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POST-TRAUMATIC STRESS AMONG ADOLESCENTS SURVIVING NEPALESE EARTHQUAKE AND CHILDREN OF IMMIGRANTS IN FINLAND

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To my family

UNIVERSITY OF TURKU
Faculty of Medicine
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Child Psychiatry
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ABSTRACT

The aim of this dissertation was to identify risk factors associated with post-traumatic stress symptoms (PTSS) using two study designs: a longitudinal post-earthquake survey and a Finnish population-based study. Studies I and II were carried out 18 and 31 months after the 2015 Nepal earthquake. They examined the prevalence of psychiatric symptoms, namely PTSS and depressive symptoms among 893 adolescents aged 11-17 years, together with potential risk factors associated with their psychiatric symptoms. The participants were enrolled from schools (grades 7-10) from two earthquake-affected areas, one more severely affected than the other. Psychiatric symptoms were assessed using the Child PTSD Symptom Scale and Depression Self-Rating Scale. The aim of Study III, the Finnish population-based study, was to examine the association between parental immigration status and post-traumatic stress disorder (PTSD) in their offspring. The study was a nested matched case-control study that used several nationwide registers. The cases were all singleton births in Finland between 1 January 1987 and 31 December 2010, who had been diagnosed with PTSD by the year 2012 in the Care Register for Health Care. The controls were all singletons born in Finland during the study period, alive and living in Finland when the matched cases were diagnosed. The study included 3639 cases and 14434 controls.

In Study I, the prevalence of PTSS and depressive symptoms among adolescents was higher in the severely affected area. The factors associated with psychiatric symptoms were being female, pre-earthquake trauma exposure and being trapped and/or wounded. In Study II, no significant change in the prevalence of PTSS and depressive symptoms was observed from 18 months to 31 months after the earthquake. Living in the severely affected area and post-earthquake trauma exposure increased the risk for delayed and chronic PTSS and depressive symptoms. In Study III, children with an immigrant father had at an increased risk of developing PTSD, compared to those with two Finnish parents. The risk of PTSD increased if the child's father migrated to Finland less than five years before their birth and the father was born in North Africa or the Middle East. These studies highlighted the need for psychosocial support and services for earthquake survivors and second-generation immigrants.

KEYWORDS: post-traumatic stress symptoms, depression, adolescents, earthquake, immigrants, second-generation

TIIVISTELMÄ

Väitöskirjan tavoitteena on tunnistaa traumaperäisen stressihäiriön (PTSD) oireiden riskitekijöitä hyödyntämällä kahta eri tutkimusasetelmaa: maanjäristyksen jälkeen toteutettua seurantatutkimusta sekä suomalaista väestötutkimusta. Tutkimuksessa selvitettiin psyykkisten oireiden (traumaperäiset oireet ja masennusoireet) esiintyvyyttä 839:lla 11–17-vuotiaalla nuorella 18 ja 31 kuukautta Nepalin vuoden 2015 maanjäristyksen jälkeen sekä tutkittiin psyykkisten oireiden mahdollisia riskitekijöitä. Osallistujat saatiin kouluista (luokka-asteet 7–10) kahdelta alueelta, joista toinen oli kärsinyt maanjäristyksestä enemmän. Psyykkisiä oireita kartoitettiin Child PTSD symptom scale –kyselyn ja Depression Self-Rating Scale –kyselyn avulla. Suomalaisessa rekisteritutkimuksessa tavoitteena oli tutkia vanhempien maahanmuuttajuuden ja heidän jälkeläisillään diagnosoidun traumaperäisen stressihäiriön välistä yhteyttä. Tutkimus on pesitetty, kaltaistettu tapaus-verrokkitutkimus, joka perustuu useisiin kansallisiin rekistereihin. Tapaukset kattoivat kaikki Suomessa yksösraskauksista ajalla 1.1.1987–31.12.2010 syntyneet lapset, jotka olivat Hoitoilmoitusrekisterin mukaan saaneet PTSD-diagnoosin vuoteen 2012 mennessä. Verrokit poimittiin samalla ajanjaksolla Suomessa yksösraskauksista syntyneistä henkilöistä, jotka olivat elossa ja asuivat Suomessa ajankohtana, jona kaltaistetut tapaukset diagnosoitiin. Tutkimuksessa oli 3639 tapausta ja 14 434 verrokkia.

Tutkimuksessa I traumaperäisen stressihäiriön sekä masennuksen oireiden esiintyvyys nuorilla oli korkeampi maanjäristyksestä pahemmin kärsineellä alueella. Psyykkisiin oireisiin olivat yhteydessä naissukupuoli, altistuminen traumaattiselle kokemukselle ennen maanjäristystä sekä loukkuun jääminen tai loukkaantuminen. Tutkimuksessa II ei havaittu merkitsevää muutosta traumaperäisten oireiden tai masennusoireiden esiintyvyydessä 18 ja 31 kuukauden välillä maanjäristyksen jälkeen. Asuminen maanjäristyksestä pahoin kärsineellä alueella sekä maanjäristyksen jälkeinen trauma-altistus lisäsivät viivästyneiden ja kroonisten PTSD- ja masennusoireiden riskiä. Tutkimuksessa III PTSD:n riski oli kohonnut lapsilla, joiden isä on maahanmuuttaja verrattuna lapsiin, joiden molemmat vanhemmat ovat suomalaisia. Jälkeläisten PTSD-riski oli kohonnut jos isä oli muuttanut Suomeen alle viisi vuotta ennen heidän syntymäänsä ja jos isä oli syntynyt Pohjois-Afrikassa tai Lähi-idässä. Tutkimus korosti maanjäristyksen kokeneiden sekä toisen polven maahanmuuttajien psykososiaalisen tuen tarvetta.

AVAINSANAT: Traumaperäinen stressihäiriö, masennus, nuoret, maanjäristys, maahanmuuttaja

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Abbreviations

AUDADIS-IV	Alcohol Use Disorder and Associated Disabilities Interview Schedule
CI	Confidence Interval
CPSS	Child PTSD Symptom Scale
CRHC	Care Register for Health Care
DAG	Directed acyclic graph
DALY	Disability-Adjusted Life Years
DSRS	Depressing Self-Rating Scale
DSM	Diagnostic Statistical Manual of Mental Disorders
FMBR	Finnish Medical Birth Register
ICD	International Classification of Disease and Related Health Problems
LMIC	Low-and Middle-Income Countries
mhGAP	Mental Health GAP Action Programme
MHPSS	Mental Health and Psychosocial Support
NCC	Nested Case-Control
NCD	Non-Communicable Disease
NGO	Non-Governmental Organizations
OR	Odds ratios
PHC	Primary Health Care
PRC	Population Register Centre
PTSD	Post-Traumatic Stress Disorder
PTSS	Post-Traumatic Stress Symptoms
SDG	Sustainable Developmental Goals
SES	Socio-economic status
SPSS	Statistical Package for the Social Sciences
WHO	World Health Organization
WMH	World Mental Health

List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals I-III:

I   Silwal, S., Dybdahl, R., Chudal, R., Sourander, A., Lien, L. Psychiatric symptoms experienced by adolescents in Nepal following the 2015 earthquakes. Journal of Affective Disorders, 2018; 234: 239-246

II Silwal, S., Chudal, R., Dybdahl, R., Sillanmäki, L., Lien, L., Sourander, A. 2021. Post-traumatic Stress and Depressive Symptoms Among Adolescents After the 2015 Earthquake in Nepal: A Longitudinal Study. Child Psychiatry & Human Development. doi: 10.1007/s10578-021-01136-3

III Silwal, S., Lehti, V., Chudal, R., Suominen, A., Lien, L., Sourander A. Parental immigration and offspring post-traumatic stress disorder: a nationwide population-based register study. Journal of Affective Disorders, 2019; 249: 294-300

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1   Introduction

1.1   General

About 70% of individuals experience a traumatic event in their lifetime that could be stressful, life-threatening and cause physical and psychological stress (Benjet et al., 2016). Typically, in the face of these traumatic events, people would experience fear, nervousness, and helplessness, and/or trouble sleeping. Most people find that symptoms eventually subside, and they adapt to adverse situations and continue to lead an active, healthy life. However, some are less fortune. Instead of experiencing a normal recovery, they develop a long-lasting psychiatric disorder, known as post-traumatic stress disorder (PTSD). PTSD is a trauma-and stressor-related disorder that develops after exposure to disasters, accidents, conflicts, sexual violence, or other traumatic events (APA, 2013). Symptoms experienced by individuals with PTSD are nightmares, avoidance, negative thoughts and feelings, and hyperarousal. PTSD has been associated with serious disabilities, chronic conditions, substance abuse, and suicide (Schlenger et al., 2015). The lifetime prevalence of PTSD has been reported to range from 1.3%-12.2% in adults (Shalev, Liberzon, & Marmar, 2017) and from 0.5%-15.9% in children and adolescents (Alisic, Jongmans, van Wesel, & Kleber, 2011; Copeland, Keeler, Angold, & Costello, 2007).

Research on mental health problems after traumatic events has become more critical than ever, due to the increasing number of disasters and armed conflicts. One in four children are living in countries affected by armed conflict and disasters and often lack access to medical care, nutrition, and protection (UNICEF, 2019). Most of these children live in low-and middle-income countries, where less priority and resources are targeted at mental health (Themnér & Wallensteen, 2014). Besides, there is a surge of migration from war-torn areas to the developed countries, and the traumatic experiences during and/or after migration increase people's susceptibility to PTSD (Bustamante, Cerqueira, Leclerc, & Brietzke, 2018). Furthermore, increasing evidence has highlighted the risk of transmitting trauma from one generation to another (Sangalang & Vang, 2017).

The development of PTSD has been associated with genetic and environmental risk factors (Banerjee, Morrison, & Ressler, 2017; Koenen, Nugent, & Amstadter, 2008). The environmental factors that are associated with PTSD have been

categorized into three areas: 1) pre-trauma such as lower socioeconomic status, being female, prior personal psychiatric disorders or family psychiatric disorders, childhood trauma, and a history of substance use, 2) peri-trauma, which includes severity, intensity, frequency and duration of trauma, and 3) post-trauma situations, such as social support and life stress (Brewin, Andrews, & Valentine, 2000; Kirkpatrick & Heller, 2014; Tortella-Feliu et al., 2019). Twin studies have reported that monozygotic twins have a significantly higher concordance for PTSD than dizygotic twins, and the heritability estimates range from 30% to 40% (Stein, Jang, Taylor, Vernon, & Livesley, 2002; True et al., 1993). There is growing interest in the role of epigenetic changes, such as DNA methylation in a number of genes (McGowan, 2013; Zannas, Provençal, & Binder, 2015), changes in gene expression (Rampp, Binder, & Provençal, 2014), the HPA-axis (Yehuda et al., 2010) and immune function (Uddin et al., 2010). However, there are still gaps in the literature that limit the understanding of vulnerability and resilience of an individual to trauma exposure and the risk of developing PTSD. We opted to identify environmental risk factors of post-traumatic stress symptoms (PTSS) as investigating genetic risk factors was beyond the scope of this dissertation. Our aim was to identify the risk factors associated with PTSS using two study designs: a longitudinal post-earthquake survey and a Finnish population-based study. The findings of this study could inform policymakers when they are planning cost-effective mental health services and help clinicians to identify individuals who would benefit from early interventions.

1.2   Motivation

This dissertation continues the research I began in my Master thesis (Silwal, 2018) at the University of Oslo, Norway. That research examined the psychiatric symptoms experienced by adolescents who were exposed to the 7.8 magnitude earthquake in Nepal, which caused 8,900 deaths and displaced 450,000 people. I could not contact my family for more than six hours after the disaster. I later found out that they had been safely evacuated to a secure place, but that some of my relatives had lost their lives in the aftermath. This incident shook me to the core and made me appreciate the efforts of the rescue teams and the importance of being prepared for disasters and psychosocial support after the event. I felt that I needed to research the psychological impact of the earthquake on the lives of adolescents. This was particularly important, because health priorities and budgets tend to focus on communicable and non-communicable diseases in countries like Nepal, rather than mental health.

After I completed my Master's study, which focused on the immediate aftermath of the earthquake, I moved to Finland for family reasons. I was interested in continuing the master thesis and follow participants to explore the long-term mental

health effects of the earthquake. I discussed my interest with Professor Andre Sourander and he offered me a PhD position at the University of Turku. He encouraged me to conduct a follow-up study in Nepal and made it possible for me to carry out study of PTSD based on the Finnish registers.

My PhD provided with the opportunity to study a broader perspective of PTSD by using the large datasets that Scandinavian countries like Finland are noted for. Being an immigrant myself, I was interested in exploring the effect of traumatic experiences of parents on their children's well-being. The summer course on Cultural Psychiatry at McGill University, Canada, also deepened my understanding of the complexity of trauma and migration. This course inspired me to explore the relationship between parental migration and the risk of their offspring developing PTSD. It is widely known that migrants, particularly asylum seekers and refugees, experience traumatic events in their host countries and during migration. These trauma experiences could adversely affect the parent-child relationship and increase the risk for psychiatric disorders in the child.

2 Review of the Literature

2.1 Post-traumatic stress

2.1.1 Diagnosis

Trauma is an emotional response after exposure toa catastrophic and life-threatening traumatic event. In the immediate aftermath of trauma, reactions such as fear, anxiety, hopelessness, intrusive memories of the trauma, and trouble sleeping are both normal and normative. These psychological reactions subside over time in most people, but some develop long-term, trauma-related mental health symptoms, known as posttraumatic stress symptoms (PTSS). PTSD is clinically diagnosed when PTSS persists for at least a month after the acute phase of the trauma and continue to cause significant distress (APA, 2013; WHO, 2018).

There are two main systems of classification for the diagnosis of mental disorders: International Classification of Diseases and Related Health Problems (ICD) (World Health Organization, 1992) and the Diagnostic Statistical Manual of Mental Disorders (DSM) (APA, 2013). DSM is the diagnostic manual used for mental disorders in the United States, and the latest version is DSM-V. European countries use the ICD mental disorder classification, developed by the World Health Organization (WHO) for reimbursement purposes and compiling health statistics (WHO, 2019). There are some differences in the criteria used by the two diagnostic classifications to diagnose PTSD (Table 1). In DSM-V, the code for PTSD diagnosis is 309.81, and it is based on 20 qualifying symptoms. The PTSD diagnosis is made on a number of symptoms: one re-experiencing, one avoidance, two cognition-related and mood-related, and two arousal- related and reactivity-related. In ICD-10, a PTSD diagnosis is coded F43.10 and there are 17 symptoms in the diagnostic criteria. ICD-10 refers to the importance of events that would cause distress to almost anyone. The diagnosis is based on one re-experiencing, one avoidance, and one feeling of continued symptoms. The diagnosis relates to symptoms that begin within six months of the event and persist. The latest ICD-11 has recently been released and will come into effect by 2022 (WHO, 2018). In this thesis, PTSD diagnoses were based on ICD-10 in Study III, the Finnish immigration study. Thus, diagnostic criteria of PTSD in the ICD-10 are described in Table 1.

Table 1.   Diagnostic criteria for Post-Traumatic Stress Disorder in DSM-5 and ICD-10.

DSM-5 CRITERIA	ICD-10
309.81 Post-traumatic stress disorder The following criteria apply to children older than 6 years, adolescents, and adults. A. Exposure to actual or threatened death, serious injury, or sexual violence in one (or more) of the following ways: 1. Directly experiencing the traumatic event(s). 2. Witnessing, in person, the event(s) as it occurred to others. 3. Learning that the traumatic event(s) occurred to a close family member or close friend. In cases of actual or threatened death of a family member or friend, the event(s) must have been violent or accidental. 4. Experiencing repeated or extreme exposure to aversive details of the traumatic event(s) (e.g., first responders collecting human remains; police officers repeatedly exposed to details of child abuse). Note: Criterion A4 does not apply to exposure through electronic media, television, movies, or pictures, unless this exposure is work related.	**F43.1 Post-traumatic stress disorder** A. Exposure to a stressful event or situation (either short or long-lasting) of exceptionally threatening or catastrophic nature, which is likely to cause pervasive distress in almost anyone.
B. Presence of one (or more) of the following intrusion symptoms associated with the traumatic event(s), beginning after the traumatic event(s) occurred: 1. Recurrent, involuntary, and intrusive distressing memories of the traumatic event(s). 2. Recurrent distressing dreams in which the content and/or affect of the dream are related to the traumatic event(s). 3. Dissociative reactions (e.g., flashbacks) in which the individual feels or acts as if the traumatic event(s) were recurring. (Such reactions may occur on a continuum, with the most extreme expression being a complete loss of awareness of present surroundings.) 4. Intense or prolonged psychological distress at exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event(s). 5. Marked physiological reactions to internal or external cues that symbolize or resemble an aspect of the traumatic event(s).	B. Persistent remembering or "reliving" the stressor by intrusive flashbacks, vivid memories, recurring dreams, or by experiencing distress when exposed to circumstances resembling or associated with the stressor.

C. Persistent avoidance of stimuli associated with the traumatic event(s), beginning after the traumatic event(s) occurred, as evidenced by one or both of the following: 1. Avoidance of or efforts to avoid distressing memories, thoughts, or feelings about or closely associated with the traumatic event(s). 2. Avoidance of or efforts to avoid external reminders (people, places, conversations, activities, objects, situations) that arouse distressing memories, thoughts, or feelings about or closely associated with the traumatic event(s).	C. Actual or preferred avoidance of circumstances resembling or associated with the stressor (not present before exposure to the stressor).
D. Negative alterations in cognitions and mood associated with the traumatic event(s), beginning or worsening after the traumatic event(s) occurred, as evidenced by two (or more) of the following: 1. Inability to remember an important aspect of the traumatic event(s) (typically due to dissociative amnesia and not to other factors such as head injury, alcohol, or drugs). 2. Persistent and exaggerated negative beliefs or expectations about oneself, others, or the world (e.g., "I am bad," "No one can be trusted," "The world is completely dangerous," "My whole nervous system is permanently ruined"). 3. Persistent, distorted cognitions about the cause or consequences of the traumatic event(s) that lead the individual to blame himself/herself or others. 4. Persistent negative emotional state (e.g., fear, horror, anger, guilt, or shame). 5. Markedly diminished interest or participation in significant activities. 6. Feelings of detachment or estrangement from others. 7. Persistent inability to experience positive emotions (e.g., inability to experience happiness, satisfaction, or loving feelings).	D. Either (1) or (2): (1) Inability to recall, either partially or completely, some important aspects of the period of exposure to the stressor
E. Marked alterations in arousal and reactivity associated with the traumatic event(s), beginning, or worsening after the traumatic event(s) occurred, as evidenced by two (or more) of the following: 1. Irritable behavior and angry outbursts (with little or no provocation) typically expressed as verbal or physical aggression toward people or objects. 2. Reckless or self-destructive behavior. 3. Hypervigilance. 4. Exaggerated startle response. 5. Problems with concentration. 6. Sleep disturbance (e.g., difficulty falling or staying asleep or restless sleep).	(2) Persistent symptoms of increased psychological sensitivity and arousal (not present before exposure to the stressor) shown by any two of the following: a) difficulty in falling or staying asleep; b) irritability or outbursts of anger; c) difficulty in concentrating; d) hyper-vigilance; e) exaggerated startle response.

F. Duration of the disturbance (Criteria B, C, D, and E) is more than 1 month.	E. Criteria B, C and D all occurred within six months of the stressful event, or the end of a period of stress. (For some purposes, onset delayed more than six months may be included, but this should be clearly specified separately.)
G. The disturbance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.	
H. The disturbance is not attributable to the physiological effects of a substance (e.g., medication, alcohol) or another medical condition. Specify whether: With dissociative symptoms: The individual's symptoms meet the criteria for posttraumatic stress disorder, and in addition, in response to the stressor, the individual experiences persistent or recurrent symptoms of either of the following: 1. Depersonalization: Persistent or recurrent experiences of feeling detached from, and as if one were an outside observer of, one's mental processes or body (e.g., feeling as though one were in a dream, feeling a sense of unreality of self or body or of time moving slowly). 2. Derealization: Persistent or recurrent experiences of unreality of surroundings (e.g., the world around the individual is experienced as unreal, dreamlike, distant, or distorted). Note: To use this subtype, the dissociative symptoms must not be attributable to the physiological effects of a substance (e.g., blackouts, behavior during alcohol intoxication) or another medical condition (e.g., complex partial seizures). Specify if: With delayed expression: If the full diagnostic criteria are not met until at least 6 months after the event (although the onset and expression of some symptoms may be immediate).	

