Children's Exposure to China's Wenchuan Earthquake: Mental Health Sequelae

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Abstract

China is one of the countries most affected by earthquakes. Since the devastating magnitude 8.0 Wenchuan Earthquake in Sichuan Province, there has been growing concern over the mental health sequelae for children and adolescents exposed to seismic events. This chapter introduces epidemiological characteristics of the effects of earthquake exposures on mental health problems, as well as on other health-related problems among Chinese children and adolescents. Psychosocial, biological, and genetic factors related to post-earthquake adaptation are described, and implications for post-earthquake mental health services are discussed.

7.1 Introduction

Earthquakes are one of the most common natural disasters worldwide. These events are unpredictable and uncontrollable and have the potential to endanger hundreds of thousands of persons simultaneously. Earthquakes generate a variety of stressors and are unique among traumatic experiences. These stressors include severe physical injury, witnessing of dead and/or mutilated bodies, and destruction of homes and property, as well as other real and perceived threats, all of which induce psychophysical distress during and in the aftermath of an earthquake. Persons who survive these disasters are prone to a myriad of mental health problems, including posttraumatic stress disorder (PTSD), depression, anxiety, as well as stress-related risks

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to physical health. For some survivors, these problems can persist for years after the disaster (Louis et al. 2008; Neria et al. 2008).

Children and adolescents may be more susceptible to the harmful influences of disasters than their adult counterparts (Furr et al. 2010), as they are mentally and physically less mature and less capable of coping effectively with traumatic experiences. Children and adolescents may also be more likely to encounter secondary stressors following disasters, such as separation from family members and interruption of schooling. Moreover, collective disasters like earthquakes can also enhance the risk of mental health problems in children and adolescents through the transfer of stress from parents or caregivers (Belfer 2006). Fortunately, there has been a global growth of concern for children and adolescents exposed to disasters.

Before 2008, very limited attention was paid to child and adolescent survivors of natural disasters in China. However, after a magnitude 8.0 earthquake struck Wenchuan County in China's southwestern Sichuan Province on May 12, 2008, the impact of these disasters could no longer be ignored. The 2008 Wenchuan Earthquake was the deadliest of its kind since the 1976 Tangshan Earthquake and the strongest since the 1950 Tibet Earthquake. This devastating disaster left 69,197 people dead, 374,176 injured, and 18,222 listed as missing. Of the 15 million people living in earthquake-affected areas during the Wenchuan Earthquake, at least 4.8 million were rendered homeless (Sina News 2008). Moreover, in the years since the Wenchuan Earthquake, a number of subsequent earthquakes have ravaged southwestern China.

Since the Wenchuan Earthquake, numerous studies have been conducted to examine the mental health sequelae of earthquake exposure among Chinese children and adolescents. Following the event, our team established the Wenchuan Earthquake Adolescent Health Cohort (WEAHC) (Fan et al. 2016b). The cohort was set up in Dujiangyan City, one of the ten areas most affected by the Wenchuan Earthquake. We enrolled a large sample of 2250 adolescents in the initial survey conducted 6 months post-earthquake. Subsequently, we followed up with 1573 of them at 12-, 18-, 24-, and 30-month intervals. Data were collected on the adolescents' mental health problems (i.e., PTSD, depression, anxiety, and sleep disturbances), earthquake-related stressors (i.e., earthquake exposure and negative life events post-earthquake), psychosocial and familial factors (e.g., trait resilience, coping styles, social support, and parenting styles), and behavioral/social functioning (e.g., prosocial behaviors and academic performance). Five and a half years after the earthquake (October and November 2013), we conducted another screening survey on mental health problems among 3501 adolescents. This group consisted of both members of the original cohort and those newly recruited. Then, based on survey results, 512 of these adolescents were brought to the research center for individual clinical interviews; in addition, they provided an oral mucosal sample for genetic analysis.

The WEAHC study provided a great opportunity to investigate longitudinal epidemiological characteristics of mental health disorders among Chinese adolescent earthquake survivors and to explore the psychosocial and genetic mechanisms underlying these disorders. In addition to the research by the WEAHC, other

research teams have conducted longitudinal investigations of child and adolescent earthquake survivors in China since 2008. Unfortunately, many of them were limited by small sample sizes, few survey waves, or short follow-up duration. Despite limitations, these studies have offered insight into the epidemiological impact of earthquakes on children and adolescents in China. In this chapter, we will introduce important findings from the WEAHC study as well as these other studies. Specific issues we will cover are as follows: (1) epidemiological characteristics of mental health problems among Chinese children and adolescents exposed to the Wenchuan Earthquake and other major earthquakes; (2) the role of sleep in mental health problems; (3) the impact of earthquake exposure on other health-related problems; (4) psychosocial, biological, and genetic factors related to post-earthquake adaptation; and (5) post-traumatic growth.

7.2 Prevalence and Developmental Trajectories

Exposure to a massive earthquake can greatly impact a person's psychological homeostasis. One classic stress theory, the Conservation of Resources (COR) stress theory (Hobfoll 1989), informs our understanding of the relationship between disaster exposure and psychological adjustment. According to this theory, a person's internal psychological characteristics (such as self-efficacy and sense of control) and external resources (such as social network, economic resources, and professional skills) provide for a variety of coping options when he/she encounters a stressful or traumatic event. By applying these resources, an individual can construct coping mechanisms to rebuild and maintain a high level of psychological well-being. However, because serious natural disasters are generally unpredictable and have enormous destructive power, they can interrupt these coping mechanisms by depriving the victims of those very internal and external resources needed for effective coping and thereby increase stress even further, which results in psychological disturbances instead of healthy adaptation (Hobfoll 1989).

This also explains why acute stress responses (transient mental or somatic symptoms) are quite normal reactions to a disaster and are seen in the majority of exposed people. These stress responses gradually resolve with the application of internal and external resources. However, in some cases, especially in severe disasters, these resources are not easily recovered, and pathological mental and somatic symptoms of acute stress can persist or worsen instead of resolving.

The most common mental disorder after a disaster is PTSD, with an estimated prevalence of 5–10% (Kessler et al. 1995; Copeland et al. 2007). The fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) describes four distinct symptom clusters linked with PTSD: re-experiencing, avoidance, hyperarousal, and negative alterations in thoughts and mood (see Table 7.1). Compared to adults, children appear to be more prone to developing PTSD symptoms following disasters (Norris et al. 2002). Yet, studies concerning PTSD in disaster-exposed children are relatively scarce. One systematic review (Neria et al. 2008) identified 284 studies of PTSD following disasters between 1980 and 2007. Among them,

Table 7.1 Symptoms of post-traumatic stress disorder according to DSM-5

Re-experiencing	• Recurrent, involuntary, upsetting memories of the traumatic event • Recurrent upsetting dreams • Dissociative flashback episodes (feeling as though the traumatic event is happening again) • Strong psychological distress upon exposure to internal or external cues that are connected to the traumatic event • Strong physiological reactions upon exposure to internal or external cues that are connected to the traumatic event
Avoidance	• Avoiding "internal" reminder (e.g., thoughts, feelings, physical sensations) of the traumatic event • Avoiding "external" reminder (e.g., people, places, conversations) of the traumatic event
Negative cognitive and affective changes	• Unable to recall important details of the traumatic event • Negative thoughts about the self, others, or the world • Blaming oneself or others for the cause or outcome of the traumatic event • Pervasive negative emotions (e.g., anger, fear) • Losing interest in things that used to enjoy • Feeling detached from others • Unable to feel positive emotions (e.g., joy, love)
Hyperarousal	• Irritability or aggressive behavior • Impulsive or self-destructive behavior • Hypervigilance • Heightened startle response • Difficulty concentrating • Difficulty falling or staying asleep

only 18 were conducted among children and adolescents. There are even fewer studies focused on child and adolescent survivors of earthquakes, and those have found varying rates of PTSD.

For example, 1.5 years after the 1988 Armenia Earthquake, Pynoos et al. (1993) randomly screened 231 children from three cities at varying distances from the epicenter, using the Children's Post-Traumatic Stress Disorder Reaction Index (CPTSD-RI). Of 111 children who lived in the two most damaged cities, as many as 74% were found to have severe, chronic PTSD symptoms (Pynoos et al. 1993). In contrast, 12 months after the 1994 Northridge Earthquake in Los Angeles, Asarnow et al. (1999) conducted telephone interviews among 66 children with prior history of psychopathology and reported that 28.6% of the children exhibited PTSD symptoms. In another study conducted 6 months after the 1999 Athens Earthquake, Kolaitis et al. investigated 115 children (mean age 11 years) located in the epicenter, using the CPTSD-RI. Results revealed a high rate (78%) of PTSD with symptoms ranging from mild to severe when children were included. Reported rates for moderate and severe PTSD were 23.5% and 16.5%, respectively (Kolaitis et al. 2003). Among such research, great variations in prevalence of PTSD were found, and it may be due to the difference in assessment time and different measures.

In 1999, a study completed in the aftermath of two major earthquakes in the Marmara Region of Turkey found that PTSD affected a group of 321 children between the ages of 2 and 15 at a rate of 25.5% (Demir et al. 2010). Again, different results were reported 6 weeks after the 1999 Taiwan Earthquake. Among adolescents (aged 12–14 years) who lived in the most affected region near the epicenter, 21.7% demonstrated PTSD (Hsu et al. 2002). The above studies have looked closely at PTSD in children and adolescents who have been exposed to natural disasters all over the world. However, these studies ignored other health concerns that could result from these same experiences.

