimated that the 2010 earthquake "affected over 1.5 million people and that children and youth represented more than one-half of those impacted by the disaster" (p. 77). Some of the challenges that occurred for this population were disrupted and limited access to basic needs, uprooted families, insecurity, risk for exploitation, and further endangerment of vulnerable lives that already faced adversity. Dube et al. [15•] completed a literature review of published articles from January 2010 through May 2016 which included 58 articles out of the original 647 screened articles. Out of the 58 articles there were 9 mental health-related articles. Dube et al. [15•] found that the articles reported children experienced very high rates of PTSD, ranging from 34.9% in children aged 10–13 years and 39.1% among ages 14–17 years within a sample size of 658 children. Derivois, Cénat, and Mérisier [16] and Cénat and Derivois [17•] found that among 872 school children and children at two homeless shelters, 36.9% and 46.2% respectively presented severe symptoms of PTSD and depression. Interestingly, children identified as orphans had lower prevalence of PTSD than children living with biological family members [15•]. Dube et al. [15•] noted that due to "on-going stressors that many youths in Haiti face on a regular basis (e.g. poverty, violence, and food insecurity), it appears difficult to definitively link mental health outcomes to the earthquake" (p. 83).

Common themes during this literature review of PTSD for this population included reliance on case studies and retrospective research in English and French, which did not capture baseline mental health conditions prior to the earthquake, limiting conclusive analysis of direct earthquake-related PTSD symptoms [15•, 18•, 19]. Many scholars introduced their own perspectives of what PTSD encompassed but did not provide in-depth exploration of the developmental dimensions and expressions of Haitian children's traumatic reactions. With this narrow focus, there is a lack of emphasis on the spectrum of post-traumatic reactions. Scholars did not provide