2.1.2   History of PTSD

The history of PTSD diagnosis mirrors the history of war. In the American civil war (1861-1865), surgeons found that many patients suffered from what they called - *'soldier's heart'*-, and the symptoms included a rapid pulse, anxiety and trouble breathing (Wooley, 1982). After World War I (1914-1918), soldiers were described as *'shell shocked',* which was changed to *'battle fatigue'* during World War II (Macleod, 2004; Myers, 1915). After World War II (1939-1945), the medical community took war-induced psychological trauma more seriously and called it a *'gross stress reaction'*. This was included in DSM I in 1952, but was then removed from DSM-II in 1968 when it was replaced with adjustment reaction to adult life (Wilson, 1994). It was only about 30 years later, in 1980, that the term *'post-traumatic stress disorder'* was included and defined in DSM-III (APA, 1980). The diagnostic criteria for PTSD was clarified and changed in DSM-III, DSM-III R, DSM-IV, and most recently DSM-V (Pai, Suris, & North, 2017; Wilson, 1994).

In DSM-III and DSM-IV, PTSD was categorized as an anxiety disorder, but PTSD is now classified in a new category, trauma-and stressor-related disorders in DSM-V (APA,2013). The symptoms in this latest version include anhedonic/dysphoric presentations such as negative cognitions and mood swings. Symptoms such as avoidance have been added as one of the required *'diagnostic clusters,'* and negative cognitions, self-denigration, and negative worldviews criteria are highlighted. Post-traumatic stress disorder differs from other anxiety disorders because it is solely caused by experiencing traumatic events.

DSM-IV and ICD-10 have been criticized for the overlap of symptoms of PTSD with depression and anxiety. In contrast, ICD-11 proposes two distinct sibling conditions, PTSD and complex PTSD. Complex PTSD is diagnosed in adults or children who have been exposed to prolonged and recurring traumatic events. It has been suggested that ICD-11 will remove the symptoms common to PTSD and other disorders and that it will comprise six disorder diagnostic criteria. These will be dissociative flashbacks, nightmares, hypervigilance, exaggerated startle response, avoidance of external reminders, and avoiding thoughts and feelings associated with the traumatic events. The duration of the impairment must be at least one month and symptoms onset cannot be delayed more than six months of post-trauma.

When the diagnosis of PTSD was first formulated, it was not believed to occur in children and young people. In the early days, the criteria for PTSD in children were based on adult populations and presentation of symptoms. Some modifications were made after DSM-IV to address symptoms in children and adolescents. DSM-V contains separate PTSD diagnostic criteria for children aged six years or younger. These criteria are developmentally sensitive and focusing on behavior that demonstrates PTSD symptoms (APA, 2013).

There has been less research on traumatic experiences of children and adolescents than adults. Freud and Burlingham were the first to describe the effect of war on children when London was bombed during the Blitz in World War II (Burlingham, 1943). Their writing about children's reactions to the war is the most valuable insight available on the topic even today. The study indicated that being separated from their parents was more disturbing for children than the sight of military destruction, injury, and death. Children who had calm, supportive parents developed resilience than those with anxious parents. Their findings were supported by a study of European refugee children of the Holocaust during World War II (Papanek & Linn, 1975). Further studies later identified potentially traumatic events for children, such as separation from their loved ones and abuse. A study by Giaconia and colleagues (1995) reported that when parents were sent to prison, their children had the same risk of PTSD as those that had been raped. Many studies investigated the risk of PTSD when children were exposed to disasters, school attacks, military operations, and when children and adolescents became refugees (March et al., 1997; Sack et al., 1993; McDermott et al., 2005; Nader et al., 1990; Ahmad et al., 2000; Pynoss et al., 1993).

2.1.3   Epidemiology of PTSD

2.1.3.1   Global distribution

According to the World Mental Health survey, 70% of individuals had been exposed to a traumatic event during their lifetime, and 31% had experienced four or more events (Benjet et al., 2016). The risk of being exposed to trauma was higher in low-income countries compared to high-income countries (Atwoli, Stein, Koenen, & McLaughlin, 2015). The South African Stress and Health survey reported a lifetime prevalence of traumatic events was 73.8% (Atwoli et al., 2013). This was higher than European (Carmassi et al., 2014; Ferry et al., 2014; Olaya et al., 2015) and Japanese surveys (Kawakami, Tsuchiya, Umeda, Koenen, & Kessler, 2014), which ranges from 54-64%. Approximately one-third of individuals exposed to traumatic events develop PTSD. The lifetime prevalence of PTSD in adults has been reported to range from 1.3%-12.2% (Shalev et al., 2017). A large meta-analysis by Alisic et al. (2014) showed that 15.9% of children and adolescents who were exposed to traumatic events developed PTSD. The prevalence of PTSD has been reported to vary with the severity of traumatic events (Kessler et al., 2017), with high rates being reported by rape victims (46.0%), people physically abused by a romantic partner (11.7%) and people who had been kidnapped (11.0%) (Liu et al., 2017; Shalev et al., 2017). In an American study of adolescents aged 12-17 years, 47% had experienced either a sexual or physical assault or witnessed violence (Kilpatrick, 2000).

The estimates for long-term outcomes may vary. More than half of diagnosed PTSD cases may persist for over a year and a minority may persist for decades after the traumatic event. A systematic review by Santiago et al. (2013) reported that the prevalence of PTSD was 25% in adults one month after being exposed to trauma and 17% after one year. On the other hand, some individuals develop symptoms or their symptoms progress and they meet the clinical diagnosis of PTSD more than six months after traumatic events. A systematic review by Utzon-Frank et al. (2014) reported that 5.6% of subjects developed late onset PTSD after being exposed to trauma.

2.1.3.2   Comorbidities and other mental disorders

Individuals exposed to traumatic events are often diagnosed with other psychiatric disorders beyond PTSD. PTSD is commonly comorbid with depression, anxiety disorders, and substance abuse disorders (Copeland et al., 2007; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995; Rytwinski, Scur, Feeny, & Youngstrom, 2013). About half of the people with PTSD were diagnosed with depression (Rytwinski et al., 2013). According to Copeland et al. (2007), 37% of adolescents with PTSS had a diagnosis of depression during their lifetime, compared to 7% of adolescents without PTSS. The co-occurrence of these two diagnoses could partly be explained by the overlap of the symptom criteria for PTSD and depressive disorders in DSM-IV and DSM-5 (Flory & Yehuda, 2015). However, even in ICD-11, where the symptoms overlap is minimal, the co-occurrence of PTSD and depression has been reported (Barbano et al., 2019). Depressive symptoms can exacerbate distress in people who suffer from PTSS and vice-versa (Stander, Thomsen & Highfill-McRoy, 2014).

PTSD could be expressed differently in adolescents. They may engage in traumatic play or reenactment and are more likely to exhibit impulsive and aggressive behaviors than younger children or adults. A review of sexually abused children with PTSD, also identified problems with fear, anxiety, depression, sexually inappropriate behavior, aggression, self-destructive behavior, feeling of isolation, and substance abuse (Driscoll & Flanagan, 2015). Other disorders in children and adolescents with PTSD include attention-deficit/hyperactivity disorder, oppositional defiant disorder, and conduct disorder (Danielson et al., 2010; Biderman et al., 2013). The comorbid disorders occurring before exposure to any traumatic event increase the risk of developing PTSD when exposed to trauma (DiGangi et al., 2013). Other disorders might be triggered by exposure to the trauma or to secondary stressors. This makes it difficult for an individual to adjust and elevates distress and dysfunction.

2.2 Disasters

Disasters are sudden, calamitous events causing massive destruction, loss of human life, material, economy, and environment that are beyond the community's ability to cope using its own resources (International Federation of Red Cross and Red, Crescent Societies, 2015). Disasters can be natural, such as earthquakes, floods, and tsunamis, or technological or man-made hazards, such as conflicts, famine, industrial and transport accidents. Some disasters result from a combination of both natural and man-made factors causing a complex emergency, such as epidemics, food insecurity, conflicts and displaced populations. People exposed to complex emergencies are vulnerable in the sense that they have diminished capacity to anticipate, cope, resist and recover from the impact of disasters. Exposures to disasters causes trauma and affect one's belief about future as they experience loss of hope, uncertainty, limited expectations about life and fears that their life will end abruptly or early. When people are exposed to multiple traumatic events, their risk of developing psychiatric disorders increases throughout their lifespan (Johnson & Thompson, 2008).

On average, disasters affect 350 million people each year and cause billions of US dollars of damage (UNOCHA, 2019). Climate change has also triggered increased mortality and morbidity as a result of climate-sensitive disasters (Handmer et al., 2012). The consequence of community-wide disasters can be severe and long-lasting both during and after the disasters. Research has shown an association between exposure to disasters and the risk of developing mental health problems (Norris et al., 2002). According to the WHO, about 20% of the population faces an increased risk of developing mental health problems after any disaster (IASC Reference Group on Mental Health and Psychosocial Support in Emergency Settings, 2012). Today, one in four children live in countries that are affected by conflicts and disasters, which have a significant impact on the mental health, social well-being and economy of those countries (UNICEF, 2019). A strong association has been established between exposure to disasters and the development of PTSS (Lai et al., 2017).

2.2.1 Earthquakes and PTSS among children and adolescents

Earthquakes are one of the most destructive natural disasters caused either by earth's crust shifting or by volcanic activity. The sudden release of violent ground energy is felt as seismic waves that destroy everything that sits above it. The main event is often followed by violent aftershocks that cause more damage and are a further threat to life. When an earthquake strikes, there is little time to prepare, and people's survival is more likely to depend on the strength of the building they are in and the

time of the day. The weather also plays an important role, as earthquakes can trigger avalanches or mudslides. The Global Earthquake Model Foundation has listed 15 countries that account for most of the death and destruction caused by earthquakes, such as China, Japan, Iran, Indonesia, Nepal, Turkey, Mexico, etc. (Silva, Pagani, Schneider, & Henshaw, 2018). The impact of earthquakes can be vast and particularly for children and adolescents, due to their developmental status and their risk of developing psychological problems, including physical harm and emotional burdens (Kolaitis et al., 2003). The risk for mental disorders in childhood can persist or even become more severe, until adulthood. The impact of earthquakes is much higher in developing countries than developed countries due to poverty, the poor structural quality of buildings and the lack of earthquake preparedness (Naeem et al., 2011). After any earthquake, where relief and rescue efforts and emergency services are needed, research lacks behind. Conducting any research after an earthquake is complicated, and this means that the timing of studies varies widely. However, it is important to understand the scale of the problem to plan and provide necessary psychosocial support.

Over the past few decades, a growing number of studies have investigated the psychosocial effect of earthquakes (Dai et al., 2016; Tang, Bihan, Deng, Glik, Dong, & Zhang, 2017). In a metanalysis by Tang et al. (2017), the prevalence of PTSD after earthquakes ranged from 4.1%-67.1% in adults and from 2.5%-60.0% in children. Depression was the second most commonly reported psychological problem after earthquakes, with prevalence rates ranging from 11.3%-81.0% within the first year after the disaster and between 5.4%-76.0% after one year had passed (Wang, Chan, & Ho, 2013).

2.2.2   Cross-sectional studies on earthquake exposure and psychiatric symptoms among adolescents

Table 2 summarizes the findings of previous cross-sectional studies on mental health problems in adolescents after earthquakes. The prevalence of PTSD and/or symptoms varied widely, ranging from 2.5%-76.0% (Dogan, 2011; Ma et al., 2011) and depression ranged from 4.8%-64.5% (Qi, Yang, Tan, Wu, & Zhou, 2019; Schwind et al., 2018). The variation in rates could be attributed to methodological differences such as psychiatric symptoms assessed by self-reports (Jin, Deng, An, & Xu, 2019; Sharma & Kar, 2019; Xu, Wang, Zhao, Tang, & Lu, 2019) or clinical interview (Feo et al., 2014; Ma et al., 2011). Similarly, the time between the earthquakes occurring, and the assessments being carried out could be another possible reason for the different rates. A study carried out 6-20 weeks after the 1999 Marmara earthquake showed that the prevalence rates of PTSD and depression were 60% and 31%, respectively (Ekşi et al., 2007). On the other hand, another study carried out three years after the 2013 Lushan

earthquake reported that 21.7% of adolescents had developed PTSD and 31.7% had developed depressive symptoms (Xu et al., 2019).

Most of the studies were conducted in schools (Cénat & Derivois, 2015; Ekşi et al., 2007; Fan, Fang, Zhang, Yang, Mo, & Liu, 2011; Forresi et al., 2019; Giannopoulou et al., 2006; Goenjian et al., 1995; Hsu, Chong, Yang, & Yen, 2002; Liu, Jing, & Chen, 2016; Ma et al., 2011; Pan et al., 2015; Roussos et al., 2005; Tang, Lu, & Xu, 2018; Xiao, Liu, Liu, & Jiang, 2019; Xu et al., 2019; Ying, Wu, Lin, & Chen, 2013; Zhang et al., 2012; Zheng, Fan, Liu, & Mo, 2012). A small number were conducted in communities (Acharya, Bhatta, & Assannangkornchai, 2018; Ayub et al., 2012; Jia et al., 2010; Schwind et al., 2018), with street children (Derivois, Daniel, Cénat, Joseph, Karray, & Chahraoui, 2017), in the displaced area (Küçükoğlu, Yıldırım, & Dursun, 2015; Qu et al., 2014) and in clinical settings (Feo et al., 2014). A study by Derivois et al. (2017) reported that 14.9% of street children PTSD symptoms four years of the 2010 Haiti earthquake, while 29.7% showed depressive symptoms. Another study by Küçükoğlu, Yıldırım, and Dursun (2015), which was conducted in adolescents living in the displaced area, reported that 24% of them developed PTSD symptoms.

Previous studies showed various risk factors associated with PTSD and depressive symptoms. Female gender was an important predictor for PTSD and depressive symptoms (Duffy et al., 2015; Fan et al., 2011; Giannopoulou et al., 2006; Jin, Deng, An, & Xu, 2019; Pynoos et al., 1993; Qi et al., 2019; Qu et al., 2014; Sharma & Kar, 2019; Wang et al., 2012; Xu, Wang, & Tang, 2018; Xu et al., 2019). However, the effect of age on the development of PTSD was inconsistent. Older age was associated with PTSD in some studies (Fan et al., 2011; Liu et al., 2016), while other studies came to the opposite conclusion (Ayub et al., 2012; Jin, Deng, An, & Xu, 2019). In terms of trauma factors, such as being trapped or injured or buried were associated with PTSD (Forresi et al., 2019; Qi et al., 2019; Xu et al., 2019). Loss of family members, classmates and relatives was another important predictor for PTSD (Fan et al., 2011; Forresi et al., 2019; Hsu et al., 2002; Jia et al., 2010; Liu et al., 2019; Tang et al., 2018; Tian, Wong, Li, & Jiang, 2014; Xiao et al., 2019; Zheng et al., 2012). Furthermore, adolescents living near the epicenter of the earthquake or in high impact area were more likely to develop PTSD and depressive symptoms (Feo et al., 2014; Forresi et al., 2019; Goenjian et al., 1995; Pynoos et al., 1993; Xu et al., 2019; Zheng et al., 2012). The degree of property loss was another predictor for PTSD and depressive symptoms in adolescents (Qi et al., 2019; Tian et al., 2014; Zhang, Weiqing, Jiang, Ho, & Wu, 2011; Zhang et al., 2010). Some studies showed that adolescents with previous exposure to trauma faced an increased risk of PTSD symptoms (Cénat & Derivois, 2015; Liu et al., 2016). In addition, post-trauma conditions like negative life events and traumas were associated with PTSD and depressive symptoms (Tang et al., 2018).

Table 2. Cross-sectional studies on PTSS and depressive symptoms after earthquakes among children and adolescents.

S.N	Author, publication year, country	Sample size, age range, sample characteristics	Earthquake's name and year	Instruments	Time after disaster	Results	Measures of association and risk of PTSD or PTSS	Measures of association and risk of depressive symptoms
1	(Qi et al., 2019) China	1241 Age:14.69 (SD 1.56) (12-19 years) Sample: School (1 middle and 1 high school)	Jiuzhaigou earthquake 2017	PTSD checklist for DSM-V CEC-DS	1 year	PTSD-46.3% Depression-64.5% Comorbid-39.2%	Female, having been self-injured or trapped, loss of property and intrusive rumination	Female, having been self-injured or trapped, intrusive and deliberate rumination
2	(Forresi et al., 2019) Italy	682 Age: 9-14 years Sample: 10 schools earthquake zone vs control zone	Northern Italy earthquake 2012	UCLA PTSD-Index for DSM-IV	2 years	PTSD Earthquake zone: 1.94% Near the epicenter:4.4%	Lifetime trauma (death of a relative), degree of earthquake exposure, parental psychopathology	
3	(Xu et al., 2019) China	2447 Age:13-18 years Sample: 11 Schools	Lushan earthquake 2013	CRIES-13 KADS-6	3 years	PTSD- 21.7% Depression-31.6%	Gender, earthquake exposure, living in Lushan city, other caregiver (except parents and grandparents)	Gender, older age, earthquake exposure, living in Lushan city, caregiver (except parents and grandparents), longer duration of being left behind
4	Xiao et al., 2019 China	867 Age:11-18 years Sample: 5 schools, one city	Yushu earthquake 2010	PTSD Checklist-Civilian Version	3 years	PTSD: 24.4%	Having been buried/injured/amputated, witness burial/injury/ death, property damage, negative coping style	

5	Jin et al., 2019 China	3962 Age: 12-18 years Sample: School, Left-behind child (LBC) vs non-LBC	Ya'an earthquake 2013	CRIES SMFQ	3 years	PTSD symptoms:13.1% Depression symptoms 20.8%	Being female, being aged less than 15, having siblings, being an LBC, and having higher exposure	Being female, being aged less than 15, having siblings, being an LBC, and having higher exposure
6	Liu et al., 2019 China	1125 Sample: Schools (2 junior high)	Wenchuan earthquake 2008	Self-rating manual of DSM-IV CCMD-2-R	4 years	PTSD: 23.4%	Older age, death or injury of a family member in the earthquake, Self-esteem (protective)	
7	Sharma & Kar, 2019 Nepal	409 Age: 12-19 years Sample: School	Nepal earthquake 2015	CPSS DSRS	1 year	PTSD: 43.3% Depression:38.1%	Female, joint family, financial problems, displacement, injury or being trapped, damaged to livelihood, fear of death	
8	Schwind et al., 2018 Nepal	62 Age: 8-17 years Sample: Household survey	Nepal earthquake 2015	CPSS DSRSC	1 year	PTSD symptomatology: 3.2% Depression symptomatology: 4.8%	Earthquake exposure (family member seriously injured)	Earthquake exposure (family member seriously injured)
9	Tang, Liu & Xu, 2018 China	6132 Age: 9-18 years Sample: School 11 primary and secondary (3 counties)	Ya'an earthquake 2013	CRIES-13 SMFQ	3 years	PTSD: 13.1% Depression: 19.8%	Feeling extremely scared, injured, parents injured, witnessed bloody injuries, lost loved one, trouble falling sleep disturbance, nightmares, high negative life events, daytime dysfunction	Feeling extremely scared, witnessed bloody injuries, subjective quality of sleep, more than 5 hours of sleep, trouble falling sleep disturbance, nightmares, high negative life events, daytime dysfunction

10	Xu, Wang & Tang, 2018 China	3851 Age: 13-18 years Sample: School 11	Lushan earthquake 2013 and Wenchuan earthquake 2008	CRIES-13	3 years	PTSD: 14.1% (among all) 15.9% - experienced both Lushan and Wenchuan earthquake 11.3% -only experienced Lushan earthquake	Female, feeling scared of dying, trapped, injured, witnessed someone trapped, witnessed someone injured, relative death, witnessed death, exposure to Wenchuan, post-earthquake, negative life events (interpersonal issues, academic stress, health adaptation)	
11	Acharya et al., 2018 Nepal	800 Age: 7-16 years Sample: community-based	Nepal earthquake 2015	CPSS	1 year and 3 months	Moderate-to-severe PTSD symptoms: 51%	Severely affected by earthquake, attending low-secondary school, school age, low psychosocial acuity	
12	Derivois et al., 2017 Haiti	128 Age: 7-18 years Sample: Street children from rehabilitation centers or streets	Haiti earthquake 2010	PDI CRIES-13 CDI	4 years	PTSD symptoms: 14.9% Depression symptoms: 29.7%	Age, peritraumatic distress, endured violence, have been in domesticity	Age, exposed to traumatic life events before earthquake, exposed to traumatic life events after earthquake, peritraumatic distress, family violence experienced