Disasters can disrupt victims' lives in many ways and, in addition to creating symptoms presenting of PTSD, can result in a variety of symptoms that we typically link to mood disorders, such as a sense of losing control, helplessness, feeling guilty or worthless, social withdrawal, and a lack of energy. Depression and anxiety disorders are commonly observed after disasters and are highly comorbid with PTSD (Kessler et al. 1995). A review by Lai et al. analyzed 72 studies (published before May 1, 2013) that examined post-disaster depressive symptoms among children under the age of 18 (Lai et al. 2014). Among these studies, 26 were conducted in the context of an earthquake. However, the reported rates varied widely (4–69%) at different points in time after exposure to a natural disaster. For example, depressive symptoms were found to be as high as 69% among adolescents (mean age = 18.25 years for males and 17.23 years for females) two weeks after an earthquake in Greece (Papadatos et al. 1990). But the prevalence rate was only 10% among displaced children (mean age = 15.51 years) at two months after an earthquake in Turkey (Vehid et al. 2006).

As for anxiety symptoms, studies using pre- and post-disaster longitudinal designs revealed that children's anxiety levels significantly increased in the early months after the exposure (La Greca et al. 1998; Weems et al. 2007). Specifically, existential anxiety, panic attacks, and various phobias have been observed in disaster-exposed children and adolescents (Weems et al. 2016; Sinclair et al. 2007; Fan et al. 2011). Research looking at earthquake exposure has revealed a similar trend. In a survey of 738 adolescents (aged 13–17 years) evaluated 6 months after the 2001 Van Earthquake in Turkey that used the Screen for Child Anxiety-Related Emotional Disorders, researchers found that 53% of participants were afflicted with anxiety-related disorders (Kadak et al. 2013).

Therefore, our research aimed to describe the epidemiological characteristics of PTSD, as well as depression and anxiety among children and adolescents exposed to earthquakes in China. In the WEAHC study, the initial sample of 2250 adolescents was selected from 1 junior high school (Grades 7–9) and 1 senior high school (Grades 10–12) in Dujiangyan, China. For follow-up surveys, 1573 students from the seventh and tenth grades were included, of which 720 were male and 853 were female, with an average age of 15.0 (SD = 1.26). Of those surveyed, 13.7% reported having an injured family member, and 12.8% reported the death or disappearance of family members. House damage (42.5% with severe damage plus 47.4% with moderate damage) and other property losses (21.4% with severe loss and 68.3% with moderate loss) were common. During the earthquake, 61.3% directly witnessed

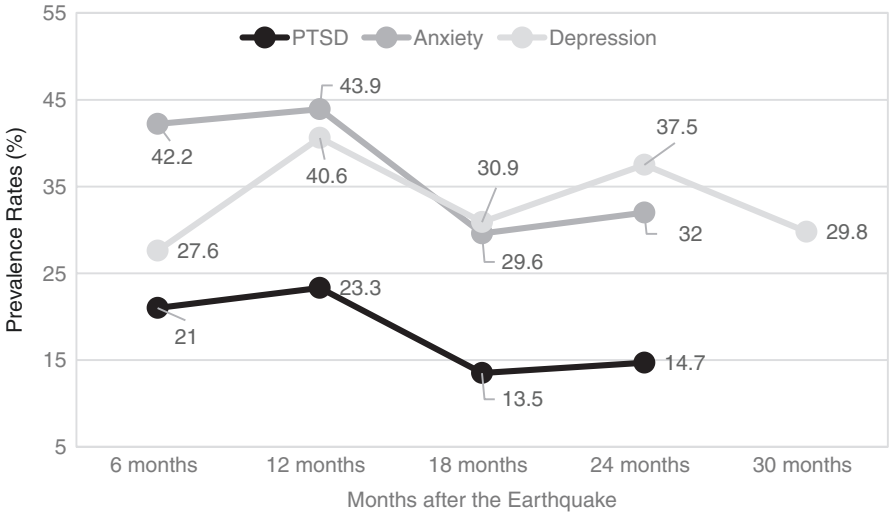

Fig. 7.1 Prevalence rates of PTSD, depression, and anxiety among adolescents exposed to the Wenchuan Earthquake based on WEAHC data ($N = 1573$)

mutilated bodies or other tragic scenes. During the first four waves, researchers used the Post-Traumatic Stress Disorder Self-Rating Scale (PTSD-SS; clinical cutoff: ≥50) (Liu et al. 1998) and the Chinese version of Screen for Child Anxiety-Related Emotional Disorders (SCARED; clinical cutoff: ≥25) (Su et al. 2008) to assess PTSD and anxiety symptoms. Depression symptoms were assessed at all five waves using the Chinese version of Depression Self-Rating Scale for Children (DSRSC; clinical cutoff: ≥15) (Su et al. 2003).

According to the WEAHC data, 6 months after the Wenchuan Earthquake, the estimated prevalence rates of PTSD, anxiety, and depression among the 2250 adolescents were 15.8%, 40.5%, and 24.5%, respectively (Fan et al. 2011). Figure 7.1 illustrates the time-varying prevalence rates of these mental health conditions among the subgroup of 1573 adolescents. It is notable that the rates tended to be higher at 12 and 24 months, which may indicate an "anniversary reaction" in adolescents' mental adaptation following a trauma experience, highlighting the importance of providing adolescents with more intensive mental health support around the anniversary date. Many additional studies investigated the prevalence of mental health problems among children exposed to the Wenchuan Earthquake and other major earthquakes in China. As shown in Table 7.2, the estimates varied greatly across studies. Such variation may be due to different demographics across samples, differences in the severity of each sample's earthquake exposure, or different measures of mental health symptoms.

In recent years, there has been a growing consensus on the existence of large individual variation in post-disaster responses and adaptation processes (Bonanno and Mancini 2012). Not everyone reacts to disasters in the same way. Although some people are vulnerable to mental disorders following this kind of trauma,

Table 7.2 Some research findings on the prevalence of PTSD, depression, and anxiety among child and adolescent earthquake survivors in China

Authors	Earthquake	*N*	Age	Measures	Timepoint (months after earthquake)	PTSD	Depression	Anxiety
Liu et al. (2011)	Wenchuan	330	8–11 years	TSCC-A	6 months 12 months	11.2% 13.4%	14.5% 16.1%	23.3% 22.7%
Ying et al. (2013)	Wenchuan	3052	8–19 years	CPSS, CES-DC	12 months	8.6%	42.5%	
Liu et al. (2010b)	Wenchuan	1474	Average age 15.0 years	PCL-C	4 months 6 months 9 months 12 months	11.2% 8.8% 6.8% 5.7%		
Zhang et al. (2012)	Wenchuan	548	Average age 16.86 years	PCL-C	6 months 12 months 18 months	9.7% 1.3% 1.6%		
Wang et al. (2012)	Wenchuan	1841	Average age 14.2 years	CRIES, DSRSC	10 months	28.4%	19.5%	
Lin et al. (2013)	Wenchuan	2737	4th–12th grade	CPSS, CDS	30 months	6.6%	69.5%	
Du et al. (2012)	Wenchuan	553	Average age 11.61 years	CRIES, DSRSC	24 months	25.9%	21.7%	
Tian et al. (2014)	Wenchuan	4604	Average age 15.0 years	PCL-C, diagnostic interviews	3 years	5.7% [a]		
Jia et al. (2010)	Wenchuan	596	8–16 years	CPTSD-RI, CDI	15 months	12.4%	13.9%	
Xu et al. (2012)	Wenchuan	21,652	7–15 years	RCMAS	12 months			18.9%
Liu et al. (2016)	Yushu	4072	12–18 years	PCL-C	3 years	17.8%		
Jin et al. (2015)	Yushu	850	Average age 15.73 years	PCL-C, SAS	3 years	8.9%		49.3%
Tang et al. (2017)	Ya'an	435 (153 at follow-up)	Average age 14.0 years	Diagnostic interviews	12 months 30 months	43.9% 15.7%[a]	20.9% 21.6%[a]	

TSCC-A Trauma Symptom Checklist for Children-Alternate Version, *CPSS* Child PTSD Symptom Scale, *CES-DC* Center for Epidemiologic Studies Depression Scale for Children, *DSRSC* Depression Self-Rating Scale for Children, *CDS* Children's Depression Scale, *PCL-C* PTSD Checklist-Civilian Version, *CRIES* Children's Revised Impact of Event Scale, *CPTSD-RI* Child Post-Traumatic Stress Disorder Reaction Index, *CDI* Children's Depression Inventory, *RCMAS* Revised Children's Manifest Anxiety Scale, *SAS* Self-Rating Anxiety Scale

[a]Based on diagnostic interviews

others can adapt to a disaster very well, with minimal psychological cost. Likely the earliest empirical evidence of this phenomenon was provided by James Stewart Tyhurst in a paper published in 1951 in *The American Journal of Psychiatry*. Based on psychiatric interviews with disaster survivors, Tyhurst observed that the majority of survivors (75–88%) exhibited acute stress reactions during the earliest phases that follow a disaster, yet most of them were able to overcome these reactions and re-establish homeostasis with the passage of time. The duration of the period of recoil also varies, which mainly is determined by individual differences rather than by the nature of the stresses. These initial reactions only persisted in about 10–25% of the individuals, leading to long-term emotional or behavioral difficulties (Tyhurst 1951). There were another 12–25% of survivors who appeared undisturbed, with no apparent stress reactions, even in the initial post-disaster phase (Tyhurst 1951). Tyhurst's observation opened the door to research on individual variability in people's disaster responses and adaptation processes.