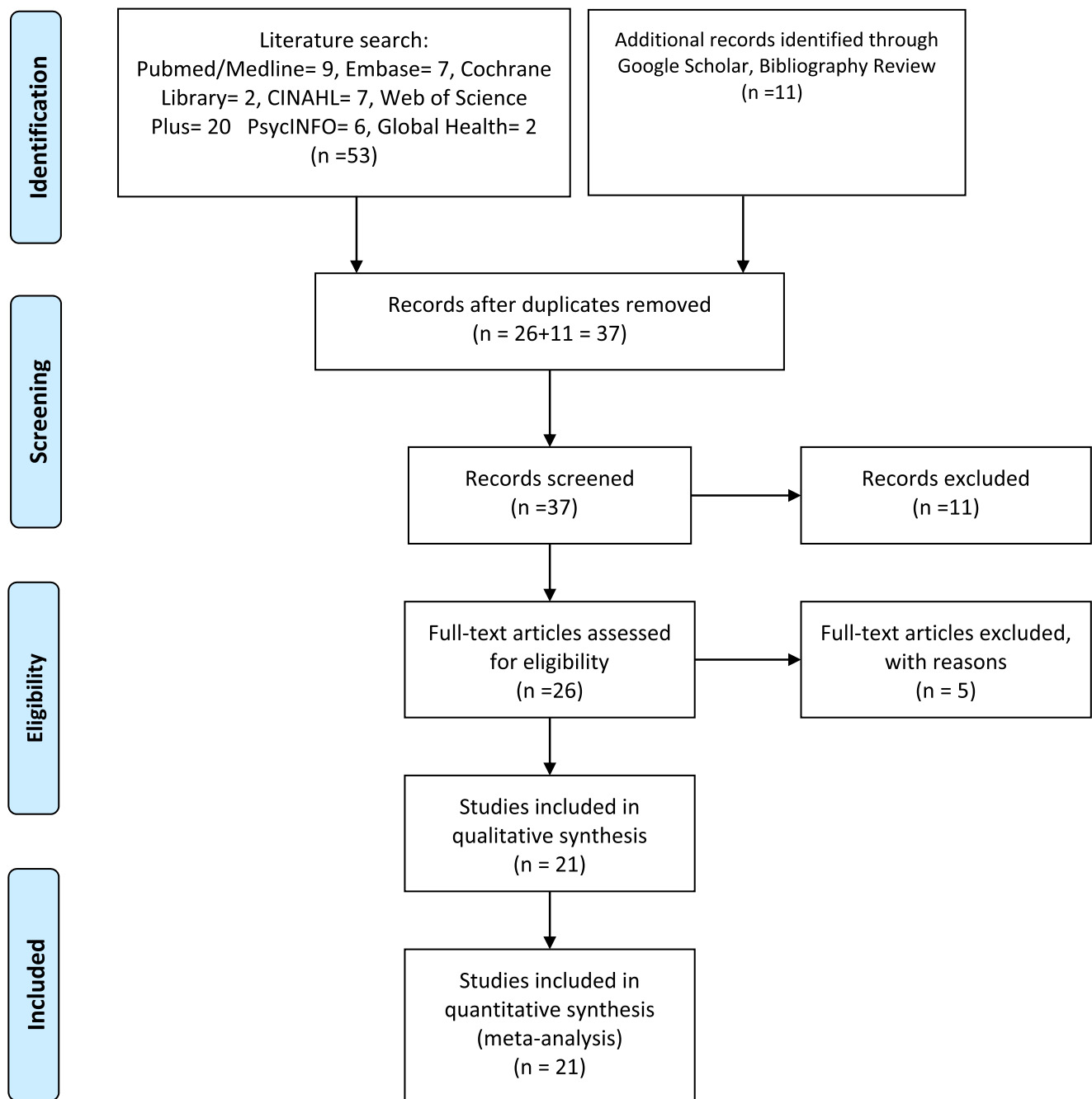


Fig. 1 Literature review on child mental health post 2010 Haiti earthquake

evidence that PTSD could have been the most frequent trauma-related disorder for children and adolescents in Haiti; rather, it was the most studied.

Additional limitations include differences in age ranges of children and adolescents in articles especially when stating a general description of under 18 years old. Some of the instruments (e.g., questionnaires, scales) that were used to assess symptoms of PTSD were not validated for Haitian-Creole and Haiti regardless of steps to adapt them to the Haitian culture [18•].

Post-Disaster Violence Research

Different forms of violence are commonly seen in the disaster context. There are mixed findings about disasters contributing to the increase of violence. In Haiti, violence was already high before the disaster. Some studies show increased violence after the disaster (especially for restavèk children that are put to the service of a household in exchange of food and formal education) [18•, 20, 21]. Other studies highlighted examples of similar high violence rates before and after disasters in Haiti

Table 1 Summary of studies on the mental health amongst children older than 10 years exposed to the Haiti 2010 earthquake

Authored by	Published	Study sample	Age (years)	Recruitment area	N=	1-Questionnaire 2-Intervention	Summary
1. Blanc, Rahill, Spruill, Jean-Louis and Mouchenik	2019	Mother-child dyads	3 and 1/2	West and south regions of Haiti	364	1. PTSD-Specific Checklist 2. Evaluation for Autistic Behaviors 3. Childhood Autism Rating Scale (CARS)	Eight (2.2%) out of 364 children surveyed met criteria for intense autistic behaviors; 4 came from the epicenter and 4 were exposed as a fetus at the 3rd trimester; a large part of their mothers (7) needed psychological support, and 5 of those mothers experienced the death of family member following the disaster. It was observed that all the children, promoting the development of sensory-motor skills, willingly accepted the creative activities. Depending on the age of the children and the instructions given by the artists, the children's gestures were more or less assured, and their expression more or less opens. The comorbidity of symptoms of PTSD and depression was 7.81%; 5.47% between the symptoms of PTSD and anxiety; and 7.03% between the symptoms of anxiety and depression. The comorbidity between all three is 3.12%.
2. Brolles, Derivois, Joseph, Karay, Pasut, Cenat, Pamphile, Lafontant, Felix and Chouvier	2017	Street children	7–18	Port-au-Prince	33	1. Art therapy workshop	The literature revealed that large numbers of children in Haiti have significant symptoms of post-traumatic stress disorder (PTSD), peritraumatic stress, depression, and anxiety, and that food insecurity and malnutrition continue to be important issues.
3. Derivois, Cenat, Joseph, Karay, Chahraoul	2017	Street children	7–18	Port au Prince	128		It was found that PTSD is the most commonly occurring mental health condition among earthquake survivors. Major depressive disorder, generalized anxiety disorder, obsessive compulsive disorder, social phobia, and specific phobias were also listed.
4. Dube, Moffatt, Davison, Bartels	2017	Systematic review summarizes published research conducted since the 2010 earthquake, focusing on health outcomes for children in Haiti, including physical, psychological, and socioeconomic well-being.	Less than 18	Various regions in Haiti		Fifty-eight full-length research articles were reviewed, covering infectious diseases (non-cholera ($N = 12$) and cholera ($N = 7$), nutrition ($N = 11$), traumatic injuries ($N = 11$), mental health ($N = 9$), anemia ($N = 4$), abuse and violence ($N = 5$), and other topics ($N = 3$).	
6. Faraoui, Quadri, Suriya, Khan, Ovais, Sohail, Shoalb, Tohid and Hassan	2017	Review of studies published in the last 20 years related to post-traumatic stress disorder (PTSD) occurring after the earthquake. The review also describes other psychiatric complications that can be associated with earthquakes, to provide readers with better overall understanding, and discusses several sociodemographic factors that can be associated with post-earthquake PTSD.		Worldwide	N/A	A search for literature was conducted on major databases such as MEDLINE, PubMed, EMBASE, and PsycINFO and in neurology and psychiatry journals, and many other medical journals. Terms used for symptoms, anxiety, depression, major depressive disorder, earthquake, and natural disaster. The relevant information was then utilized to determine the relationships between earthquakes and post-traumatic stress symptoms. Electronic searches included, but were not limited to, post-traumatic stress disorder (PTSD), post-traumatic. Drawing workshops	