13	Liu et al., 2016 China	4072 Age: 12-18 years Sample: Schools 5	Yushu earthquake 2010	PTSD Checklist-Civilian version	3 years	PTSD-17.8%	Being aged 14 or older, being senior student, being monitor, being buried/injured, have family member died/amputated, have severe property loss, have witnessed death, have negative coping skills, and have power others locus of control	
14	Cénat & Derivois, 2015 Haiti	872 Age:7-12 years Sample: Schools and rehabilitation centers	Haitian earthquake 2010	IES-R CDI	30 months	PTSD-36.9% Depression-46.2%	Age, sex, traumatic experience before and after earthquake insignificant	Age and Sex significant Insignificant-traumatic experience before and after earthquake
15	Küçükoğlu, Yıldırım, Dursun, 2015 Turkey	304 Age: 7-12 years Sample: Children living in displaced area	Vane earthquake 2011	CPTS-RI interview	3 months	PTS Mild-8.6% Moderate-19.7% Severe- 47.7% Very severe-24.0%		
16	Pan et al., 2015 China	373 Age:11-16 years Sample: School (2 junior high)	Wenchuan earthquake 2008	IES-R Zung Self-rating Depression Scale	3 years	PTSD:29.6% Depression:44.8%	Having witnessed someone being killed, family members being killed, close friends seriously injured or being killed, felt scared	Having witnessed someone seriously injured, felt scared
17	Tian et al., 2014 China	4604 Age: 15.0 (SD: 1.84) Sample: Schools 3	Wenchuan earthquake 2008	PCL-C	3 years	PTSD:5.7%	Loss of houses and property, being injured, deaths of family members, witness of death, no physical exercise, without social support	

18	Feo et al., 2014 Italy	1839 Age:3-14 years Sample: Clinical	L'Aquila earthquake 2009	CBCL YSR	1 year	PTS Epicenter- 8.4% Remainder earthquake zone- 4.0% Unaffected area- 2.2%	Living in the epicenter, child or maternal history of mental health care prior to earthquake	
19	Ying et al., 2013 China	3052 Age:8-19 years Sample: Schools 20	Wenchuan earthquake 2008	CPSS CES-DC	1 year	PTSD: 8.6% Depression:42.5%	Age, female, direct exposure, living location, prior witnessing trauma, close one's exposure, fear of safety of close ones, house damage	Age, female, living location, prior witnessing trauma, close one's exposure, fear of safety of close ones, house damage, direct exposure
20	Wang, 2012 China	1841 Age: 11-20 years Sample: 1 School in rural area	Wenchuan earthquake 2008	CRIES-13 DSRSC	10 months	PTSD: 28.4% Depression:32.7%	Having felt despair, or danger, having own house destroyed or damaged	Female, delayed evacuation in female, earthquake related experiences in males
21	Zheng et al., 2012 China	2250 Age:11-14 years Sample: Schools 2	Wenchuan earthquake 2008	PTSD-SS	6 months	PTSD: Mean 37.4 (SD 13.9)	Female, family residence, casualties of family members, property loss, witness of tragic disaster, interpersonal conflicts, academic pressure, being punished physical health problems	
22	Ayub et al., 2012 Pakistan	1154 Age: 7-16 years Sample: Household	Pakistan earthquake 2005	CRIES-13	2 years	PTSD: 64.8%	Young age, living in tent	

23	Zhang et al., 2011 China	1976 Age:12-20 years Sample: School	Wenchuan earthquake 2008	PCL-C	3 months	PTSD: Mean score 33.6 (SD 11.2)	Property loss, witnessed death, gender, injured, low grade, psychological consultation, friend's death, father's death or missing, chance locus of control, power other locus of control, withdrawing skill, social support	
24	Ma et al., 2011 China	3208 Age:12-18 years Sample: 3 middle schools	Wenchuan earthquake 2008	DSM-IV	6 months	PTSD: 2.5%	Female, being buried/injured during the earthquake, having parents who were severely injured, having classmate(s) who died, having a house destroyed, witnessing someone buried/wounded/dying during the earthquake	
25	Dogan, 2011 Turkey	695 Age: 12-17 years Sample: Schools 3 regions High, medium and low impact	Marmara earthquake	CPTSD-RI	13 months	Moderate to very severe PTSD:76%	Female, disruptions in daily living, perceived life threat, number of life-threatening events	
26	Fan, 2011 China	2081 Mean age: 14.5 (boys) and 14.6 years (girls) School-based	2008 Wenchuan earthquake	PTSD-SS DSRS	6 months	PTSD: 15.8 % Depression: 24.5%	Female, Age ≥ 15 years, Family member injured or killed, directly witnessed to earthquake	Female, Age ≥ 15 years, Family member injured or killed

27	Jia et al., 2010, China	596 Age: 8-16 years Sample: Household sample	Sichuan earthquake 2008	CPTSD-RI CDI	15 months	PTSD: 12.4% Depression: 13.9%	Loss of family members, guilt on someone's' death or injury, been in serious danger, seriously injured, witnessed someone killed or seriously injured, lost significant others, lost important belongings, no utilization of mental health services	Loss of family members, been in serious danger
28	Eksi et al., 2007 Turkey	160 Age: 9-18 years Sample: School	Marmara earthquake 1999	CAPS	6-20 weeks	PTSD:60.0% Depression: 31%	Witnessed death, experienced extreme parental reaction	Male, high trait anxiety score, sustain injury, lost family member in earthquake
29	Giannopoulou et al., 2006 Greece	2037 Age: 9-17 years Sample: Schools 24	Athens earthquake 1999	CRIES-13 DSRS CDI	6 months	PTSD: Direct exposure:35.7% Indirect exposure:20.1%	Female, perceived life threat, post-earthquake adversity	Female, perceived life threat, post-earthquake adversity
30	Roussos et al., 2005 Greece	1937 Age: 9-18 years Sample: Schools 13	Athens earthquake 1999	UCLA PTSD index DSRS	3 months	PTSD: 4.5% Depression: 13.9%	Depression, subjective and objective earthquake-related experiences, difficulties at home	PTSD reaction index score, gender
31	Hsu et al., 2002 Taiwan	337 Age: 12-14 years Sample: 2 Schools 2	Taiwan 1999	SCL-90-R ChIPS	6 weeks	PTSD: 21.7%	Being physically injured, experiencing the death of a close family member	

| 32 | Goenijian et al., 1995 Armenia | 218 Age:Mean Siptak: 13.7 Gumri: 13.1 Yerevan-12.1 Sample: Schools 8. 3 cities | Armenia earthquake 1988 | CPTSD-RI DSRS | 11 /2 years | PTSD: Mean (SD) Siptak: 54.2 (8.1) Gumri: 44.4 (9.8) Yerevan-33.6 (10.5) Depression: Mean (SD) Siptak: 19.2 (3.9) Gumri: 16.4 (5.5) Yerevan:12.9 (5.4) | High impact cities | |
| 33 | Pynos et al., 1993 Armenia | 231 Age: 8-16 years Sample:Schools | Armenia earthquake 1988 | CPTSD-RI DSM-III | 18 months | PTSD: 70.3% | High impact area, female | |

CEC-DS, Chinese version of the Center for Epidemiologic Studies Depression Scale for Children; PCL C, PTSD Check List Civilian Version; SZDS, Self-Rating Depression Scale; CRIES-13,Children's Revised Impact of Event Scale; KADS-6, Kutcher Adolescent Depression Scale; DSRS, Depression Self-Rating Scale; CPSS, Child PTSD Symptom Scale; LBC, Left-behind child; SMFQ, short mood and feelings questionnaire; CCMD-2-R, Chinese Classification and Diagnostic Criteria of Mental Disorders; CDI, Children Depression Inventory; PDI, Peritraumatic Distress Inventory; CBCL, Child Behavior Checklist; IES-R, Impact of Event Scale-Revised; CPTS-RI, Childhood Post-Traumatic Stress Reaction Index; CAPS, Clinician-Administered Post-traumatic Stress Disorder Scale; PTSD-SS, Post-traumatic Stress Disorder Self-Rating Scale; CPTSD-RI, CPTSD-RI, Child Posttraumatic Stress Disorder Reaction Index; CES-DC, Center for Epidemiologic Studies Depression Scale for Children; PTSD-SS, Posttraumatic Stress Disorder Self-Rating Scale.; CPTSD-RI, Child Posttraumatic Stress Disorder Reaction; CPAS, Clinician-Administered Post-Traumatic Stress Disorder Scale; SCL-90-R, Symptom Checklist-90-Revised; ChIPS, Children's Interview for Psychiatric Syndromes.

2.2.3 Longitudinal studies on earthquake exposure and change in psychiatric symptoms among adolescents

Table 3 summarizes the findings of previous longitudinal studies on the mental health consequences of earthquakes on adolescents. Relatively few longitudinal studies addressed mental health problems compared to cross-sectional studies. Of the total 13 studies we identified, eight studies showed a decline in PTSS after the aftermath of earthquakes (Geng et al., 2019; Jin & Li, 2015; Liu et al., 2010; Sahin, Batigün, & Yilmaz, 2007; Tang et al., 2017; Zhang et al., 2012) while two studies showed persistent of symptoms (Jia et al., 2013; Shi, Yu, Zhou, Geng, & Fan, 2016). Only one study by Liu et al. (2011) conducted at six and 12 months after the 2008 Sichuan earthquake reported an increase in the prevalence of PTSD and depressive symptoms between these two time points. However, the prevalence rates have varied widely between studies. Du et al. (2019) reported that PTSD was 11.2% when it was measured 36 months after the 2008 Wenchuan earthquake, while another study by Jia et al. (2013) stated that it was 10.7% in their study cohort after the same time period. The prevalence rates of PTSD 12 months after the 2008 Wenchuan earthquake also showed considerable variations, including 43.9% (Tang et al., 2017); 1.3% (Zhang et al., 2012), 13.4% (Liu et al., 2011) and 5.7% (Liu et al., 2010). These differences could have been due to variations in diagnostic measurements and data collection of adolescents from different age groups. The age range varied from 12-20 years. Various measures were used across studies to measure PTSS, such as Trauma Symptom Checklist For Children, Kiddie Schedule for Affective Disorders and Schizophrenia, Children's Revised Impact of Event Scale, PTSD Checklist–Civilian Version, Child Posttraumatic Stress Disorder Reaction Index.

The prevalence of depression increased in some studies (Liu et al., 2011; Tang et al., 2017) and decreased in others (Jin & Li, 2015; Zhang et al., 2012). No significant change were observed in some studies (Jia et al., 2013; Shi et al., 2016). However, in Du et al. (2019), the rate was 32.3% one month after the earthquake, had declined by 12 months (20.1%), spiked at 24 months (31.0%) and had decreased again at 36 months (30.3%). A similar trend was observed by Chui et al. (2017) study, the prevalence was higher at 12 months (42.9%) than six months (27.3%) and 18 months (33.3%).

Of the 13 studies, summarized in Table 3, 11 were from China, one study was from Greece, and one was from Turkey. The assessment time varied from two weeks (Zhang, Ye, Zhang, Zhu, Du, & Zhang, 2017) to 36 months after earthquakes (Du et al., 2019; Jia et al., 2013). Being female was associated with PTSS and depression in some studies (Chui et al., 2017; Du et al., 2019; Geng et al., 2019; Jia et al., 2013; Shi et al., 2016; Zhang et al., 2012), but no association was observed in other studies (Goenjian et al., 2011; Jin & Li, 2015; Liu et al., 2011; Liu et al., 2010; Tang et al., 2017). The degree of exposure, such as being trapped or buried, and bereavement,

were associated with psychiatric symptoms three years after the earthquake (Geng et al., 2019; Jin & Li, 2015; Liu et al., 2011; Tang et al., 2017). Witnessing someone being killed or seriously injured was another risk factor for PTSD and depression among adolescents (Liu et al., 2011; Tang et al., 2017). Property loss increased the risk of PTSD and depression in adolescents, even years after the earthquake (Chui et al., 2017; Geng et al., 2019; Liu et al., 2010; Sahin et al., 2007; Zhang et al., 2012). A Chinese study showed that being an only child and lack of social support 30 months after an earthquake increased the risk for depression in adolescents (Shi et al., 2016). In some studies, depressive symptoms at an earlier phase predicted PTSD later and vice versa (Goenjian et al., 2011; Jia et al., 2013; Zhang et al., 2012). Other risk factors for PTSD and depression were extreme fear (Liu et al., 2010), the frequency of trauma reminders in the past month (Goenjian et al., 2011), and length of living in a transferred safe place after the earthquake (Du et al., 2019).

Table 3. Longitudinal studies on PTSS and depressive symptoms after earthquakes among children and adolescents.

SN	Author, publication year, Country	Sample size, age range, sample characteristics	Earthquake's name And year	Instruments	Time after disaster (months)	Results	Measures of association and risk of PTSD or PTSS	Measures of association and risk of depressive symptoms
1	Du et al., 2019 China	1m-1643 12m-330 36m-294 Age:16.3 (SD 1.04) years Sample: 1 school	Wenchuan earthquake 2008	R-IES DSRSC	1m 12m 24m 36 m	PTSD 1m-42.2% 12m-20.1% 24m-30.3% 36m-11.2% Depression 1m-32.3% 12m-20.7% 24m-31.0% 36m-30.3%	Female, witnessed collapse, severity of family's injury, length of living in transferred safe place	Female, family relation, felt despair or not
2	Geng et al., 2019 China	6m-1573 18m-1341 Sample: 2 schools (1 junior high and 1 senior high)-1 city	Wenchuan earthquake 2008	PTSD-SS DSRS	6m 18m	PTSD 6m:18.9% 18m:13.57%	PTSD At 6m-Female, death or injury of family members, property loss, direct witness of tragic scenes At 18 m- non-only children, death or injury of family members, direct witness of tragic scenes	
3	Tang et al., 2017 China	435-12m 153-30m Age: 13.7 (SD 2.3) years Sample: Schools 6 (2 primary, 2 secondary, 2 high school)	Ya'an and Wenchuan earthquake	Kiddie-SADS DSM-IV	12m 30m	PTSD 12m-43.9% 30m-15.7% Depresssion12m-20.9% 30m-21.6%	Witnessing someone getting seriously injured, witnessing someone getting killed, economic pressure or poverty quarreling with parents or feeling neglected	Witnessing someone getting buried or seeing a dead body losing a family member, economic pressure or poverty quarreling with parents or feeling neglected

4	Zhang et al., 2017 China	1623 Age: 8-19 years Sample: 21 schools (primary and secondary)	Lushan earthquake 2013	CRIES	2 weeks 3m 6m	no PTSD to PTSD: 8% PTSD to no PTSD:20% Persistent PTSD 3m-29.6% 6m-16.4%	Being female, sedentary lifestyle, actively helping, initiating communication with other, actively playing with classmates and friends, and the ability to concentrate on academic studies after resuming class	
5	Chui et al., 2016 China	548 Sample: School 1	Wenchuan earthquake 2008	PCL-C BDI	6m 12m 18m	Depression: 6m-27.3% 12m-42.9% 18m-33.3%		Being female, trauma-related self-injury, loss of family property, hope to move out, depression symptoms, suicidal ideation and PTSD symptoms at 6-month predicted depression at 18 month follow-up
6	Shi et al., 2016 China	1573 Age: 15±1.3 years Sample: School 2 high school	Wenchuan earthquake 2008	DSRSC	6m 30m	Depression 6m:27.5% 30m:27.2%		At 6m-Being female, witnessed disaster, negative life events, social support, dispositional resilience At 30m-being female, being only child, negative life events and social support at 24m, dispositional resilience at 6m
7	Jin et al., 2015 China	6m-459 24m-291 Age:12-20 years Sample. 1 high school	Yushu earthquake	PCL-C	6m 12m	PTSD 6m-10.9% 24m-5.8%	Bereavement, being buried in the ruins, and personal injury	

8	Jia et al., 2013 China	596- 15m 430-36m Age:8-16 years Sample: Community-based	Sinchuan Earthquake 2008	CPTSD-RI CDI	15 m 36 m	No significant change PTSD 15m-12.4% 36m-10.7% Depression 15m-13.9% 36m-13.5%	At 36m-female, Depression, subjective experiences, earthquake-related loss	PTSD, perceived social support
9	Zhang et al., 2012 China	737-6m 685-12m 548-18m Age. 16.86 (SD 0.58) years Sample: 1 high school	Wenchuan Earthquake Wenchuan earthquake 2008	PPCL-C BDI	6 m 12 m 18 m	PTSD: 6m-9.7% 12m-1.3% 18m-1.6% Depression 6m- 39.4% 12m-36.9% 18m-29.4%	6m-Depression, Gender, 12m-gender, home damage, depression, only-child 18m- Depression, only-child	
10	Goenjian et al., 2011 Greece	549-3m 511-32m Age: 13-18 years, Sample: 13 schools	Parnitha earthquake 1999	UCLA PTSD-RI, DSRS	3 m 32 m	Mean PTSD scores subsided to mild levels-8.8% Depression-13.6%	Depression at 3m, frequency of experiencing reminders of earthquake, Having being seriously hurt or ill since earthquake	PTSD-RI score at 3-months, financial difficulties, female, education level, someone close got seriously hurt or ill
11	Liu et al., 2011 China	330 Mean age: 10.36 (SD 0.98) years Sample: 1 school	Sichuan Earthquake 2008	TSCC-A	6m 12m	PTSD 6m-11.2% 12m-13.4% Depression 6m-14.5% 16.1%	At 6m: grade 4 and 5, bereavement, witnessed death Extreme fear At 12m: extreme fear	At 6m: Being injured, bereavement, witness death, extreme fear At 12m: Being injured, bereavement, extreme fear
12	Liu et al., 2010 China	1474 Age:13-17 years Sample: 3 secondary schools	Wenchuan earthquake 2008	PCL-C	4m 6m 9m 12m	PTSD 4m-11.2% 6m-8.8% 9m-6.8% 12m-5.7%	School proximity to epicenter, time duration, grade, nationality, parent injury, severe property damage	

| 13 | Sahin et al., 2007 Turkey | 948 275 Age: 12-16 years Sample: 13 schools in 9cities | İzmit earthquake 1999 | R-IES BSI | 8m 11m | PTSD 8m-7.7% 11m-6.90% Depression Mean, 8m-10.93(SD 8.76) 11m-9.89 (9.6) | | |

PTSD, Post-traumatic Stress Disorder; CRIES, Children's Revised Impact of Event Scale; Kiddie-SADS, Kiddie Schedule for Affective Disorders and Schizophrenia; DSM, Diagnostic and Statistical Manual of Mental Disorders; PCL-C, PTSD CheckList – Civilian Version; BDI, Beck Depression Inventory; CPTSD-RI, Child Posttraumatic Stress Disorder Reaction Index; CDI, Children Depression Inventory; TSCC-A, Trauma Symptom Checklist For Children; R-IES, Revised impact of events scale; BSI, Brief Symptom Inventory; DSRS, Depression Self-Rating Scale; PTSD-SS, PTSD Self-rating Scale; DSRSC, Depression Self-Rating Scale for Children.

2.3   Migration and PTSD

Migration is a universal phenomenon that has existed as long as human beings have lived on the earth. People have migrated in search of food, shelter, or, most importantly, to find a better future. The process of migration is heterogeneous. Some people migrate to study or to seek better employment or to marry, while others are forced to relocate due to political and/or religious persecution. Historically, the reasons for migration influence how people adjust and respond to stressors during and after migration. There are pull factors that encourage people to migrate, such as economic opportunities, climate, safety. Other are push factors, which forced people to migrate, such as war or disasters. In 2018, almost 70.8 million individuals were displaced worldwide due to conflicts, human rights violations, violence or persecution. This was an increase of 2.3 million in the past year (UNHCR, 2019). The push factors that force individuals to move or become displaced are greatly affected by traumatic experiences (Morina, Akhtar, Barth, & Schnyder, 2018).