Considerable effort has been made to gain better understanding of such variability (Bonanno and Mancini 2012), and various hypothesized patterns of symptom trajectory have been put forward (Norris et al. 2009). Research into the heterogeneity of disaster victims' mental adaptation processes is important for early detection and prevention. If those at high risk for persistent symptomology could be identified early and provided with appropriate mental health services, interventions could be targeted, and much suffering could be avoided. However, existing studies on post-disaster trajectories of mental health symptoms have mostly focused on adult samples in Western countries. The temporal course and possible patterns of PTSD, depression, and anxiety symptoms among disaster-exposed Chinese children and adolescents have not previously been determined.

Using the WEAHC data, our analyses (Fan et al. 2015) identified five PTSD symptom trajectories among adolescents exposed to the Wenchuan Earthquake: resilience, recovery, chronic dysfunction, delayed dysfunction, and relapsing/remitting (Fig. 7.2). Grouping participants based on the varied timing of their PTSD development (i.e., reaching the clinical cutoff on PTSD-SS, which is a score of 50) revealed distinct patterns. The resilience pattern, comprising 65.3% of the sample, was characterized by participants' PTSD-SS scores falling below the cutoff at all four follow-ups. The chronic dysfunction pattern (7.2% of the sample) was characterized by participants' PTSD-SS scores being equal to or above the cutoff value at all four follow-ups. The recovery pattern (20.0% of the sample) was characterized by participants' PTSD-SS scores being equal to or above the cutoff value at 6, 12, and/or 18 months but below the cutoff at 24 months. The delayed dysfunction pattern (4.2% of the sample) was characterized by participants' PTSD-SS scores falling below the cutoff value at 6, 12, and/or 18 months but equal to or above the cutoff value afterward. The relapsing/remitting pattern (3.3% of the sample) was characterized by participants' PTSD symptoms fluctuating and showing a cyclical course across the follow-up period.

We adopted the growth mixture modeling analysis approach to explore the possible trajectories of depression (Zhou et al. 2016) and anxiety symptoms (Shi et al. 2016b). Four patterns emerged for both depression and anxiety trajectories:

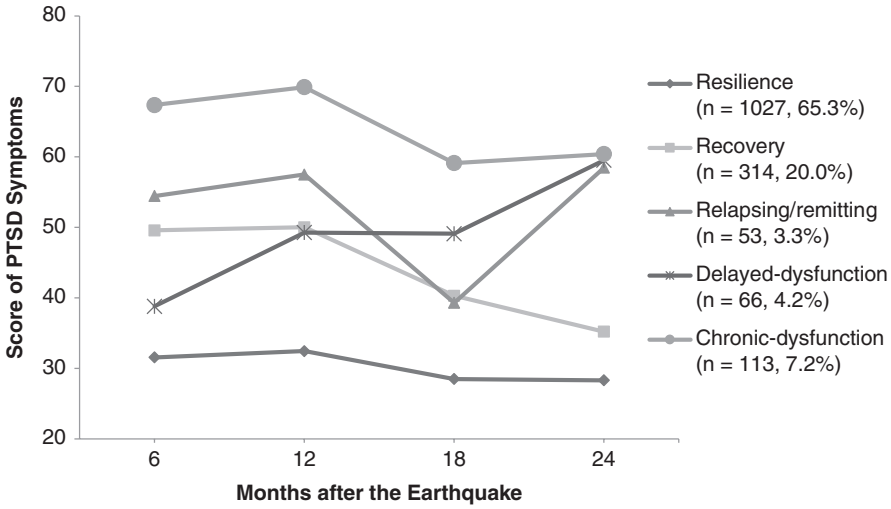

Fig. 7.2 Post-traumatic stress symptom trajectories among adolescents exposed to the Wenchuan Earthquake based on WEAHC data. (Reproduced from Fan et al. 2015)

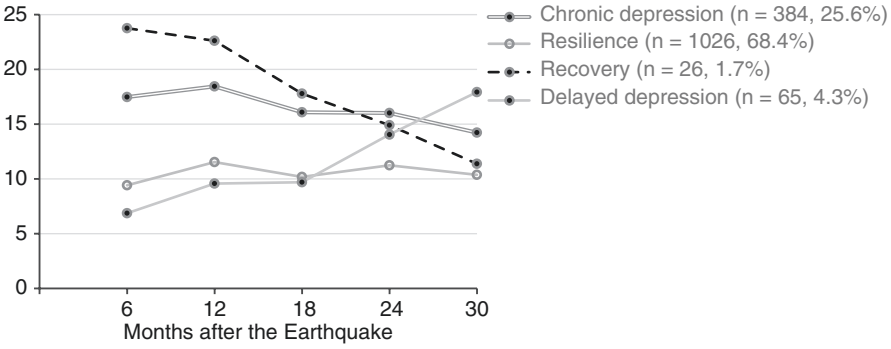

Fig. 7.3 Depression symptom trajectories among adolescents exposed to the Wenchuan Earthquake based on WEAHC data. (Reproduced from Zhou et al. 2016)

resilience, recovery, chronic dysfunction, and delayed dysfunction. As depicted in Figs. 7.3 and 7.4, the majority of adolescent earthquake survivors remained euthymic or gradually recovered from depression and anxiety symptoms over time, while only about one fourth to one third of them exhibited chronic or delayed symptoms. These findings are consistent with those from a separate meta-analysis (Bonanno et al. 2010; Foa et al. 2006), which found that more than half of those exposed to disasters experience transient psychological distress immediately after disasters but manage to maintain healthy functioning in the long run. Additional findings from this meta-analysis concluded that one third of those exposed suffered from long-term adverse impacts of disasters. Consequently, those adolescent earthquake survivors who are at high risk for chronic, delayed, or remitting/relapsing symptoms

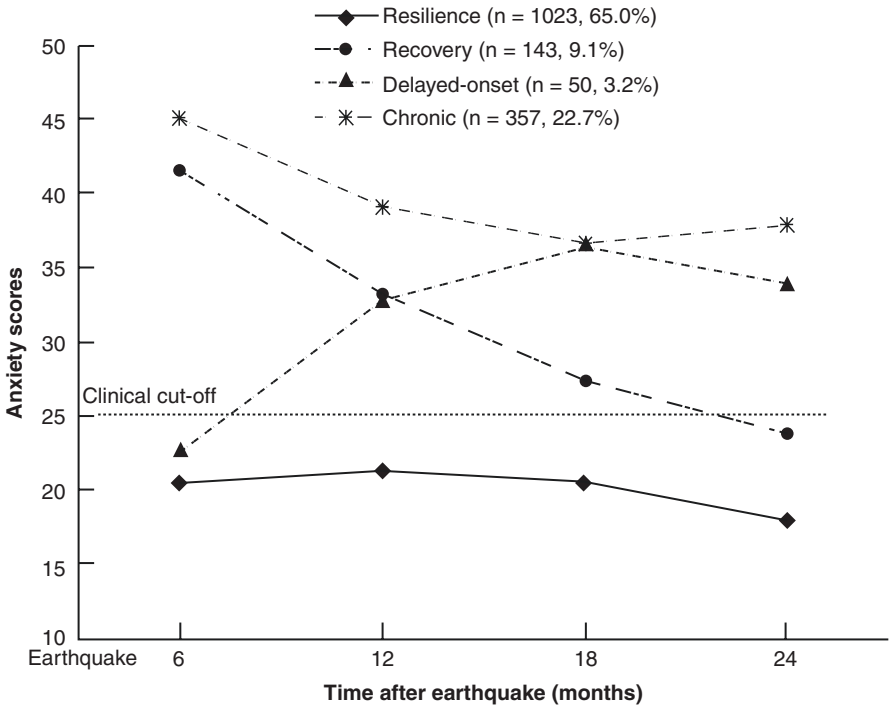

Fig. 7.4 Anxiety symptom trajectories among adolescents exposed to the Wenchuan Earthquake based on WEAHC data. (Reproduced from Shi et al. 2016b)

should be much more intensely followed and provided with more comprehensive mental health care. This makes early identification of those at such risk a public health priority.