Table 1 (continued)

Authored by	Published	Study sample	Age (years)	Recruitment area	N=	1-Questionnaire 2-Intervention	Summary
7. Karray, Derivois, Brolles, Buzaglo							The fragilities are linked with past trauma in these young people. The analysis also showed that external environmental envelopes that were destroyed in the earthquake (house, school, church, club, etc.) were characterized by internal disorganization, discontinuity, and insecurity.
8. Sloand, Killion, Yarandi, Sharps, Lewis-O'Connot, Hassa, Gary, Cesar and Campbell	2017	Internally displaced adolescent girls	12–17	Port au Prince		Data were collected from participants using computer-assisted self-interviews between 2011 and 2013 including demographics, pre- and post-earthquake violence, perpetrators, risk factors, and health consequences. Analysis included frequency, logistic regression, and multiple regression.	A majority of the participants reported physical, psychological, or sexual abuse both pre- (59%) and post- (64.1%) earthquake. Pre-earthquake, abused adolescents reported the perpetrator as a boyfriend (50%) or family member (30%). Post-earthquake, 20.5% of physical abuse perpetrators were family members. Pre- and post-earthquake physical and sexual abuse did not change. The risk of being sexually abused post-earthquake increased after controlling for age and education.
9. Cadichon, Lignier, Cénat and Derivois	2017	Adolescents and young adults	14–24	Port au Prince	723	Participants were assessed by means of the Impact of Event Scale-Revised (IES-R) in addition to social demographic characteristics.	Among the sample, 35.82% reported clinically significant symptoms of PTSD, with a higher prevalence for girls and young women. They also had consistently higher scores than boys and young men on every subscale. Participants with working parents had consistently higher scores across all the subscales than participants whose parents did not work. This study showed that, more than 6 years after the earthquake, more than one-third of the participants assessed had severe PTSD symptoms.
10. Cénat, Derivois, Hébert, Amédée, Karray	2018	Street children	13.1	Port-au-Prince	A group of 176 street children, aged 7–18 (N = 21 girls)	Semi-structured interviews	Street children experienced multiple traumas such as neglect, maltreatment, psychological, physical, and sexual abuse. However, they also showed self-efficacy to face their traumatic experiences and few of them (less than 15%) obtained scores reaching clinical rates of PTSD, while a large majority presented a level of resilience between moderate and very high.
11. Gilbert, Reza, Mercy, Lea, Lec, Xu, Marcelin, Hast, Vertefeuille and Domercant	2018	Children in domestic servitude	13–14	Various Regions in Haiti	2916		In this study, 17.4% of females and 12.2% of males reported having been restaveks before age 18. Females who had been reporting childhood physical (OR 2.04 (1.40–2.97)); emotional (OR 2.41 (1.80–3.23)); and sexual violence (OR 1.86 (95% CI 1.34–2.58)) compared with

Table 1 (continued)