Migration is a stress-inducing process and it can heighten the risk of mental health problems (Bhugra, 2004). The adverse life events, bereavement issues related to loss of family members, relationships, assets, and support are relevant to understand the impact of migration (Chen, Hall, Ling, & Renzaho, 2017). On the other hand, even after migration, factors such as socioeconomic status, social context, and host country environment has found to play an important role in the social integration and mental health of immigrants (Bogic, Njoku, & Priebe, 2015). Ødegaard (1932) proposed an explanation of *'selective migration'* based on the findings of an increased risk of schizophrenia in Norwegian migrants to the USA. He explained that Norwegians who migrated had disturbed personalities that prevented them from socially adapting in their own country and encouraged them to emigrate. However, many studies have opposed this theory (van der Ven et al., 2015; Pedersen et al., 2011; Selten et al., 2002). Van der Ven et. al. (2015) reported that low intelligence quotient and poor social adjustment were less prevalent in people who left Sweden than those who did not. They also had a low prevalence of non-affective psychotic disorders. On the other hand, there appears to be a -'healthy-immigrant effect'- paradox that explains why recent immigrants tend to be in better health than the native population in their own country (Beiser & Hou, 2001; Bollini & Siem, 1995). Some of the explanations for the healthy-migrant effect could be the presence of external screening and medical examinations in the host country. Moreover, only healthy population in their best health can migrate and the fact that healthy people opt to have good habits (no smoking nor drinking) (Kennedy, Kidd, McDonald, & Biddle, 2015). Unhealthy migrants may be more unlikely to migrate or even if they migrate, they return to their own home countries. However, the effect seems to disappear the longer they stay in their host country. Studies have found that health of migrants deteriorate with additional years in the host country (Kearns,

Whitley, Egan, Tabbner, & Tannahill, 2017). Longer stay in the host country could increase psychological distress in immigrants due to factors such as lack of social support, separation from family members, reflecting on past traumatic experiences, language barriers, cultural differences, increasing racism, perceived discrimination and differences in socio-economic or social defeat (Guajardo et al., 2016; Selten, van der Ven, Rutten, & Cantor-Graae, 2013; Kirmayer et al., 2011).

In recent decades, a growing number of studies have shown links between migration and psychiatric disorders, such as PTSD (Fazel., Wheeler, & Danesh, 2005; Foo et al., 2018; Selten, Cantor-Graae, & Kahn, 2007). The prevalence of PTSD has varied between immigrants and refugees who have resettled in developed countries. The prevalence of PTSD among migrants is estimated to be around 47%, and the rates are higher among refugees (Bustamante et al., 2018). A systematic review by Fazel et al. (2005) showed that refugees in western countries had a 10-fold increased risk for PTSD than the age-matched general population. The prevalence of immigrants in developed countries varies, depending on the region they are born in. For example, Steel et al. (2017) reported that 47% of Sub-Saharan refugees to Sweden showed clinically significant PTSD. Similarly, the incidence of PTSD was three times higher in immigrants from North Africa and the Middle East and from Eastern Europe than the native Finns (Markkula, Lehti, Gissler, & Suvisaari, 2017). A systematic review of Iraqi refugees in western countries showed that the prevalence rate of PTSD ranged from 8-37% (Slewa-Younan, Uribe Guajardo, Heriseanu, & Hasan, 2015).

Most refugees travel long-haul routes in dangerous conditions to seek asylum in high-income countries. Even after they arrive, they face challenges about whether they will be able to seek asylum, together with huge social, cultural and linguistic differences. One study reported that the most common and severe traumatic events exposed by refugees in Finland had been war and witnessing a violent death or injury (Castaneda et al., 2017). The traumatic experiences of migration could be even more harmful to children and adolescent refugees and unaccompanied minors (Fazel, Mina, Reed, Panter-Brick, & Stein, 2012; Müller, Büter, & Rosner, 2019; Reavell & Fazil, 2017). One study reported that 63% of refugee children living in London were diagnosed with PTSD (Heptinstall, Sethna, & Taylor, 2004).

The link between migration and psychiatric disorders was first reported in Norwegian people who moved to the USA when an association was found between migration and schizophrenia (Ödegaard, 1932). This was followed by reports of consistently high incidence rates of schizophrenia in Caribbean immigrants in the UK (Fearon & Morgan, 2006; Harrison et al., 1997) and in immigrants in other European countries (Cantor-Graae & Pedersen, 2013; Selten & Sijben, 1994; Veling et al., 2006). The mechanisms underlying this association remain unclear, but possible explanations include a broad range of risk factors. These include selective

migration, pregnancy and birth-related complications, cannabis use, childhood trauma and urban upbringing (Cannon, Jones, & Murray, 2002; Heinz, Deserno, & Reininghaus, 2013; Marconi, Di Forti, Lewis, Murray, & Vassos, 2016; Selten et al., 2007; Varese et al., 2012). A meta-analysis by Mindlis and Boffetta (2017) showed that the risk for mood disorders increased by a quarter in migrants and the risk was higher in newly arrived immigrants (Foo et al., 2018). Similarly, a Danish study reported an increased risk for psychiatric disorders among first-generation immigrants (Cantor-Graae & Pedersen, 2013). In contrast, a Finnish study reported that the risk of mental disorders was generally lower in native Finnish citizens except for PTSD (Markkula, Lehti, Gissler, & Suvisaari, 2017). A Finnish TERTTU survey reported that 13% of asylum seekers had mental and behavioral disorders (Skogberg et al., 2019). It is crucial to consider the mental health needs of immigrants, provided that there is evidence linking parental traumatic experiences to psychological conditions in their children.

2.3.1   Trauma transmission across generations

Earlier studies have showed that the risk of psychiatric disorders increased among second-generation immigrants (Bourque, Ven, & Malla, 2011). Increased rates of schizophrenia were reported not only among first-generation immigrants but also among the second-generation immigrants (Leão et al., 2006). A Danish study reported a significantly elevated risk for all psychiatric disorders if second-generation immigrants had one foreign-born parent and one native Danish parent (Cantor-Graae & Pedersen, 2013). Second-generation immigrants have also been reported to face an increased risk of childhood autism (Lehti et al., 2013), ADHD (Lehti, Chudal, Suominen, Gissler, & Sourander, 2016) and learning disorders (Lehti, Gyllenberg, Suominen, & Sourander, 2018), but a decreased risk for Asperger's syndrome (Lehti et al., 2015) in children with immigrant parents.

There has been converging evidence to support intergenerational transmission of trauma, in which offspring are affected by the traumas that their parents were exposed to -during pregnancy or even before their conception (Yehuda & Lehrner, 2018). The concept of intergenerational trauma has been used to describe the thoughts, behaviors, and feelings experienced by parents and how their post-traumatic state influenced their children's mental health (Kretchmar & Jacobvitz, 2002). Trauma transmission occurs when children and their parents share similar symptoms or as a result of an indirect process when the experiences of earlier generations influence parenting attitudes and behaviors (Rosenheck, 1986; Snyder et al., 2016). A more recent claim is that traumatic experiences are transmitted from one generation to the next through epigenetic mechanisms (Chan, Nugent, & Bale, 2018; Clarke & Vieux, 2015). Studies showed associations between parental trauma

and changes in their offspring's cortisol metabolism compared to the offspring of non-traumatized parents (Yehuda et al., 2005; Yehuda & Bierer, 2008).

The earliest study of intergenerational trauma was the descriptions of behavioral and psychiatric problems in the offspring of Holocaust survivors (Rakoff, 1966). A systematic review by Dashorst et al. (2019) stated that parental mental health problems, perceived parenting, attachment quality, and parental gender appeared to influence the mental well-being of their offspring. Similar findings were later reported in the children of Vietnam veterans (Ancharoff & Danieli, 1998; Harkness, 1993) and were more commonly termed *'secondary traumatization'* (Rosenheck & Nathan, 1985). Other studies have reported that the offspring of Holocaust survivors and veterans exhibited distress, anxiety, nightmares, and hypervigilance (O'Toole et al., 2017b; Yehuda, Bell, Bierer, & Schmeidler, 2008).

The association between parental PTSD and offspring PTSD has been widely studied. A systematic review by Leen-Feldner et al. (2013) suggested that parental PTSD symptoms were associated with mental health problems in their offspring, including internalizing and general behavioral problems. PTSD has been found to mediate the effect of veterans' combat experience on the family (Galovski & Lyons, 2004). However, some studies have failed to show any associations between parental PTSD and offspring PTSD (Kellerman, 2001; van IJzendoorn, Bakermans-Kranenburg, & Sagi-Schwartz, 2003). Recently, there have been discussions on the impact of colonization, slavery, torture, genocide and being refugees on PTSD in offspring (Bezo & Maggi, 2015; Field, Muong, & Sochanvimean, 2013; Lee et al., 2019; Sangalang & Vang, 2017). There are also a growing number of studies that show that mothers being mistreated during childhood had an impact on the mental health of their children (Jovanovic et al., 2011).

2.3.2   Parental migration and offspring PTSD

Table 4 summarizes three studies that investigated the association between parental migration and the risk of PTSD in offspring. A study of 4826 second-generation immigrants in the USA showed a lower risk of PTSD than the first-generation migrants and the native-born population (Salas-Wright, Kagotho, & Vaughn, 2014). In contrast, a study from Denmark showed that children with one immigrant parent were at an increased risk for PTSD than native Danish parents but decreased risk among children with two immigrant parents (Cantor-Graae & Pedersen, 2013). However, PTSD diagnosis was included in the category of anxiety and somatoform disorders in that study. Another Danish study included PTSD in neurotic, stress-related and somatoform disorders, using codes F40-48. The risk of PTSD among children whose refugee parents had experienced torture and war-trauma was higher than children of native-born Danish parents (Bager et al., 2020).

Table 4. Studies on parental immigration and PTSD.

SN	AUTHOR, PUBLICATION YEAR, COUNTRY	STUDY DESIGN	SAMPLE SIZE, AGE RANGE,	DIAGNOSTIC CRITERIA	COVARIATES	RESULTS RISK FACTORS
1	Bager et al., 2020 Denmark	Population-based cohort study	19294	ICD-10 PTSD included in the category of neurotic, stress-related and somatoform disorders	Gender, child age at immigration, parental physical morbidity, parental psychiatric morbidity	Children of refugee parents with torture and war-trauma have estimated lower relative risk of being diagnosed with neurotic, stress-related and somatoform disorders compared to children of Danish-born parent without torture and war-trauma. The Middle East and North Africa, HR 0.55 (95% 0.49-0.63); Former Yugoslavia, HR 0.44 (95% CI 0.32-3.60); Other, HR 0.66 (95% CI 0.50-0.88)
2	Salas-Wright et al., 2014 USA	Cross-sectional Based on NESARC data	34650 first generation (n=5363) Second generation (n=4826) Native-born Americans (n=24461) Age range: 18 years and older	AUDADIS-IV	Age, gender, race/ethnicity, household income, education level, marital status, region of the United States, urbanicity, and lifetime diagnosis of alcohol and any drug abuse or dependence.	Second-generation immigrant less likely to meet criteria for PTSD, AOR = 0.84, 95% CI 0.79–0.91
3	Cantor-Graae and Pedersen, 2013 Denmark	Population-based cohort study	1858430 Second generation (n=183179) Native Danes (n=1576396) Age range: 10-40 years	ICD-10 PTSD included in the category of anxiety and somatoform disorders[++]	Age and sex	Increased incidence rate among children with one immigrant mother OR 1.17, 95% CI 1.12-1.23, one immigrant father OR 1.32, 95% CI 1.27-1.38 but decreased risk among both immigrant parents, OR 0.89, 95% CI 0.85-0.94 compared to native Danes.

+Neurotic, stress-related and somatoform disorders: ICD-10 F40-48; Anxiety and somatoform disorders: ICD-10 codes F40-45 and F48; equivalent ICD-8 codes 300, 305, and 307.99.

MINI, Mini International Neuropsychiatric Interview; NESARC, National Epidemiologic Survey on Alcohol and Related Conditions; AUDADIS-IV, Alcohol Use Disorder and Associated Disabilities Interview Schedule.

2.4 Gaps in the Literature

When we searched for literature relevant to studies I and II, we found that a growing number of studies had focused on the mental health consequences experienced by adolescents after earthquakes. Most of these studies used cross-sectional rather than longitudinal designs. Previous studies mainly examined PTSS and explored a limited number of risk factors associated with PTSS. The severity of the earthquakes, based on their location and the post-earthquake trauma exposure, were rarely investigated. These studies were largely conducted in developed countries and were mostly from China. Previous studies after the 2015 earthquake in Nepal were limited and mainly covered adults and were based on small sample sizes. There were not any longitudinal studies that had investigated the long-term mental health problems of adolescents exposed to the 2015 Nepal earthquake.

With regard to study III, which investigated immigration in Finland, few studies had examined parental migration as a risk factor for offspring PTSD. There were two Danish population-based studies that included PTSD with other disorders (Bager et al., 2020; Cantor-Graae and Pedersen, 2013). The third study was from the USA and was a cross-sectional study that based the diagnoses on questionnaires (Salas-Wright et al., 2014). The differential effect of maternal and paternal immigrant trauma exposure on offspring has been rarely explored. There is a need for more studies that shed light on the risk of PTSD among second-generation immigrant children. This is the first large nationwide population-based study with a strong design that was adjusted for several confounders that have not previously been explored.

3 Aims

The aim of this dissertation was to identify risk factors associated with post-traumatic PTSS using two study designs: a longitudinal post-earthquake survey in Nepal and a Finnish population-based study on second-generation immigrants.

The objectives of the studies were:

Study I and II

Aim 1. To assess the prevalence of PTSS and depressive symptoms among adolescents exposed to the 2015 earthquake in Nepal and compare two districts affected by the earthquake, including one that was more severely affected

Hypothesis: The prevalence of PTSS and depressive symptoms would be higher among adolescents from the severely affected area

Aim 2. To explore potential risk factors associated with psychiatric symptoms, namely PTSS and depressive symptoms of adolescents exposed to the 2015 earthquake in Nepal

Aim 3. To compare changes in psychiatric symptoms (PTSS and depression) among adolescents 18 and 31 months after the earthquake

Hypothesis: The psychiatric symptoms among adolescents would decrease from 18 to 31 months after the earthquake

Aim 4. To explore potential risk factors associated with the change in psychiatric symptoms PTSS and depressive symptoms of adolescents exposed to the 2015 earthquake in Nepal.

Study III

Aim 5. To investigate the association between parental immigration status and PTSD diagnosis in their offspring

Hypothesis: Children with immigrant parents would be at increased risk of developing PTSD

4 Context of the study

The study used two study designs: a longitudinal post-earthquake Nepal survey and a Finnish population-based study.

4.1 Nepal

Nepal is a small landlocked country that covers 147,181 square kilometers and is bordered by China in the north and surrounded by India to the east, west and south. Because of its location, the country has frequently been described as '*a yam between two boulders*'. It is topographically divided into three ecological zones: Terai, the Central Hill region, and the Mountain in the north. The altitude ranges from 70 meters above sea level to the top of Mount Everest, which, at 8848 meters, is the highest point on the earth (CIA, 2019). Nepal lies on the boundary of two massive tectonic plates, the Eurasian and Indian tectonic plates, which makes it prone to earthquakes. A collision between these two plates resulted in the elevation of the Himalayas in the north.

Nepal is a low-income country of about 29 million people, and most of the population is young. It falls into the medium United Nation's human development category and ranks 142 out of 189 countries and territories (UNDP, 2019). Although it is a small country, Nepal provides great diversity and cultural richness, with 123 languages spoken by more than 126 different ethnic groups (CBS, 2012). Agriculture is the main source of income for 75% of the population. In 2018, the gross domestic product per capita was 1,026 $US dollars, compared to 49,845 for Finland (World Bank, 2018) (Ministry of Health and Population (MOHP) in Nepal, New ERA, and ICF International Inc., 2012).
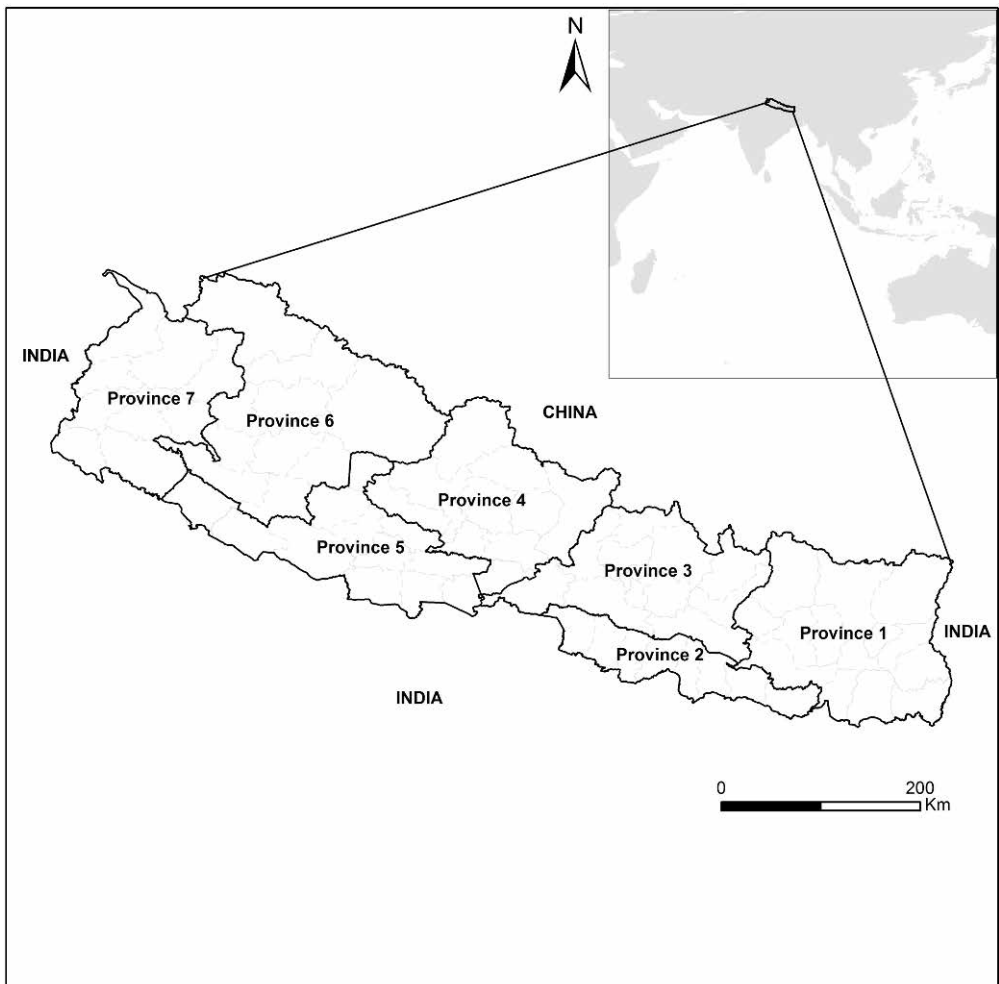
Figure 1. Map of Nepal.

4.1.1   Earthquake in Nepal

On 25 April 2015, Nepal was hit by a major 7.8 magnitude earthquake, which was followed by a main aftershock, with a magnitude of 7.3 on 12 May 2015. The two events caused nearly 8,900 deaths and 22,000 injuries, and 450,000 people were displaced (Government of Nepal, 2015). About one-third of the deaths were children and adolescents and an estimated one million children were affected by issues such as injuries, temporary or damaged housing, unsafe study environments, health, medication problems, sleep issues, and bereavement. More than 400 aftershocks triggered a series of landslides, increasing deaths and injuries and causing around seven billion US dollars' worth of damage (Nepal Planning Commission, 2015).

Nepal is divided into 77 districts, 14 were highly affected by the earthquake and 21 were moderately affected. About 462 public and private health facilities were completely destroyed and 765 health facilities were partially damaged. At the time of the earthquake, Nepal was experiencing continued political instability. However, people were recovering from the impact of the Nepalese civil war, of 1996-2006, which was between the communist party and the Government of Nepal. That decade-long conflict had caused more than 16,000 deaths and many people had been tortured, intimidated, extorted and abducted.

4.1.2   Overview of the Nepalese Healthcare System

Health care services in Nepal are provided by both the public and private sectors. The country's 1997 mental health policy made a commitment to provide mental health services for all residents by integrating mental health care into the existing health care system. However, the policy framework has yet to be implemented, and, as a result, mental health services are limited to a few hospitals, which are mainly located in larger cities (Luitel et al., 2015). Community mental health services are led by non-governmental organizations or international organizations. Government investment in mental health has been limited and less than 1% of the health budget was spent on mental health (Regmi, Pokharel, Ojha, Pradhan, & Chapagain, 2004). The country has about 110 psychiatrists, 15 clinical psychologists, and 400–500 paraprofessional psychosocial workers (Luitel et al., 2015; Sherchan et al., 2017). An estimated 440 in-patient beds are provided for people with mental illnesses, with the private sector providing nearly three times as many beds as the Government (327 versus 112), i.e., 1.5 beds per 100,000 population (Luitel et al., 2015) are available. However, no in-patient services are available for children and adolescents. Due to the stigma attached to mental illness, most people seek help from traditional healers, who are the primary source of treatment for mental health problems in the community (Pradhan, Sharma, Malla, & Sharma, 2013).

After the earthquake in 2015, there was a rapid increase in investment in Nepal's mental health sector and mental health and psychosocial services were provided from national and international stakeholders (Seale-Feldman & Upadhaya, 2015). A desk review of existing knowledge relevant to mental health and psychosocial support (MHPSS) was undertaken (Inter-Agency Standing Committee, 2015). Mental health services were provided by hospital-based clinical services and mobile health camps. Health workers were trained using the World Health Organization's Mental Health Gap Action Programme. Mental and psychosocial services were provided as part of the country's primary health care level and a screening tool for laypersons, which was effective in detecting and referring cases. Some NGOs focused on community-based psychosocial interventions and school-based psychosocial support was provided by training teachers.