7.3 Bidirectional Relationship: Sleep Disturbances and Mental Health

Sleep disturbances, including difficulty falling asleep, frequent awakenings, short sleep duration, poor sleep quality, and daytime sleepiness, are very common among survivors in the immediate and long-term aftermath of traumatic events, such as natural disasters (Mellman et al. 1995; Kato et al. 1996), industrial disasters (Grievink et al. 2007; Realmuto et al. 1991), terrorist attacks (Chemtob et al. 2008; Schuster et al. 2001), combat exposure, and other human-related disasters (Seelig et al. 2010; Sharon et al. 2009). In the WEAHC study, adolescents' sleep disturbances were measured at 12 months after the Wenchuan Earthquake using five core items (sleep duration, difficulty initiating sleep, difficulty maintaining sleep, sleep quality, and daytime functioning) from the Pittsburgh Sleep Quality Index (PSQI). We administered the full PSQI at 18, 24, and 30 months, which allowed us to

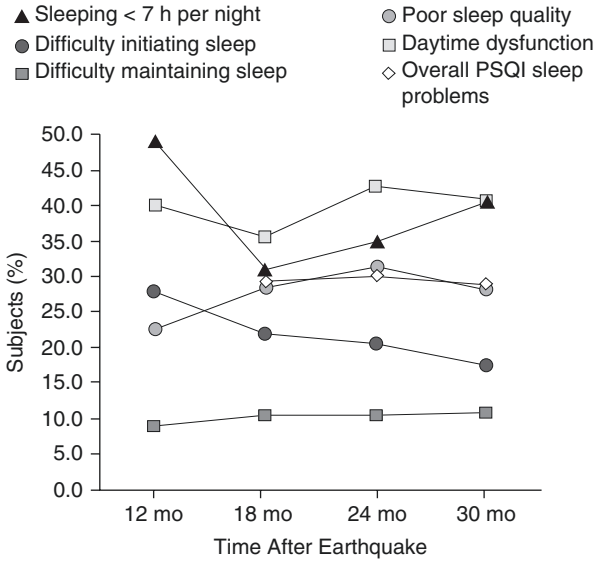

Fig. 7.5 Time-varying changes of sleep disturbances among adolescents exposed to the Wenchuan Earthquake based on WEAHC data. (Reproduced from Geng et al. 2013)

Abbreviation: PSQI = Pittsburgh Sleep Quality Index.

examine the prevalence and time-varying changes of sleep disturbances among Chinese adolescent earthquake survivors. At 12 months after the earthquake, 48.9% of the cohort reported less than 7 h of sleep per night, 27.7% reported difficulty initiating sleep, 8.8% reported difficulty maintaining sleep, 22.6% reported poor sleep quality, and 40.0% reported not having enough energy to engage in daytime activities. Latent variable growth modeling further revealed that the percentages of participants reporting short sleep duration (slope = −1.27, $p < 0.01$) and impaired daytime functioning (slope = −0.51, $p < 0.01$) declined during the period from 12 to 18 months after the earthquake and increased afterwards. Difficulty initiating sleep consistently declined from 12 to 30 months after the earthquake (slope = −0.39, $p < 0.01$). Difficulty maintaining sleep was relatively stable over time (slope = 0.32, $p = 0.12$), while poor sleep quality increased over time (slope = 0.39, $p < 0.01$). The prevalence rates of overall sleep problems as assessed by the full version of PSQI (clinical cutoff: ≥8) were 29.2%, 30.2%, and 28.8% at 18, 24, and 30 months after the earthquake. Figure 7.5 illustrates the course of these sleep problems over time.

Traditionally, researchers have assumed that sleep disturbances are merely comorbid or secondary symptoms of mental disorders and will naturally abate with remission of or recovery from an existing mental disorder (Harvey 2008). The majority of earlier longitudinal studies have focused on a unidirectional relationship, either examining the predictive validity of earlier sleep problems on later mental disorders or vice versa (Koren et al. 2002). In recent years, however, there is a growing consensus among scholars for a reciprocal relationship between sleep disturbances and mental disorders, specifically that each may be implicated in the cause and/or maintenance of the other (Alvaro et al. 2013; Harvey 2008). Empirically, close links between sleep disturbances and mental disorders have been

demonstrated both cross-sectionally (Blank et al. 2015; Germain et al. 2006; Sivertsen et al. 2014) and longitudinally (Buysse et al. 2008; Jansson and Linton 2006; Pigeon et al. 2008).

Thus, more recent studies have tried to test the hypothesis of a bidirectional relationship between sleep problems and mental disorders, which might help to further elucidate the etiological relationship between these constructs. For example, one study assessing insomnia, anxiety, and depression symptoms among 1812 Swedish adults at two points over a 1-year period observed that baseline insomnia significantly predicted new cases of anxiety and depression at follow-up and vice versa (Jansson-Frojmark and Lindblom 2008). Another group conducted a 2-year test-retest study on elderly participants' insomnia and depressive symptoms among 1204 Koreans aged 65 years or above, which showed that baseline insomnia independently predicted incident depression 2 years later and, conversely, baseline depression independently predicted incident insomnia 2 years later (Kim et al. 2009). These studies provide more direct evidence for the existence of a bidirectional relationship between sleep problems and mental disorders. However, existing studies concerning the sleep-mental health relationship have been mostly conducted among adult samples in developed countries. It is unknown whether or to what extent the observed findings are generalizable to disaster-exposed Chinese children or adolescents.

The WEAHC data provide a unique chance to explore the associations between sleep disturbance and mental health problems in a large cohort of Chinese adolescents. In a study describing the prevalence and changing patterns of sleep disturbances in the WEAHC, previous depression and anxiety symptoms were shown to be significant predictors for later sleep disturbances, i.e., higher levels of depression and anxiety symptoms contributed to greater severity of sleep disturbances later on (Geng et al. 2013). In another study, we examined sleep disturbances as risk factors for the incidence and persistence of PTSD and depressive symptoms (Fan et al. 2016a). The prevalence rates of PTSD and depressive symptoms between 12 and 24 months after the earthquake were found to notably increase when problems with sleep, including short sleep duration, difficulty initiating sleep (DIS), difficulty maintaining sleep (DMS), and poor sleep quality, were also present at the 12-month mark. After adjusting for demographics, earthquake exposure, and PTSD symptoms at 12 months, sleep problems at 12 months were still significantly associated with increased risk for PTSD symptoms at 24 months. Overall, sleep problems at 12 months also predict persistent PTSD (OR = 2.35, 95% CI 1.43–3.85) and depression symptoms (OR = 2.41, 95% CI 1.80–3.24) from 12 to 24 months. That is, the risk for persistent PTSD and depression symptoms from the 12-month interview to the 24-month interview more than doubled among adolescents who had sleep disturbances at 12 months post-earthquake compared to those without sleep disturbances. These findings support the reciprocal relationship between sleep disturbances and mental health problems among post-disaster Chinese adolescents. They also suggest that by asking simple questions about sleep quality in the months following a disaster, clinicians can identify children and adolescents at higher risk of later mental health problems. Furthermore, because PTSD and comorbid mental health

symptoms caused by exposure to a natural disaster may develop weeks or even months later than sleep disturbances, assessing and treating sleep disturbance as early as possible may be an important strategy for prevention of these mental health disorders in child and adolescent disaster survivors.

While it is not specifically clear why patterns emerge that link mental health disorders with sleep problems, there are some common biological and genetic mechanisms underlying these issues, which might explain their bidirectional relationship. For example, over-activation of the hypothalamic-pituitary-adrenal (HPA) axis has been recognized as a contributing factor for both mental health disorders (Guerry and Hastings 2011) and disrupted sleep and insomnia symptomology (Steiger 2007). Dysregulated monoaminergic, cholinergic, serotonergic, and/or noradrenergic neurotransmissions occur in response to sleep abnormalities (Stenberg 2007) and are also implicated in depression and anxiety disorders (McEwen and Olie 2005). At the genetic level, abnormal expression of circadian genes has been found to be associated with insomnia symptomology (Serretti et al. 2003) and mental health disorders (Lamont et al. 2010). Previous studies have most often investigated the physical causes of sleep abnormalities and mental health disorders separately. Future research should explore possible connections in the etiologies of these disorders.

7.4 The Impact of Earthquake Exposure on Somatic Health

Earthquake exposure can dramatically impact survivors' physical health in at least two ways. The first pathway is through direct physical injury and harm. Worldwide, there are about 3000 earthquakes each year that are perceptible by human beings, of which more than 30 produce disaster-level outcomes, including at least 10 deaths and considerably more nonfatal traumatic injuries (Ramirez and Peek-Asa 2005). The other way that earthquakes might influence physical health pertains to chronic stress reactions. Acute stress responses that affect immune function and mobilize physiological and psychological coping resources are essential for adaptation to daily life stressors, as well as to disasters. However, chronic stress leads to wear and tear on these systems, a phenomenon referred to as allostatic load. High allostatic load can in turn cause impaired immunity, atherosclerosis, obesity, bone demineralization, and atrophy of brain cells (McEwen 2004). In one study conducted 3 weeks after the Wenchuan Earthquake, 842 earthquake-affected children and adolescents (413 boys and 429 girls) between the ages of 6 and 16 (mean age = 11.48 years, *SD* = 2.30) and 986 non-affected controls (442 boys and 544 girls, mean age = 11.49 years, *SD* = 2.35) were surveyed for physical complaints. As compared with controls, earthquake-affected children reported notably more respiratory, cardiovascular, nervous, digestive, and urogenital system problems (Sun et al. 2014).

Another study investigated the prevalence of somatic symptoms among 3053 children (1545 girls, mean age = 12.01 years, *SD* = 2.62) exposed to the Ya'an Earthquake, approximately 3 months following the disaster. Based on the clinical cutoff of the Children's Revised Impact of Event Scale, 1166 children were

identified as having probable PTSD and 1887 as not having it. Scores on the Patient Health Questionnaire-13 (PHQ-13) revealed higher rates of somatic symptoms in the group with probable PTSD. The study concluded that fainting spells, heart palpitations, shortness of breath, constipation or diarrhea, and indigestion were significantly higher in the probable PTSD group than in the control group. The most frequent somatic symptoms in the probable PTSD group were trouble sleeping (83.2%), feeling tired or having low energy (74.4%), stomach pain (63.2%), dizziness (58.1%), and headache (57.7%) (Zhang et al. 2015).