Authored by	Published	Study sample	Age (years)	Recruitment area	N=	1-Questionnaire 2-Intervention	Summary
12. Grelotti, Gerbasi, Eustache, Fils-Aimé, Thérosméc, Severeb, Raviola, Daughouthd, Leghae, Pierre, Affricot, Alcindor, Boyd, Becker, Smith and Fawzi	2018	Young adults attending high school	18–22	Central Plateau	145 (120 assessed)	Baseline cross-sectional Assessment. The modified Structured Clinical Interview for DSM-IV (SCID), a French language version was obtained (Ouellet, personal communication). The Stressful Life Events (SLE) Checklist is a 13-item self-report questionnaire documenting exposure to a broad range of stressful life events (Bean et al., 2004).	females who had never been restavéks. Similarly, males who had ever been restavéks in childhood had significantly increased odds of emotional violence (OR 3.06 (1.99–4.70)) and sexual violence (OR 1.85 (1.12–3.07)) compared with males who had never been restavéks, but there was no difference in childhood physical violence. Results revealed only 51.7% of participants on the SLE Checklist and 31.7% in the interview endorsed being affected by the earthquake or another disaster. Sexual assault showed the strongest association with PTSD in multivariable logistic regression. Exposure to earthquake or another disaster was not significantly associated with current PTSD. In this population, exposure to interpersonal violence may have had a greater impact on PTSD risk than exposure to natural disaster. Among events examined, sexual abuse or assault demonstrated a statistically significant relationship with PTSD diagnosis. The themes that emerged in the focus groups included the following: the pervasiveness of poverty, fractures infrastructure, cultural nuances related to GBV, different strategies for coping that encompasses individual, familial, community, institutional/clinical levels of care, and strategies. Study findings gave important insights into barriers to address the needs of women and girls especially while compounded by reoccurring disasters.
13. Killion, Sloand, Gary, Glass, Dennis, Muller, Hassan, Callwood and Campbell	2018	Displaced women, men, and adolescent girls; health care providers and NGO program directors	18–26	Port-au-Prince	44	Five focus groups conducted in English, Haitian Creole, and French with areas of interest on gender-based violence, risk factors, safety, and the 2010 earthquake in Haiti; in the groups including health care providers and NGO program directors, key GBV reports from the Pan American Health Organization Needs Assessment (PAHO 2010) and the International Rescue Committee Report (IRC 2010) were used.	The results demonstrated different factors that contributed to interpersonal violence including the accumulation of daily stressors, loss of power/control, learned behavior (intergenerational cycle of abuse), inequitable gender norms, and substance use which all conversed with the context caused by Hurricane Matthew. This chapter highlighted the risk and protective factors that affect children and their development while critically assessing the limitations and barriers that
14. Bermudez, Stark, Bennouna, Jensen, Potts, Kaloga, Tilus, Buteau, Marsh, Hoover and Williams	2019	Men, women, and adolescents affected by Hurricane Matthew	13–50+	Côteaux	36	Qualitative methodology with the use of photography then followed up with interviews occurred over three sessions.	The authors did not conduct one specific study but attempted to provide insight into pre- and post-earthquake research
15. Blanc and van Balkom	2019	Children and adolescents	2–18	Port-au-Prince, Jacmel, Leogance	N/A		

Table 1 (continued)