4.2   Finland

Finland is a developed Nordic country in Northern Europe, which covers an area of 338,440 square kilometers. It is bordered by Russia to the east, Sweden to the west, Estonia to the south and north-east Norway to the north. Most of its 5.52 million, residents live in the center and south of the country and speak Finnish language and Swedish is the second official language (Official Statistics of Finland, 2020). Finland is in the United Nation's very high human development category and it ranks 11 out of 189 countries and territories (UNDP, 2019). The country is heavily forested and contains 56,000 lakes, numerous rivers and extensive areas of marshland. The largest economic sector is the service sector (74%), followed by manufacturing and industry, namely industrial machinery, paper, oil and mineral fuels (21%) and agriculture and forestry (4%) (Official Statistics of Finland, 2020).
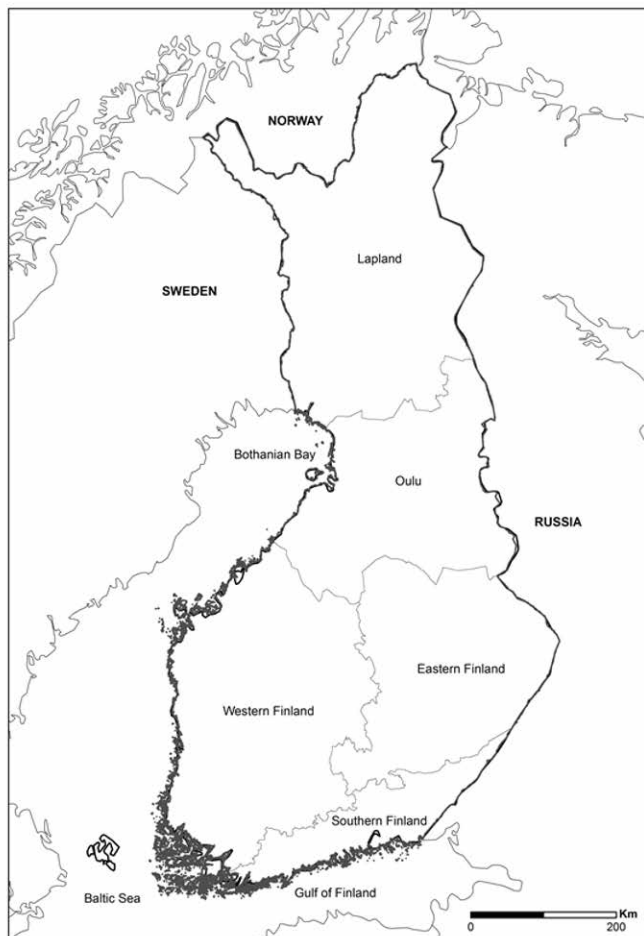

Figure 2.   Map of Finland.

4.2.1 Overview of the Finnish healthcare system

Public and private health sectors are both available in Finland, but public health services are widely used. Health services are divided into primary health care and specialized medical care. The country's network of municipalities provides primary health care services, while specialized medical care is usually provided at hospitals (EU-Health Care, 2020). Treatment is provided by primary or specialized care, depending on the level of care required. When psychiatric services are needed, most patients are referred to specialized services by primary health professionals, including child welfare clinics and school health care. The specialized psychiatric services are mostly free of charge for both children and adults. Social services and NGOs also provide a wide range of mental health services. There are 236 psychiatrists per million inhabitants in Finland (Eurostat, 2020). The specialized psychiatric services are led by multi-professional teams that work together with child and adolescent or adult psychiatrists. In Finland, PTSD is diagnosed based on the characteristic symptoms that are identified during unstructured or structured interviews. The more complex cases are assessed by a psychologist.

4.2.2 Immigrants in Finland

The Finnish government recognizes the importance of labor migration to the economy and laws have been changed to make Finland more attractive for international specialists. The number of immigrants in Finland is relatively small compared to other Nordic countries, but it increased rapidly from 1990 to 2019, from around 1.3% of the national population to 8.3% (Official Statistics of Finland, 2020). Finnish immigrants tend to be a heterogeneous group and most of them have migrated from Estonia, Russia, Iraq, China, and Sweden. In 2018, the most common reasons for migration were family reasons (36.2%), work (30.9%), study (20.8%), refugees (11.0%), and others (1.1%) (Finnish Immigration Service, 2019). Most of the people who migrated to Finland were of working group (18-64 years) and there were more males than females (Official Statistics of Finland, 2018). Finnish immigrants have same rights to health and well-being as Finnish citizens. Even asylum seekers, including adults, children and pregnant women, are entitled to urgent and essential treatment.

5 Materials and Methods

5.1 Post-earthquake Nepal study

5.1.1 Study design and participants

This was a longitudinal study that measured mental health problems experienced by adolescents after they were exposed to the 2015 earthquake in Nepal. Participants were enrolled and assessed at two time points -18 months and 31 months after the earthquake. A total of 893 participants were included in the first assessment at 18 months after the earthquake (Study I). The participants consisted of adolescents aged 11-17 years, from grades 7 to 10, in eight schools. They were enrolled from two districts affected by the earthquake: Sindhupalchok, which is a rural mountainous area that was severely affected by the earthquake and the urban capital of Nepal, Kathmandu, which was affected to a lesser extent. The two study areas were selected to provide variations in the locations, the socioeconomic status profile of the respondents and the degrees to which participants were affected. The total number of schools in Sindhupalchok is 606, while Kathmandu 1343 (Government of Nepal, 2015).

We invited participants who were still studying in the same schools to take part in a follow-up study 31 months after the earthquake. However, many of the participants had graduated or moved to other schools by the time of second assessment, which resulted in a total number of 558 participants in the 31-month cohort. Of these, 32 (3.58%) were not present during the follow-up evaluation and 11 (1.97%) did not complete the questionnaires fully. This resulted in a sample of 515, with a retention rate of 57.67%. The students who dropped out and the adolescents who took part at 31 months did not differ significantly with regard to the demographic measures, and PTSS scores and depressive symptoms.
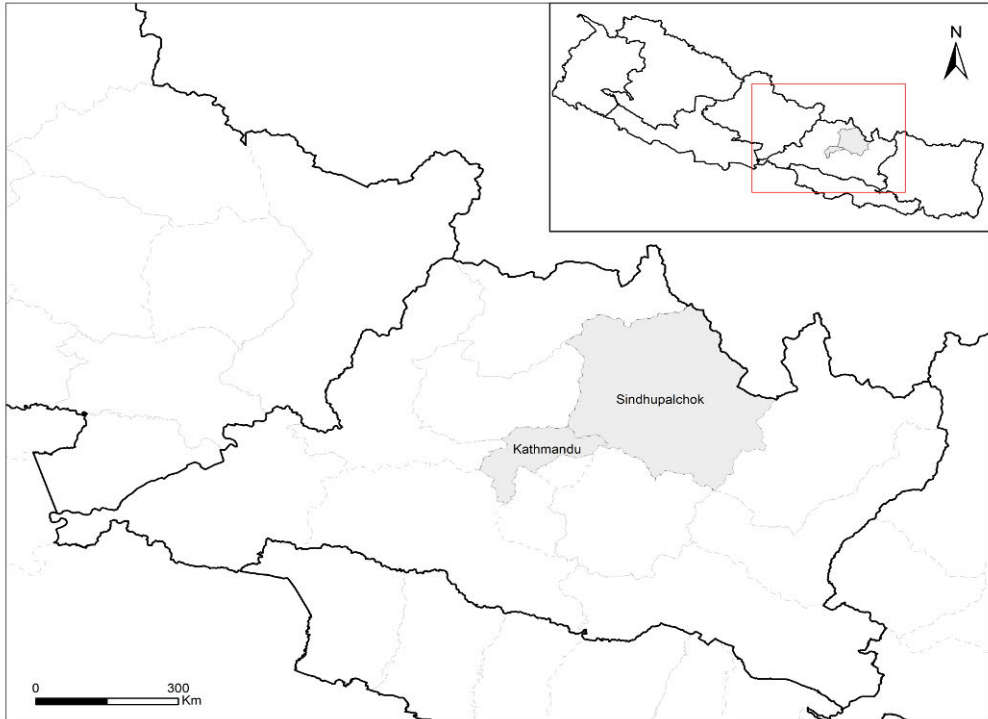
Figure 3. Districts of Nepal included in Study I and Study II (Kathmandu and Sindhupalchok).

5.1.2   Sampling methods and procedure

The first district affected by the earthquake, Sindhupalchok, has a population of nearly 288,000 and covers just over 2,500 square kilometers. The earthquake caused 3,570 deaths and about 605 million Nepalese rupees worth of damage, which is equivalent to 6 million US dollars. The second, Kathmandu, is the capital of Nepal, and has a population of about 1.7 million, and covers just under 400 square kilometers. It is estimated that the earthquake caused 1,233 deaths and about 302 million Nepalese rupees' worth of damage, which is about three million US dollars) (Ministry of Health and Population (MOHP) in Nepal, New ERA, and ICF International Inc., 2012). Sindhupalchok is one of the least developed districts in Nepal. Most of the people live in villages and depend on agriculture for survival. It is characterized by its mountainous terrain and underdeveloped roads. Kathmandu is the capital of Nepal and a hub for trade, industry, tourism and job opportunities. It has a relatively high Human Development Index (0.63). Kathmandu residents are also more highly educated than people living in Sindhupalchok, with an adult literacy rate of 84.0% and 49.5%, respectively (Nepal Planning Commission, 2015).
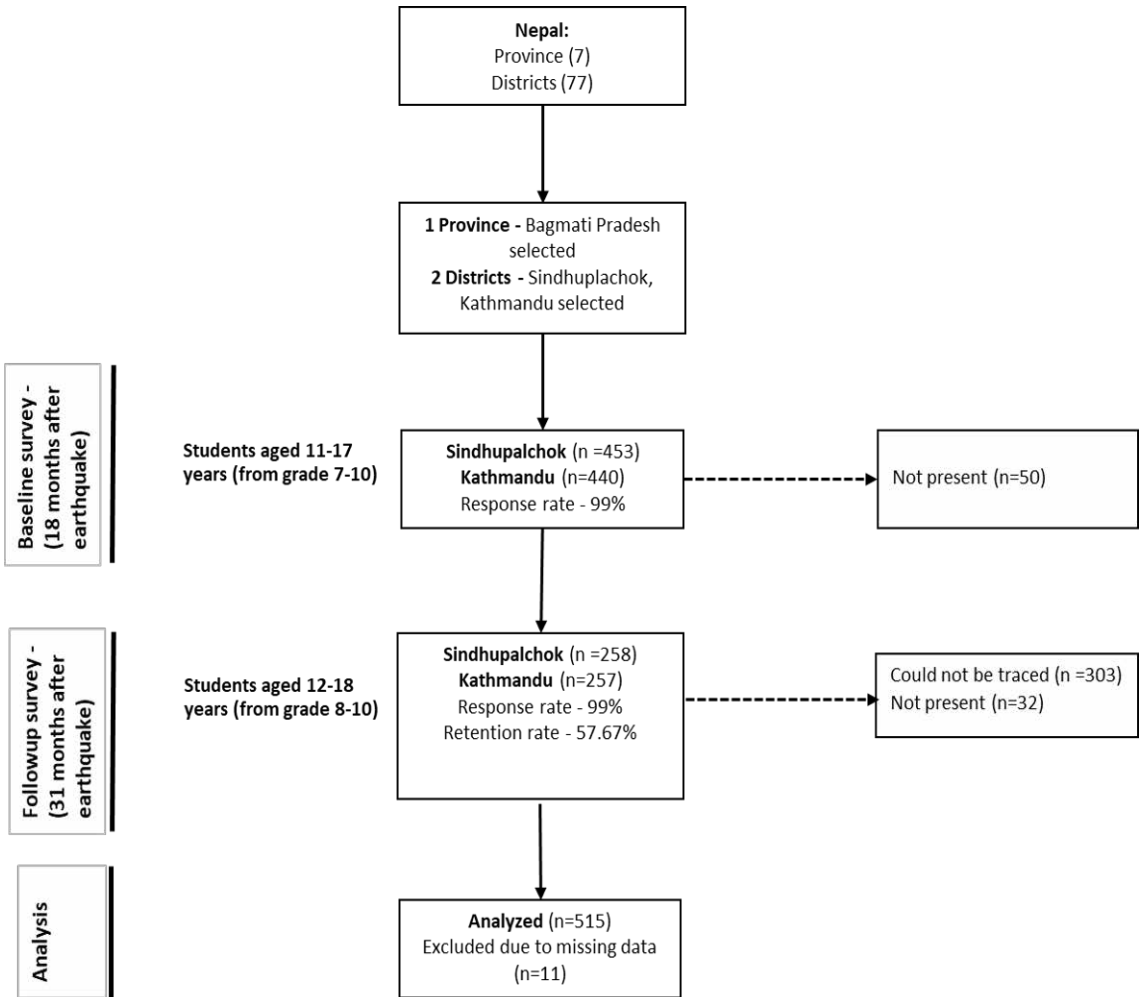
Figure 4.   Flow chart of sample collection.

Each district is divided into an administrative unit, known as a municipality. One municipality - Chautara and Kathmandu- was selected from each district and then one school was selected from each ward (administrative unit) in that municipality. Both public and private schools were selected to include wider socio-economic groups and the cohort comprised of five schools in the Chautara region of Sindhupalchok and three in the Kathmandu district of the Capital. The study participants were recruited from the selected schools. First, the list of students was collected from the teacher or principal of the chosen schools. Second, researcher, the author of this dissertation and one research assistant, went to each classroom and explained the aims of the study. We also talked about informed consent and what they were expected to do. They were then handed two informed consent forms, one

for their parents and the other for them to read and sign. They were asked to give an informed consent form to their parents and informed that only students with written informed consent from one of their parents would be included in the study. Third, the date for data collection was agreed upon with the school authorities. The questionnaire was written in the local Nepali language and handed to the students in the classroom. The questions were read aloud by the researcher in the first instance. The students were informed that participation in the study was voluntary, and they could stop responding to the questionnaire whenever they wanted to, without providing any explanation. The participants took about 45 minutes to complete the paper copy of the survey, using paper and pencil, with the help of the researcher and the teachers in the classroom.

The same procedures were used to enroll students in the study who had taken part in the first study in the follow-up study. The list of the students in the first assessment was reached out in each school. We went through the same informed consent process and only students were with informed consent from parents and themselves were included in the study. The questionnaire was distributed in the classroom and the teacher and research assistant helped participants if they had any issues understanding the questionnaire. In both Studies I and II, students were given a small gift worth 50 Nepalese rupees to appreciate their participation.

Figure 5. Pictures showing data collection in Nepal post-earthquake (baseline and follow-up study).

        a. Data collection in classroom.   b. Teacher guided students to fill in questionnaire.

        c. With principal and teacher.   d. Picture with school staffs and students.

5.1.3   Measures

5.1.3.1   Demographic factors

The demographic characteristics included gender, age, area of location, ethnicity and parents' education. Sex was assessed as boys, girls, and others. Age was categorized into ≤ 15 years and > 15 years. The area of location comprised Sindhupalchok and Kathmandu. Ethnicity was classified into three categories: Brahmin or Chhetri, Janjati and Dalit. Parental education was classified as no education, secondary

education (10 years of schooling) and a minimum of higher education (12 years of schooling).

5.1.3.2   Trauma exposure

Pre-earthquake trauma exposure was assessed as binary information, namely (yes or no response). If they answered yes, they were asked to specify the type of traumatic events they had experienced before the earthquake. The list of traumatic events in the questionnaire included accidents, natural disaster, community violence, domestic violence, loss of family members and other relatives and sexual abuse. The questions related to trauma exposure during the earthquake was based on whether they were trapped or wounded during the earthquake. Information on any post-earthquake trauma exposure was assessed in a similar way to pre-earthquake trauma, and the participants were asked for yes or no response. If they answered yes, then they were asked to specify the type of traumatic events they had experienced. Information on demographics and trauma exposure before the earthquake and as a result of the earthquake were only collected in the first assessment that was carried out 18 months after the earthquake. The participants were asked if their house had sustained earthquake damage and this was identified on a four-point Likert scale; 'not at all,' 'mild,' 'moderate (home inhabitable),' and 'severe (home uninhabitable).'

5.1.3.3   Instruments

Standardized instruments were used to measure the severity of PTSS and depressive symptoms. These instruments were validated and translated into the local Nepalese language.

5.1.3.3.1   Post-traumatic stress symptoms

PTSS was evaluated using the Child Posttraumatic Stress Disorder Scale (CPSS), which is a self-report questionnaire designed to assess PTSS for children and adolescents between 8 and 18 years (Foa, Johnson, Feeny, & Treadwell, 2001). This instrument has frequently been used to assess children exposed to trauma after major disasters and catastrophic violence. It has shown good psychometric properties in the Nepalese context, with Cronbach's alpha of 0.86 (Kohrt et al., 2011). It consists of 17 items, such as '*having a bad dream or nightmare*''. The children were asked to rate the items on a four-point Likert scale, based on the frequency over the past week. The individual questions were scored as follows: zero = not at all, one =once in a week or less/once in a while, two =2-4 times a week/ half the time, and three = five or more times a week almost always. The total score ranges from zero to 51, with a cut-off of ≥ 20.

5.1.3.3.2 Depression

Depressive symptoms were assessed by the Depression Self-Rating Scale (DSRS), which is a self-report measure widely used to measure depression in children and adolescents between eight and 14 years of age (Birleson, 1981). It contains 18-items, such as '*I sleep very well.* It assessed the participant's condition over the past week by using a three-point Likert scale, with zero (mostly), one (sometimes), and two (never). The total score ranges from zero to 36, with a clinical cut-off score of ≥14. The DSRS has previously been validated in Nepalese children (Kohrt et al., 2011).

5.1.4 Pre-test questionnaires

The questionnaire was pilot tested on 10 adolescents age ranged 11-15 years. The participants filled in the questionnaire without much help from the researcher. Major changes were not required, except for few items, that were difficult for the students to understand. We made modifications to those items in the questionnaire.

5.1.5 Ethical consideration

Ethical approval was provided by the Nepal Health Research Council and the Ethics Committee of the University of Turku, Finland. The District Education office in Nepal and the respective schools gave their approval for their students to participate in the study. The participants were only included in the study after they had provided written, informed consent from their parents and themselves.

5.2 Finnish register-based study

5.2.1 Overview, design, and description of the study

The nationwide register study was based on a nested case-control design. Cases and controls were identified from the three Finnish registers: The Care Register for Health Care (CRHC), the Finnish Medical Birth Register (FMBR), and the Finnish Population Register Centre (PRC).

5.2.2 Overview of the Finnish Nationwide Registers

5.2.2.1 Care Register for Health Care

The Care Register includes digital data on all public and private inpatient diagnoses since 1967 and all outpatient diagnoses since 1998. The information it provides

includes personal identity codes (PICs), admission and discharge dates, details of any day surgery and a primary diagnosis and up to three secondary diagnoses. The diagnostic classification in Finland is based on the ICD, which is the international standard for reporting diseases and health conditions maintained by the WHO. The ICD has been used since 1996 (World Health Organization, 1992), ICD-9 from 1987 to 1995 (World Health Organization, 1977) and ICD-8 from 1969 to 1986 (World Health Organization, 1967).

5.2.2.2   Finnish Medical Birth Register

The Birth Register was established in 1987 and includes comprehensive and standardized data on all pregnancies, prenatal periods, and neonatal periods up to the age of seven days for all live births in Finland. It also includes stillbirths, where the fetuses had reached at least 22 weeks of gestation or had a birth weight of at least 500g. In addition, the data in the register include demographic characteristics, reproductive history, maternal health-related behaviors and perinatal events.

5.2.2.3   Finnish Population Register Centre

The Population Register, which was established in 1969, is a national digital archive that contains basic demographic information about Finnish-born citizens and permanent residents in Finland. The personal data recorded in the system includes their name, personal identity code, address, country and municipality of birth, native language, family relationships and date of birth, migration, and death, if applicable. Asylum seekers and migrants are not included in the Population Register until they receive their personal identification numbers.