Other researchers examined the relationship between mental status and menstrual problems in earthquake-affected female adolescents. About 9 months after the Wenchuan Earthquake, 569 high school girls were assessed using the PTSD Checklist-Civilian Version, Symptom Checklist-90, and a menstruation questionnaire. Common menstrual problems, such as irregular menstrual cycle, heavy/little menstruation, menstrual period lasting longer than 7 days, amenorrhea, and dysmenorrhea, were classified as abnormal menstruation. The incidence of abnormal menstruation in the whole sample was as high as 76.6%. Girls who screened positive for PTSD and other mental health symptoms, such as phobic anxiety and obsessive symptoms, were more likely to have abnormal menstruation than those who did not (Liu et al. 2010a). Taken together, these findings indicate that somatic symptoms are often comorbid with mental health disorders among earthquake-affected children and adolescents. Therefore, the alleviation of somatic symptoms should be recognized as an important and integral component in any health-related services following disaster.

7.5 The Impact of Earthquake Exposure on Social and Academic Functioning

In addition to mental health and somatic problems, impaired social or academic functioning has also been observed among Chinese children and adolescents exposed to earthquakes. One study investigated 596 children between 8 and 16 years of age in severely impacted areas of the Wenchuan Earthquake about 15 months following the disaster. The Post-Traumatic Stress Disorder Reaction Index (CPTSD-RI), Children's Depression Inventory (CDI), and Pediatric Quality of Life Inventory (PedsQL) were used to assess children's PTSD and depression symptoms and other health-related outcomes, including social and academic functioning. Results showed that more than 25% of the samples were identified as having probable PTSD or depression. Those with probable PTSD or depression showed greatly compromised social and academic functioning compared to those without these mental health problems (Jia et al. 2010).

Another study longitudinally examined the time course of physical, psychosocial, and academic functioning among children exposed to the Wenchuan Earthquake. Using the PedsQL, 430 children between 8 and 16 years old were assessed both 15 and 30 months following the earthquake. The PedsQL total score and scores on subscales of physical functioning, emotional functioning, social

functioning, and school performance were significantly lower than normal scores of generally healthy children at both assessments, demonstrating the broad adverse impact of earthquake exposure on children and adolescents' health and well-being. Moreover, a significant reduction in school performance was observed from the initial assessment to the follow-up, which may be due to adversities occurring secondary to the earthquake, such as relocation of families and interruption of school attendance (Tian et al. 2013). These findings suggest that post-earthquake intervention and prevention programs should focus not only on children and adolescents' mental well-being but also on their physical, social, academic, and other health-related functioning, in order to facilitate a more holistic approach to children and adolescents' quality of life.

7.5.1 Psychosocial Factors Related to Post-earthquake Adaptation

Psychosocial factors related to disaster victims' adaptation processes have been extensively researched and can be divided into a few different categories. First, pre-existing individual characteristics such as age, gender, ethnicity, socioeconomic status, personality traits, previous psychiatric history, and previous traumatic exposure have proven themselves to be strong predictors of post-disaster adaptation (Brewin et al. 2000; Tang et al. 2014). Second, the nature of the exposure to the disaster, such as injury to self or loved one, bereavement, property damage, perceived life threats, and psychophysical distress, as well as secondary stressors such as relocation, loss of job, interruption of schooling, damage to one's social network, and other hardships during and after the disaster, are also closely linked with the incidence and development of mental health disorders and other health-related problems following disasters (Brewin et al. 2000; Tang et al. 2014). Furthermore, factors that impact the person's post-disaster responses, such as perceived social support, coping strategies, optimistic thinking, sense of gratitude, and other psychological resources, can also have considerable impact on victims' adaptation processes in the aftermath of a disaster (Cohen and Wills 1985; La Greca et al. 1996; Adams and Boscarino 2006).

Regarding individual characteristics, two of the most widely researched demographic factors are age and gender. Findings on the relationship between a child or adolescent's age and post-disaster adaptation are inconsistent. Some studies indicate that younger children, as compared to older ones, are more vulnerable to the adverse effects of disasters and less likely to recover from disaster-related PTSD, depression, and anxiety symptoms. Others have posited that very young children are less impacted by disasters because they may not be able to perceive or recall specific traumatic experiences, due to their immature cognitive development (Bahrick et al. 1998). There has also been evidence to suggest that children of varying ages may be susceptible to different psychopathological symptoms following disasters. Specifically, younger children may have higher risk for PTSD symptoms (Yelland et al. 2010; Mcdermott et al. 2005), while older children may have higher risk for

depression symptoms (Thienkrua et al. 2006). However, in the WEAHC study, we found that older age was a risk factor for PTSD symptoms (i.e., higher levels of PTSD symptoms were reported in high school students than in junior high school students) (Fan et al. 2015). Approximately 3 years after the Yushu Earthquake, another study assessing PTSD and anxiety symptoms in 850 Chinese children (mean age 15.73 years) also found that high school students had greater severity of anxiety symptoms than junior high school students (Jin et al. 2015). However, it should be noted that in the normal course of their development, students in high school experience greater academic pressure than those in junior high school, and this could contribute to the age effect observed in our study.

Regarding the effect of previous traumatic exposure, there are two main opposing views. One is the sensitization hypothesis, which posits that people with a history of traumatic exposure become sensitized and more vulnerable to later traumas or disasters (Post and Weiss 1998). Supporting this view are studies confirming that an individual's post-disaster psychopathology is predicted by the history of prior disasters (Bonanno et al. 2007; Brewin et al. 2000). On the other hand, the inoculation hypothesis posits that previous traumatic exposure serves as a protective factor, facilitating adaptation to similar traumas or disasters. Researchers with this view suggest that having survived previous trauma helps victims cope more effectively and promotes their "immunity" (Eysenck 1983). One study providing support for the inoculation hypothesis was conducted among 166 adults aged 30–102, around the 1994 Northridge Earthquake in California (Knight et al. 2000). Longitudinal data on depression symptoms were collected before and after the earthquake. As California is an earthquake-prone area, most of the participants had at least one prior earthquake experience. The results showed an inverse relationship between the number of prior earthquake experiences and the severity of depression symptoms following the Northridge Earthquake (Knight et al. 2000). That is, the more earthquakes a person had encountered, the less likely he/she was to have severe symptoms of mental disorder in reaction to the more recent earthquake.

Studies focusing on disaster-exposed Chinese children have seldom examined the potential effect of previous traumatic experiences. Only one study addressed this issue after the 2013 Ya'an earthquake. In a sample of 435 children who survived the earthquake, 275 were previously exposed to the 2008 Wenchuan Earthquake (Tang et al. 2017). Children with previous earthquake experience demonstrated significantly increased PTSD and depression symptoms following the Ya'an Earthquake (Tang et al. 2017). This seems to support the sensitization hypothesis, yet it is not definitive. More research is needed to determine how previous traumatic experience influences adaptation to a later disaster among Chinese children.

Existing studies have consistently evidenced the strong effects of disaster exposure and subsequent stressors on mental health symptoms and other health-related problems among earthquake-affected Chinese children and adolescents (Liu et al. 2010b, 2011, 2016; Ying et al. 2013; Zhang et al. 2012, 2015; Xu et al. 2012; Tang et al. 2017; Wang et al. 2012; Lin et al. 2013; Du et al. 2012; Tian et al. 2013, 2014; Jia et al. 2010; Jin et al. 2015; Sun et al. 2014). According the WEAHC data, different aspects of earthquake exposure could result in different psychiatric symptoms

among affected adolescents. For example, the injury/loss of a loved one could devastate adolescents' affective attachment system. Directly bearing witness to tragic scenes during earthquakes might exert adverse effects on an adolescents' cognitive and emotional functioning. These types of exposure were found to increase children's risk of chronic mental health symptoms (Fan et al. 2015; Zhou et al. 2016; Shi et al. 2016b). However, house damage and property loss appeared to have transient influences on adolescents' post-earthquake psychiatric symptoms, if any (Fan et al. 2015; Shi et al. 2016b; Zhou et al. 2016). One possible reason could be that the Chinese government implemented timely and effective relocation measures and provided financial compensation for the affected population after the earthquake, thereby alleviating the potential adverse effects of house damage and property loss on victims' mental health status.

As for post-disaster stressors and negative life events, some research has shown that individuals' mental health may actually be more affected by post-disaster negative life events than they are by the disaster itself (Freedy et al. 1994). Our studies also found that the quantity of negative life events experienced by adolescent earthquake survivors increased their risk of suffering from chronic or delayed mental health symptoms (Fan et al. 2015; Zhou et al. 2016; Shi et al. 2016b). There are many possible explanations for this effect. Negative life events could aggravate adolescent post-earthquake stress reactions and increase ongoing daily irritations, which could in turn have a strong adverse impact on their mental health status. However, it is not clear how impactful negative life events may be with regards to an individual's long-term mental health outcome. One of our studies reported that negative life events at 6 months post-earthquake were concurrently associated with increased risk of depressive symptoms at 6 months, but not associated with the risk of depressive symptoms at 30 months. However, negative life events at 24 months could predict depressive symptoms at 30 months (Shi et al. 2016a), suggesting that negative life events may have strong but short-term effects on adolescents' depressive symptoms post-earthquake.