Authored by	Published	Study sample	Age (years)	Recruitment area	N=	1-Questionnaire 2-Intervention	Summary
16. Derivois, Cénat, Karray and Charpillat-Richard	2020	Street children	7–18	Port-au-Prince and the surrounding areas (Femathe, Petion-Ville, Delmas, Carrefour-Aereport Centre-Ville, Champs de Mars, Carrefour Feuilles, Carrefour, and Santo).	28	<p>surrounding mental health, trauma, culture, economic background; adverse effects on children and their development and protective factors.</p> <p>Youth participants were recruited from the street or rehabilitation center and experience the 2010 earthquake and continued to live on the streets.</p> <p>All the questionnaires: 1. Life Events Checklist Subscale, The Traumatic Exposure Scale, Peritraumatic Distress Inventory, Resilience Scale, Children's Revised Impact of Event Scale, Social Support Questionnaire, and the Child Depression Inventory were translated into Creole using a translation–back-translation protocol.</p>	<p>exist in Haiti to adequately support children during and post-disasters. There still lacks full recognition of the mental health needs of children in Haiti and accounting for the contextual factors, such as cultural and historic background, family and community, and belief systems.</p> <p>The result from this study found that children and adolescents all reported that they experienced at least one traumatic event prior to the earthquake and post the earthquake, and only a single participant experienced no traumatic event. Over half of the children reportedly experienced between 6 and 10 (57.81%) of the difficult life events compared with 46.87% after the earthquake. Also, results showed that the youth living in the street have medium to high resilience scores with age being a factor.</p>
17. Mesidor	2019	Haitian college students and residents who survived the 2010 Haitian earthquake.	18–60	Port-au-Prince	257	<p>1. Short Post-traumatic Stress Disorder (PTSD) Rating Interview and The Post-traumatic Growth Inventory</p> <p>Short Post-traumatic Stress Disorder Rating Interview.</p>	<p>According to the results, a positive relationship between PTG and PTSD symptoms and an inverse relationship between PTG and the experience of the earthquake were found. Also, females had significantly higher scores on PTSD symptoms compared with males. However, there was no significant gender differences regarding scores for PTG.</p> <p>The results suggested a significant positive correlation between PTG and resilience, PTSD symptoms, perceived social support, positive religious coping, and active coping. There was a significant positive relationship between perceived social support and resilience and between resilience and active coping. PTSD symptoms were positively correlated with both positive and negative religious coping. Also, positive religious coping, active coping, perceived social support, resilience, and PTSD symptoms contributed to participants' PTG. The strongest predictor of PTG was positive religious coping, followed by active coping, perceived social support,</p>
18. Mesidor, Kaye and Sly	2019	Haitian college students and residents	18–60	Port-au = Prince	256	<p>1. Post-traumatic Growth Inventory (PTG), Brief Religious Coping Scale, Brief Coping Orientation to Problems Experienced Scale, Multidimensional Scale of Perceived Social Support, Connor-Davidson Resilience Scale, and Short Post-Traumatic Stress Disorder Rating Interview; all instruments were translated into Haitian-Creole and back-translated.</p>	<p>The results suggested a significant positive correlation between PTG and resilience, PTSD symptoms, perceived social support, positive religious coping, and active coping. There was a significant positive relationship between perceived social support and resilience and between resilience and active coping. PTSD symptoms were positively correlated with both positive and negative religious coping. Also, positive religious coping, active coping, perceived social support, resilience, and PTSD symptoms contributed to participants' PTG. The strongest predictor of PTG was positive religious coping, followed by active coping, perceived social support,</p>

Table 1 (continued)

Authored by	Published	Study sample	Age (years)	Recruitment area	N=	1-Questionnaire 2-Intervention	Summary
19. Roysircar, Thompson and Geisinger	2019	Mothers/caregivers and children	20–50 (adults) 6–14 (youth)	Blanchard-Damien, Canaan	27 (adults) 42 (youth)	Qualitative research through focus groups for Haitian mothers to understand their ways of coping and beliefs; quantitative research through the House-Tree-Person (HTP) test to assess children's trauma adjustment scores.	resilience, PTSD symptoms, and negative religious coping. Results illustrated religious, African humanism, and shame stigma themes emerged from the focus groups. Correlations emerged among mothers and their children regarding resilience vulnerability and feeling unloved. Significant negative relationships of religious and African humanism coping with shame stigma coping and their respective significant negative and positive relationships with children's trauma adjustment scores.
20. Roysircar, Geisinger and Thompson	2019	Children and adolescents	88	Blanchard-Damien, Canaan	3–14	1. All measures (House-Tree-Person test, Hare Area Specific Self-Esteem, Child report of post-traumatic symptoms, and Child Self-Concept Scale) were translated and administered in Créole. Also, participants were interviewed.	The results indicated that the HTP measured the attributes of interest such as resilience and vulnerability. In terms of age, the HTP may not worked as well for younger children, and drawing skills improved with age and received more positive scores. Also, when the home environment felt safer, feelings of self-alienation and personal ineffectiveness were less at a moderate level and vice versa. When there was a more balanced expression of resilience and vulnerability, the home and family felt safer. Scales such as self-esteem and self-concept were significantly correlated.
21. Subedi, Bartels and Davison	2020	Children and adolescents	Varied	10 geographic regions of Haiti and a "camps" region were separated into urban and rural parts.	2–15	Haiti specific data from the 2005/2006 (household $N = 9998$) and 2012 (household = 13,181) cycle of the Demographic and Health Survey including randomly selecting a child in each household	The prevalence of emotional, physical, and severe physical abuse in 2012 was estimated to be 78.5%, 77.0%, and 15.4%, respectively. Mapping revealed no conclusive patterns between the proximity of each region to the epicenter and the prevalence of the different forms of abuse. However, the prevalence of severe physical abuse was notably higher in settlement camps (25.0%) than it was in Haiti overall (15.4%).