5.2.3   Linkage of the registers

The linkage of the information from the different registers is possible through the unique personal identity codes. The PIC is a unique code issued to all Finnish citizens and foreign residents registered in the population information system. The PICs was introduced in Finland in the 1960s and consist of person's date of birth, sex, and a unique number. The PIC does not change over the lifetime of an individual. The only exceptions are to protect individuals when their health and safety are permanently threatened, i.e., the PIC is abused by someone other than the one issued with the code and in case of change of the sex of the individual, in accordance with the Gender Confirmation of Transsexual Individuals Act (563/2002) (Digital and Population Data Services Agency, 2020; IBM Corp, 2013). The information on parents and children can be linked in the Population Register by using their individual codes.

5.2.4   Study subjects

The information on the cases and controls were obtained from the Care Register. All the diagnosed cases were singletons births who were born in Finland between 1 January 1987 and 31 December 2010 and diagnosed with PTSD by 31 December 2012. The information about PTSD was based on the following ICD codes in the Care Register: 3098X (ICD-9) or F43.1 (ICD-10). We excluded seven cases with severe or profound mental retardation and those who were diagnosed before two years of age. The total number of identified PTSD cases was 3639.

The controls comprised all singletons born in Finland during the study period who were alive and living in Finland when the matched cases were diagnosed. The controls did not have any diagnosis of PTSD or severe or profound mental retardation. Each case was matched with four controls based on their date of birth (±30 days), sex, and place of birth. This resulted in 14,434 controls. The cases and controls were linked through the Care Register and the Population Register.

5.2.5   Parental immigration status and PTSD

Information on the parents' country of birth and native language were obtained from the Population Register. Immigrant parents were defined as those who were born abroad and were not native Finnish, Swedish or Sami speakers, which are the country's three official languages. Finnish parents were those who were born in Finland and/or whose native language was Finnish, Swedish or Sami. Parental immigration status was divided into four categories: both parents Finnish, immigrant mother and Finnish father, immigrant father and Finnish mother and immigrant mother, and immigrant father. The regional analysis on immigration status was based on the parent's country of birth: Finland; Western countries which comprised most European countries, plus North America, Australia, and New Zealand; countries that were part of the former Soviet Union or former Yugoslavia; Sub-Saharan Africa; North Africa and the Middle East and Asia, excluding the Middle East. Paternal immigration was divided into two categories depending on whether they migrated to Finland less than five years before the birth of the child or five years or more after the child was born.

5.2.6   Ethical consideration

Approval for the use of the data in health and population registers and linkage of data were obtained from the data protection authorities. Ethical approval for the study was provided by the Ethics Committee of the Hospital District of Southwest Finland.

5.3 Statistical analysis

5.3.1 Study I

The descriptive analysis was conducted and the results were presented as mean scores and standard deviations for continuous variables and as percentages for categorical variables. The cut-off scores for the two psychiatric instruments, the CPSS and DSRS, were used to identify cases of PTSS and depression in adolescents. Stepwise forward multivariate logistic regression analysis was performed to find the relationship between risk factors and the mental health outcomes, namely PTSS and depression, in the subjects. We used odds ratio (OR) to estimate the strength of associations. Independent variables with a statistical significance of $p<0.05$ were included in the multivariate model. A 95% confidence interval (95% CI) was calculated for each OR or adjusted OR (aOR) value. All the statistical analyses were performed with Statistical Package for Social Sciences, version 24.0 (IBM Corp, Armonk, NY, USA). A directed acyclic graph was drawn to show the relationship of possible predictors with PTSS and depression.

5.3.2 Study II

The descriptive analysis and changes in PTSS and depressive symptoms were analyzed by Pearsons's chi-square test. PTSS and depressive symptoms were categorized based on the clinical cut-off score at both time points, namely 18 months and 31 months. Four groups were identified with regard to the changes in PTSS and depressive symptoms over time. Resilience indicated no symptoms over time, recovery referred to initially moderate/severe symptoms followed by a gradual return to pre-trauma functioning, delayed related to no symptoms, followed by elevated symptoms and chronic indicated moderate or severe symptoms over time. The resilience group was characterized by the participant's CPSS scores being below the cut-off of 20 at both time points. The recovery group had CPSS scores that were at least the cut-off of 20 at 18 months, but below that cut-off point at 31 months. The delayed group was characterized by participants having CPSS scores that were below the cut-off of 20 at 18 months, but above the cut-off point at 31 months. The chronic group comprised participants whose CPSS scores were 20 or more at both time points. We also identified four groups with regard to changes in depressive symptoms over time. The resilience group comprised participants with DSRS scores below the cut-off point of 14. The recovery group comprised participants whose DSRS scores were at least 14 points at 18 months but below that cut-off point at 31 months. The delayed group was characterized by participants having DSRS scores that were below the cut-off point of 14 at 18 months, but above the cut-off point at

31 months. The chronic group comprised participants whose DSRS scores were 14 or more at both time points.

Stepwise multivariate logistic regression analysis was used to estimate the association between the potential risk factors and PTSS and depressive symptoms at 31 months after the earthquake. We then used multinomial logistic regression to examine the predictors for different symptom groups: resilience, recovery, delayed and chronic. The ORs were used to estimate the strength of the associations. Independent factors with a statistical significance of p<0.05 were included in the logistic multiple predictor models. 95% CI were calculated for the OR values. All the statistical analyses were performed with SAS software, version 9.4 (SAS Institute 2012 Cary, NC, USA).

5.3.3   Study III

We analyzed the association between covariates such as parental age, parental psychiatric disorders, number of previous births, maternal marital status, maternal and socio-economic status. The analysis of bivariate associations was conducted to evaluate the relationship between the covariates and the parents' immigration status among controls. The covariates were then examined for associations with PTSD. The chi-square test identified the covariates that were significantly associated (p<0.1) with the parent's immigration status among the controls and with PTSD. These potential confounders were then selected in the adjusted analyses. Conditional logistic regression models were used for matched sets in order to examine the association between parental immigration status and PTSD. The associations were each quantified using an unadjusted OR and aOR with a 95% CI. In the unadjusted and adjusted models, a two-sided p-value of < 0.05 was considered statistically significant. The statistical analyses were performed with SAS statistical software, version 9.4 (SAS Institute Inc., Cary, NC, USA).

6   Results

The demographic factors and trauma exposures of participants in Study I are shown in Figure 6. Of the 893 participants aged 11-17 years, 453 (55.4% girls) were from Sindhupalchok, with 50.9% between 13-15 years of age, and 440 (47.1% girls) from the Kathmandu, districts with 54.5% between 13-15 years of age. Most of the houses in Sindhupalchok (67.8%) were severely damaged compared to the houses in Kathmandu (7.5%). The number of fathers and mothers with higher education were 53.6% and 31.1%, respectively, in Kathmandu but only 16.8% and 7.9% in Sindhupalchok. More adolescents in Sindhupalchok had been exposed to pre-earthquake trauma (14.1%) and trauma during the earthquake (19.9%) compared to adolescents living in Kathmandu (9.8% and 7.1% respectively). The prevalence of PTSS and depressive symptoms was higher in Sindhupalchok than in Kathmandu, at 39.5% versus 10.7%, and 40.4% versus 23.8% respectively.

6.1   Psychiatric symptoms 18 and 31 months after the earthquake (Studies I and II)

Table 5 shows the change in the prevalence of PTSS and depressive symptoms at 18 and 31 months after the earthquake. No significant changes were observed in the prevalence of PTSS and depressive symptoms from 18 months to 31 months after the earthquake. The prevalence of PTSS was 26.01% at 18 months after the earthquake and 20.38% at 31 months. The corresponding prevalence of depressive symptoms at 18 and 31 months after the earthquake were 37.47% and 33.20% respectively. The changes in these psychiatric symptoms by demographic and trauma exposure showed significant changes by sex, area of location, ethnicity, age, pre-earthquake trauma exposure, during earthquake trauma exposure, namely trapped or wounded and having their house damaged. Parental education had a significant effect on PTSS but not on depressive symptoms. The correlation between PTSS and depressive symptoms was 0.59, $p<0.001$. About 16% of adolescents experienced both PTSS and depressive symptoms 31 months after the earthquake.
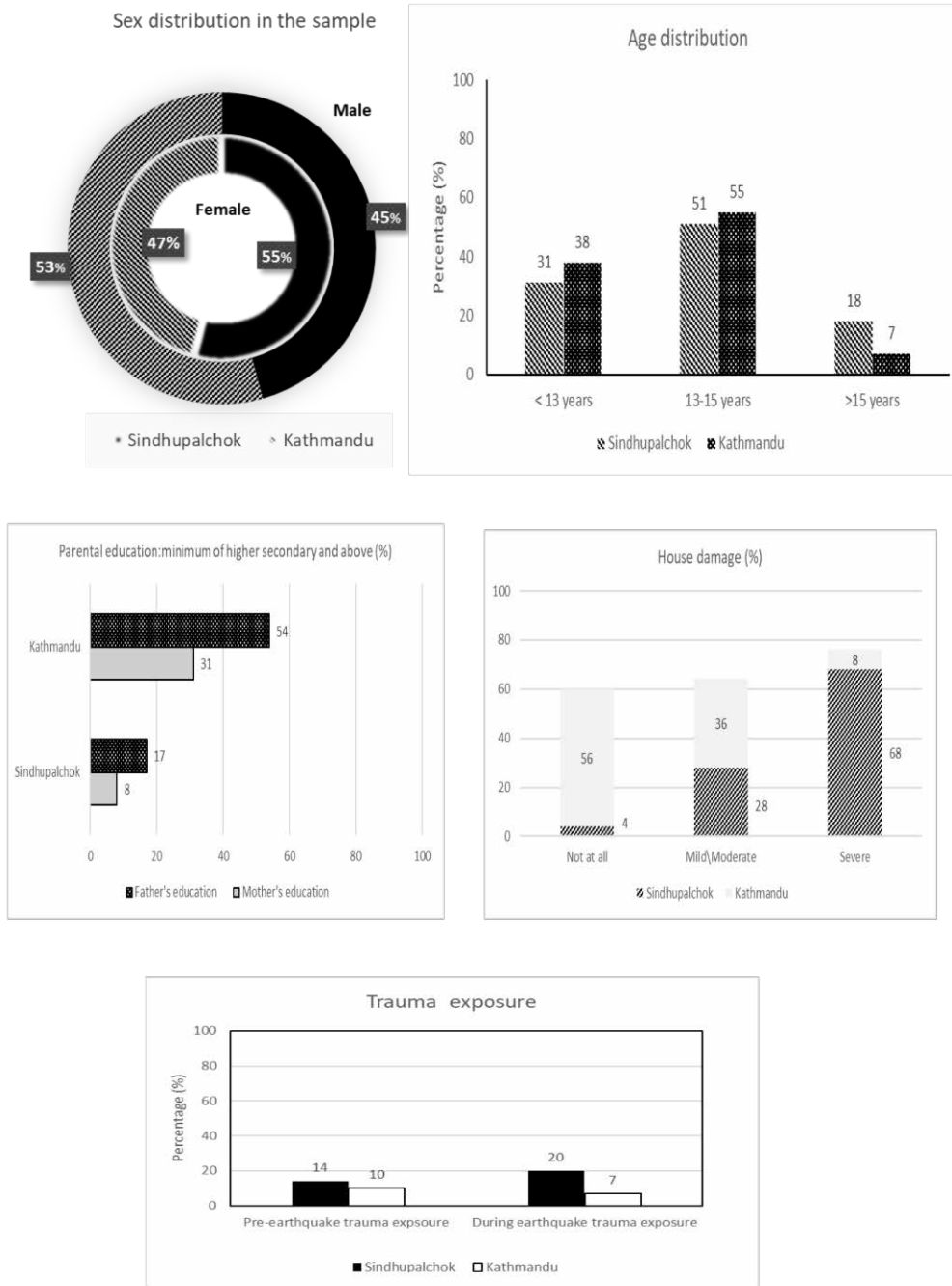
Figure 6.   Demographic factors and trauma exposure of participants in Study I.

Table 5. Demographics and PTSS and depressive symptoms among adolescents assessed at 18 and 31 months after the earthquake (Studies I and II).

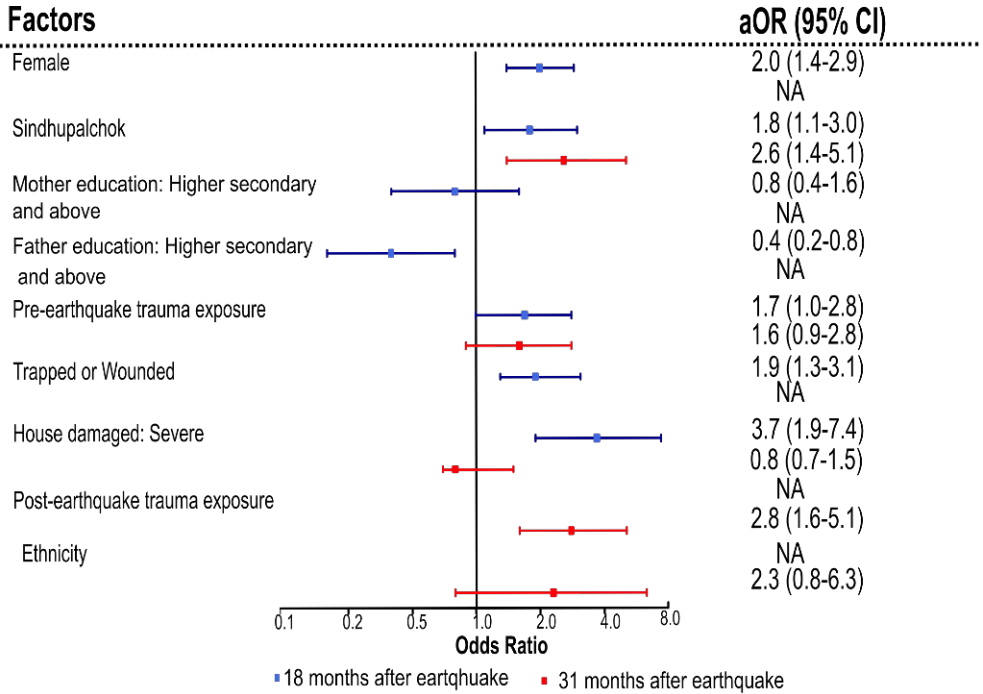|	PTSS			DEPRESSIVE SYMPTOMS		
	18 months	31 months	P-value [a]	18 months	31 months	P-value [a]
	n (%)	n (%)		n (%)	n (%)	
Overall	134 (26.01)	105 (20.38)	0.10	193 (37.47)	171 (33.20)	0.69
Sex			0.003			0.036
Female	88 (65.67)	64 (60.95)		116 (60.10)	102 (59.65)	
Male	46 (34.33)	41 (39.05)		77 (39.89)	69 (40.35)	
Age (years)			<0.001			<0.001
≤ 15	92 (68.66)	62 (59.05)		128 (66.32)	104 (60.82)	
>15	41 (30.59)	42 (38.09)		64 (33.16)	66 (38.59)	
Ethnicity			<0.001			<0.001
Brahmin/ Chettri	70 (52.23)	46 (43.81)		90 (46.63)	80 (46.78)	
Janjati	52 (38.81)	47 (44.76)		87 (45.08)	77 (45.03)	
Dalit	11 (8.21)	11(10.48)		13 (12.38)	12 (7.02)	
DistrictS			<0.001			<0.001
Sindhupalchok	100 (74.63)	81 (77.14)		119 (61.66)	117 (68.42)	
Kathmandu	34 (25.37)	24 (22.86)		74 (38.34)	54 (31.58)	
Mother's education			0.007			0.741
No education	37 (27.61)	27 (25.71)		53 (27.46)	48 (28.07)	
Secondary	67 (50.00)	54 (51.43)		94 (48.71)	83 (48.54)	
Higher secondary and above	28 (20.89)	21 (20.00)		44 (22.79)	37 (21.64)	
Father's education			0.004			0.138
No education	18 (13.43)	16 (15.24)		30 (15.54)	27 (15.79)	
Secondary	69 (51.49)	50 (47.62)		94 (48.71)	72 (42.11)	
Higher secondary and above	46 (34.33)	38 (36.19)		68 (35.23)	71 (41.52)	
Pre-earthquake trauma exposure			<0.001			<0.001
Yes	73 (54.48)	63 (60.00)		92 (47.67)	90 (52.63)	
No	57 (42.54)	38 (36.19)		94 (48.71)	77 (45.03)	
Trapped/wounded			<0.001			<0.001
Yes	22 (16.41)	17 (16.19)		35 (18.13)	22 (12.87)	
No	112 (83.58)	88 (83.81)		158 (81.87)	149 (87.13)	
House damaged			<0.001			<0.001
Not at all	26 (19.40)	24 (22.86)		46 (23.83)	43 (25.15)	
Mild	37 (27.61)	31 (29.52)		55 (28.49)	47 (27.49)	
Moderate	10 (7.46)	7 (6.67)		15 (7.77)	12 (7.02)	
Severe	61(45.52)	43 (40.95)		77 (39.89)	69 (40.35)	

[a] Binary logistic regression with generalized estimating equation (GEE). Summary of separate GEE models.

6.2 Predictors of PTSS and depressive symptoms (Studies I and II)

Figures 7 and 8 depict forest plot showing predictors of PTSS and depressive symptoms 18 and 31 months after the earthquake. The plots only show the results of multiple predictor models. The risk factors associated with PTSS and depressive symptoms varied over time. At 18 months, females were twice more likely to experience PTSS symptoms, but at 31 months, the association was no longer significant (Figure 7). Adolescents from Sindhupalchok, which was more severely affected than Kathmandu, had 1.8 times increased risk for PTSS at 18 months and by 31 months, this had risen further to 2.6 times. At 18 months, adolescents with high parental education had decreased risk for developing post-traumatic stress symptoms, for mothers and for fathers. If the adolescents were trapped or wounded during the earthquake, they had about a two-fold increased risk of PTSS at 18 months, but the association between high parental education and being trapped or wounded was not significant for PTSS at 31 months.
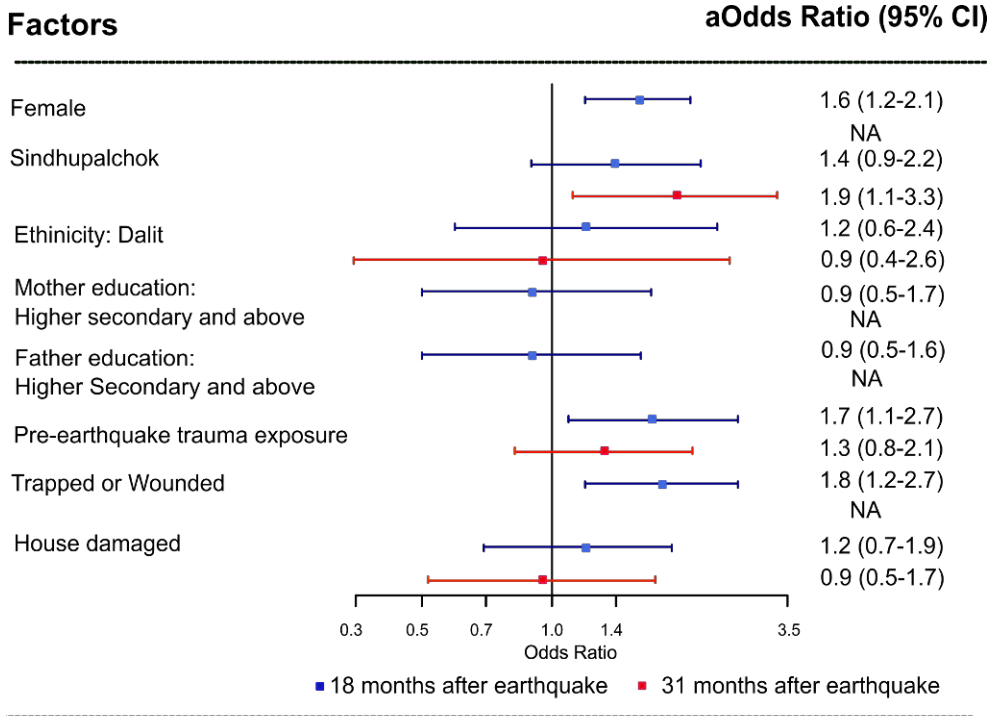
Pre-earthquake trauma exposure increased the risk for PTSS about two-fold at 18 months after the earthquake but was not significant at 31. Adolescents whose house was severely damaged by the earthquake were about four times more likely to experience PTSS at 18 months, but the association was not significant at 31 months. Similarly, the risk of developing PTSS among adolescents with post-earthquake trauma exposure at 31 months was about three-fold compared to those who were not exposed to any trauma after the earthquake.