Internal or external psychological resources that impact a person's post-disaster adjustment have been shown to include social support, coping strategies, personality traits, and familial variables, such as parental psychopathology and family functioning (Fan et al. 2015; Zhou et al. 2016; Shi et al. 2016b; Liu et al. 2016; Tian et al. 2014). For example, the WEAHC data showed that adolescents with fewer social supports were more likely to develop chronic or relapsing patterns of PTSD, depression, and anxiety symptoms (Fan et al. 2015; Zhou et al. 2016; Shi et al. 2016b). We also found the recovery pattern could be accounted for by a combination of less social support at 6 months and more social support at 24 months; in contrast, more social support at 6 months and less at 24 months increased the risk for delayed mental health symptoms (Zhou et al. 2016; Shi et al. 2016b). Overall, these findings provide evidence for the protective effect of social support on children and adolescents' mental health after a disaster.

As for coping strategies, positive coping strategies, such as problem solving, positive reappraisal, and support seeking, were found to decrease the risk of chronic, relapsing, or delayed PTSD symptoms. On the other hand, negative coping

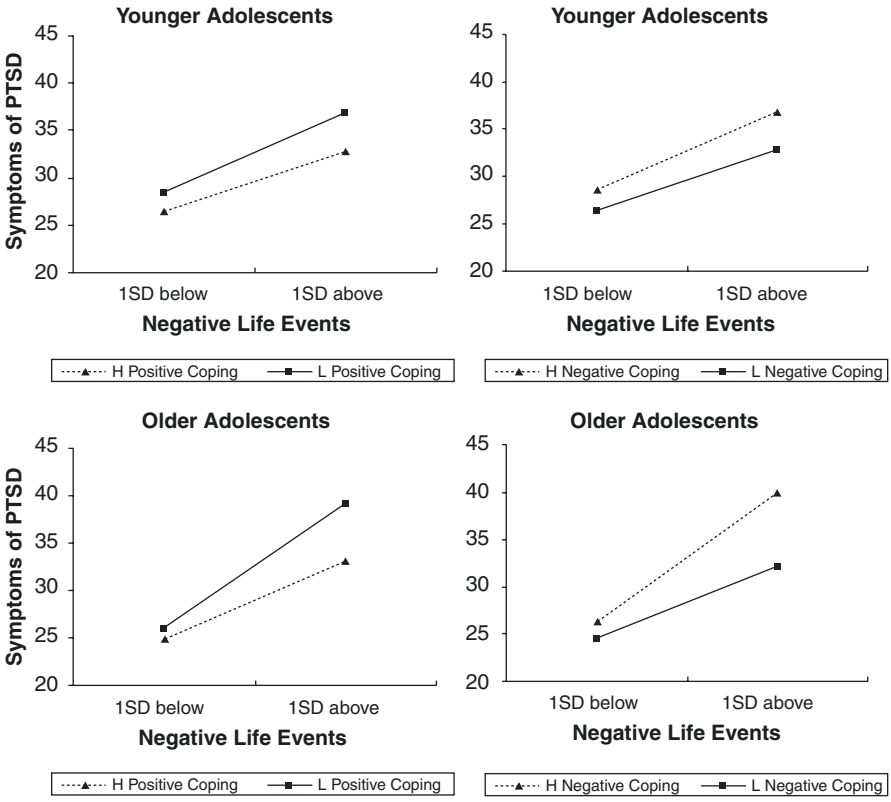

Fig. 7.6 Positive and negative coping moderating the relationship between negative life events and PTSD symptoms among adolescent earthquake survivors based on the WEAHC data (Zheng et al. 2012)

strategies, such as denial and distancing oneself from the problem, can enhance the risk (Fan et al. 2015; Liu et al. 2016). In one of our studies, we examined the moderating role of coping strategies in the relationship between post-earthquake negative life events and PTSD symptoms (Zheng et al. 2012). The cross-sectional data of 2250 adolescents at 6 months after the Wenchuan Earthquake were analyzed in this study. Negative life events, positive coping, and negative coping had significant effects on PTSD symptoms for both younger (11–14 years) and older (15–18 years) adolescents, after controlling for earthquake exposure. The moderating effects of positive and negative coping only emerged for older adolescents (see Fig. 7.6). Specifically, the relationship between negative life events and PTSD symptoms was stronger among those with low levels of positive coping than those with high levels of positive coping. The opposite was true among those with low levels of negative coping compared to those with high levels of negative coping (Zheng et al. 2012). This may indicate that high levels of positive coping and low levels of negative coping could mitigate the adverse effects of negative life events on PTSD symptoms.

Some studies also looked into specific coping behaviors. For example, one survey among 4604 adolescents (2617 girls; mean age 15.0 years) 3 years after the Wenchuan Earthquake demonstrated that PTSD symptoms could be negatively predicted by physical exercise. That is, adolescents who exercised frequently were less likely to have PTSD symptoms (Tian et al. 2014). Together, these results highlight the importance of integrating coping training into post-earthquake psychological interventions.

7.5.2 Familial Factors Related to Post-earthquake Adaptation

Familial factors could also have a large impact on children's post-disaster psychological adjustment. One commonly investigated familial factor is parental psychopathology. Numerous studies have confirmed its adverse effect on children's mental health conditions following disasters. For example, Scheeringa et al. (2015) assessed PTSD symptoms and several maternal factors of 62 children exposed to life-threatening traumas over a 2-year period and found that initial maternal PTSD symptoms significantly predicted children's PTSD symptoms 2 years later. Li et al. (2010) conducted a retrospective investigation on 3698 families who suffered from the 1998 Yangtze River flood in China and found that children of parents with PTSD were more likely to develop PTSD compared to children of parents without this disorder. Studies among the offspring of holocaust survivors also demonstrated that the presence of parental (especially maternal) psychopathology contributed to increased risk of PTSD, depression, and anxiety disorders in their offspring (Yehuda et al. 2001, 2008).

There has also been evidence indicating that children's post-disaster distress may affect parents' symptoms. For example, Koplewicz et al. (2002) longitudinally investigated 21 children exposed to the 1993 World Trade Center bombing and their parents and found that children's PTSD symptoms and other disaster-related mental health symptoms 3 months post-disaster positively predicted parental PTSD symptoms 9 months post-disaster. These findings provided preliminary support for a bidirectional relationship between parental and child psychopathology following disaster. Two limitations of most of these studies are that parents and children were exposed to different traumas or disasters (Scheeringa et al. 2015; Koplewicz et al. 2002; Yehuda et al. 2001, 2008) and the data was collected based on either child or parent reports (Li et al. 2010; Yehuda et al. 2001).

The WEAHC collected data on parental psychopathology of certain participants, based on parents' own reports at 12 and 18 months after the Wenchuan Earthquake. This provides a unique opportunity to investigate the mutually influenced parent-child mental health symptoms in a large sample of Chinese adolescents and their parents who survived the same disaster. One of our studies adopted the longitudinal Actor-Partner Interdependence Model (APIM) analyses to examine the interdependent relations of child and parental PTSD symptoms in 688 parent-child dyads from the WEAHC (Shi et al. 2018). Longitudinal APIM evaluates both actor and partner effects by applying structural equation modeling. The actor effect measures how

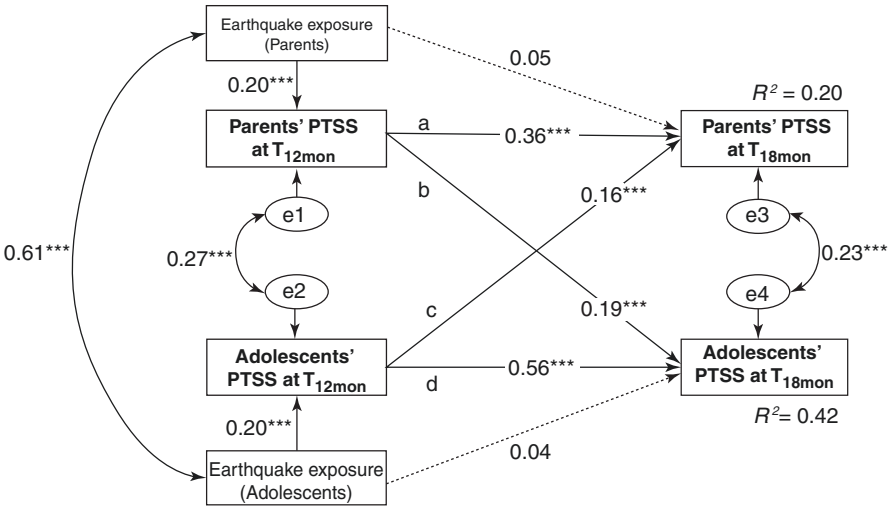

Fig. 7.7 Longitudinal Actor-Partner Interdependence Model of post-traumatic stress symptoms (PTSS) among adolescents and their parents who had both experienced the 2008 Wenchuan Earthquake in China (n = 688 dyads) (Shi et al. 2018). Actor effects are reflected by paths "a" and "d." Partner effects are reflected by paths "b" and "c." Standardized beta coefficients were presented. Children's and parents' earthquake exposures were controlled for. R^2 indicated variances in children's and parents' PTSD symptoms explained by the model. $^{***}p < 0.001$

much a dyad member's previous behaviors/symptoms predict his or her own future behaviors/symptoms, and the partner effect measures how much one dyad member's previous behaviors/symptoms affect the other's future behaviors/symptoms. Both actor and partner effects were positive and statistically significant in our results, suggesting that child and parental PTSD symptoms were both stable over time and reciprocally associated with each other (see Fig. 7.7).