[22, 23]. Given what is known about post-disaster violence for children and adolescents, the inclusion of gender received limited consideration in the experiences of survivors. More can be learned from the intersectionality of gender and trauma when it comes to disaster settings that further exacerbates the level of dependency and risk factors for this unique population.

Exposure to Sexual Violence Post-Earthquake Among Children: a Gender Perspective

Prior to the Haiti 2010 earthquake, sexual violence was believed to be a systemic problem in Haiti [24]. In the aftermath of the earthquake, many international media outlets put the spotlight on the increase of sexual violence against women and girls. Some spoke about the rape epidemic while humanitarian field workers stated that the media exaggerated the situation arguing that Haitians were too traumatized by the earthquake to think about sexual activity. For the purpose of this article, out of the studies that were screened and published between 2017 and 2020, only two stressed the issue of sexual violence against children after the 2010 earthquake in Haiti. The earthquake increased children's vulnerability to sexual exploitation and child trafficking. Three studies pointed out the situation of street children and "restavèk," children sent by their parents or relatives to work for a host household as domestic servants, faced adverse situations including physical and sexual violence in the context of the earthquake, and political turmoil [2, 25, 26]. The increase of physical and sexual violence against street children was associated with family violence and dysfunction [14]. For example, girls who were restavèk in their childhood had a significantly high prevalence of attempted sex and pressure to engage in sexual activities. However, restavèk boys were not exempt from sexual violence and were often exposed to unwanted touching [14]. According to the *Medecins Sans Frontieres* [27] report, 53% of the patients who have presented at the clinic "Pram Men'm" (*take my hands in Haitian Creole*) from May 2015 to March 2017 were minors, and most of whom were victims of rape or other forms of sexual abuse of sexual violence. Although 97% of the patients at *Pram Men'm* are female, sexual violence also affects boys and men. From May 2015 to March 2017, the clinic provided care to 33 patients from male victims of gender-based violence (GBV). Of these, 23 (70%) were minors, of whom 13 were under 10 years of age and 7 were between 10 and 14 years of age years [27].

Post-Disaster Research with Street Children, and Other Special Populations

Studies of survivors of earthquakes from around the world have shown high prevalence rates for depression in children and

teenagers after such a disaster [26]. For the purpose of this review, five articles published between 2017 and 2020 have reported on depression, specifically in post-disaster street children's mental health [7, 14, 26, 28, 29, 30]. The rates of depression were lower in children who lived on the streets prior to the earthquake, compared with those living with their parents [26]. In relation to special populations, only Blanc et al. [31] introduced a focus on children prenatally exposed to the disaster and their subsequent autism behaviors/symptoms.

Depression Rate of Haitian Children Post 2010 Earthquake

As a country, Haiti has faced a number of devastating environmental struggles, and one of the most detrimental has been the 2010 earthquake. Haiti's misfortunate with natural disasters has tested the country's strength and continues to contribute to the depletion of the people's ability to rely on their internal social support for emotional or financial assistance [1]. Coupled with lack of resources, families may have found it difficult to adequately provide the necessary nurturing support needed to attend to the socio-emotional development of their children, depending on the type or severity of the stress [32]. In the past 3 years, several articles have examined mental health outcomes in Haitian children exposed to the earthquake. The data generated focused on several mental health issues, of which depression has been a common theme.

In a report provided by Derivois et al. [14], studies conducted 4 years after the earthquake demonstrated high rates of depression among children between the ages of 7 and 18 years. Risk factors such as adverse childhood experiences related to living in an impoverished country, emotionally and physically unsafe family environments, interpersonal violence, and lack of resources may have contributed to the prevalence of depression [2].

Derivois et al. [14] conducted research with street children that included a sample of 128 children and adolescents (120 boys and 8 girls) between the ages of 7 and 18 who lived through the earthquake. They found that the children living on the streets due to economic reasons had a lower prevalence of depression compared with those who had endured psychological or physical abuse within their own families. Cénat et al. [28] proposed that children experience symptoms from their different socio-ecological living environments (e.g., family, foster family, children's houses, and streets). The authors pointed out that despite previous studies of children exposed to the earthquake showing higher prevalence to mental health symptoms, street children did not appear to yield the same results as those who resided with their families. They posited that "traumatic numbing" may account for the low rates of symptoms [28]. As children navigate strategies for living on the streets, succumbing to expressions of depressive symptoms would not bode them well. Rather than let their guards

down, activation of survival instincts becomes necessary, thereby freezing any emotional reactions [28•]. On the other hand, Roysircar et al. [12] highlighted parents who displayed more religious behaviors with their children appeared to be better able to assist and protect their children against depression, regardless of natural disasters.