Similarly, adolescents living in the severely affected area had an increased risk for depressive symptoms at both time points at 18 months and at 31 months (Figure 8). Females were twice more likely to experience depressive symptoms at 18 months than males, but the association was not significant at 31 months. Similarly, being trapped or wounded increased the risk for PTSS two-fold at 18 months, but the association was not significant at 31 months. On the other hand, parental education decreased the risk of depressive symptoms at 18 months, for both mothers and fathers, but the associations were not significant at 31 months. Adolescents who had experienced pre-earthquake trauma were about twice more likely to experience depressive symptoms at 18 months and 31 months. On the other hand, if adolescents experienced post-earthquake trauma, the risk increased to about three times for depressive symptoms at 31 months. The associations with parental education, ethnicity, and being trapped or wounded were not significant at both time points.

Figure 7. Forest plot showing predictors of PTSS in adolescents at 18 and 31 months after the earthquake.

Factors   **aOdds Ratio (95% CI)**

Factors	aOdds Ratio (95% CI)
Female	1.6 (1.2-2.1)
	NA
Sindhupalchok	1.4 (0.9-2.2)
	1.9 (1.1-3.3)
Ethinicity: Dalit	1.2 (0.6-2.4)
	0.9 (0.4-2.6)
Mother education: Higher secondary and above	0.9 (0.5-1.7)
	NA
Father education: Higher Secondary and above	0.9 (0.5-1.6)
	NA
Pre-earthquake trauma exposure	1.7 (1.1-2.7)
	1.3 (0.8-2.1)
Trapped or Wounded	1.8 (1.2-2.7)
	NA
House damaged	1.2 (0.7-1.9)
	0.9 (0.5-1.7)

■ 18 months after earthquake ■ 31 months after earthquake

NA:Not available
aOR: Adjusted Odds Ratio, CI: Confidence Interval

Figure 8. Forest plot showing predictors of depressive symptoms in adolescents at 18 and 31 months after the earthquake.

6.3 Predictors of change in PTSS and depressive symptoms groups (Study II)

Table 6 illustrates the predictors of PTSS and the depressive symptomatic change groups: resilience (no symptoms over time), recovery (initially moderate/severe symptoms followed by a gradual return to pre-trauma functioning), delayed (no symptoms, followed by elevated symptoms) and chronic (moderate or severe symptoms over time). Adolescents in the delayed group were about three times more likely from the severely affected area and about four times more likely to have experienced post-earthquake trauma exposure. The risk for developing chronic PTSS increased was about two times higher in females than males. It was four times higher in adolescents from the more severely affected area and more than three times in adolescents with post-earthquake trauma exposure than those without.

Table 7 shows that delayed depressive symptoms were observed among adolescents who had experience post-earthquake trauma exposure. In the chronic depressive symptom group, females had two times increased odds of developing

chronic symptoms. Adolescents from the severely affected area had about three-fold increased risk of developing chronic depressive symptoms. Similarly, the odds for chronic depressive symptoms was two-fold both in adolescents who had pre-earthquake trauma exposure and post-earthquake trauma exposure.

Table 6. Multiple predictor multinomial logistic regression analysis results predicting PTSS groups. Modified from Silwal et al., 2020, Study II.

	POST-TRAUMATIC STRESS SYMPTOMS		
	Recovery	**Delayed**	**Chronic**
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex			
Female	1.40 (0.79 - 2.47)	0.85 (0.43 - 1.68)	2.14 (1.08 - 4.25) *
Male	Ref.	Ref.	Ref.
Age			
≤15years	Ref.	Ref.	Ref.
>15years	0.74 (0.39 - 1.43)	1.90 (0.94 - 3.85)	0.92 (0.44 - 1.91)
Ethnicity			
Brahmin/Chhetri	Ref.	Ref.	Ref.
Janjati	0.62 (0.34 - 1.11)	1.21 (0.59 - 2.48)	0.75 (0.37 - 1.49)
Dalit	1.39 (0.34 - 5.7)	2.35 (0.54 - 10.19)	2.82 (0.74 - 10.79)
Area of location			
Sindhupalchok	2.98 (1.45 - 6.09) **	2.58 (1.04 - 6.42) *	4.34 (1.76 - 10.75) **
Kathmandu	Ref.	Ref.	Ref.
Pre-earthquake trauma exposure			
Yes	1.31 (0.69 - 2.47)	1.68 (0.78 - 3.63)	1.69 (0.80 - 3.55)
No	Ref.	Ref.	Ref.
House damage			
Not at all	Ref.	Ref.	Ref.
Mild	0.99 (0.45 - 2.19)	0.72 (0.28 - 1.87)	1.13 (0.44 - 2.91)
Moderate	1.17 (0.37 - 3.71)	0.98 (0.26 - 3.75)	0.34 (0.06 - 1.93)
Severe	1.27 (0.5 6 - 2.87)	0.65 (0.24 - 1.79)	1.09 (0.41 - 2.88)
Post-earthquake trauma exposure			
Yes	2.31 (1.19 - 4.45) *	3.62 (1.60 - 8.19) ***	3.37 (1.52 - 7.47) **
No	Ref.	Ref.	Ref.

OR, odds ratio; CI confidence interval; Reference group for change in PTSS was resilient group. Ref. = Reference.
*p<0.05, **p<0.01, ***p<0.001.
Adjusted for sex, age, ethnicity, area of location, pre-earthquake trauma exposure, house damaged and post-earthquake trauma exposure.

Table 7. Multiple predictor multinomial logistic regression analysis results predicting depressive symptoms groups. Modified from Silwal et al., 2020, study II.

	DEPRESSIVE SYMPTOMS		
	Recovery	**Delayed**	**Chronic**
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex			
Female	0.92 (0.54 - 1.56)	0.97 (0.56 - 1.67)	1.86 (1.05 - 3.31) *
Male	Ref.	Ref.	Ref.
Age			
≤15years	Ref.	Ref.	Ref.
>15years	0.76 (0.39 - 1.46)	1.28 (0.69 - 2.36)	1.77 (0.96 - 3.24)
Ethnicity			
Brahmin/Chhetri	Ref.	Ref.	Ref.
Janjati	1.39 (0.82 - 2.40)	1.13 (0.64 - 1.98)	1.18 (0.66 - 2.09)
Dalit	1.94 (0.49 - 7.62)	1.20 (0.30 - 4.76)	1.05 (0.29 - 3.86)
Area of location			
Sindhupalchok	1.53 (0.81 -2.92)	1.79 (0.89 - 3.62)	2.61 (1.25 - 5.44) **
Kathmandu	Ref.	Ref.	Ref.
Pre-earthquake trauma exposure			
Yes	1.58 (0.86 - 2.92)	1.06 (0.57 - 2.00)	2.09 (1.12 - 3.94) *
No	Ref.	Ref.	Ref.
Trapped/wounded			
Yes	2.42 (1.14 - 5.15) *	0.85 (0.31 - 2.33)	1.61 (0.71 - 3.66)
No	Ref.	Ref.	Ref.
House damage			
Not at all	Ref.	Ref.	Ref.
Mild	1.02 (0.52 - 2.01)	0.68 (0.34 - 1.39)	1.18 (0.53 - 2.62)
Moderate	1.01 (0.31 - 3.28)	0.75 (0.22 - 2.60)	0.91 (0.25 - 3.26)
Severe	1.10 (0.53 - 2.32)	0.75 (0.34 - 1.65)	1.41 (0.61 - 3.27)
Post-earthquake trauma exposure			
Yes	0.50 (0.25 - 1.02)	2.42 (1.26 - 4.62) **	2.09 (1.07 - 4.09) *
No	Ref.	Ref.	Ref.

OR, odds ratio; CI confidence interval; Reference group for change in depressive symptoms was resilience group. Ref. = Reference (resilient group).
*p<0.05, **p<0.01, ***p<0.001.
Adjusted for sex, age, ethnicity, area of location, pre-earthquake trauma exposure, trapped/wounded, house damaged, and post-earthquake trauma exposure.

6.4 Parental immigration and PTSD in offspring (Study III)

Of the 3639 cases, 1136 (31.2%) were boys and 2503 (68.8%) were girls. The mean age at the time of the first diagnosis was 14.5 years in the sample, and the age range was 2-25 years. Just over half (52.7%) of the cases were aged 2-15 years at the time of their first diagnosis. Information on their use of health service showed that 77.7% of the cases had only used, and 8.3% had only used inpatient care only. The remaining 14.0% had used both inpatient and outpatient services.

Figure 9 shows the association between parental immigration status, the timing of the paternal immigration in relation to the child's birth and region of birth, and PTSD in the offspring. The plot depicts aORs. The risk for PTSD increased in children with an immigrant father and Finnish mother than both Finnish parents. No significant association was observed between two immigrant parents or an immigrant mother with Finnish father and offspring PTSD.

Children had two times increased risk for PTSD if their immigrant father was born in North Africa and the Middle East. No significant association was observed between the regions where the mother was born and offspring PTSD.

There was a statistically significant association between the timing of paternal immigration and offspring PTSD. If the father had migrated less than five years before the birth of their child, the risk of PTSD in offspring increased compared to more than five years.
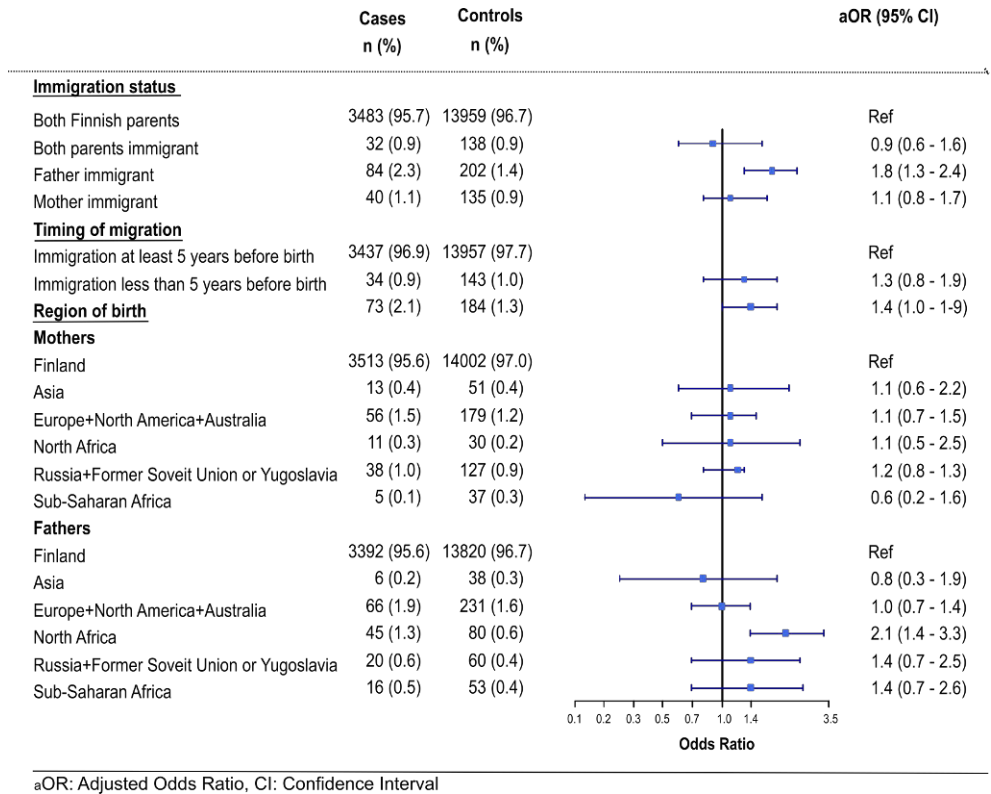
Figure 9. Forest plot showing associations between immigration status, the timing of migration and region of birth, and PTSD in offspring.

7 Discussion

7.1 Main findings

This thesis examined risk factors for PTSS using two study designs: a longitudinal post-earthquake survey in Nepal and a Finnish population-based study on second-generation immigrants. The main findings were 1) the prevalence of psychiatric symptoms, namely PTSS and depression, was high in adolescents living in the area that was more severely affected by the 2015 Nepal earthquake, 2) the factors associated with PTSS and depression 18 months after the earthquake were: being female, pre-earthquake trauma exposure and being trapped or wounded, 3) no significant change was observed in the prevalence of PTSS and depressive symptoms from 18 to 31 months after the earthquake, 4) at 31 months after the earthquake, living in the severely affected area and post-earthquake trauma exposure were associated with psychiatric symptoms, 5) the change in symptoms were categorized into four groups: resilience, recovery, delayed and chronic. Living in severely affected areas and post-earthquake trauma were important risk factors for the delayed and chronic groups, 6) children with an immigrant father and Finnish mother were at an increased risk of developing PTSD compared to children with both Finnish parents. No significant association was observed between having an immigrant mother and Finnish father or two immigrant parents and receiving a diagnosis of PTSD in offspring, and 7) the risk for PTSD diagnosis was higher if children had an immigrant father who had migrated less than five years before their birth and if their immigrant father had been born in North Africa or the Middle East.

7.2 Methodological discussion

7.2.1 Study design

We used three types of study designs: cross-sectional, longitudinal and nested case-control in this dissertation. Both cross-sectional and longitudinal study designs were used in the Nepal earthquake study (Studies I and II). The cross-sectional study was used to examine the prevalence of psychiatric symptoms experienced by adolescents after the 2015 earthquake (Study I) and the longitudinal study helped to explore

changes in psychiatric symptoms (Study II). Cross-sectional studies are a one-time measurement where the exposure and outcomes have already occurred (Susser et al., 2006). They provide a snapshot of the outcomes and the characteristics associated with those outcomes at a specific time. The purpose of a cross-sectional study design is to describe a specific population or sub-group to determine the prevalence of outcomes of interest and investigate the association between risk factors and outcomes. However, this design cannot determine a causal inference. Moreover, it does not provide information on changes over time. Therefore, to investigate changes in individual psychiatric symptoms, we also used a longitudinal study.

The longitudinal study design is used for continuous or repeated measures, as it can follow individuals over a prolonged period, such as years or decades. One of the advantages of this study design is that it can track changes over time in the group as a whole and/or extract individual-level information. The longitudinal design is used to investigate the relationship between risk factors and the development of diseases and symptoms with regard to their presence, timing, and chronicity (Caruana, Roman, Hernández-Sánchez, & Solli, 2015). Unlike longitudinal designs, cross-sectional designs can be used to study multiple variables at different time points, but it is not possible to include information about the influence of time.

The limitations of cross-sectional study designs are that they are unable to make a causal inference, and they are not suitable to study rare diseases or diseases with a short duration. The limitations of longitudinal study designs are that they are unsuitable for studying rare diseases or diseases with long latency. They can provide associations between risk factors and the outcome of interest, but not causal inference. There is also the risk that over time, participants can leave the cohort, move away, lose contact or die from a cause and that this can produce a bias in the results. Finally, longitudinal designs are relatively expensive and time-consuming.

In Study III, we used a nested case-control study design. The nested case-control involves a selection of a cohort, which forms a source population, and cases and controls are selected from the cohort. Cases were those who had been diagnosed with a disease from the cohort and the controls were selected from the same cohort, in this case, the national Finnish registers. Controls are those who are at risk of developing the disease but have not developed the disease of interest by the time disease has occurred in the cases (Ernster, 1994). The important features of the nested case-control designs are time-matching, where the controls are matched with cases on their age, date of entry to the cohort, length of time or combination of these factors (Wacholder, 1991). Using this study design, together with good matching procedures, provides efficient and unbiased estimates from the full cohort (Breslow, 1996; Langholz, 2005). In this study, the source population comprised all singletons born in Finland between 1 January 1987 and 31 December 2010. The cases were those diagnosed with PTSD and recorded in the CRHC by 31 December 2012. Four

controls were identified from the same cohort for each case and these were matched by their date of birth (±30 days), sex and place of birth. The controls had to be alive and living in Finland when the cases were diagnosed to ensure time matching.

The advantages of using nested case-control design are that this method is cost-effective and less time consuming than cohort studies (Sedgwick, 2014). This study design is suitable when the disease outcome is rare, but is known for all subjects in the cohort. The method is expensive if all the information on exposures is collected for all subjects. On the other hand, the data on exposure for this study had already been collected prior to diagnosis. This means that recall bias was not an issue for those exposures. However, the design had some disadvantages. First, the cases and controls only represented a fraction of the source population, and this means that they may not have represented the whole cohort, which reduced the statistical power. Second, causation could not be inferred, as only the association between exposure and outcomes could be measured. It is also difficult to measure and control the data for all the confounders that affect the association. Third, clinical assessments of outcomes and exposures may not have been measured with the same accuracy and consistency in the nationwide register-based studies, as many clinicians had been involved in patient care.

7.2.2   Data sources

The data included in the thesis were obtained from the post-earthquake Nepal cohort and the Finnish nationwide registers.

The post-earthquake Nepal cohort included information on the adolescents' earthquake exposures and psychiatric symptoms at two time points, 18 and 31 months after the earthquake. The strength of using a longitudinal study was that the changes in psychiatric symptoms could be obtained for the whole group, and individual-level information could be extracted at the same time. Study II was the first longitudinal study that investigated the mental health problems of adolescents exposed to the 2015 earthquake in Nepal and it built on the result of Study I. Previous studies after the Nepal earthquake had been cross-sectional and mostly among adults. Moreover, our study findings divided the changes in symptoms into four groups, resilience, recovery, delayed, and chronic, which helped us understand the risk factors associated with heterogeneity in disaster responses. The study was pilot tested, and any modifications that were necessary were made before the data collection. Validated instruments that were culturally adapted and available in the local Nepali language were used.

The Finnish nationwide registers that formed the basis of Study III included information on various aspects of health and social welfare, which meant that we could study the entire country as a source population. Using nationwide registers was

a strength of the study and provided us with five key advantages. It was a nationally representative population-based study and it provided information on potential risk factors at various points and the possibility to link data from multiple sources. The large sample size increased the statistical power of the analysis. In addition, the data were complete, with limited selection bias and no attrition bias and were prospectively collected, which reduced recall bias.

The studies in this thesis had several limitations that need to be considered. In Study I, the pre-earthquake prevalence rates of mental disorders were not available, and thus the rates observed in our study could have been due to poverty and low access to physical and mental health services. Attrition was high in Study II, which was carried out 13 months after Study I. The adolescents who took part in the first assessment when they were in grade 10 had graduated or changed schools and were difficult to trace. In Nepal, students change schools after grade 10, and most of the students from rural areas move to urban areas if they go on to higher education. In addition, some students who had participated in the first assessment, and were still studying in the same schools, were absent at the time of the assessment. Although attrition was high, we did not find significant differences in the PTSS or depression scores between those who had participated in the follow up and dropouts.

The Nepal study (Studies I and II) was based on the self-reported questionnaires completed by the adolescents. It is possible that the adolescents tended to overestimate characteristics that are desirable and underestimate those that are undesirable. The prevalence rates in Study I could have been higher compared to psychiatric interviews. Studies I and II also could have been subjected to selection bias as the schools in the study were a convenience sample. However, at least one school from each municipality was selected and both public and private schools were included in the study. Information bias also needs to be considered. Since the earthquake had already occurred before the study started, information on exposures were assessed retrospectively, which might have lead to information bias. Adolescents living in the severely affected area might have recalled past exposure more completely than adolescents living in less severely affected area. Confounding bias also needs to be considered. This is the systematic distortion of association between an exposure and health outcome by an extraneous, third variable, which is called a confounder. We used multivariate logistic regression to control for confounders. The study findings have been presented in adjusted odds ratios, meaning that the odds ratio were adjusted for other covariates, including confounders. The findings should be interpreted with caution, with regard to the above limitations. The prevalence rates in this study could have provided better information on the impact of the earthquake if we had been able to include information on pre-earthquake prevalence rates. If we had conducted a qualitative study, along with a quantitative study, this would have enriched the findings and

provided a better understanding of the adolescents' interpretation of trauma and mental health symptoms. The use of parental and teacher reports could also have provided more information on adolescents' mental health problems.

In the Finnish register-based study (Study III), the sample only consisted of cases who had used specialized mental health services and may have only included severe cases leading to selection bias. In Finland, less severe PTSD cases are not referred to specialized mental health services and are not recorded in the national registers. The Care Register for Health Care only includes specialized outpatient services that are provided by public hospitals and outpatient service diagnoses was included only since 1998. However, most of the children in our study might have visited specialized services later, and the diagnoses of these were included in the register. The patients with PTSD using the private health sector are not included in the registers and were therefore missing from our sample. However, as public services are widely used in Finland, and specialized health services are mostly free of charge, we assume that most of the cases have been included in our study. Information on socioeconomic status (SES) is limited and is less reliable among immigrants. The classification of SES is not optimum and an immigrant's occupation might not have been reported.