We also conducted gender-specific APIM analyses and observed significant actor and partner effects among mother-son, mother-daughter, father-son, and father-daughter dyads, with the exception that child PTSD symptoms at 12 months could not predict paternal PTSD symptoms at 18 months (Shi et al. 2018). The mutual impact between child and parental psychopathology may be partly due to shared disaster exposure. However, findings in our study remained significant when both children's and parents' earthquake exposures were controlled for. Several other reasons might explain the mutual relations of parent-child psychopathology. As indicated in previous literature, parents struggling to deal with their own distress are less capable of providing care and support to their disaster-exposed children (Scheeringa and Zeanah 2001) and tend to adopt an indifferent or aggressive parenting style when interacting with their children (Kelley et al. 2010). These parenting shifts could put children at higher risk for negative adaptation and psychopathology following disasters.

Conversely, mental health problems in children can be extremely stressful for parents and thus increase the risk of parental psychopathology. It is also possible

that mothers bear a disproportionate amount of this burden. Since children commonly have more frequent interactions and more intimate relationships with their mothers than fathers (Collins and Russell 1991), it may be inferred that after exposure to a disaster, children may be more willing to express their feelings and thoughts to their mothers and seek comfort and support with them. As a result, mothers could become more troubled by their children's mental health, which may explain why we found that children's PTSD symptoms predicted their mothers' PTSD symptoms but not the symptoms of their fathers (Shi et al. 2018).

Another important mechanism involved in the mutual relations of child-parent psychopathology pertains to genetic resemblance between children and their parents. Behavioral genetic studies have substantiated that approximately 30–50% of individual variation in the risk to develop common mental health disorders such as depression and anxiety could be accounted for by genetic factors (Gordon and Hen 2004; Kessler et al. 2005; Kendler 2001). Research evidence on some important genetic variants associated with post-disaster psychopathology will be elaborated in the following section.

7.6 The Role of HPA Axis and Related Genetic Variants

In addition to psychosocial factors, efforts have increasingly been made to explore the biological and genetic mechanisms implicated in children's post-disaster adaptation. The hypothalamic-pituitary-adrenal axis (HPA axis), a major neuroendocrine system that modulates stress reactions as well as many other bodily processes, is involved in the etiology of mental health disorders and functional illnesses. The HPA axis consists of the paraventricular nucleus of the hypothalamus, the anterior pituitary, and the adrenal cortex, and it is regulated largely through a negative feedback mechanism. In response to stress, the paraventricular nucleus of the hypothalamus secretes vasopressin and corticotropin-releasing hormone (CRH), which stimulate the secretion of adrenocorticotropic hormone (ACTH) in the anterior pituitary. ACTH in turn acts on the adrenal cortex and produces the glucocorticoid cortisol. In people with normal HPA axis functioning, cortisol feeds back on the hypothalamus and the pituitary to suppress CRH and ACTH production and promote a return to homeostasis. Dysregulation of the HPA-negative feedback mechanism is linked to hypercortisolism, which has an important role in various mental health disorders (Guerry and Hastings 2011; Juruena et al. 2004; Faravelli et al. 2012).

In samples of earthquake-exposed Chinese children, researchers investigated functional changes in the HPA axis linked with post-disaster psychopathology. For example, one study examined cortisol production using hair samples in 84 Chinese girls, among whom 32 had survived the Wenchuan Earthquake and been diagnosed with PTSD, 32 had survived the same earthquake but had not been diagnosed with PTSD, and 20 were non-traumatized controls (Luo et al. 2012). The three groups were matched on demographic variables including age (12–15 years), school location, and education level. Seven months after the Wenchuan Earthquake, researchers

obtained hair samples from each participant, each greater than 12 cm and cut into four 3 cm segments. The four segments labeled S1, S2, S3, and S4 from proximal (the scalp terminal) to distal segments were assayed for cortisol concentration. As the average hair growth rate is about 1 cm per month, S1 represented hair growth during the period from the fifth to seventh months following the earthquake, S2 represented the period from second to fourth months, S3 represented the period from 2 months before to 1 month after the earthquake, and S4 represented the period from 5 to 3 months before the earthquake. Results revealed that the S4 segment cortisol levels were very similar among the three groups. Cortisol levels of both traumatized groups increased during the first several months following earthquake. However, as compared with the PTSD group, the non-PTSD group displayed notably higher cortisol levels until 7 months after the earthquake (Luo et al. 2012). These findings corroborate the assertion that blunted cortisol reactivity, indicative of impaired HPA axis function, could be a crucial biomarker for PTSD risk.

Efforts have been made to detect the role of HPA axis-related genes on the probability of developing mental health disorders. A glucocorticoid receptor gene (NR3C1), located on chromosome 5q31, is one of the key genes involved in the HPA axis regulation (DeRijk et al. 2002). Prior studies have verified the close link between genetic variants in NR3C1 and post-disaster psychopathology. For example, Hauer et al. (2011) found that homozygous rs41423247 G allele carriers were more likely to have PTSD symptoms after completion of treatment for severe cardiac disease. Using a Chinese sample of 460 PTSD patients and 1158 controls, Lian et al. (2014) demonstrated a 3.26-fold increased risk of developing PTSD in individuals with rs258747 G allele and rs41423247 G allele.

The WEAHC study also collected DNA samples from 117 adolescents diagnosed with anxiety disorders, 139 with diagnosed depression, and 121 controls. In one study (Zhou et al. 2017), we examined the genetic variants in NR3C1 and their interaction with paternal and maternal parenting styles in relationship to adolescent anxiety disorders. Among the 117 cases diagnosed with at least one type of anxiety disorder, there were 13 cases of PTSD, 6 of panic disorder, 17 of agoraphobia, 10 of social phobia, 18 of specific phobia, 4 of obsessive-compulsive disorder, 12 of generalized anxiety disorder, and 37 of mixed anxiety disorders. The Chinese version of Parental Bonding Instrument was used to measure four types of paternal/maternal parenting styles (i.e., warmth, autonomy, overprotection, indifference). Results revealed that rs6191 GG genotype, rs6196 AA genotype, and rs41423247 GG genotype were associated with decreased risk of anxiety disorders. Higher level of paternal/maternal overprotection and indifference, as well as lower level of paternal warmth, predicted increased risk of anxiety disorders. Moreover, there was a significant interaction between rs41423247 genotypes and maternal warmth in predicting adolescent anxiety disorders; that is, rs41423247 GG genotype was linked with reduced risk of anxiety disorders only when maternal warmth was high. Haplotype analysis revealed three haplotypes with frequencies of >5% (rs6191-rs6196-rs41423247): GAG, TAC, and TGC. GAG and TGC were, respectively, associated with decreased and increased risk of anxiety disorders. Maternal warmth and overprotection were found to moderate these effects. GAG would reduce the

risk of anxiety disorders only when maternal warmth was high, while TGC would enhance the risk only when maternal overprotection was high. This study is the first to investigate the role of NR3C1 polymorphisms and parenting styles in anxiety disorders among Chinese adolescents. Our findings on gene-environment interactions lend support to the vantage sensitivity hypothesis (Pluess and Belsky 2013), which proposes variations in people's responsiveness to exclusively positive environmental influences as a function of individual endogenous characteristics.

Genetic etiologies of mental health disorders like depression and PTSD are complicated, meaning that many genes, by themselves or through interaction with environmental factors, could be involved in the development and maintenance of these disorders. In addition to HPA axis-related genes, some commonly investigated candidate genes for depression and anxiety disorders include the serotonin transporter gene, dopamine receptor gene (DRD1–DRD5), catechol O-methyltransferase gene (COMT), monoamine oxidase gene (MAOA/MAOB), neuropeptide Y gene (NPY), and brain-derived neurotrophic factor (BDNF) (Lanni et al. 2009; Nugent et al. 2011; Amstadter et al. 2009). Despite the limited number of studies done on this topic, associations between some of these genes and post-disaster psychopathology have also been examined among earthquake-exposed Chinese children. For example, in a case-control study conducted 3 years after the Wenchuan Earthquake, 64 adolescents diagnosed with PTSD (37 boys; mean age = 14.55 years, SD = 1.74) and 119 controls (62 boys; mean age = 15.00, SD = 1.55) were investigated. Significant interaction effects of serotonin transporter gene polymorphisms (i.e., 5-HTTLPR and 5-HTTVNTR) × earthquake exposure on PTSD were found. Specifically, carrying an S allele combined with high level of earthquake exposure would cause a fourfold increase in the possibility of developing PTSD (Tian et al. 2015). Another study examined the association of an adiponectin gene polymorphism rs1501299 with depression. Using the Beck Depression Inventory, depression symptoms among 746 adolescent survivors were assessed at 6, 12, and 18 months after the Wenchuan Earthquake. Results showed that female T allele carriers, in relation to female GG homozygotes, exhibited lower prevalence of depression at 18 months, but not at 6 or 12 months after the earthquake (Wang et al. 2015). This result implies a potential role of adiponectin gene polymorphism rs1501299 in adolescent girls' recovery from depression symptoms in the later stages following the earthquake.