Research conducted since 2017 provided a framework for exploring other factors contributing to mental health outcomes among children older than 10 years of age. More research is needed to investigate the depth and breadth of the potential psychological effects of violence such as those inflicted by family members, causing greater negative impact than natural disasters [26••]. There continues to be inconsistent reporting regarding the understanding of youth's access to mental health services [7•]. As violence and abuse continue in Haiti, a broader range of mental health support would better serve the country rather than research that focuses on diagnostic criteria rather than other issues. It is necessary to take into account Haiti's delicate contextual factors related to culture, history, religion, family, community, and systems. The usual approaches for working with disenfranchised populations may require more ingenuity and heightened cultural sensitivity. Providing support from a non-western standpoint may assist with better conceptualized treatment approaches.

Prenatal Maternal Stress During the Haiti 2010 Earthquake and Subsequent Symptoms of Autism

Besides the impact of direct exposure to traumatic events on children's psychological development, the long-term effects of prenatal maternal stress on her offspring caught the attention of researchers from the subfield of developmental psychopathology as well. According to Slykerman et al. [33], an interaction between the intensity of stress experienced by pregnant women and subsequent depressive symptoms of their offspring at age 11 and lower birth weight has been observed. Watson et al. [34] set out to test the hypothesis of the teratogenic effect of prenatal stress in a sample of students, 18 years of age, born to mothers who survived the 7.8 earthquakes that devastated China's Tangshan region in 1976. The earthquakes killed 240,000 people, injured thousands, and destroyed a large proportion of homes and basic service structures. Thus, depressive symptomatology was more severe in the group of participants exposed antenatally to the earthquake, unlike their peers that have not been exposed. In addition, these symptoms were more intense in males whose mothers had survived the disaster in the second trimester of gestation compared with non-exposed children or those exposed at a different trimester to the disaster.

In this context, the relationships between maternal exposure to the Haiti 2010 earthquake, maternal PTSD, and autism behaviors/symptoms have been also investigated by Blanc

et al. [31••]. The researchers studied the association between pregnant women's exposure to the 2010 earthquake in Haiti and symptoms/behaviors of autism in their offspring 3 years following the disaster. In a sample of 364 mother-offspring dyads who survived the 2010 earthquake, maternal data were elicited via the Earthquake Experience Questionnaire (EEQ), the Peritraumatic Distress Inventory (PDI), and the PTSD Checklist Specific (PCL-S). Child-related data were obtained from maternal completion of the Échelle d'Évaluation des Comportements Autistiques Révisée (ECAR) (Autistic Behaviors Scale-Revised), and the Child Behavior Checklist (CBCL). The authors found that peritraumatic distress was significantly associated with maternal PTSD symptoms. Moreover, when maternal PTSD symptoms were added to final models of predictors for offspring behaviors related to autism and pervasive developmental disorder, there was an increase in the total of variance explained. The researchers concluded that exposure to the 2010 earthquake in Haiti during pregnancy may be a risk factor for maternal PTSD, which may be associated with the presence of autism spectrum disorder (ASD) symptoms/behaviors in the offspring at age three.

This Blanc et al. [31••] study was rare research that explored relationships between maternal stress, PTSD, and behaviors/symptoms of autism. Nevertheless, it was a cross-sectional study. In the Blanc et al. [31••] study, there was no comparison between baseline and follow-up data. Other post-traumatic stressful events that took place from January 2010 up to 2013 could have been a confounding factor in the relationship between maternal PTSD and autistic behavior/symptoms. Additionally, new follow-up study with those mother and child dyads could bring insight into how they have been developing 10 years later.