Reliability refers to the replicability of the measures, i.e., whether the measurement gives the same answer through different tests and time periods. Cronbach's alpha value is the method that is used most frequently to estimate internal consistency reliability. In (Studies I and II), Cronbach's alpha values for the CPSS were good, 0.91 at 18 months and 0.91 at 31 months after the earthquake. However, for depression, the Cronbach's alpha values for the DSRS were 0.52 at 18 and 0.56 at 31 months. This was low and could indicate an invalid result reflecting measurement errors. This has been a limitation of our study. However, we still reported the DSRS results in the study, as these scores were in line with the changes in the PTSS scores, which showed some level of internal consistency.

Validity indicates whether a study has measured what it is intended to do. In Studies I and II, validated instruments were used to assess PTSS and depressive symptoms. These instruments have been previously shown good psychometric properties in Nepal (Kohrt et al., 2011). In Study III, the PTSD cases were based on the ICD-9 and ICD-8 codes. The diagnosis of PTSD, using ICD codes is based on structured interviews, questionnaires and physiological assessments with diagnostic criteria of being exposed to traumatic events and set of symptoms. We did not feel the need to conduct a validation study. External validity meant that the findings of the study could be extrapolated to a broader population beyond the study population. The schools included in Study I and II were selected by convenience sampling, so the findings could not be generalized to adolescents of Nepal. The results could have been representative of the population if the data had been sampled using a multistage

sampling technique. However, the study included both public and private schools from two geographic areas, Sindhupalchok and Kathmandu, which incorporated adolescents from all socioeconomic strata. The findings of the study could be generalized to a certain extent with respect to the earthquake-affected areas. In Study III, the study sample was a heterogeneous group and information on refugees was not recorded separately in the registers. This meant that the findings could not be generalized to the refugee population as the traumatic experience of refugees are different from other migrant population. The cases were obtained from specialized health care. Thus, the findings of the study did not represent PTSD cases with mild or moderate symptoms.

7.2.3 Study sample

The Nepal earthquake cohort consisted of adolescents aged 11-17 years from two areas affected by the earthquake. The first assessment, 18 months after the earthquake, comprised 893 adolescents. Of these 515 completed another questionnaire during the second assessment, which was 31 months after the earthquake. The source population of PTSD included 1,410,082 all singleton live births in Finland from 1 January 1987 to 31 December 2010. The cases were identified from the source population and cases with severe or profound mental retardation and those who were diagnosed before two years old were excluded. This resulted in 3639 cases. Each case was matched with four controls based on their date of birth (±30 days), sex, and place of birth resulting in 14434 controls. The controls had to be alive and living in Finland until the date of diagnosis of cases. The controls were without any diagnosis of PTSD or severe or profound mental retardation. The age of the cases and controls ranged from 2-25 years.

7.3 Discussion of results

7.3.1 Prevalence of psychiatric symptoms (Studies I and II)

There was no significant change in the prevalence of PTSS and depressive symptoms 18 and 31 months after the earthquake in Studies I and II. This was in contrast to previous studies, which showed a decline in prevalence (Chui et al., 2017; Geng et al., 2019; Goenjian et al., 2011; Jin & Li, 2015; Tang et al., 2017; Zhang et al., 2012). Zhang et al. (2012) reported that the prevalence of PTSS after the Wenchuan earthquake decreased from 9.7% at six months after the earthquake to 1.6% 18 months later. Depression fell from 39.4% to 29.4% over the same time period. Tang et al. (2017) carried out a study similar to ours, as it follow up participants 12 and 30 months after an earthquake. The authors reported that the prevalence of PTSS

decreased from 43.9% to 15.7%. However, the rates of PTSS and depressive symptoms in our study were higher than in previous studies. The difference in the prevalence rates could be attributed to differences in the measurements, time points when the participants were assessed, and the degree of exposure to trauma. The assessment tools varied from self-reports (Goenjian et al., 2011) to psychiatric reviews (Tang et al., 2017) and the studies were conducted in schools (Geng et al., 2019) or in a community sample (Jia et al., 2013) in the most affected areas (Goenjian et al., 2011) or far from the epicenter (Shi et al., 2016). It is also possible that the higher rates in our study were linked to low SES, which increased the risk due to secondary stressors associated with poverty and lower educational level.

7.3.2 Predictors of PTSS and depressive symptoms (Studies I and II)

Adolescents from the severely affected area of Sindhupalchok had an increased risk for developing PTSS and depressive symptoms, 18 and 31 months after the earthquake. This finding showed that the severity of the earthquake exposure was an important predictor for developing psychiatric symptoms. In a study by Feo et al. (2014), adolescents living in the epicenter of 2009 L'Aquila earthquake showed higher PTSS one year after the event. In another study by Zhang et al. (2010), mental health problems were greater in adolescents in highly exposed groups compared to low exposed groups. One of the possible explanations for this was that adolescents living in areas with high exposures might have experienced more loss of life or destruction and witnessed greater economic losses. Adolescents living in these areas might have suffered directly from the earthquake, by being either trapped or wounded. The Sindhupalchok district was the hardest hit by the 2015 Nepal earthquake as 90% of the houses were destroyed and there was a high number of casualties. This area is characterized by low SES and poor access to health care compared to Kathmandu, which is the capital city. The relief and rescue efforts might have been delayed in the Sindhupalchok district, due to the difficult mountain terrain and inaccessible roads, making adolescents more vulnerable to mental health problems. Moreover, the adolescents who lived there had a low socioeconomic status and already lacked many resources, which meant that the loss of family members and economic loss could had a greater impact on their lives. Years after the disaster, most of the adolescents in the Sindhupalchok district were still living in temporary shelters and were waiting for rebuilding installments distributed by the government.

Females had an increased risk of PTSS symptoms 18 months after the earthquake and this was consistent with previous studies (Tolin & Foa, 2006; Zheng et al., 2012). One possible explanation could be related to different cognitive appraisals of traumatic events by males and females. Studies have shown that females perceive

the same traumatic events as a greater threat than males and have reported more extreme acute reactions, thus increasing the risk for PTSD and depression (Pine & Cohen, 2002). Sex differences in responses to traumatic events have also been explained by genetic factors. A study has shown that polymorphisms of pituitary adenylate cyclase-activating polypeptide pathways are involved in stress responses following psychological trauma and that gender-specific effects occur via estrogen regulation of ADCYAP1R1 (Ressler et al., 2011). Estrogen has been appeared to play a key role in increasing the risk for PTSD (Garza & Jovanovic, 2017). Lower the levels of estrogen, more the fear responses (Glover, Jovanovic, & Norrholm, 2015; Goldstein, Jerram, Abbs, Whitfield-Gabrieli, & Makris, 2010). However, 31 months after the earthquake, the association between female and PTSS and depressive symptoms was not observed in our study, which was in line with previous studies (Jin & Li, 2015; Liu et al., 2011; Liu et al., 2010).

Parental education seemed to be a protective factor for PTSS 18 months after the earthquake. It is likely that the earthquake would have hit low-income families hardest, as they had poor housing conditions and low access to health care. However, the association was not seen 31 months after the earthquake. The possible explanation for this could be that the effect of socioeconomic status disappears with time, but later secondary stressors and other factors might increase an individual's susceptibility to mental health problems (Stroud, Davila, & Moyer, 2008). Pre-earthquake trauma exposure was an important risk factor for PTSS and depressive symptoms in our study, which was consistent with previous disaster research (Ying et al., 2013; Youngner et al., 2012). Earlier studies have shown that adolescents who were exposed to traumatic events had neurobiological changes (De Bellis et al., 1999), which increased their responsiveness to subsequent stressors (Breslau, Naomi, Chilcoat, Kessler, & Davis, 1999; Youngner et al., 2012). The risk for PTSS was highest for adolescents belonging to the Dalit caste group. This is a minority and stigmatized caste group with low access to health care, making them vulnerable to mental health problems (Kohrt, 2009; Kohrt et al., 2010). Adolescents exposed to post-earthquake trauma were more likely to develop PTSS and depressive symptoms than those who were not, which was in line with previous studies (Hagenaars, Fisch, & van Minnen, 2011; Tanskanen et al., 2004). Studies have shown that additional trauma has a cumulative effect on post-traumatic reactions and that this exacerbates symptoms (Green et al., 2000; Suliman et al., 2009).

7.3.3 PTSS and depressive symptoms symptomatic group (Study II)

When the sample was categorized based on changes in symptoms, four groups were identified, namely the resilience, recovery, delayed, and chronic groups. This finding

was consistent with previous trajectory studies (Bonanno & Mancini, 2012; Fan, Long, Zhou, Zheng, & Liu, 2015; Foa, Stein, & McFarlane, 2006; Storr, Schaeffer, Petras, Ialongo, & Breslau, 2009), where almost half of the participants who were exposed to trauma developed acute stress responses, but then later maintained a stable trajectory of normal functioning.

Of the adolescents in our study that developed initial PTSS symptoms, 9.7% of adolescents developed delayed PTSS symptoms, and 10.7% developed chronic PTSS symptoms. Trajectory studies on adolescents after disasters have reported limited on the of delayed symptoms (Lai, Lewis, Livings, La Greca, & Esnard, 2017). In most of the studies, less than 5% of the children had a delayed trajectory (Fan et al., 2015; Liu et al., 2011), in contrast to high rates in the adult population (La Greca et al., 2013; Orcutt, Bonanno, Hannan, & Miron, 2014). It is possible that the differences in measurements, follow-up duration and severity of the disasters might have caused inconsistent results. The adolescents in our study did not receive any psychosocial support after the earthquake and the rebuilding program was slow. The culmination of the direct impact of the earthquake and secondary stressors, without any psychosocial support, could have made it more difficult for these adolescents to cope with their symptoms.

Adolescents in the severely affected area in our study were at increased risks for developing delayed and chronic symptoms. Studies have reported that adolescents with PTSS either avoided social support or perceived less support than others, which might have increased their vulnerability (Lai, Osborne, Piscitello, Self-Brown, & Kelley, 2018). Similarly, the adolescents who had experience post-earthquake trauma in our study were more likely to have experienced delayed or chronic symptoms because additional trauma has an additive effect on post-trauma reactions. Studies have showed that there could be a dose-response relationship that impairs interpersonal behavior and coping strategies in traumatic situations (Green et al., 2000; Suliman et al., 2009).

Our study also showed that females had an increased risk for developing chronic symptoms, consistent with previous studies (Fan et al., 2015; Osofsky, Osofsky, Weems, King, & Hansel, 2015; Ye, Fan, Li, & Han, 2014). The gender differences in cognitive appraisals and biological variations could explain why females are more vulnerable to developing chronic PTSS or depressive symptoms (Breslau & Anthony, 2007; Christiansen & Hansen, 2015). The findings of these studies mean that early targeted interventions and support could alleviate future chronic symptoms. They also highlight the importance of taking context and gender into consideration.

7.3.4   Parental immigration and offspring PTSD (Study III)

Children with an immigrant father and Finnish mother were more likely to be diagnosed with PTSD than those with two Finnish parents. The risk of diagnosis increased in children when their father were born in North Africa and the Middle East and if they had migrated less than five years before they were born. However, no significant association was observed in children with two immigrant parents or a Finnish father and immigrant mother.

These findings were in line with a previous Danish study (Cantor-Graae & Pedersen, 2013). This study showed an increased risk among children with an immigrant father, but PTSD was included in anxiety and somatoform disorders. The probable explanation could be related to family relationships in mixed marriages. Mixed marriages are prone to domestic conflict because of differences in culture, religion and economic roles. Adult migrants have been reported to maintain their attitudes towards working women, in line with the gender roles in their country of origin (Pessin and Arpino, 2018). In addition, divorce rates in Finland are higher among marriages between immigrant men and Finnish women (Statistics of Finland, 2018). Studies have shown that children living in disputed families tend to show negative development outcomes, including antisocial behavior, poor academic attainment, criminality and serious mental health problems (Bernet, Wamboldt, & Narrow, 2016; Harold & Sellers, 2018; Holmes, 2013). It has been shown that immigrant fathers are more likely to experience traumatic experiences than immigrant mothers and Finnish parents (Castaneda et al., 2017; Markkula et al., 2017). Most men migrate to Finland to study, work, or because they are refugees, while women are more likely to migrate to be with their families. Moreover, immigrant men have reported experiencing traumatic events, such as war, torture, and witnessing violent death or injuries (Castaneda et al., 2017). In addition, evidence shows that immigrant men who live in Finland are diagnosed with PTSD more frequently than immigrant women or native Finnish men and women (Markkula et al., 2017; Schubert, Punamäki, Suvisaari, Koponen, & Castaneda, 2019).

The increased risk of PTSD in the offspring of immigrant fathers could be linked to the intergenerational transmission of PTSD. Converging evidence has shown intergenerational transmission of PTSD in other traumatized populations such as Holocaust survivors, Vietnam veterans, refugees and tortured survivors (Dashorst et al., 2019; O'Toole et al., 2017; Sangalang & Vang, 2017). The mechanism for this transmission could be partly explained by the genetic factors (Banerjee, Morrison, & Ressler, 2017), changes in epigenetic mechanisms (McGowan, 2013; Rampp et al., 2014) and environmental factors (Tortella-Feliu et al., 2019). Certain behavior of traumatized parents, such as communication patterns, for example, disclosing too much about traumatic events or being silent and denying any traumatic events, may

have negative consequences on the child's mental health (Dalgaard, Todd, Daniel, & Montgomery, 2016). Moreover, parents with unresolved trauma could be emotionally unavailable, hostile or less sensitive, which could affect the parent-child attachment and could make them more vulnerable to develop later psychopathology (van Ee, Kleber, Jongmans, Mooren, & Out, 2016). In addition, PTSD symptoms among parents have shown to increase family violence and parent-to child aggression (Marshall et al., 2019). It is also possible that the children of traumatized parents could display hyperarousal, irritability or angry outburst, which could, in turn, provoke more violent behavior from their parents. Moreover, children's exposure to traumatic events may be related to parental psychopathology, through disruptions in family function, divorce, job losses, and maladaptive coping strategies, such as substance abuse (Breslau, 2004).

The study showed no association between having an immigrant mother and Finnish father or two immigrant parents and a PTSD diagnosis in offspring. However, the Danish study reported that children were less likely to experience anxiety disorders, including PTSD if both of their parents were immigrants (Cantor-Graae & Pedersen, 2013). Immigrant men are more likely to be severely traumatized than immigrant women in Finland (Markkula et al., 2017). Immigrant women in relationship with native-born Finnish men do not typically migrate from conflict-afflicted countries but are more likely to come from the Soviet Union or South-East Asia (Statistics of Finland, 2019). Families with two immigrant parents may include refugee parents or others with traumatic experiences, which could buffer the effect of trauma transmission because they can understand and support each other. Having two immigrant parents could be a protective factor for their children and might increase resilience in the family. This could motivate children to work hard and compensate for their parents' missed opportunities (Hernandez, Denton, Macartney, & Blanchard, 2012).

Some of our results could be explained by immigrant parents underusing of health services and the under-diagnosis of PTSD in children with immigrant parents. Underuse of health services in immigrants has particularly been reported in immigrants in Nordic countries and the USA (Abebe, Lien, & Elstad, 2017; Barghadouch et al., 2016; Derr, 2016; Markkula et al., 2018). A study by Kieseppä et al. (2019) reported that immigrants in Finland from Eastern Europe, Sub-Saharan Africa, the Middle East and Northern Africa received low-intensity treatment. The factors that mediated help-seeking behavior in immigrants included mistrust in the health system, past traumatic experiences, and small social networks were factors mediating help-seeking behavior for mental and somatic health services (Schubert et al., 2019). Families with two immigrant parents may not be aware of their children's' behavioral problems or might be less likely to seek treatment due to stigma (Derivois, Jaumard, Karray-Khemiri, & Kim, 2013; Gary, 2005). Somali immigrants

in Finland have found to prefer traditional care, in particular, religious healing for mental health problems (Mölsä, Tiilikainen, & Punamäki, 2017). However, families with Finnish mothers know the system well and may be more likely to seek health services for their children than immigrant mothers. The language barriers, communication problems, and variation in cultural representation of trauma and lack of cultural competence could increase under-diagnosis rates in immigrant children (Ahmed et al., 2016; Kortmann, 2010).

Our study showed an association between immigrant fathers born in North Africa and the Middle East and a diagnosis of PTSD diagnosis in their children. In Finland, immigrants from those geographical areas are refugees and are more likely to have experienced traumatic events (Castaneda et al., 2017). A study by Markkula et al. (2017) reported a high risk of PTSD among immigrants from North Africa and the Middle East in Finland. Besides, it is more likely that children might be exposed to traumatic events or hear more about the traumatic experiences of their parents and relatives during their home visits. The timing of parental immigration has been associated with offspring PTSD diagnosis. Our study found that children with an immigrant father who had migrated to Finland less than five years before they were born were more likely to be diagnosed with PTSD. A probable explanation could be that a recently migrated father might have more memories of traumatic experiences and be more traumatized, which might affect their daily functioning and child-parent attachment (Rask et al., 2016). Moreover, acculturation, socioeconomic disadvantage and language barriers could increase stress among immigrant parents and this could increase the risk of child abuse (Rhee, Chang, Berthold, & Mar, 2012; Schick et al., 2016).

8 Summary/Conclusions

The aim of this thesis was to identify risk factors associated with PTSS using two study designs: a longitudinal post-earthquake survey and the Finnish population-based study. First, the prevalence rates of PTSS and depressive symptoms were higher in the severely affected area, Sindhupalchok than the country's capital - Kathmandu. Second, no significant change in the prevalence of PTSS and depressive symptoms from 18 to 31 months after the earthquake was observed between 18 and 31 months after the earthquake. Third, the risk factors associated with PTSS and depressive symptoms varied with time. Being female, parental education, being trapped or wounded were associated with PTSS and depressive symptoms 18 months after the earthquake. However, the associations were not significant 31 months after the earthquake. Adolescents from the severely affected area, and those who had been exposed to trauma before the earthquake had an increased risk for PTSS and depressive symptoms at both time points. Adolescents who had experienced trauma after the earthquake had an increased risk for developing PTSS and depressive symptoms in the 31 months after the earthquake.

Fourth, when the sample was categorized into four groups based on the changes in symptoms, living in the severely affected area and exposure to trauma after the earthquake were associated with the delayed PTSS, chronic PTSS and depression groups. Females had an increased risk of developing chronic PTSS and adolescents with pre-earthquake trauma exposure had an increased risk of developing chronic depressive symptoms. This study suggested that adolescents exposed to severe and accumulated trauma were at risk of developing delayed and chronic symptoms.

Fifth, the Finnish population-based study showed that children with an immigrant father had an increased risk for PTSD, but no significant association was observed if they had between two immigrant parents, an immigrant mother and a Finnish father or two Finnish parents. The risk for offspring PTSD increased if the children's father was born in North Africa and the Middle East, and if the immigrant father had migrated less than five years before the birth of their child. This study underlined the increased need for psychosocial services for immigrant families, particularly for second-generation immigrant children.

Implications

The findings of these two studies have implications for both public health and research.

Public health implications

- The results could assist policymakers to plan cost-effective mental health services.

- They highlight the importance of screening adolescents for psychiatric symptoms with adequate follow up and identify subgroups at risk of developing PTSD.

- Clinicians need help to identify individuals who have developed delayed or chronic symptoms and could benefit from early interventions.

- Our findings emphasize the need for psychosocial support after disasters and highlight the need for disaster preparedness and interventions that strengthen support at various levels.

- Teachers need training to deliver psychosocial crisis plans in schools and there is a need to develop a curriculum that includes life skills and crisis interventions.

- It is important that community health workers receive the training they need to detect negative outcomes in at-risk children and adolescents.

- Country needs to develop policies that increase survivors' resilience, so that they can improve how they cope with disasters in the long term and be prepared for future disasters.

- Psychosocial services need to be provided to second-generation immigrant children, especially as the number of immigrants coming to Finland is rising.

- Schools and clinicians need to pay more attention to understand the cultural contexts and behavioral problems in immigrant children.

- There is a need to provide support for families and programs to improve good parenting skills.

- Our findings highlight the importance of culturally sensitive psychoeducation and cultural competency in school teachers and clinicians.

Research implications

- More studies are needed to address the protective and risk factors of PTSS and depressive symptoms in children and adolescents following disasters. Research is also needed to identify how developmental factors influence children's response to trauma.

- Longitudinal studies should be conducted to explore the developmental trajectories of psychopathology among different populations who are exposed to earthquakes.

- Future studies on second-generation immigrants in different population groups are required to explore possible trauma transmission.

- Research is needed to address the contribution of genetic and environmental factors to understand the transmission of trauma in offspring.

- Future studies need to explore the effect of the developmental stage of parental trauma exposure to offspring.

- Empirical research needs to address the effect of families' psychopathology on the intergenerational transmission of trauma.

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