7.7 Post-traumatic Growth

In recent years, increasing research has been devoted to the exploration of the potential positive impacts of disaster. As noted earlier, important individual differences exist in people's post-disaster adaptation. The majority of disaster victims can adjust very well and maintain euthymia. Some may even achieve positive changes in mental and social functioning, such as higher self-efficacy, improved spirituality, greater faith and trust in others, and closer interpersonal relationships (Linley and Joseph 2004). These positive changes are referred to as post-traumatic growth (PTG). In

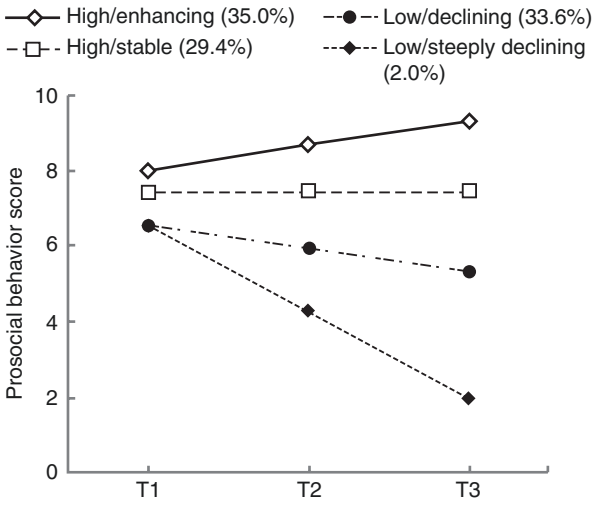

Fig. 7.8 Change patterns of prosocial behavior among adolescents exposed to the 2008 Wenchuan Earthquake at three time points (conditional model). T1 = 6 months, T2 = 18 months, and T3 = 30 months after the earthquake. Potential predictors were earthquake exposure, demographics, negative life events, post-traumatic stress disorder, depression, anxiety symptoms, social support, and positive/negative coping all at T1 (Qin et al. 2016)

child samples, post-disaster positive changes tend to occur at the behavioral level. For example, one study aggregated data on Hurricane Andrew-exposed children and their disruptive behaviors, including defiance of school authority, damaging school property, rude and discourteous behavior, excessive tardiness, and trespassing, from the records of both pre- and post-hurricane school years in Dade County, Florida, USA (Shaw et al. 1995). Results showed that the disruptive behaviors of children whose schools were most heavily affected by the hurricane significantly decreased following the disaster (Shaw et al. 1995).

In the WEAHC study, we assessed adolescent survivors' prosocial behavior at 6, 18, and 24 months after the earthquake and observed four developmental trajectories of post-disaster prosocial behavior: high/enhancing (35.0% of the sample), high/stable (29.4%), low/declining (33.6%), and low/steeply declining (2.0%) (see Fig. 7.8). As seen in the developmental psychology literature, age-related trends in prosocial behavior during adolescence are more likely to follow decreasing or stable patterns. For example, the study by Carlo et al. (2007) analyzed data on a 4-year follow-up of 657 American high school students and found an overall decrease in mean level of prosocial behavior across early to middle adolescence with a slight rebound in the 12th grade. Nantel-Vivier et al. (2009, study 1) longitudinally investigated a sample of 1037 Canadian boys using a multi-informant approach. Teacher and mother reports, respectively, revealed three (low/declining 53%, high/declining 16%, high/steeply declining 31%) and five (low/stable 7%, low/declining 19%, moderate/stable 41%, high/declining 24%, high/stable 9%) trajectories of prosocial behavior for Canadian boys from age 10 to 15. Possible explanations for the decrease

or stability in prosocial behavior during adolescence have been discussed, e.g., such trends might be a result of the increase in self-focused modes of moral reasoning (i.e., thinking of own needs and benefits) from early to later adolescence (Eisenberg et al. 1991). In contrast to normal patterns of adolescent prosocial development, only about two thirds of adolescents in our study showed declining or unchanging levels of prosocial behavior, whereas as high as 35.0% of them exhibited prosocial enhancement after earthquake. Presence of such enhancing trajectory should be considered evidence supporting the validity of PTG.

Prior studies have also directly investigated PTG and possible contributing factors among earthquake-exposed Chinese children. For example, one study examined the longitudinal relationship between PTSD symptoms and PTG in a sample of 245 adolescents (124 girls; mean age 14.18 years, SD = 1.39) that survived the Wenchuan Earthquake (Zhou et al. 2015a). Participants completed the Revised Child PTSD Symptom Scale and the Post-Traumatic Growth Inventory at 3.5, 4.5, and 5.5 years after the earthquake. Results found that PTSD symptoms at 3.5 and 4.5 years, respectively, predicted subsequent PTG at 4.5 and 5.5 years, indicating that PTSD symptoms and PTG could coexist in adolescent survivors after a disaster and that the diminution of PTSD symptoms could contribute to PTG.

Disaster exposure can challenge a person's core beliefs and cause repetitive thinking about possible causes and outcomes of the disaster. Challenges to core beliefs and excessive repetitive thinking could, on the one hand, increase the risk of PTSD and comorbid psychiatric symptoms following trauma (Lilly and Pierce 2013). On the other hand, these challenges could produce an opportunity for reforming a belief system and achieving personal growth (Yanez et al. 2011; Cann et al. 2010b). Researchers have proposed a distinction between two types of repetitive thinking: intrusive rumination and deliberate rumination (Cann et al. 2010a). The former refers to those unwanted thoughts that invade a person's cognition, whereas the latter refers to deliberate contemplation about an event. Intrusive rumination and deliberate rumination may have different impacts on PTSD and PTG of disaster victims. This has been addressed in studies among Chinese children and adolescents exposed to earthquakes. For example, in one study investigating 354 adolescents 4.5 years after the Wenchuan Earthquake, disaster-caused challenges to adolescents' core beliefs were found to have direct positive effects on both PTSD and PTG, suggesting that such challenges were linked with significant distress as well as growth.

Challenges to core beliefs could also affect PTSD and PTG through the mediation of intrusive rumination and deliberate rumination, respectively (Zhou et al. 2015b). Disaster victims stuck in intrusive rumination might think involuntarily, repetitively about the traumatic experiences and related consequences in a catastrophic way, which could make them prone to dysfunctional behaviors and symptoms such as re-experiencing and increase their risk for PTSD. In contrast, deliberate rumination could help disaster victims achieve a comprehensive understanding of the traumatic experiences; as such they might not be cognitively overwhelmed by trauma-related stimuli and have lower risk for PTSD but higher probability to develop PTG. Another study measured intrusive rumination, deliberate rumination,

and PTG among 310 adolescents impacted by the Ya'an Earthquake at 6, 12, and 18 months after the disaster. Results revealed a mediating role of deliberate rumination at 12 months in the relationship between intrusive rumination at 12 months and PTG at 18 months (Zhou and Wu 2016). This suggests that intrusive rumination might direct adolescents to engage in more purposive and deliberate rumination about the meaning of the disaster, which may in turn lead to increased PTG.

There was also one study examining the causal paths between dispositional gratitude, deliberate rumination, and PTG among 217 adolescents exposed to the Wenchuan Earthquake. Dispositional gratitude usually refers to the personality characteristic of feeling thankful for common things in daily life. Dispositional gratitude at 3.5 and 4.5 years after the earthquake was found to significantly predict PTG at 4.5 and 5.5 years, respectively. Dispositional gratitude at 3.5 years also significantly predicted PTG at 5.5 years through the mediation of deliberate rumination at 4.5 years (Zhou and Wu 2015). The above findings have important practical implication for facilitating children and adolescents' post-disaster mental adaptation, perhaps by teaching and encouraging deliberate rumination skills.

7.8 Summary

In the face of destructive natural hazards such as earthquakes, children and adolescents are usually more fragile than adults are and need more attention paid to them after disasters. Some important conclusions can be drawn from the existing studies on Chinese child and adolescent earthquake survivors. Epidemiologically, mental health problems such as PTSD, depression, anxiety, and sleep problems are prevalent among this population, even several years after earthquakes. In the general course of these mental health problems, there is an evident anniversary phenomenon, meaning increased symptom prevalence around the anniversary date. These findings indicate that long-term clinical and psychosocial interventions are needed, especially around anniversary dates, to help children and adolescents maintain or regain normal mental functioning after experiencing catastrophic earthquakes.

Large individual differences also exist in the post-disaster mental adaptation process among child and adolescent earthquake survivors. Although many children and adolescents can remain euthymic or gradually recover over time, some exhibit chronic, delayed, or fluctuating symptomology, especially those with the risk factors such as being female, severe disaster exposure, post-disaster life adversity, negative coping style, and poor social support. These findings indicate the importance of early screening and identification of high-risk children and adolescents, as well as the importance of providing targeted and individualized mental health services and interventions for those at greatest risk.

Studies have also presented evidence on some biological and genetic factors implicated in children and adolescents' post-disaster mental adaptation. Impaired HPA axis function could be a crucial biomarker for PTSD risk. Some candidate genes such as HPA axis-related genes and the serotonin transporter gene and their

interaction with environmental variables also have an important role in the etiologies of disaster-related mental disorders. Future research on the epigenetic mechanisms underlying the gene-environment interacting effects on these mental disorders is warranted, to further explore their etiologies.

Finally, exposure to disasters can not only cause mental problems or disorders but also can promote personal growth in some children and adolescents. Psychological professionals, educators, or parents could guide adolescents to think about the disaster and its impacts in positive ways, helping them reexamine their core beliefs, establish more mature views of the world and the self. Implementing interventions such as gratitude journals to enhance a sense of gratitude may supply an avenue through which children and adolescents may adapt to a disaster more efficiently and achieve personal growth after a disaster.

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