Determinants of Resilience Factors Among Haitian Children Exposed to the Earthquake

Resilience is commonly defined as an individual's capacity to bounce back creatively in the aftermath of potentially traumatic events (PTE) or life adversities [35]. Rutter [36–39] conducted various research on resilience, including longitudinal studies among children exposed to adversities and concluded that resilience is an interactive and evolving process. For Rutter [36], the degree of resistance to stress varies over time and depends in part on the circumstances of life. Children who may be identified as vulnerable (or with low resilience) during early childhood are not necessarily sentenced for life. Conversely, even if resilient children are described as having good coping mechanisms and even if they demonstrate a high level of resilience factors, there is enormous variation among children's resiliency [37]. Rutter [37] distinguishes among risk factors, internal and external protective factors of the

individual enabling him/her to cope with stressful life events. In the aftermath of the earthquake in Haiti, most of the studies on resilience focused on adults. Studies with a focus on Haitian children's resilience, in the long run, are scarce [2••].

Between May and June 2016, using the Resilience Scale [40], Cadichon [41] and Cadichon and Derivois [42••] investigated resilience among children and adolescents exposed to the disaster. Total score varied from 25 to 175 with 6 stages going from very low (25 to 100) to a very high resilience score (161 to 175). On average, they found moderately high resilience scores among adolescent (14–17 years) and young adult (18–24 years old) survivors of the disaster, more than 6 years later. The majority (64.4%) had a resilience score between moderately high and very high. There were no significant differences according to sex, age, and the professional status of their parents. Similar observations for 50.35% girls and young women within a sample of 723 obtained a moderately high resilience score. The results of the variance analysis of resilience by parents' level of education showed that adolescents and young adults whose parents have no education ($N = 41$) had significantly lower total resilience scores than the others ($F = 2.35$; $p = 0.04$). Their mean resilience score was moderately low. Surprisingly, their findings suggested that number of siblings was negatively associated with resilience level. However, PTSD scores were not associated with resilience level among Haitian youth [41].

In fact, based on the analysis of post-traumatic narratives of those young survivors of the 2010 earthquake, protective factors such as family commitment to caring for children, community support, school, and religious/spiritual practices were influential in mitigating the emergence of PTSD symptoms [42••]. These young survivors made sense of the event through their religious beliefs. The attribution of the tragedy to the will of God allowed them to accept the disaster and its consequences, and eventually to transcend their feelings of guilt in order to move forward. In this context of unending sociopolitical crisis, school represented the best way leading to a bright future.

In their conclusion, Cadichon [41] and Cadichon and Derivois [42••] suggested that the moderately high level of resilience could reflect the survivors' ability to find adequate psychological, social, and cultural resources to recover despite psychological distress generated by the event. One limit the authors pointed out is their non-representative study sample, as their participants were recruited from Port-au-Prince only. Another limitation of their studies was reliance on a cross-sectional framework. There were no baseline and follow-up data to conclude the following: (1) potential effect of resilience on mental health, and (2) the direction of the relationships between the exposure to the disaster and resilience level among those young survivors 6 years later.

Conclusion

This review provided an overview of multiple topics that were addressed in the scientific literature within the years of 2017–2020 post the 2010 earthquake in Haiti concerning young Haitian mental health. The literature made attempts to identify the unique and contextual experiences that children and adolescents lived and responded to given prior environmental factors and pre-existing hardships. While examples of protective factors were buffers for some children and adolescents due to their own socio-emotional development, the pre-traumatic risk factors they were exposed to seem to have exacerbated their vulnerabilities to the 2010 earthquake.

Throughout this review, the authors discovered that most of the studies focused on children's mental health in relation to PTSD and depression rather than in-depth examination of a wide range of traumatic responses commonly studied in children survivors of natural disasters. Gender is also mentioned to show the vulnerability of the children after a disaster. The intersection of gender and disaster provides underlying constructs that are driven by culture and society and may dictate how children are treated and how their mental health needs are addressed. The authors also discovered that the long-term impact on Haitian children's mental health and psychological development exposed to the disaster prior to birth was greatly neglected by researchers and scholars as only a single cross-sectional study investigated the topic among mother–children dyads over the past 3 years.

Ten years following this unprecedented and devastating event, public health research infrastructures are almost non-existent in Haiti. Consequently, there is an enormous lack of awareness among most public health stakeholders, healthcare providers, community leaders, and the public, about the utility of scientifically sounded data. The majority of the findings analyzed in this review on mental health in young Haitian survivors of the 2010 earthquake came from cross-sectional studies conducted in the Metropolitan region of Port-au-Prince. There was a paucity of longitudinal and translational data available. The results of this critical review can inform disaster preparedness programs with emphasis on protecting children's development and mental health which are fragile in this disaster-prone island.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict 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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